PANIMALAR ENGINEERING COLLEGE

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai

B.E - ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION 2021

CURRICULUM & SYLLABUS

PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)
Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600 123.

Department of Electrical and Electronics Engineering
B.E- Electrical and Electronics Engineering

CURRICULUM AND SYLLABUS

REGULATION-2021

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

1. To prepare students to analyze, design and implement basic electrical circuits and power systems using the knowledge of basic science and mathematics.
2. To train students with scientific and engineering knowledge so as to comprehend, analyze, design and create novel products and solutions for real time problems.
3. To prepare students with robust knowledge in core engineering for the betterment of placement, research and higher studies.
4. To inculcate graduates with communication skills, leadership qualities in their profession and adopt to current trends by engaging in lifelong learning.
5. To prepare graduates to demonstrate professionalism with social and ethical values

PROGRAM OUTCOMES (PO)

1. **Engineering knowledge:**

   Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.

2. **Problem Analysis:**

   Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:**

   Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:**

   Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information.

5. **Modern tool usage:**

   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.

6. **The engineer and society**

   Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**

   Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**

   Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**

   Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**

    Communicate effectively on complex engineering activities with the engineering community and with society at large. Some of them are, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**

    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.

12. **Lifelong learning**

    Recognise the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO 1. Apply the basic knowledge of mathematics, science, electrical and electronics engineering to analyze and solve the complex problems in Electrical Machines, Control Systems, Instrumentation, Power Systems and Power Electronic Systems.

PSO 2. Design and develop hardware and software requirements to meet the needs of Electric drives, Automation, Power Systems and Embedded systems based industries.

PSO 3. To take up roles in a team, develop managerial skills, and contributes towards the electrical community globally.

PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

B.E- Electrical and Electronics Engineering

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABUS - R 2021

Semester I

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21HS1101	Communicative English & Language Skills Lab I Integrated	HS	5	3	0	2	4
2.	21MA1101	Engineering Mathematics – I	BS	4	3	1	0	4
3.	21PH1101	Engineering Physics	BS	3	3	0	0	3
4.	21CY1101	Engineering Chemistry	BS	3	3	0	0	3
5.	21ES1101	Problem Solving and Python Programming	ES	3	3	0	0	3
6.	21ES1102	Engineering Graphics	ES	5	3	0	2	4
PRACTICALS								
7.	21ES1111	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
8.	21BS1111	Physics and Chemistry Laboratory	BS	4	0	0	4	2
TOTAL				**31**	**18**	**1**	**12**	**25**

Semester II

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21HS1201	Communicative English & Language Skills Lab II Integrated	HS	5	3	0	2	4
2.	21MA1201	Engineering Mathematics – II	BS	4	3	1	0	4
3.	21PH1201	Physics for Electronics Engineering	BS	3	3	0	0	3
4.	21ES1202	Basic Civil and Mechanical Engineering	ES	3	3	0	0	3
5.	21EE1201	Electric Circuit Analysis	PC	3	3	0	0	3
6.		Mandatory Course – I	MC	2	2	0	0	0
Practical								
7.	21EE1211	Electric Circuits Laboratory	PC	4	0	0	4	2
8.	21ES1211	Engineering Practices Laboratory	ES	4	0	0	4	2
TOTAL				**28**	**17**	**1**	**10**	**21**

SEMESTER III

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21MA1303	Transforms and Partial Differential Equations	BS	4	3	1	0	4
2.	21CS1304	Object Oriented Programming Paradigm	ES	3	3	0	0	3
3.	21EE1301	Electromagnetic Theory	PC	3	3	0	0	3
4.	21EE1302	Analog Electronics	PC	3	3	0	0	3
5.	21EE1303	Signals and Systems	ES	4	3	1	0	4
6.		Mandatory Course – II	MC	2	2	0	0	0
PRACTICALS								
7.	21EE1311	Analog Electronics Laboratory	PC	4	0	0	4	2
8.	21CS1312	Object Oriented programming Laboratory	ES	4	0	0	4	2
			TOTAL	**27**	**17**	**2**	**08**	**21**

SEMESTER IV

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21MA1404	Numerical Methods	BS	4	3	1	0	4
2.	21EE1401	Measurements and Instrumentation	PC	3	3	0	0	3
3.	21EE1402	Electrical Machines – I	PC	3	3	0	0	3
4.	21EE1403	Transmission and Distribution	PC	3	3	0	0	3
5.	21EE1404	Control Systems	PC	4	3	1	0	4
6.	21EE1405	Digital Electronics	PC	3	3	0	0	3
PRACTICALS								
7.	21EE1411	Electrical Machines Laboratory – I	PC	4	0	0	4	2
8.	21EE1412	Digital Electronics Laboratory	PC	4	0	0	4	2
9.	21EE1413	Control and Instrumentation Laboratory	PC	4	0	0	4	2
			TOTAL	**32**	**18**	**2**	**12**	**26**

SEMESTER V

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21EE1501	Power System Analysis	PC	3	2	1	0	3
2.	21EE1502	Microprocessors, Microcontrollers and Applications	PC	3	3	0	0	3
3.	21EE1503	Electrical Machines – II	PC	3	3	0	0	3
4.	21EE1504	Power Electronics	PC	3	3	0	0	3
5.		Professional Elective – I	PE	3	3	0	0	3
6.		Open Elective – I	OE	3	3	0	0	3
PRACTICALS								
7.	21EE1511	Microprocessors, Microcontrollers and Applications Laboratory	PC	4	0	0	4	2
8.	21EE1512	Electrical Machines Laboratory – II	PC	4	0	0	4	2
9.	21EE1513	Industrial Automation Laboratory	PC	4	0	0	4	2
			TOTAL	**30**	**17**	**1**	**12**	**24**

SEMESTER VI

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21EE1601	Electrical Drives	PC	3	3	0	0	3
2.	21EE1602	Power System Operation and Control	PC	3	3	0	0	3
3.	21EE1603	Embedded Systems	PC	3	3	0	0	3
4.		Professional Elective – II	PE	3	3	0	0	3
5.		Professional Elective – III	PE	3	3	0	0	3
6.		Open Elective – II	OE	3	3	0	0	3
PRACTICALS								
7.	21EE1611	Power Electronics and Drives Laboratory	PC	4	0	0	4	2
8.	21EE1612	Power System Simulation Laboratory	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER VII

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21EE1701	Protection and Switchgear	PC	3	3	0	0	3
2.	21EE1702	Renewable Energy Systems	PC	3	3	0	0	3
3.	21EE1703	High Voltage Engineering	PC	3	3	0	0	3
4.		Professional Elective IV	PE	3	3	0	0	3
5.		Professional Elective – V	PE	3	3	0	0	3
PRACTICALS								
6.	21EE1711	Renewable Energy Systems Laboratory	PC	4	0	0	4	2
7.	21EE1712	Mini Project	EEC	4	0	0	4	2
			TOTAL	**23**	**15**	**0**	**8**	**19**

SEMESTER VIII

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Professional Elective – VI	PE	3	3	0	0	3
2.		Professional Elective – VII	PE	3	3	0	0	3
PRACTICALS								
3.	21EE1811	Project Work	EEC	16	0	0	16	8
			TOTAL	**22**	**6**	**0**	**16**	**14**

TOTAL NO. OF CREDITS: 172

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Professional Elective	Vertical – I Power Engineering	Vertical – II Converters and Drives	Vertical – III Embedded Systems	Vertical – IV Electric Vehicle Technology	Vertical – V Automation	Vertical – VI Computer
1.	Under Ground Cable Engineering	Special Electrical Machines	Embedded Processors	Electric Vehicle Architecture	PLC Programming	Cryptocurrency and Block chain Technologies
2.	Substation Engineering and Automation	Analysis of Electrical Machines	Embedded C-Programming	Design of Motor and Power Converters for Electric Vehicles	Robotics and Automation	Augmented Reality/Virtual Reality
3.	Smart Grid	Multilevel Power Converters	Embedded System Design	Electric Vehicle Design, Mechanics and Control	Industry 4.0	Cloud Services Management
4.	Energy Management and Auditing	Embedded Control for Electrical Drives	Smart System Automation	Design of Electric Vehicle Charging System	Intelligent Automation	Computer Vision Techniques
5.	Power Quality	SMPS and UPS	Embedded System for Automotive Applications	Testing of Electric Vehicles	Smart Manufacturing	Optimization Techniques in Machine Learning
6.	HVDC and FACTS	Power Electronics for Renewable Energy Systems	MEMS and NEMS	Grid Integration of Electric Vehicles	Cyber Security	Neural Networks and Deep Learning
7.	Restructured Power Market	Control of Power Electronics Circuits	Digital Signal Processing System Design	Intelligent control of Electric Vehicles.	Building Automation	Business Analytics
8.	Utilization And Conservation of Electrical Energy	-		-	Smart Farming	

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL – I: POWER ENGINEERING

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21EE1901	Under Ground Cable Engineering	PE	3	3	0	0	3
2.	21EE1902	Substation Engineering and Automation	PE	3	3	0	0	3
3.	21EE1903	Smart Grid	PE	3	3	0	0	3
4.	21EE1904	Energy Management and Auditing	PE	3	3	0	0	3
5.	21EE1905	Power Quality	PE	3	3	0	0	3
6.	21EE1906	HVDC and FACTS	PE	3	3	0	0	3
7.	21EE1907	Restructured Power Market	PE	3	3	0	0	3
8.	21EE1908	Utilization and Conservation of Electrical Energy	PE	3	3	0	0	3

VERTICAL – II: CONVERTERS AND DRIVES

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21EE1909	Special Electrical Machines	PE	4	2	0	2	3
2.	21EE1910	Analysis of Electrical Machines	PE	4	2	0	2	3
3.	21EE1911	Multilevel Power Converters	PE	4	2	0	2	3
4.	21EE1912	Embedded Control for Electrical Drives	PE	4	2	0	2	3
5.	21EE1913	SMPS and UPS	PE	4	2	0	2	3
6.	21EE1914	Power Electronics for Renewable Energy Systems	PE	4	2	0	2	3
7.	21EE1915	Control of Power Electronics Circuits	PE	4	2	0	2	3

VERTICAL − III: EMBEDDED SYSTEMS

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21EE1916	Embedded Processors	PE	4	2	0	2	3
2.	21EE1917	Embedded C-Programming	PE	4	2	0	2	3
3.	21EE1918	Embedded System Design	PE	4	2	0	2	3
4.	21EE1919	Smart System Automation	PE	4	2	0	2	3
5.	21EE1920	Embedded System for Automotive Applications	PE	4	2	0	2	3
6.	21EE1921	MEMS and NEMS	PE	4	2	0	2	3
7.	21EE1922	Digital Signal Processing System Design	PE	4	2	0	2	3

VERTICAL − IV: ELECTRIC VEHICLE TECHNOLOGY

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21EE1923	Electric Vehicle Architecture	PE	3	3	0	0	3
2.	21EE1924	Design of Motor and Power Converters for Electric Vehicles	PE	4	2	0	2	3
3.	21EE1925	Electric Vehicle Design, Mechanics and Control	PE	4	2	0	2	3
4.	21EE1926	Design of Electric Vehicle Charging System	PE	4	2	0	2	3
5.	21EE1927	Testing of Electric Vehicles	PE	4	2	0	2	3
6.	21EE1928	Grid Integration of Electric Vehicles	PE	3	3	0	0	3
7.	21EE1929	Intelligent Control of Electric Vehicles	PE	4	2	0	2	3

VERTICAL − V: AUTOMATION

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21EE1930	PLC Programming	PE	3	3	0	0	3
2.	21EE1931	Robotics and Automation	PE	3	3	0	0	3
3.	21EE1932	Industry 4.0	PE	3	3	0	0	3
4.	21EE1933	Intelligent Automation	PE	3	3	0	0	3
5.	21EE1934	Smart Manufacturing	PE	3	3	0	0	3
6.	21EE1935	Cyber Security	PE	3	3	0	0	3
7.	21EE1936	Building Automation	PE	3	3	0	0	3
8.	21EE1937	Smart Farming	PE	3	3	0	0	3

VERTICAL − VI: COMPUTER

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21IT1913	Crypto currency and Blockchain Technologies	PE	3	3	0	0	3
2.	21CS1908	Augmented Reality/Virtual Reality	PE	3	3	0	0	3
3.	21CS1903	Cloud Services Management	PE	3	3	0	0	3
4.	21AD1921	Computer Vision Techniques	PE	3	3	0	0	3
5.	21AD1924	Optimization Techniques in Machine Learning	PE	3	3	0	0	3
6.	21AD1918	Neural Networks and Deep Learning	PE	3	3	0	0	3
7.	21AD1920	Business Analytics	PE	3	3	0	0	3

OPEN ELECTIVE – I

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21CE1008	Recent Trends in Water Treatment	OE	3	3	0	0	3
2.	21CS1004	Web Design and Management	OE	3	3	0	0	3
3.	21CS1005	Mobile Application Development	OE	3	3	0	0	3
4.	21CS1006	Fundamentals of Data Base Management Systems	OE	3	3	0	0	3
5.	21ME1009	Industrial Safety and Maintenance	OE	3	3	0	0	3
6.	21EC1007	IoT Concepts and Applications	OE	3	3	0	0	3
7.	21CS1007	Ethical Hacking	OE	3	3	0	0	3
8.	21ME1011	Power Plant Engineering	OE	3	3	0	0	3
9.	21EE1004	Energy storage systems	OE	3	3	0	0	3
10.	21EC1010	Drone Technologies	OE	3	3	0	0	3
11.	21GE1004	Principles of Management	OE	3	3	0	0	3

OPEN ELECTIVE – II

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21CS1008	Introduction to C programming	OE	3	3	0	0	3
2.	21AD1001	Fundamentals of Artificial intelligence	OE	3	3	0	0	3
3.	21CS1010	Data Structures and Algorithms	OE	3	3	0	0	3
4.	21EC1001	VLSI Design	OE	3	3	0	0	3
5.	21EE1005	Energy Conservation and Management	OE	3	3	0	0	3
6.	21EE1002	Hybrid Energy Technology	OE	3	3	0	0	3
7.	21CS1009	Business Intelligence	OE	3	3	0	0	3
8.	21GE1002	Human Resource Management	OE	3	3	0	0	3
9.	21ME1012	Industrial Engineering	OE	3	3	0	0	3
10.	21CS1001	Cloud Computing	OE	3	3	0	0	3
11.	21CE1010	Air Pollution and Control Engineering	OE	3	3	0	0	3

MANDATORY COURSES

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21MC1001	Environmental Science	MC	2	2	0	0	0
2.	21MC1002	Constitution of India	MC	2	2	0	0	0
3.	21MC1003	Human Values	MC	2	2	0	0	0
4.	21MC1004	Energy Studies	MC	2	2	0	0	0
5.	21MC1005	Essence of Indian Knowledge Tradition	MC	2	2	0	0	0
6.	21MC1006	Soft Skills and Personality Development	MC	2	2	0	0	0
7.	21MC1007	Value Education, Human Rights & Legislature Procedure	MC	2	2	0	0	0

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21HS1101	Communicative English & Language Skills Lab I Integrated	HS	5	3	0	2	4
2.	21HS1201	Communicative English & Language Skills Lab II Integrated	HS	5	3	0	2	4
			TOTAL	**10**	**6**	**0**	**4**	**8**

BASIC SCIENCES (BS)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	21MA1101	Engineering Mathematics – I	BS	4	3	1	0	4
2.	21PH1101	Engineering Physics	BS	3	3	0	0	3
3.	21CY1101	Engineering Chemistry	BS	3	3	0	0	3
4.	21BS1111	Physics and Chemistry Laboratory	BS	4	0	0	4	2
5.	21MA1201	Engineering Mathematics – II	BS	4	3	1	0	4
6.	21PH1201	Physics for Electronics Engineering	BS	3	3	0	0	3
7.	21MA1303	Transforms and Partial Differential Equations	BS	4	3	1	0	4
8.	21MA1404	Numerical Methods	BS	4	3	1	0	4
			TOTAL	**29**	**21**	**4**	**4**	**27**

ENGINEERING SCIENCES (ES)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21ES1101	Problem Solving and Python Programming	ES	3	3	0	0	3
2.	21ES1102	Engineering Graphics	ES	5	3	0	2	4
3.	21ES1111	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
4.	21ES1202	Basic Civil and Mechanical Engineering	ES	3	3	0	0	3
5.	21ES1211	Engineering Practices Laboratory	ES	4	0	0	4	2
6.	21CS1304	Object Oriented Programming Paradigm	ES	3	3	0	0	3
7.	21EE1303	Signals and Systems	ES	4	3	1	0	4
8.	21CS1312	Object Oriented programming Laboratory	ES	4	0	0	4	2
			TOTAL	**30**	**15**	**1**	**14**	**23**

PROFESSIONAL CORE (PC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21EE1201	Electric Circuit Analysis	PC	3	3	0	0	3
2.	21EE1211	Electric Circuits Laboratory	PC	4	0	0	4	2
3.	21EE1301	Electromagnetic Theory	PC	3	3	0	0	3
4.	21EE1302	Analog Electronics	PC	3	3	0	0	3
5.	21EE1311	Analog Electronics Laboratory	PC	4	0	0	4	2
6.	21EE1401	Measurements and Instrumentation	PC	3	3	0	0	3
7.	21EE1402	Electrical Machines – I	PC	3	3	0	0	3
8.	21EE1403	Transmission and Distribution	PC	3	3	0	0	3
9.	21EE1404	Control Systems	PC	4	3	1	0	4
10.	21EE1405	Digital Electronics	PC	3	3	0	0	3
11.	21EE1411	Electrical Machines Laboratory – I	PC	4	0	0	4	2
12.	21EE1412	Digital Electronics Laboratory	PC	4	0	0	4	2
13.	21EE1413	Control and Instrumentation Laboratory	PC	4	0	0	4	2
14.	21EE1501	Power System Analysis	PC	3	2	1	0	3
15.	21EE1502	Microprocessors, Microcontrollers and Applications	PC	3	3	0	0	3
16.	21EE1503	Electrical Machines – II	PC	3	3	0	0	3
17.	21EE1504	Power Electronics	PC	3	3	0	0	3
18.	21EE1511	Microprocessors, Microcontrollers and Applications Laboratory	PC	4	0	0	4	2
19.	21EE1512	Electrical Machines Laboratory – II	PC	4	0	0	4	2
20.	21EE1513	Industrial Automation Laboratory	PC	4	0	0	4	2
21.	21EE1601	Electrical Drives	PC	3	3	0	0	3
22.	21EE1602	Power System Operation and Control	PC	3	3	0	0	3
23.	21EE1603	Embedded Systems	PC	3	3	0	0	3
24.	21EE1611	Power Electronics and Drives Laboratory	PC	4	0	0	4	2

25.	21EE1612	Power System Simulation Laboratory	PC	4	0	0	4	2
26.	21EE1701	Protection and Switchgear	PC	3	3	0	0	3
27.	21EE1702	Renewable Energy Systems	PC	3	3	0	0	3
28.	21EE1703	High Voltage Engineering	PC	3	3	0	0	3
29.	21EE1711	Renewable Energy Systems Laboratory	PC	4	0	0	4	2
			TOTAL	**99**	**53**	**2**	**44**	**77**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	21EE1712	Mini Project	EEC	4	0	0	4	2
2.	21EE1811	Project Work	EEC	16	0	0	16	8
			TOTAL	**20**	**0**	**0**	**20**	**10**

CREDIT DISTRIBUTION

S. No.	Subject Area / Semester	Credits Per Semester I	II	III	IV	V	VI	VII	VIII	Credits Total	Percentage %
1.	Humanities and Social Studies (HS)	4	4							8	4.7
2.	Basic Sciences (BS)	12	7	4	4					27	15.7
3.	Engineering Sciences (ES)	9	5	9						23	13.4
4.	Professional Core (PC)		5	8	22	18	13	11		77	44.8
5.	Professional Electives (PE)					3	6	6	6	21	12.2
6.	Open Electives (OE)					3	3			6	3.5
7.	Project Work (PR/EEC)							2	8	10	5.8
8.	Non-Credit/ (Mandatory)		0	0						0	0
	Total	**25**	**21**	**21**	**26**	**24**	**22**	**19**	**14**	**172**	**100**

21HS1101	COMMUNICATIVE ENGLISH & LANGUAGE SKILLS LAB I INTEGRATED	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To induce the basic reading and writing skills among the first year engineering and technology students.
- To assist the learners to develop their listening skills, which will enable them listening to lectures and comprehend them by asking questions and seeking clarifications
- To succor the learners to develop their speaking skills and speak fluently in real contexts.
- To motivate the learners to develop vocabulary of a general kind by developing their reading skills for meeting the competitive exams like GATE, TOFEL, GRE, IELTS, and other exams conducted by Central and State governments

UNIT I INTRODUCING ONESELF 9

Listening: Listening and filling details, Listening to Speeches by Specialists and Completing Activities such as Answering Questions, Identifying the Main Ideas, Style, etc. Speaking: Introducing Oneself – Introducing Friend/ Family. Reading: Descriptive Passages (From Newspapers / Magazines).Writing: Writing a Paragraph (Native Place, School Life), Developing Hints. Grammar: Noun, Pronoun & Adjective. Vocabulary Development: One Word Substitution.

UNIT II DIALOGUE WRITING 9

Listening: Listening to Conversations (Asking for and Giving Directions).Speaking: Making Conversation Using (Asking for Directions, Making an Enquiry), Role Plays, and Dialogues. Reading: Reading a Print Interview and Answering Comprehension Questions. Writing: Writing a Checklist, Dialogue Writing Grammar: Tenses and Voices. Vocabulary Development: Prefix &Suffix, Word formation.

UNIT III DRAFTING OFFICIAL COMMUNICATIONS 9

Listening: Listening for specific information. Speaking: Giving Short Talks on a given Topic. Reading: Reading Motivational Essays on Famous Engineers and Technologists (Answering Open – Ended and Closed Questions). Writing: Writing Formal Letters / Emails. Grammar: Adverb, Prepositions & Conjunctions. Vocabulary Development: Collocations – Fixed Expressions.

UNIT IV WRITTEN COMMUNICATION 9

Listening: Listening to Short Talks (5 Minutes Duration and Fill a Table, Gap-Filling Exercise) Note Taking/Note Making .Speaking: Small Group Discussion, Giving Recommendations .Reading: Reading Problem – Solution Articles/Essays Drawn From Various Sources. Writing: Making Recommendations Note Making – Complaint Letters. Grammar: Subject-Verb Agreement, Framing Questions. Vocabulary Development: Connectives, Reference Words, Technical Vocabulary.

UNIT V WRITING DEFINITIONS AND PRODUCT DESCRIPTION 9

Listening: Listening to a Product Description (Labeling and Gap Filling) Exercises. Speaking: Describing a Product and Comparing and Contrasting it with Other Products. Reading: Reading Graphical Material for Comparison (Advertisements). Writing: Writing Definitions (Short and Long)– Compare and Contrast Paragraphs, Essay writing. Grammar:– Phrasal Verbs – Cause and Effect Sentences – Compound Nouns Vocabulary Development: Use of Discourse Markers.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Comprehend conversations and short talks delivered in English
2. Participate effectively in informal conversations; introduce themselves and their friends and express opinions English
3. Read articles of a general kind in magazines and newspapers
4. Write short essays of a general kind and personal letters and emails in English
5. Recognize the use of grammar in speech and writing

TEXT BOOKS:

1. N P Sudharshana & C Savitha. English for Technical Communication Delhi: CUP, 2019. Board of Editors. English for Engineers and Technologists Volume 1 Orient Black Swan Limited, 2020.

REFERENCES:

1. Board of Editors. “Using English-A course book for Undergraduate engineers and Technologists”, Orient Black Swan Limited, 2017
2. Bailey, Stephen. “Academic Writing: A Practical Guide for Students”. New York: Rutledge, 2011.
3. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
4. Means,L. Thomas and Elaine Langlois. “English & Communication For Colleges. Cengage Learning” ,USA:2007
5. Redston, Chris & Gillies Cunningham, “Face2Face (Pre-intermediate Student’s Book & Workbook)”, Cambridge University Press, New Delhi: 2005.

WEB REFERENCES:

1. https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabulary-exams/wordformation
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/2018031621.pdf
3. http://xn--englishclub-ql3f.com/grammar/parts-of-speech.htm
4. https://www.edudose.com/english/grammar-degree-of-comparison-rules/

ONLINE COURSES / RESOURCES:

1. https://basicenglishspeaking.com/wh-questions/
2. https://agendaweb.org/verbs/modals-exercises.html

3. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/20180316
21.pdf
4. https://www.ego4u.com/en/cram-up/grammar/prepositions

LANGUAGE SKILLS LAB

List of exercises MINIMUM OF EXERCISES TO BE CONDUCTED 15

1. Reading: Different text type
2. Reading: Predicting content using pictures and title.
3. Reading: Use of graphic organizers to review
4. Reading: Aid comprehension.
5. Reading: Understanding reference words
6. Reading: Use of connectors in a passage-
7. Reading: Speed reading Techniques.
8. Reading and Comprehending the passages in the competitive exams like GATE, TOFEL, GRE,IELTS, and other exams conducted by Central and State governments.
9. Reading: Sentence Completion: Exercises used in competitive exams.
10. Writing: Error Detection:
11. Writing: Spotting and reasoning the errors found from the passages in competitive exams.
12. Writing: Email writing
13. Writing: Job Application: Resume
14. Writing: Elements of a good essay-
15. Writing: Types of essays- Descriptive-Narrative- issue based.
16. Writing: Statement of Purpose
17. Writing: Letter of recommendation
18. Writing: Vision statement
19. Writing: Verbal Analogy,
20. Writing: Phrases, and Idioms associated with competitive exams.

TOTAL: 30 PERIODS

SOFTWARE REQUIRED:

Globarena

REFERENCES:

1. Suresh Kumar.E and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012
2. Davis, Jason and Rhonda Liss. Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006
3. Withrow, Jeans and et al. Inspired to Write. Readings and Tasks to develop writing skills. Cambridge University Press: Cambridge, 2004
4. Goatly, Andrew. Critical Reading and Writing. Routledge: United States of America, 2000

21MA1101	ENGINEERING MATHEMATICS- I	L	T	P	C
		3	1	0	4

OBJECTIVES: To impart Knowledge on the following topics:

- Matrix transforms are very useful within the world of computer graphics. A matrix algebra can be readily applied to the structural properties of graphs from an algebraic point of view.
- The aim of this course to get depth knowledge about calculus.
- Familiarize the functions of two variables and finding its extreme points.
- To make the students understand various techniques of integration.
- Apply multiple integral ideas in solving areas, volumes and other practical problems

UNIT - I MATRICES 9+3

Eigen values and Eigen vectors of a real matrix —Rank of the matrix – Characteristic equation — Properties of Eigen values and Eigen vectors — Cayley Hamilton theorem — Diagonalization of matrices— Reduction of a quadratic form to canonical form by orthogonal transformation and similarity transformation —Nature of quadratic forms.

UNIT - II DIFFERENTIAL CALCULUS 9+3

Representation of functions – Limit of a function – Continuity – Derivatives – Differentiation rules (Sum, Product & Quotient rule, Chain rule, logarithmic and implicit differentiation) – Maxima and Minima of functions of one variable-Rolle's theorem- Mean value theorem.

UNIT - III FUNCTIONS OF SEVERAL VARIABLES 9+3

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables –Lagrange's method of undetermined multipliers.

UNIT - IV INTEGRAL CALCULUS 9+3

Definite and Indefinite integrals – Substitution rule – Techniques of Integration – Integration by parts – Bernoulli's formula- Trigonometric integrals – Trigonometric substitutions – Integration of rational functions by partial fraction – Integration of irrational functions – Improper integrals.

UNIT - V MULTIPLE INTEGRALS 9+3

Double integrals in modelling and polar coordinates – Change of order of integration in modelling coordinates– Area enclosed by plane curves – Change of variables in double integrals – Triple integrals –Volume of Solids.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Find eigen values and eigen vectors, diagonalization of a matrix, symmetric matrices, positive definite matrices and similar matrices.
2. Apply limit definition and rules of differentiation to differentiate functions.
3. Understand familiarity in the knowledge of Maxima and Minima, Jacobian, Taylor series and apply the problems involving Science and Engineering
4. Understand the knowledge of Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction.
5. Understand the knowledge of Area enclosed by plane curves, Change of variables in double integrals, Triple integrals, Volume of Solids.

TEXT BOOKS:

1. Grewal B.S., — "Higher Engineering Mathematics", Khanna Publishers, NewDelhi, 43rd Edition, 2014.
2. James Stewart, — "Calculus: Early Transcendentals", Cengage Learning,7th Edition, NewDelhi, 2015.
3. Bali N., Goyal M. and Walkins C., —Advanced Engineering Mathematics‖, Firewall Media (An imprint of Lakshmi Publications Pvt. Ltd.,), New Delhi, 7th Edition, 2009

REFERENCES:

1. Anton, H, Bivens, I and Davis, S, —"Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., —"Advanced Engineering Mathematics", Narosa Publications, NewDelhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., —"Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007
4. Srimantha Pal and Bhunia, S.C, —"Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, —"Thomas Calculus", 12th Edition, Pearson India, 2016.
6. B.V. Ramana, — "Higher Engineering Mathematics", McGraw Hill Education, India.
7. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley sons,10th edition, 2015.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ma60/preview
2. https://onlinecourses.nptel.ac.in/noc21_ma58/preview

21PH1101	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT - I MECHANICS 9

System of particles: centre of mass in one and two dimensions – rotational motion of continues system– torque – moment of inertia – conservation of angular momentum – Newton's laws for rotation – equations of rotational motion – work energy theorem for rotational motion. Stress, strain, Hooke's law and elastic moduli – twisting couple per unit twist for solid and hollow cylinders – torsional pendulum theory – bending moment of beam – cantilever and non-uniform bending theory – uniform bending theory – I shape girder.

UNIT - II ELECTROMAGNETIC THEORY 9

Divergence – curl – integral calculus – Gauss divergence theorem – Stoke's theorem – equation of continuity – displacement current – Maxwell's equations – Gauss's laws – Faraday's law –Ampere- Maxwell law – mechanism of electromagnetic wave propagation – Hertz observation – production and detection of electromagnetic wave – electromagnetic waves in free space and matter – energy carried by electromagnetic wave – momentum and radiation pressure – properties of electromagnetic waves.

UNIT - III THERMAL PHYSICS 9

Mode of heat transfer: conduction, convection and radiation – thermal expansion of solids – bimetallic strips – thermal conductivity – heat conduction through compound media (series & parallel) – Forbe's and Lee's disc method; theory and experiment – thermal insulation – applications – heat exchangers – refrigerators, solar water heater.

UNIT - IV OSCILLATORY MOTION, LASERS AND FIBER OPTICS 9

Spring mass system – differential equation-simple harmonic motion-damped oscillation-forced oscillation –analogy with LCR circuits and mechanical oscillation – plane wave equation – equations of wave motion in a rope and velocity of wave. Population of energy levels, Einstein's A and B coefficients derivation – optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction –components and principle of fiber optics – numerical aperture and acceptance angle derivation – types of optical fibers (material, refractive index, mode) – losses associated with optical fibers – fiber as pressure and displacement sensors.

UNIT - V **QUANTUM MECHANICS** **9**

Blackbody radiation – Planck's hypothesis and derivation – wave particle duality of light: concepts of photon – Compton effect: theory and experiment – de Broglie hypotheses - concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional box – tunnelling (qualitative) – scanning tunnelling microscope.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Understand the basics of mechanics and especially elastic properties of materials.
2. Gain knowledge on the basic concepts of electromagnetic waves and its properties.
3. Acquire knowledge on the concepts of thermal properties of materials and their applications in heat exchangers.
4. Acquire knowledge on the concepts of oscillations, lasers and fiber optics and their technological applications
5. Get knowledge on advanced physics concepts of quantum theory and its applications in modelling microscopes.

TEXT BOOKS:

1. Gaur, R.K. & Gupta, S.L. ―Engineering Physics‖. Dhanpat Rai Publishers, 2012.
2. Santhosam, K. Russel Raj, K. & Maheswaran, A. ―Engineering Physics, KRAM Publications, 2021
3. Pandey, B.K. & Chaturvedi, S. ―Engineering Physics‖. Cengage Learning India, 2012.

REFERENCES:

1. Halliday, D., Resnick, R. & Walker, J. ―Principles of Physics‖. Wiley, 2015.
2. Tipler, P.A. & Mosca, G. ―Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.
3. Arthur Beiser, ―Concepts of Modern Physics‖, Mc Graw Hill, Sixth edition, 1994.
4. Douglas. C., Giancoli. ―Physics: Principles with applications‖, Pearson, 2014.

WEB REFERENCES:

1. https://kluniversity.in/physics/pdfs/crypdf.pdf
2. https://mrcet.com/downloads/digital_notes/ECE/III%20Year/FIBER%20OPTICAL%20COMMUNICATIONS.pdf
3. https://nptel.ac.in/content/storage2/courses/117101002/downloads/Lec01.pdf
4. https://nptel.ac.in/content/storage2/courses/117101002/downloads/Lec19.pdf
5. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecturenotes/MIT8_04S16_LecNotes3.pdf

6. https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/lecturenotes/MIT8_04S16_LecNotes5.pdf

ONLINE COURSES /RESOURCES:

1. https://nptel.ac.in/courses/115/102/115102023/
2. https://nptel.ac.in/courses/115/106/115106066/

21CY1101	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the importance of Chemistry in Engineering domain.
- To understand the Chemistry background of industrial process.
- To apply Chemistry knowledge for Engineering disciplines.

UNIT - I WATER TECHNOLOGY 9

Hardness –Types of hardness – Estimation by EDTA method – Boiler troubles-scale, sludge, priming, foaming, caustic embrittlement, Boiler corrosion – Internal Conditioning – Carbonate, phosphate, Calgon conditioning – External Conditioning – Zeolite and Demineralization process – Desalination, Reverse Osmosis Method – Domestic water treatment.

UNIT - II HIGH POLYMERS AND NANOCHEMISTRY 9

Polymers – Introduction – Classification of Polymers (Origin/Source, Structure, Monomers, Inter- molecular Forces, Synthesis) – Commercial Polymers (Poly Vinyl Chloride (PVC), Polytetrafluoroethylene (PTFE), Nylon-6 6, Nylon-6, Polyethylene Terephthalate (PET) – Conducting Polymers – Polyaniline, Polythiophene, Trans-Polyacetylene – Basic definition – FRP – General Engineering applications of FRP (Civil Engineering Structures). **Nanomaterials** – Introduction, size dependent properties (Surface area, Electrical, Optical, Catalytic and Thermal properties). Synthesis of nanomaterials: Top-down and bottom-up approaches, Chemical Synthesis – Co precipitation, Sol-Gel process and Chemical vapor deposition, Nanoscale materials: Fullerenes, Carbon nanotubes and modelling – Characterization, properties and applications. Green synthesis of Nanoparticles.

UNIT - III INSTRUMENTAL METHODS AND ANALYSIS 9

Introduction to Spectroscopy – Types of spectroscopy – Absorption spectra – Emission spectra – Wave length and Wave number- Electromagnetic radiation – Flame Photometry, Atomic Absorption Spectroscopy, UV-Visible spectrum. Introduction – basic principles – Instrumentation& Applications – Infrared Spectroscopy. Chromatographic methods – Types (column, Thin layer, paper, Gas, High Performance Liquid Chromatographic methods) – principle- Separation and quantification of Organic compounds by GC and HPLC. Conductometric Titrations: Instrumentation – Advantages – Applications Potentiometric Titrations: Instrumentation –Advantages-Applications. Measurement of pH: pH metry – Instrumentation – Applications.

UNIT - IV ELECTROCHEMISTRY AND CORROSION 9

Introduction- Electrode potentials-Electrochemical series-Electrochemical cell-redox reaction – measurement and applications – Nernst Equation Derivation-Electrochemical extraction of metals – Electrolytic refining of metals –Nano electrochemical Sensors. Corrosion – causes, factors, types, Chemical and Electrochemical Corrosion (Galvanic, Differential aeration) – Corrosion Control, Electrochemical protection – Sacrificial Anodic method – Impressed Current Cathodic Protection – Corrosion Inhibitors – Biocorrosion. Protective Coatings – Paints, Constituents, Functions- Surface preparation for metallic coatings, Electroplating and Electroless Plating.

UNIT - V ENERGY SOURCES AND STORAGE DEVICES 9

Introduction – Nuclear energy – Nuclear fission – Controlled Nuclear fission – Nuclear Fusion – Differences – Nuclear chain reactions –Nuclear Reactor – Classification of Nuclear Reactor – Light Water Nuclear Reactor, Breeder Reactor – Solar Energy, Conversion, Solar Cells – Wind Energy. Batteries and Fuel Cells – Types of batteries –– Zinc – carbon dry cell –Lead Storage battery– Nickel-Cadmium Battery – Lithium battery – Battery Engineering – Battery hazards – Biological Batteries. Fuel Cells – Hydrogen-Oxygen Fuel Cell – Hondas cell-Supercapacitors (elementary idea).

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Analyze the water quality parameters in purification and significance in industries, daily life.
2. Explain the types, fabrication and engineering applications of polymers. Develop economically ne methods of synthesizing nanomaterial and their applications.
3. Demonstrate the knowledge of analytical techniques using spectroscopy.
4. Relate the electrode potential for its feasibility in electrochemical reaction. Illustrate the causes, co corrosion and to achieve its protection.
5. Compare the economic and efficient usage of non-conventional and conventional energy source and various storage devices.

TEXT BOOKS:

1. P.C.Jain and Monika Jain, —"Engineering Chemistry", Dhanpat Rai Publishing Company (P) LTD., New Delhi.
2. S. S. Dara and S.S. Umare, —"A Textbook of Engineering Chemistry" S. Chand and Company Ltd, New Delhi.
3. V.R.Gowariker, N.V.Viswanathan and JayadevSreedhar, —Polymer Sciencell, New Age International P (Ltd.,), Chennai, 2006
4. P. Kannan and A. Ravikrishnan, —"Engineering Chemistry", Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai, 2009. 16
5. S. Vairam, P. Kalyani and Suba Ramesh, —"Engineering Chemistry", Wiley India, 2011

REFERENCES:

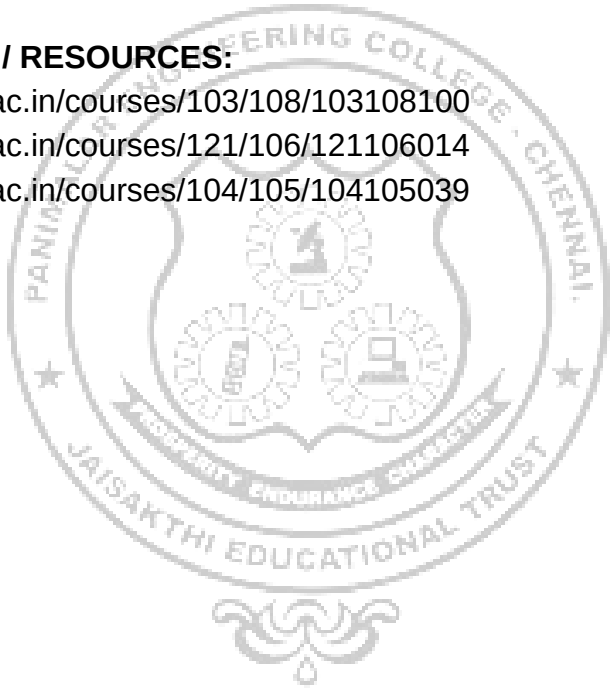
1. Friedrich Emich, —"Engineering Chemistry", Scientific International Pvt. Ltd., New Delhi.
2. PrasanthaRath, —"Engineering Chemistry", Cengage Learning India Pvt., Ltd., Delhi.
3. P.W. Atkins and de Paula Julio, —Physical Chemistry‖, Oxford University Press, 8th Ed., (Indian Student Edition) (2009).
4. K. K. Rohatgi-Mukherjee, —"Fundamental of Photochemistry" New Age International (P) Ltd., New Delhi, 1986.
5. G.A. Ozin and A.C. Arsenault, —Nanochemistry: A Chemical Approach to Nanomaterials‖, RSC Publishing, 2005 Nanomaterials, B.Viswanathan, Alpha Science, ISBN: 9781842654941.

WEB REFERENCES:

http://www.mhhe.com/engcs/compsci/forouzan/dcn/student/olc

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/103/108/103108100
2. https://nptel.ac.in/courses/121/106/121106014
3. https://nptel.ac.in/courses/104/105/104105039



21ES1101	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the basic programming constructs –data types, decision structures, and control structures in python
- To know how to use libraries for string manipulation
- To Use python data structures – Lists, Tuples and Dictionary
- To know the basic concepts of Object-Oriented Programming
- To learn about input/output with files in Python.

UNIT - I ALGORITHMIC PROBLEM SOLVING 9

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language); Python: Data types, variables, expressions, precedence of operators, algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, and guess an integer number in a range, Towers of Hanoi.

SUGGESTED ACTIVITIES:

- Developing Pseudo codes and flowcharts for real life activities such as railway ticket Booking using IRCTC, admission process to undergraduate course, academic schedules during a semester etc.
- Developing algorithms for basic mathematical expressions using arithmetic Operations
- Installing Python.
- Simple programs on print statements, arithmetic operations.

SUGGESTED EVALUATION METHODS:

- Quizzes on algorithm and basic python.
- Assignments on illustrative problems.
- Quizzes on simple python programs.

UNIT - II CONTROL FLOW, STRINGS & FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; functions, function definition and use; Fruitful functions: return values, parameters and arguments, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module. Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

SUGGESTED ACTIVITIES:

- Simple Python program implementation using Operators, Conditionals, Iterative Constructs and Functions.
- Developing simple applications like calculator, calendar, phone directory, to-do lists etc.
- Flow charts for GCD, Exponent Functions, Fibonacci Series using conditionals and Recursion vs. Iteration.

SUGGESTED EVALUATION METHODS:

- Quizzes on strings.
- Assignments on illustrative problems.
- Quizzes on control flow and functions.

UNIT - III LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension; Lists as arrays. Illustrative programs: selection sort, insertion sort, merge sort, histogram.

SUGGESTED ACTIVITIES:

- Implementing python program using lists, tuples, sets for the following scenario:
- Simple sorting techniques
- Student Examination Report
- Billing Scheme during shopping.
- Implementing any application using List and Tuple data structures.

SUGGESTED EVALUATION METHODS:

- Quizzes on list slices.
- Assignments on illustrative problems.
- Quizzes on tuples and dictionaries.

UNIT - IV OBJECT ORIENTED PROGRAMMING WITH PYTHON 9

Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modelling; persistent storage of objects – inheritance, polymorphism, operator overloading; abstract classes; exception handling, try block. Illustrative programs: demonstrate the concept of class and objects.

SUGGESTED ACTIVITIES:

- Features of OOP.
- Persistent storage of objects
- Operators and its usage.
- Simple programs using OOP concepts.

SUGGESTED EVALUATION METHODS:

- Quizzes on basic OOP concepts.
- Assignments on illustrative problems.
- Quizzes on inheritance and exception handling.

UNIT - V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

SUGGESTED ACTIVITIES:

- Developing modules using Python to handle files and apply various operations onfiles
- Usage of exceptions, multiple except blocks – for applications that use delimiters like age,range of numerals etc.
- Implementing Python program to open a non-existent file using exceptions.

SUGGESTED EVALUATION METHODS:

- Quizzes on basic file operations.
- Assignments on illustrative problems.
- Quizzes on packages and modules.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Develop algorithmic solutions to simple computational problems.
2. Write and execute simple Python programs.
3. Familiarize with python string handling techniques and user defined functions.
4. Represent compound data using Python lists, tuples and dictionaries.
5. Understand the concept of object oriented programming techniques.
6. Read and write data from/to files in Python Programs.

TEXT BOOKS:

1. Reema Thareja, ``Problem Solving and Programming with Python'', 2nd edition, OXFORD University Press, New Delhi, 2019.(UNIT 1,2,3,4 (Exception Handling) and 5).
2. Bill Lubanovic, —Introducing Python-Modern Computing in Simple Packagell, 2nd edition, O'REILLY, 2019.(UNIT 4(Object Oriented Programming)).

REFERENCES:

1. Steven F. Lott, —Modern Python Cookbook'', 2nd Edition, O'REILLY, 2020.
2. Ryan Marvin, Mark Ng'ang'a, Amos Omondi, —Python Fundamentals, Packt Publishing., 2018.
3. Paul J. Deitel, Python for Programmers, Pearson India Education Services Pvt. Ltd, 2020.
4. Martin C. Brown, Python: The Complete Reference, McGraw Hill Education; Forthedition, 2018.

WEB REFERENCES:

1. https://greenteapress.com/thinkpython2/thinkpython2.pdf
2. https://freecomputerbooks.com/An-Introduction-to-Python-Guido-van-Rossum.html#downloadLinks
3. http://marvin.cs.uidaho.edu/Teaching/CS515/pythonTutorial.pdf

ONLINE COURSES / RESOURCES:

1. https://docs.python.org/3/tutorial/
2. https://www.w3schools.com/python/
3. https://www.tutorialspoint.com/python/index.htm
4. https://www.javatpoint.com/python-tutorial
5. https://nptel.ac.in/courses/

21ES1102	ENGINEERING GRAPHICS	L	T	P	C
		3	0	2	4

OBJECTIVES: To impart Knowledge on the following topics:

- Drawing free hand sketches of basic geometrical shapes and multiple views of objects.
- Drawing orthographic projections of lines and planes.
- Drawing orthographic projections of solids.
- Drawing development of the surfaces of objects.
- Drawing isometric and perspective views of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination): 2

Importance of graphics in engineering applications – Use of drafting instruments.BIS conventions and specifications. Size, layout and folding of drawing sheets – Lettering and dimensioning. Introduction to drafting packages like CAD and demonstration of their use in engineering fields.

UNIT - I PLANE CURVES AND FREEHAND SKETCHING 14

Basic Geometrical constructions, Curves used in engineering practices-Conics: Construction of Ellipse, Parabola and Hyperbola by eccentricity method – Construction of cycloid, Involutes of square, pentagon and circle – Drawing of tangents and normal to the above curves. Free Hand sketching-Orthographic projection – Orthographic views of simple three-Dimensional objects.

UNIT - II PROJECTION OF POINTS, LINES AND PLANE SURFACES 15

Orthographic projection- principles-Principle planes-First angle projection-Projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes- Determination of true lengths eg and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT - III PROJECTION OF SOLIDS 15

Projection of simple solids like prisms, pyramids, cylinder, and cone when the axis is inclined to one principle planes by rotating object method and auxiliary plane method.

UNIT - IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 15

Sectioning of solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple solids and frustum and truncated solids – Prisms, pyramids cylinders and cones.

UNIT - V ISOMETRIC AND PERSPECTIVE PROJECTIONS 14

Principles of isometric projection – isometric scale –Isometric projections of simple solids and frustum and truncated solids – Prisms, pyramids, cylinders, cones-combination of two solid objects in simple vertical positions. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

TOTAL: 75 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Draw free hand sketching of basic geometrical shapes and multiple views of objects.
2. Draw orthographic projections of lines and planes
3. Draw orthographic projections of solids
4. Draw development of the surfaces of objects
5. Draw isometric and perspective views of simple solids.

TEXT BOOKS:

1. Natarajan, K. V., ―A text book of Engineering Graphics‖, 28th Ed., Dhanalakshmi Publishers, Chennai, 2015.
2. Venugopal, K. and Prabhu Raja, V., ―Engineering Graphics‖, New Age, 2008.

REFERENCES:

1. Bhatt, N.D.,Panchal V M and Pramod R. Ingle, ―Engineering Drawing‖, Charotar Publishing House, 53rd Edition, 2014.
2. Parthasarathy, N. S. and Vela Murali, ―Engineering Drawing‖, Oxford University Press, 2015
3. Agrawal, B. and Agrawal C.M., ―Engineering Drawing‖, Tata McGraw, N.Delhi, 2008.

WEB REFERENCES:

1. https://nptel.ac.in/courses/105/104/105104148/
2. https://www.youtube.com/channel/UCkCk0nvNyWhEOLge9JtDLDg

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112/103/112103019/

21ES1111	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditions and loops.
- To use functions for structuring Python programs.
- To represent compound data using Python lists, tuples, dictionaries.
- To use OOPS concepts in Python.
- To read and write data from/to files in Python

LIST OF EXPERIMENTS

1. Basic Python Programs.
2. Write programs to demonstrate different number data types in python.
3. Develop python programs to demonstrate various conditional statements.
4. Implement user defined functions using python.
5. Develop python scripts to demonstrate functions.
6. Develop python programs to perform various string operations like slicing, indexing& formatting.
7. Develop python programs to perform operations on List & Tuple.
8. Demonstrate the concept of Dictionary with python programs.
9. Develop python codes to demonstrate concept of class and objects.
10. Demonstrate OOPS concepts like inheritance and polymorphism with python programs.
11. Demonstrate python codes to print try, except and finally block statements.
12. Implement python programs to perform file operations.
13. Implement python programs using modules and packages.
14. Simulate bouncing ball using Pygame.

Mini Project :Suggested Topics(but not limited to)

1. Dice roll simulator.
2. Guess the number game.
3. Sending emails using python.
4. Random password generator.
5. Alarm clock.
6. URL shortener.

TOTAL: 60 PERIODS

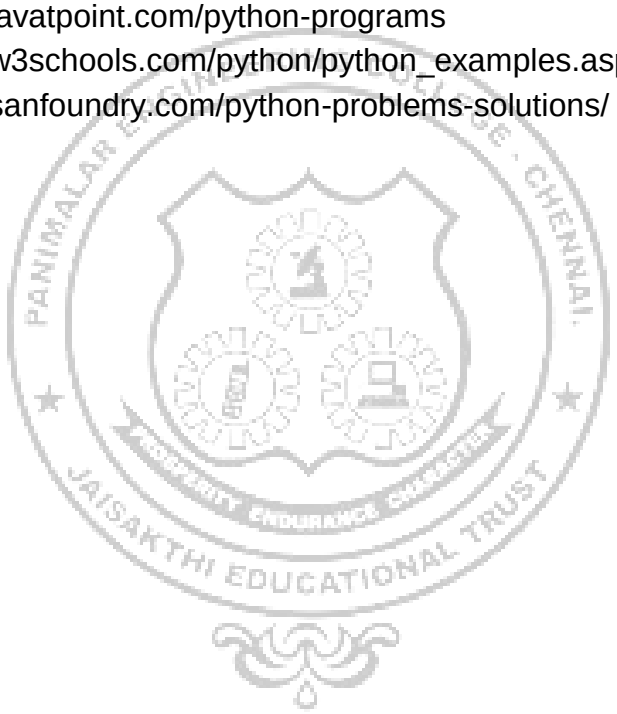
OUTCOMES:

On successful completion of the course student will be able to:

1. Write, test, and debug simple Python programs.
2. Implement Python programs with conditions and loops.
3. Use functions for structuring Python programs.
4. Represent compound data using Python lists, tuples, dictionaries.
5. Use OOPS concepts in Python.
6. Read and write data from/to files in Python

WEB REFERENCES:

1. https://www.programiz.com/python-programming/examples
2. https://www.geeksforgeeks.org/python-programming-examples/
3. https://beginnersbook.com/2018/02/python-programs/
4. https://www.javatpoint.com/python-programs
5. https://www.w3schools.com/python/python_examples.asp
6. https://www.sanfoundry.com/python-problems-solutions/



21BS1111	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2

PHYSICS LABORATORY

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS
(Minimum of experiments to be conducted: 5 Experiments)

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOME:

- Upon completion of the course, the students will be able to apply principles of elasticity, optics and thermal properties for engineering applications.

TEXT BOOKS:

1. Ruby Das, C.S. Robinson, Rajesh Kumar, Prashant Kumar Sahu, A Textbook of Engineering Physics Practical, University Science Press, Delhi, II Edition (2016), ISBN 978-93-80386-86-7
2. Harnam Singh, Dr.P.S. Hemne, B.Sc., Practical Physics, S.Chand & Company Ltd, New Delhi, Edition 2011, ISBN 81-219-0469-2

WEB REFERENCES:

1. https://www.vlab.co.in/broad-area-physical-sciences
2. https://vlab.amrita.edu/?sub=1

CHEMISTRY LABORATORY

OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters such as, alkalinity, hardness, DO and chloride.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of aqueous solutions.

LIST OF EXPERIMENTS
(Minimum of experiments to be conducted: 5 Experiments)

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in Water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Determination of total, temporary & permanent hardness of water by EDTA method.
10. Estimation of iron content of the water sample using spectrophotometer (1, 10- 26, Phenanthroline / thiocyanate method).
11. Estimation of sodium and potassium present in water using flame photometer.
12. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
13. Pseudo first order kinetics-ester hydrolysis.
14. Corrosion experiment-weight loss method.
15. Phase change in a solid.

TOTAL: 30 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO
2. Quantitatively analyse the aqueous solution by electroanalytical techniques

TEXT BOOKS:

1. Laboratory Manual-Department of Chemistry CEGC, Anna University (2014).
2. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

21HS1201	COMMUNICATIVE ENGLISH & LANGUAGE SKILLS LAB II INTEGRATED	L	T	P	C
		3	0	2	4

OBJECTIVES:

- To develop linguistic and strategic competence in workplace context and to enhance language proficiency and thereby the employability of budding engineers and technologists.
- To improve the relevant language skills necessary for professional communication.
- To help learners to develop their listening skills, which will, enable them to listen to lectures and comprehend them by asking questions; seeking clarification and developing their speaking skills and to speak fluently in real contexts
- To Introduce them to life skills, their importance in leading Personal & professional life, key concepts of business communication and Communicative skills.

UNIT - I INTERPERSONAL COMMUNICATION 9

Listening: Listening to Telephone Conversations. **Speaking:** Role Play Exercises Based on Workplace Contexts, Introducing Oneself - PEP Talks. **Reading:** Reading the Interview of an Achiever and Completing Exercises (Skimming, Scanning and Predicting). **Writing:** Writing a Short Biography of an Achiever Based on Given Hints, **Grammar:** Adjective, Sentence pattern. **Vocabulary Development:** Idioms and Phrases.

UNIT - II TECHNICAL COMMUNICATION 9

Listening: Listening to Talks/Lectures Both General and Technical and Summarizing the Main Points. **Speaking:** Participating in Debates, TED Talks. **Reading:** Reading Technical Essays/ Articles and Answering Comprehension Questions. **Writing:** Summary Writing , Minutes of the meeting. **Grammar:** Participle Forms, Relative Clauses. **Vocabulary Development:** Compound Words, Abbreviations and Acronyms.

UNIT - III PROCESS DESCRIPTION 9

Listening: Listening to a Process Description and Drawing a Flowchart **Speaking:** Participating in Group Discussions, Giving Instructions, Presentation **Reading:** Reading Instruction Manuals. **Writing:** Process Descriptions – Writing Instructions. **Grammar:** Use of Imperatives, Active and Passive Voice, Sequence Words. **Vocabulary Development:** Misspelt words, Homophones and Homonyms.

UNIT - IV REPORT WRITING 9

Listening: Listening to a Presentation and Completing Gap-Filling Exercises. **Speaking:** Making Formal Presentations. **Reading:** Reading and Interpreting Charts/Tables and Diagrams **Writing:** Interpreting Charts/Tables and Diagrams, Writing a Report **Grammar:** Direct into Indirect Speech, Use of Phrases. **Vocabulary Development:** Reporting Words, Technical Jargon.

UNIT - V **APPLYING FOR JOBS** **9**

Listening: Listening to a Job Interview and Completing Gap-Filling Exercises. **Speaking:** Mock Interview, Telephone Interviews, GD. **Reading:** Reading a Job Interview, SOP, Company Profile and Completing Comprehension Exercises. **Writing:** Job Applications and Resumes. **Grammar:** Conditional Clauses, Modal verbs. **Vocabulary Development:** Technical Vocabulary, Purpose Statement.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Read and comprehend technical texts effortlessly.
2. Write thoughts and insights of their own.
3. Recognize the need for life skills, apply them to different situations, the basic communication practices in different types of communication.
4. Gain confidence to communicate effectively in various situations to acquire employability skills.
5. Become an active listener of professional contexts.

TEXT BOOKS:

1. Richards, C. Jack. Interchange, New Delhi: CUP, 2017
2. Board of Editors. English for Engineers and Technologists Volume 2 Orient Black Swan Limited, 2020.

REFERENCES:

1. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
2. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: New Delhi, 2014.
3. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
4. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning, USA: 2007
5. Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading

WEB REFERENCES:

1. https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabulary-exams/wordformation
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/2018031621.pdf
3. http://xn--englishclub-ql3f.com/grammar/parts-of-speech.htm
4. https://www.edudose.com/english/grammar-degree-of-comparison-rules/

ONLINE COURSES / RESOURCES:

1. https://basicenglishspeaking.com/wh-questions/
2. https://agendaweb.org/verbs/modals-exercises.html
3. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/2018031621.pdf
4. https://www.ego4u.com/en/cram-up/grammar/prepositions

LANGUAGE SKILLS LAB

List of exercises Minimum of exercises to be conducted 15

1. Listen to lectures - articulate a complete idea as opposed to producing fragmented utterances – Tedtalks, Science Fiction – My fair lady
2. Listening to a process information – General Competitive Examinations, GRE
3. Listening for specific information: accuracy and fluency – BEC
4. Listening - following, responding to explanations, giving directions and instructions in academic and business contexts – IELTS, TOEFL.
5. Listening to transcripts and answer to the questions.
6. Listening: Read aloud in class and gap - filling.
7. Listening: Recognizing and interpreting non - verbal cues.
8. Listen first, speak second - Having the mindset of a listener.
9. Speaking – sharing personal information - Self introduction
10. Speaking – Small talk or Pep Talk
11. Speaking – Group discussion, Visume –visual presentation of resume
12. Speaking – Presentation – Formal and Informal
13. Speaking – Mock interview
14. Speaking – FAQ"S on Job interview
15. Speaking : Simulations - (show and tell)
16. Speaking: News brief - Ripped from today's headlines.
17. Speaking: Who's telling the truth?
18. Speaking: JAM
19. Speaking: Debate
20. Speaking: Story Narration

TOTAL: 45 PERIODS

SOFTWARE REQUIRED:

Globarena

TEXT BOOKS:

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press,
2. Richards, C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010

REFERENCES:

1. Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
2. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014.
3. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.

4. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.
5. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015.
6. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014.

21MA1201	ENGINEERING MATHEMATICS II	L	T	P	C
		3	1	0	4

OBJECTIVES: To impart Knowledge on the following topics:

- Vectors are very helpful for the engineering students as it will give the insight into how to trace along the different types of curves.
- To develop an understanding of the standard technique of a complex variable theory in particular of analytic functions and its mapping property.
- Complex integration is an intuitive extension of real integration. Complex variable techniques have been used in a wide variety of areas of engineering. This has been particularly true in areas such as electromagnetic field theory, fluid dynamics, aerodynamics and elasticity.
- To solve the linear differential equations with constant coefficients.
- Laplace Transform is very useful for the electronics students, this gives the basics of how to solve the problems in electronic circuits.

UNIT - I VECTOR CALCULUS 12

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane - Gauss divergence theorem and Stoke's theorem (excluding proofs) – Simple applications involving cubes, rectangular parallelopiped, sphere and cylinder.

UNIT - II ANALYTIC FUNCTIONS 12

Functions of a complex variable – Analytic functions - Cauchy-Riemann equations - Necessary and sufficient conditions– Harmonic and orthogonal properties of analytic function – Harmonic conjugate, Construction of analytic functions by Milne Thomson method– Conformal mapping: $w = z+c$, cz, $1/z$, z^2 and bilinear transformation.

UNIT - III COMPLEX INTEGRATIONS 12

Line integrals- Cauchy's integral theorem-Cauchy's integral formula - Singularities - Residues– Cauchy's residue theorem - Taylor's and Laurent's series expansions – Application of residue theorem for evaluation of real definite integrals – Use of circular contour and semi- circular contour (excluding poles on the real axis).

UNIT - IV ORDINARY DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients -Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

UNIT - V **LAPLACE TRANSFORMS** **12**

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms -Transforms of unit function, unit step function and unit impulse functions – Transform of periodic functions– Initial and final value theorems. Inverse Laplace transforms -Convolution theorem–Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Identify the Gradient, divergence and curl of a vector point function and related identities. Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
2. Understand analytic functions, harmonic functions, conformal mapping.
3. Determine the types of singularities, residues, contour integration.
4. Apply various techniques in solving differential equations.
5. Solve differential equations using laplace transforms.
6. Identify the Gradient, divergence and curl of a vector point function and related identities. Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.

TEXT BOOKS:

1. Grewel. B.S, “Higher Engineering Mathematics”, 43rd Edition, Khanna Publications, Delhi, 2014.
2. B.V. Ramana, “Higher Engineering Mathematics”, McGraw Hill Education, India.
3. Bali N., Goyal M. and Walkins C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt. Ltd.,), New Delhi, 7th Edition, 2009.

REFERENCES:

1. Kreyszig Erwin, Advanced Engineering Mathematics”, John wiley and Sons, 10th Edition, New Delhi.
2. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 3rd Edition, 2007.
3. O"Neil, P.V. “Advanced Engineering Mathematics”, Cengage Learning India Pvt. Ltd, New Delhi, 2007.
4. Sastry, S.S, “Engineering Mathematics”, Vol.I & II, PHI Learnig Pvt. Ltd, 4th Edition, New Delhi, 2014.
5. Wyile, R.C. and Barrett, L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt Ltd, 6th Edition, New Delhi, 2012.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ma69
2. https://onlinecourses.nptel.ac.in/noc21_ma57

21PH1201	PHYSICS FOR ELECTRONICS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the essential principles of Physics of semiconductor device and Electron transport properties. Become proficient in magnetic, dielectric and optical properties of materials and Nano devices.

UNIT - I ELECTRICAL PROPERTIES OF MATERIALS 9

Classical free electron theory – postulates – expression for electrical conductivity – expression for thermal conductivity – Wiedemann–Franz law – success and failures – quantum free electron theory – postulates – Fermi-Dirac statistics – density of energy states – band theory of solids – postulates – Bloch theorem – energy bands from electron wave reflections – metals, semiconductors and insulators – electron effective mass (qualitative) – concept of hole.

UNIT - II SEMICONDUCTOR PHYSICS 9

Crystal structure of Si – Czochralski method - Intrinsic Semiconductors – energy band diagram – carrier concentration in intrinsic semiconductors - extrinsic semiconductors – carrier concentration in N-type & P-type semiconductors – variation of carrier concentration with temperature - variation of Fermi level with temperature and impurity concentration - drift and diffusion transport of carriers – Einstein"s relation – Hall effect and applications – Zener and avalanche breakdown in p-n junctions – Ohmic contacts — Schottky diode – degenerate and non-degenerate semiconductors – tunnel diode

UNIT - III MAGNETIC AND SUPERCONDUCTING PROPERTIES OF MATERIALS 9

Magnetism in materials – magnetic field and induction – magnetic permeability and susceptibility – classifications of magnetic materials – ferromagnetic domain theory – M versus H behaviour - hard and soft magnetic materials - examples and uses magnetic principle in computer data storage magnetic hard disc. Superconductivity – zero resistance and Meissner effect – critical field and critical current density – BCS theory (qualitative) – Type I and Type II superconductors – maglev train – Josephson junction.

UNIT - IV DIELECTRIC AND OPTICAL PROPERTIES OF MATERIALS 9

Relative permittivity – polarization processes – internal field and Clausius-Mosotti relation – dielectric loss – dielectric breakdown (definition only) – high-k dielectrics. Classification of optical materials – carrier generation and recombination processes – Absorption and emission of light in metals, insulators and semiconductors (concepts only) – photocurrent in a P-N diode – photo detectors – pin diode – solar cell – LED.

UNIT - V NANODEVICES 9

Introduction – electron density in bulk material – size dependence of Fermi energy – quantum confinement – quantum structures – density of states in quantum well, quantum wire and quantum dot structures – excitons – quantum confined Stark effect - resonant tunneling – quantum interference effects – ballistic transport quantum resistance and conductance Coulomb blockade effects – single electron phenomena and single electron transistor – carbon nanotubes: properties and applications.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. gain knowledge on classical and quantum electron theories, and energy band structures.
2. acquire knowledge on basics of semiconductor crystalline materials and its applications in various devices.
3. get knowledge on magnetic and dielectric properties of materials.
4. have the necessary understanding on the functioning of optical materials for optoelectronics.
5. understand the basics of quantum structures and their applications in spintronics and carbon electronics.

TEXT BOOKS:

1. Kasap, S.O., Principles of Electronic Materials and Devices, 4th Edition, McGraw-Hill Education, 2018.
2. Donald A. Neamen, Semiconductor Physics and Devices: Basic Principles, 4th edition, McGrawHill, 2012.
3. K. Santhosam, K. Russel Raj and A, Maheswaran, “Electrical Engineering Materials”, Chess Educational Publishers, 2021.

REFERENCES:

1. Hanson, G.W. —Fundamentals of Nanoelectronics. Pearson Education, 2009.
2. Rolf E. Hummel, “Electronic Properties of Materials”, Springer, 2011.
3. Charles Kittel, “Introduction to Solid State Physics”, Wiley, 2012.
4. A.J.Dekker, “Solid State Physics”, Prentice – Hall, Inc., 1969.
5. Rogers, B., Adams, J. & Pennathur, S. “Nanotechnology: Understanding Small Systems”, CRC Press, 2014.

WEB REFERENCES:

1. http://tiiciiitm.com/profanurag/Semiconductors-Properties.pdf
2. https://nptel.ac.in/content/storage2/courses/112108150/pdf/Web_Pages/WEBP_M16.pdf
3. https://nptel.ac.in/content/storage2/courses/113106062/Lec16.pdf
4. G. Mohan Kumar, Nanomaterials and Nanodevices, Narosa Publishing House.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_ph10/preview
2. https://nptel.ac.in/content/storage2/courses/115103038/module1/lec1/2.html

21ES1202	BASIC CIVIL AND MECHANICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide basic knowledge about civil and mechanical.

UNIT - I SCOPE OF MECHANICAL AND CIVIL ENGINEERING 8

Overview of Civil Engineering – Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering Overview of Mechanical Engineering – Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering – Production, Automobile, Energy Engineering – Interdisciplinary concepts in Civil and Mechanical Engineering.

UNIT - II SURVEYING AND CIVIL ENGINEERING MATERIALS 8

Surveying: Objects – classification – principles – measurements of distances – angles – leveling –determination of areas– contours – examples. Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel – timber – modern materials.

UNIT - III BUILDING COMPONENTS AND STRUCTURES 11

Foundations: Types of foundations – Bearing capacity and settlement – Requirement of good foundations. Civil Engineering Structures: Brickmasonry – stonemasonry – beams – columns – lintels – roofing– flooring – plastering – floor area, carpet area and floor space index – Types of Bridges and Dams – water supply – sources and quality of water – Rain water harvesting – introduction to high way and rail way.

UNIT - IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 11

Classification of Power Plants – Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro – electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps.

UNIT - V REFRIGERATION AND AIR CONDITIONING SYSTEM 7

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner.

TOTAL: 45 PERIODS

OUTCOMES:

1. Overview of mechanical and civil engineering.
2. To know of surveying and materials.
3. Ability to explain the usage of construction material and proper selection of construction materials.

4. To study the basic concept of ic engines and power plant.
5. To know the fundamental of refrigeration and air-conditioning.

TEXT BOOKS:

1. Shanmugam Gand Palanichamy MS, “Basic Civil and Mechanical Engineering”, Tata McGraw Hill PublishingCo., NewDelhi,1996.
2. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2010.

REFERENCES:

1. Seetharaman S., “BasicCivil Engineering”, AnuradhaAgencies, 2005.
2. ShanthaKumar SRJ., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2000.
3. Venugopal K. and Prahu Raja V., “Basic Mechanical Engineering”, Anuradha Publishers, Kumbakonam, 2000.

WEB REFERENCES:

1. engagehttps://www.cengage.co.in
2. Archives of Civil and Mechanical Engineering | Home - Springerhttps://www.springer.com
3. Basic Civil and Mechanical Engineering - https://www.brainkart.com

ONLINE COURSES / RESOURCES:

1. Learn Civil Engineering with Online Courses and Classes | edXhttps://www.edx.org
2. Learn Mechanical Engineering with Online Courses and ... - edXhttps://www.edx.org
3. Top Free Online Courses Websites For Engineering Courses https://www.constructionplacements.com
4. Mechanical Engineering Courses Online | Courserahttps://www.coursera.org

21EE1201	ELECTRIC CIRCUIT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce electric circuits and its analysis
- To impart knowledge on solving circuit equations using network theorems
- To introduce the phenomenon of resonance in coupled circuits
- To educate on obtaining the transient response of circuits
- To introduce Phasor diagrams and analysis of three phase circuits.
- To introduce electric circuits and its analysis

UNIT - I BASIC CIRCUITS ANALYSIS 9

Resistive elements - Ohm"s Law Resistors in series and parallel circuits – Kirchoffs laws – Mesh current and node voltage - methods of analysis.

UNIT - II NETWORK REDUCTION AND THEOREMS FOR DC AND AC CIRCUITS 9

Network reduction: voltage and current division, source transformation – star delta conversion. Thevenins and Norton Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem.

UNIT - III TRANSIENT RESPONSE ANALYSIS 9

L and C elements -Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. sinusoidal input.

UNIT - IV THREE PHASE CIRCUITS 9

A.C. circuits – Average and RMS value - Phasor Diagram – Power, Power Factor and Energy.- Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced – phasor diagram of voltages and currents – power measurement in three phase circuits.

UNIT - V RESONANCE AND COUPLED CIRCUITS 9

Series and parallel resonance – their frequency response – Quality factor and Bandwidth - Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits.

TOTAL: 45 PERIODS

OUTCOMES:

1. Ability to comprehend the basics of circuit analysis
2. Ability of solve electrical circuits using theorems
3. Ability to analyze the transient response
4. Able to comprehend the three phase circuits
5. Able to understand coupled circuits

TEXT BOOKS:

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuits Analysis”, McGraw Hill publishers, edition, New Delhi, 2013.
2. Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, Second Edition, McGraw Hill, 2013. 36
3. Allan H. Robbins, Wilhelm C. Miller, “Circuit Analysis Theory and Practice”, Cengage Learning India, 2013
4. Sudhakar A and Shyam Mohan SP, “Circuits and Network Analysis and Synthesis”, McGraw Hill, 2015.

REFERENCES:

1. Chakrabarti A, “Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, 1999.
2. Jegatheesan, R., “Analysis of Electric Circuits,” McGraw Hill, 2015.
3. Joseph A. Edminister, Mahmood Nahri, “Electric circuits”, Schaum‟s series, McGrawHill, New Delhi, 2010.
4. M E Van Valkenburg, “Network Analysis”,Prentice-Hall of India Pvt Ltd, New Delhi, 2015.
5. Mahadevan, K., Chitra, C., “Electric Circuits Analysis,” Prentice-Hall of India Pvt Ltd., New Delhi, 2015.
6. Richard C. Dorf and James A. Svoboda, “Introduction to Electric Circuits”, 7th Edition, John Wiley & Sons, Inc. 2015.

WEB REFERENCES:

1. https://www.circuitlab.com/
2. https://www.allaboutcircuits.com/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108/104/108104139/
2. https://nptel.ac.in/content/storage2/courses/108105053/pdf/L-17(NKD)(ET)%20((EE)NPTEL).pdf.

21EE1211	ELECTRIC CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To analyse & compute solutions for electric circuits
- To impart hands on experience on analysing the electric circuits
- To simulate electric circuits
- To understand circuit theorems
- To study the measurement of electric parameters

LIST OF EXPERIMENTS

1. Experimental verification of Kirchhoff"s current and voltage law
2. Experimental verification of Thevenin"s theorem
3. Simulation and Experimental verification of Norton"s theorem
4. Simulation and Experimental verification of Superposition theorem
5. Simulation and Experimental verification of maximum power transfer Theorem
6. Simulation and Experimental verification of reciprocity Theorem
7. Study of CRO and measurement of RMS voltage, frequency and power factor
8. Experimental determination of time constant of series RL, RC circuits
9. Experimental determination of frequency response of RLC circuits
10. Design and Simulation of series resonant circuits
11. Design and Simulation of parallel resonant circuits
12. Simulation of three phases balanced and unbalanced star & delta connected networks

TOTAL: 60 PERIODS

OUTCOMES:

1. Ability to apply Kirchoff"s law to electric circuits
2. Ability to compute solution for an electric circuit using theorems
3. Ability to construct and analyze the RLC circuits
4. Ability to design and simulate resonant circuits
5. Ability to simulate three phase circuits

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Regulated Power Supply: 0 – 15 V D.C - 10 Nos / Distributed Power Source.
2. Function Generator (1 MHz) - 10 Nos.
3. Single Phase Energy Meter - 1 No.
4. Oscilloscope (20 MHz) - 10 Nos.
5. Digital Storage Oscilloscope (20 MHz) – 1 No.
6. 10 Nos. of PC with Circuit Simulation Software (min 10 Users) (e-Sim / Scilab/
7. Pspice / MATLAB /other Equivalent software Package) and Printer (1 No.)

8. AC/DC - Voltmeters (10 Nos.), Ammeters (10 Nos.) and Multi-meters (10 Nos.)
9. Single Phase Wattmeter – 3 Nos.
10. Decade Resistance Box, Decade Inductance Box, Decade Capacitance Box - 6 Nos each.
11. Circuit Connection Boards - 10 Nos.
12. Necessary Quantities of Resistors, Inductors, Capacitors of various capacities (Quarter Watt to 10 Watt)

21ES1211	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering

GROUP- A CIVIL & ELECTRICAL

I CIVIL ENGINEERING PRACTICES 15

Plumbing Work:

a. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and
b. Other components which are commonly used in household.
c. Preparing plumbing line sketches.
d. Laying pipe connection to the suction side of a pump
e. Laying pipe connection to the delivery side of a pump.
f. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household

Wood Work:

a. Introduction to Tools and Equipments
b. Simple Planning and sawing practice
c. Making Half Lap, Dovetail, Mortise and Tenon joints

Wood Work Study:

a. Studying joints in door panels and wooden furniture
b. Studying common industrial trusses using models.

II ELECTRICAL ENGINEERING PRACTICES: 15

a. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
b. Fluorescent lamp wiring.
c. Stair case wiring
d. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
e. Measurement of energy using single phase energy meter.
f. Measurement of resistance to earth of electrical equipment.

GROUP- B MECHANICAL AND ELECTRONICS

III MECHANICAL ENGINEERING PRACTICES 15

Basic Machining Work:

a. Introduction to Lathe machine, Tools and Equipments
b. Simple Turning and facing
c. Step turning
d. Simple Drilling and Tapping of flat plate

Welding Work:

a. Introduction to Arc welding
b. Welding of Butt Joints

Assembly Work:

a. Assembling a centrifugal pump.
b. Assembling an air conditioner.

Sheet Metal Work:

a. Demonstrating basic sheet metal operations

Foundry Work:

a. Demonstrating basic foundry operations.

IV ELECTRONICS ENGINEERING PRACTICES 15

a. Study of Electronic components and equipments – Resistor, color coding
b. Measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
c. Study of logic gates AND, OR, EX-OR and NOT.
d. Generation of Clock Signal.
e. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
f. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:

1. Connecting various basic pipe fittings and other components which are commonly used in household and to know about the various tools, Equipment and making different joints.
2. To know the Lathe machine, Tools and Equipments with machining experiments and have knowledge about Arc welding, Tools and Equipments with making different joints.
3. To carry out basic home electrical works and appliances and measure the electrical quantities.
4. To analyze the basic electronic circuits and to solder simple components on PCB and test simple electronic circuits.

TEXT BOOKS:

1. Jeyapoovan T, Saravanapandian M & Pranitha S, “Engineering Practices Lab Manual”, Vikas Publishing House Pvt.Ltd, (2006)
2. Kannaiah P & Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, (1999).
3. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, (2007).
4. S. Gowri & T. Jeyapoovan, “Enginering Practices Lab Manual 5/E”, S. Chand Publishing, 2019

REFERENCES:

1. K.C. John, "Mechanical workshop practice", Second edition, PHI learning Pvt Ltd, New Delhi
2. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, (2007)

WEB REFERENCES:

1. https://nptel.ac.in/courses/112/107/112107090/
2. https://nptel.ac.in/courses/112/107/112107084/

21MA1303	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT - I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations - Solutions to standard types of first order partial differential equations - Lagrange's linear equation - Second and higher order with constant coefficients of homogeneous linear partial differential equations.

UNIT - II FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series - Odd and even functions - Change of interval- Half range sine series – Half range cosine series – RMS values- Parseval's identity – Harmonic analysis.

UNIT - III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE - Fourier Series Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction in Cartesian coordinates.

UNIT - IV FOURIER TRANSFORMS 9+3

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT - V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties –Initial and final value theorems- Inverse Z-transform (Using partial fraction method and Residue method) - Convolution theorem– Formation of difference equation-Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

OUTCOMES:

1. Apply the basic Knowledge to identify and deal with partial differential equations and their solutions.
2. Understand the principles of Fourier series and apply them in real life situation.
3. Solve one dimensional equation using Fourier series techniques.
4. Solve two dimensional equations using Fourier series techniques.
5. Understand the mathematical principles on Fourier transforms.
6. Utilise the basic knowledge in solving difference equations using Z-transforms.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., ManicavachagomPillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
3. Veerarajan T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
4. Nagarajan G. and Sundar Raj M., "Transforms and Partial Differential Equations", Sreekamalamani Publications , 6th edition , Chennai , 2021.

REFERENCES:

1. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, LaxmiPublications Pvt. Ltd, 2014.
2. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016
3. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016

21CS1304	OBJECT ORIENTED PROGRAMMING PARADIGM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts of OOP.
- To understand the syntax, semantics classes, objects, invoking methods, etc.
- To understand the principles of inheritance and interfaces.
- To learn the concepts of exception handling and I/O mechanism.
- To seek the knowledge on Threading and Generic Programming.

UNIT - I INTRODUCTION TO OOP 9

Object oriented programming concepts – objects-classes- methods and messages-abstraction and encapsulation-inheritance- abstract classes- polymorphism- OOP in Java – Characteristics of Java – The Java Environment - Java Source File -Structure – Compilation- Fundamental Programming Structures in Java.

SUGGESTED ACTIVITIES

1. Design object oriented solutions for small systems involving multiple objects.
2. Frame real world scenario to explain OOP concepts

SUGGESTED EVALUATION ACTIVITIES

1. Quiz on Object oriented programming concepts
2. Implement, test and debug solutions in Java

UNIT - II JAVA FUNDAMENTALS 9

Defining classes in Java – constructors, methods -access specifiers - static members -Comments, Data Types, Variables, Operators, Strings, Control Flow, Arrays, Java Scope, Packages- Javadoc comments.

SUGGESTED ACTIVITIES

1. Simple Programs to understand the fundamentals of Java
2. Practice programs on defining the class, constructors and Packages

SUGGESTED EVALUATION ACTIVITIES

1. Quiz on fundamentals programming in Java.
2. Programming Assignments to evaluate the understanding level of basic concepts in Java.
3. Design simple application based on the concepts learnt (Class, Methods, Constructors, Packages).

UNIT - III INHERITANCE AND INTERFACES 9

Inheritance – Super classes- sub classes –Protected members – constructors in sub classes- the Object class – abstract classes and methods- final methods and classes – Interfaces – defining an interface, implementing interface, differences between classes and interfaces and extending interfaces.

SUGGESTED ACTIVITIES

1. To work on Simple programs using various types of inheritance.
2. Implementation of abstract methods from interfaces

SUGGESTED EVALUATION ACTIVITIES

1. Quiz on Inheritances.
2. Build small application based on Inheritances and Interfaces.

UNIT - IV EXCEPTION HANDLING AND MULTITHREADING 9

Exceptions - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions, Stack Trace Elements. Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups.

SUGGESTED ACTIVITIES

1. Work on sample programs to handle errors using Exception handling mechanism
2. Work on Sample programs using multithreading
3.

SUGGESTED EVALUATION ACTIVTIES

1. Debugging the code on exception handling
2. Programming assignment on solving thread based.

UNIT - V I/O AND GENERIC PROGRAMMING 9

Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files. Generic Programming – Generic classes – generic methods – Bounded Types – Restrictions and Limitations.

SUGGESTED ACTIVITIES

1. Practicing programs on I/O Stream and Files
2. Practice and apply generic methods to build small applications

SUGGESTED EVALUATION ACTIVTIES

1. Build sample application based on I/O stream and Files
2. Quiz on generic programming.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to:

1. Solve complex programming problems and to simplify the implementation.
2. Write Java application programs using OOP principles.
3. Demonstrate the concepts of inheritance and interfaces.

4. Write Java programs to implement error handling techniques using exception handling and to develop applications using stream I/O and file I/O.
5. Understand the concepts of multithreading and generic programming.
6. Design applications which mimics the real word scenarios.

TEXT BOOKS:

1. Herbert Schildt, “Java The complete reference”, 8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary cornell, “Core Java Volume –I Fundamentals”, 9th Edition, Prentice Hall, 2013.

REFERENCES:

1. Paul Deitel, Harvey Deitel, “Java SE 8 for programmers”, 3rd Edition, Pearson, 2015.
2. Steven Holzner, “Java 2 Black book”, Dreamtech press, 2011.
3. Timothy Budd, “Understanding Object-oriented programming with Java”, Updated Edition, Pearson Education, 2000.

WEB REFERENCES:

1. https://www.javatpoint.com/java-tutorial
2. https://docs.oracle.com/javase/tutorial/
3. https://www.tutorialspoint.com/java/index.htm
4. https://www.geeksforgeeks.org/java/

ONLINE COURSE / RESOURCES:

1. https://www.udemy.com/topic/java/
2. https://www.coursera.org/courses?query=java
3. https://www.edureka.co/java-j2ee-training-course

21EE1301	ELECTROMAGNETIC THEORY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To review the fundamentals of the different coordinate systems, vector algebra and calculus.
- To teach the basic laws of electrostatics and its applications.
- To impart knowledge on dielectrics and electrostatic boundary conditions.
- To impart knowledge on magnetic materials and understand the laws of magnetostatics.
- To analyse the time varying electric and magnetic fields and to understand Maxwell's equations.

UNIT - I VECTOR ANALYSIS 9

Vector fields - Different co-ordinate systems – Rectangular, Cylindrical, Spherical co-ordinate systems – Gradient, Divergence and Curl – Divergence Theorem – Stoke's Theorem.

UNIT - II ELECTROSTATICS- I 9

Sources and effects of electromagnetic fields – Coulomb's Law – Electric field intensity – Field due to point and continuous charges –Gauss's law and applications –. Electric potential – Energy density.

UNIT - III ELECTROSTATICS- II 9

Electric field in free space, conductors, dielectric - Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics – Boundary conditions– Poisson's and Laplace's equations – Capacitance.

UNIT - IV MAGNETOSTATICS 9

Magnetic field intensity – Biot-Savart Law - Ampere's Law and applications - Magnetic field due to straight conductors, circular loop, infinite sheet carrying current – Magnetic flux density (B) –Magnetization –Boundary conditions – Scalar and vector potential –Inductance – Energy density.

UNIT - V ELECTROMAGNETIC WAVES 9

Magnetic force – Lorentz Law of force –Torque –Faraday's laws, induced emf – Transformer and motional EMF – Maxwell's equations (differential and integral forms) –Displacement current – Poynting vector -Derivation of generalized Wave Equations from Maxwell's equations.

TOTAL: 45 PERIODS

OUTCOMES:

1. Apply vector calculus to static electric – magnetic field.
2. Apply the basic concepts about electrostatic fields for the calculation of Electric field intensity, Electrical potential and Energy density.
3. Explain Electric field in free space, conductors, dielectric and multiple

dielectrics and apply the basic concepts in Capacitance calculations.

4. Determine the magnetic flux density, scalar potential, vector potential and energy density.
5. Derive Electromagnetic wave equation and apply the Poynting expression.
6. Apply the Maxwell equations to solve problems in electromagnetic field theory.

TEXT BOOKS:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.
3. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.

REFERENCES:

1. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.
2. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), McGraw Hill, 2010.
3. K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Eighth Reprint :2015
4. S.P.Ghosh, Lipika Datta, 'ElectromagneticEducation(India) Private Limited, 2012

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108/104/108104087/

21EE1302	ANALOG ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on the operation and applications of electronics devices.
- To learn the Design of power amplifiers, feedback amplifier and oscillators.
- To Understand the Characteristics of op-amp.
- To gain knowledge on Design, construction, application circuits using op-amp.
- To understand Functional blocks and applications of special ICs like timer and regulator ICs.

UNIT - I ELECTRONIC DEVICES AND THEIR CHARACTERISTICS 9

BJT - Biasing circuits, FET: JFET and MOSFET, Characteristics of CS, CG and CD amplifier configurations, Biasing circuits – IGBT- Differential amplifier – Common mode and Difference mode analysis, UJT –Relaxation Oscillator.

UNIT - II POWER AMPLIFIER AND OSCILLATOR CIRCUITS 9

Classification of Power amplifiers:- Class A, B, AB and C Power amplifiers- Push-Pull amplifier, Complementary Symmetry Push-Pull amplifiers - Design of power output, efficiency and cross-over distortion – Condition for oscillations, RC phase shift, wein bridge , Crystal oscillators.

UNIT - III OPAMP AND CHARACTERISTICS 9

op-amp characteristics - DC characteristics, AC characteristics. Basic applications of op-amp – Comparators, Inverting and Non-inverting Amplifiers, summer, differentiator and integrator, Instrumentation amplifier.

UNIT - IV APPLICATION OF OPAMPS 9

Waveform generators, Clipper, Clamper, S/H circuit - D/A converter (weighted resistor and R- 2R ladder types), A/D converters (flash type, dual slope type and successive approximation type) using op-amp.

UNIT - V SPECIAL ICS 9

Functional block, characteristics and applications - 555 Timer (Astable and Monostable Multivibrator), IC voltage regulators – Fixed voltage regulators LM78XX, LM79XX, its application as Linear power supply - Variable voltage regulator 723, ICL8038 function generator IC.

TOTAL: 45 PERIODS

OUTCOMES:

1. Acquire knowledge in Semiconductor devices like FET and IGBT.
2. Design the amplifiers with various biasing circuits for FET and BJT and analyze the differential amplifier.
3. Interpret the different types of Voltage, Power Amplifiers and Oscillators.

4. Summarize the Characteristics of OPAMP and analyze the various applications of Op-Amp.
5. Develop and correlate the various Non-linear applications of op-amp and study the A/D converters and D/A converters.
6. Implementing the Semiconductor Devices and op-amp ICs for doing projects and extrapolate the IC technologies on voltage regulators.

TEXT BOOKS:

1. David A bell, "Electronic circuits", Oxford University Press, 2011.
2. Ramakant A Gayakwad, "Opamps and Linear Integrated Circuits", 4th edition, Pearson Education/ PHI, 2009.
3. D. Roy Choudary, S.B. Jain, " Linear Integrated Circuits", Third edition, New Age publishers, 2014.

REFERENCES:

1. Millman and Halkias, " Integrated Electronics", McGraw Hill Publications,
2. Muhammad H. Rashid, "Linear Integrated Circuits", Cengage Learning, 2014**.**
3. Floyd, “Electron Devices” Pearson Asia 5th Edition, 2001
4. Robert L.Boylestad, “Electronic Devices and Circuit theory”, 2002

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102095/
2. https://www.classcentral.com/provider/swayam
3. https://nptel.ac.in/courses/117103063/
4. https://www.coursera.org/specializations/semiconductor-devices
5. http://www.nptelvideos.in/2012/11/digital-integrated-circuits.html

21EE1303	SIGNALS AND SYSTEMS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To introduce the fundamentals and classifications of signals and systems.
- To get familiarized to system representation and stability study with Laplace transform.
- To analyze the continuous time signals, Fourier series and to learn to apply frequency analysis.
- To impart knowledge on discrete time signals and discretised systems.
- To understand importance of sampling theorem and its implications.

UNIT - I INTRODUCTION TO SIGNALS AND SYSTEMS 9+3

Continuous time signals - Discrete time signals – Representation of signals – Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential signals, Operations on the signals – Classification of continuous and discrete time signals – Continuous time and discrete time systems – Classification of systems –Properties of systems.

UNIT - II BEHAVIOR OF CONTINUOUS AND DISCRETE-TIME LTI SYSTEMS 9+3

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. LTI continuous time systems- Differential equations –Characterization of causality and stability of LTI systems- Laplace Transforms –properties-ROC, Transfer function and Impulse response –Block diagram representation and reduction – Convolution Integral – State variable techniques –State equations.

UNIT - III FOURIER TRANSFORMS 9+3

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response- The Discrete- Time Fourier Transform (DTFT) -properties- the Discrete Fourier Transform (DFT) – properties- Linear and Circular Convolution-Application of FFT in Harmonic calculation.

UNIT - IV Z-TRANSFORMS 9+3

The z-Transform for discrete time signals and systems, system functions- Laplace Transforms to z-transformation-poles and zeros of systems and sequences, z-domain analysis- Properties – Z Transformation: Properties – Different methods of finding Inverse Z-Transformation.

UNIT - V SAMPLING AND RECONSTRUCTION 9+3

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects- applications –filtering, feedback control systems.

TOTAL: 60 PERIODS

OUTCOMES:

1. Distinguish between different types of signals and Systems.
2. Analyze the behaviour of continuous and discrete-time LTI systems.
3. Classify systems based on their properties and determine the response in frequency domain.
4. Analyze system properties based on impulse response and Fourier analysis.
5. Apply the Z- transform for analysis of continuous-time and discrete-time signals.
6. Understand the process of sampling and its implications during signal reconstruction.

TEXT BOOKS:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India, 1997.
2. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.
3. Ingle and Proakis Digital signal Processing using MATLAB-A problem solving Companion”,4th Edition, Cengage Learning,2018.

REFERENCES:

1. Simon Haykins and Barry Van Veen, “Signals and Systems”, John Wiley and Sons, 2007.
2. H. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
3. M. J. Robert “Signals and Systems-Analysis using Transform Methods and MATLAB”, McGraw Hill Education,2004.
4. M. J. Robert “Fundamentals of Digital signal Processing using MATLAB”, Cengage Learning,2005.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee28/preview

21EE1311	ANALOG ELECTRONICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To learn design, testing and characterizing of circuit behaviour with analog ICs.
- To understand the characteristics of semiconductor devices.
- To design and test the characteristics of timer, Op-amp and voltage regulator.
- To construct the characteristics of FET devices and to design a oscillator circuit.

LIST OF EXPERIMENTS:

1. Digital Simulation and Experimental Verification of Characteristics of Semiconductor diode and Zener diode.
2. Digital Simulation and Experimental Verification of Characteristics of a NPN Transistor under common emitter, common collector and common base configurations.
3. Characteristics of JFET and draw the equivalent circuit.
4. Characteristics of UJT and generation of saw tooth waveforms.
5. Design and Frequency response characteristics of a Common Emitter amplifier.
6. Design and testing of RC phase shift and LC oscillators.
7. Differential amplifiers using FET.
8. Timer IC application: Study of NE/SE 555 timer in Astability, Monostability operation..
9. Application of Op-Amp: inverting and non-inverting amplifier, Differentiator, Integrator, Adder and comparator.
10. Simulation of OPAMP circuits Using PSPICE.
11. Variability Voltage Regulator using IC LM317.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Robert Diffenderfer, ‘Electronic Devices: Systems and Applications’, Cengage Learning, 2010.
2. Robert L.Boylestad, ‘Electronic Devices and Circuit theory’, Pearson Education, 2010.
3. Jacob Millman, Christos.C.Halkias and SatyabrataJit, ‘Electronic Devices and Circuits’, Tata McGraw Hill, 2010.
4. Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, ‘Electronic Devices and Circuits’, Pearson Education,6th edition, 2013.
5. A.Anandkumar, ‘Fundamental of Digital Circuits’, PHI Learning Private Ltd, edition, 2014.
6. James M.Fiore, ‘Opamps and Linear Integrated Circuits’, Cengage Learning India Pvt Ltd, 1st edition, 2010.

WEB REFERENCES:

1.https://nptel.ac.in/video.php?subjectId=117103063
2. https://onionesquereality.wordpress.com/.../more-video- lectures-iit-open
3. https://nptel.iitg.ernet.in/Elec_Comm_Engg/.../Video-ECE.pdf
4. https://nptel.ac.in/courses/122106025/11
5. https://www.nptelvideos.in/2012/basic-electronics- drchitralekha-mahanta.html
6. https://www.coursera.org/learn/electronics

COURSE OUTCOME:

1. Infer the characteristics of FET and BJT Characteristics.
2. Design Timer in Astable and Monostable Mutivibrator using the appropriate IC.
3. Design an experimental setup of a differential amplifier using field effect transistor and determine its gain and CMRR.
4. Design two stage RC phase shift oscillators.
5. Design an experimental setup of a Op-Amp applications like inverting and Non inverting amplifier, adder, comparator, integrator and differentiator.
6. Design linear voltage regulator using regulator IC chip.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Dual , (0-30V) variability Power Supply - 10 nos
2. Regulated 3 output Power Supply 5, ± 15V - 10 nos
3. CRO 9 nos
4. Digital Multimeter 10 nos
5. Function Generator 8 nos
6. IC Tester (Analog) 2 nos
7. Bread board 10 nos
8. Component data sheets to be provided

Consumables (sufficient quantity)

1. IC 741/ IC NE555/566/565
2. LM317
3. LM723
4. Transistor – 2N3391
5. Diodes, IN4001, BY126
6. Zener diodes
7. Potentiometer
8. Step-down transformer 230V/12-0-12V
9. Capacitor
10. Resistors, Capacitors and Inductors
11. Resistors 1/4 Watt Assorted
12. Single Strand Wire

21CS1312	OBJECT- ORIENTED PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To learn and work on programs for fundamentals of Object Oriented Programming using Java.
- To analyze and design the concepts of class, operator overloading and functions by implementation.
- To develop the program using STL and to design class in Java.
- To develop and design the packages, interfaces and inheritance.
- To learn and develop application based on exception, Java I/O and Multithreaded.

LIST OF EXPERIMENTS:

1. Demonstrate concept of variable, methods, control/conditional and looping statements using Java programs.
2. Demonstrate with java programs by creating own user defined classes and objects. Each class contains data and data members and methods to facilitate the user how to kept data encapsulated manner for the protection from the unauthorized access.
3. Write a java programs to create your own methods with or without return values, invoke a method with or without parameters, overload methods using the same names.
4. Design a java program to demonstrate the concept of package (user defined packages)
5. Write a java program to demonstrate the concept of abstract class and abstract method.
6. Demonstrate the concept of various string methods with suitable java program.
7. Write a java program to demonstrate the concept of single, multilevel inheritance and another program to illustrate how multiple inheritances is supported in java.
8. Write a java program demonstrates the use of static member and static function in a class.
9. Write a Java program to implement user defined exception handling.
10. Write a Java program to implement various file handling mechanisms.
11. Develop a mini project for any application using Java concepts.

TOTAL: 60 PERIODS

COURSE OUTCOME:

1. Understand and apply object oriented features and Java concepts.
2. Demonstrate key aspects of java Standard API library such as util, io, applets,

swings, GUI based controls.

3. Apply the concepts of class, operator overloading and function.

4. Apply the concept of STL and to design class using Java.

5. Apply the concept of Interface and inheritance and to implement exception handling and templates.

6. Develop applications using console I/O and file and to implement multi thread, generic programming.

21MA1404	NUMERICAL METHODS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT - I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations : Fixed point theorem (without proof)– Newton Raphson method - Solution of linear system of equations : Gauss elimination method - Gauss Jordan method - Iterative methods : Gauss Jacobi and Gauss Seidel - Eigen values of a matrix by Power method.

UNIT - II INTERPOLATION AND APPROXIMATION 9+3

Interpolation with unequal intervals: Lagrange's interpolation – Newton's divided difference interpolation – Interpolation with equal intervals: Newton's forward and backward difference formulae.

UNIT - III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT - IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods : Taylor's series method - Euler's method - Modified Euler's method –Improved Euler's method- Fourth order Runge - Kutta method for solving first order equations - Multi step methods : Milne's predictor corrector method for solving first order equations.

UNIT - V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIALEQUATIONS 9+3

Finite difference methods for solving second order ODE - Five point formula -Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations – One dimensional heat flow equation by explicit and implicit methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

OUTCOMES:

1. Understand the basic concepts and techniques of solving algebraic and transcendental equations.
2. Apply the numerical techniques of interpolation and error approximations in various intervals for real life situations.
3. Apply the numerical techniques of differentiation for engineering problems.
4. Apply the numerical techniques of integration for engineering problems.
5. Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
6. Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
3. .Kandasamy, P., Thilagavathy ,K.,andGunavathy,S., 'Numerical Methods', Chand and Co.,2007.

REFERENCES:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. SankaraRao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
3. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

21EE1401	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To educate the fundamental concepts of measuring instruments.
- To understand the operation of various analog and digital instruments.
- To infer the importance of various bridge circuits used with measuring instruments.
- To learn the principle and working of various transducers.

UNIT - I INTRODUCTION 9

Units and dimensions, Functional elements of an instrument, Static and dynamic characteristics, Errors in measurement, Statistical evaluation of measurement data, Standards and calibration.

UNIT - II ANALOG INSTRUMENTS 9

Moving coil instruments: Permanent magnet moving coil instruments, Moving iron: attraction and repulsion type instruments- Torque equations and errors, Single and Three phase watt meters and Energy meters.

UNIT - III DIGITAL INSTRUMENTS 9

Introduction, Digital Multi-meter: Block diagram, principle of operation, Digital Voltmeter: Block diagram, principle of operation, Types-Integrating type voltmeter, Digital Phase meter, Power quality analyzer.

UNIT - IV MEASUREMENT OF ELECTRICAL AND NON ELECTRICAL QUANTITIES 9

Measurement of Resistance: Kelvin double bridge, Wheatstone bridge, Measurement of inductance and capacitance: Maxwell and Schering bridge, Earth Resistance Tester, Measurement of Temperature: Thermocouples, Radiation and Optical pyrometer.

UNIT - V TRANSDUCERS 9

Selection of transducer, Classification of transducers: Resistive, capacitive & inductive transducers, Piezoelectric & Hall Effect Transducers.

TOTAL: 45 PERIODS

OUTCOMES:

1. Understand the fundamental concepts of measurements and instruments.
2. Analyze the static and dynamic behaviour of a measurement system and compare with standard system.
3. Categorize the working principle of various Analog instruments.
4. Examine the characteristics and performance parameters of Digital instruments.
5. Design a suitable bridge for the measurement of unknown resistance, Inductance and Capacitance.

6. Analyze the various types of transducers to measure the physical quantities.

TEXT BOOKS:

1. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements& Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2011.
2. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", Chand Pub, 2016.
3. E. O. Doebelin and D. N. Manik, " Measurement Systems – Application and Design", TataMcGraw-Hill, New Delhi, 2007.

REFERENCES:

1. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.
2. David Bell, ' Electronic Instrumentation & Measurements', Oxford University Press,2013.
3. Alan. S. Morris, Principles of Measurements and Instrumentation, 2nd Edition, Prentice Hallof India, 2003.
4. J.J. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011.

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108105153/
2. https://archive.nptel.ac.in/courses/108105064/

21EE1402	ELECTRICAL MACHINES – I	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on principles of electromechanical energy conversion in singly and doubly excited systems.
- To understand the construction, working principle of DC machines and analyze their performance.
- To understand the operation and performance of special machines.
- To familiarize with the construction details of different types of transformers, working principle and their performance.

UNIT - I PRINCIPLES OF ENERGY CONVERSION 9

Faraday's law of electromagnetic induction -singly and doubly excited magnetic field systems, EMF and torque production in rotating machines.

UNIT - II DC GENERATOR 9

Construction and components of DC Machine – Principle of operation - Lap and wave windings-EMF equations – armature reaction –methods of excitation-commutation – interpoles, compensating winding –characteristics of DC generators and application.

UNIT - III DC MOTOR 9

Principle and operations - types of DC Motors – Speed Torque Characteristics of DC Motors- starting and speed control of DC motors –Plugging, dynamic and regenerative braking, Testing and efficiency –Swinburne's test and Hopkinson's test - Permanent Magnet Brushless DC (PMBLDC)motors- Stepper motor, Applications.

UNIT - IV TRANSFORMERS 9

Construction - Principle of operation - Types - Equivalent circuit -Voltage regulation and efficiency - Auto transformer: Working and Application.

UNIT - V TRANSFORMER TESTING 9

Testing of transformers -Polarity, open circuit, short circuit and Sumpner's test - Three phase transformers connections- Parallel operation.

TOTAL: 45 PERIODS

OUTCOMES:

1. Examine the electro-mechanical energy conversion process in rotating electrical machines.
2. Understand the construction, working principle of DC machines and analyse the performance of DC Generator.
3. Interpret the characteristics of various types of DC Motor.
4. Analyze the performance of special electrical machines.
5. Interpret the constructional details of different types of transformers, working principle and their performance.

6. Analyse the performance of single and three phase transformers by various testing methods.

TEXT BOOKS:

1. Nagrath, I.J. and Kothari.D.P, Electric Machines', McGraw-Hill Education, 2004.
2. Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.
3. Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', 6th edition, McGraw Hill Books Company, 2003.

REFERENCES:

1. Theodore Wildi, "Electrical Machines, Drives, and Power Systems", Pearson Education., 5thedition, 2002.
2. B.R. Gupta, 'Fundamental of Electric Machines' New age International Publishers,3rdEdition,Reprint 2015.
3. S.K. Bhattacharya, 'Electrical Machines' McGraw - Hill Education, New Delhi, 3rd Edition,2009.
4. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.
5. Surinder Pal Bali, 'Electrical Technology Machines & Measurements, Vol.II, Pearson, 2013.

WEB REFERENCES:

1. https://www.brainkart.com/subject/Electrical-Machines-I_192

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108105017/
2. https://archive.nptel.ac.in/courses/108105155/
3. https://www.classcentral.com/course/swayam-electrical-machines-iitd-14030

21EE1403	TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the structure of electric power system and to develop expressions for the computation of transmission line parameters.
- To obtain the equivalent circuits for the transmission lines based on distance and to determine voltage regulation and efficiency.
- To understand the mechanical design of transmission lines and to analyze the voltage distribution in insulator strings to improve the efficiency.
- To study the types, construction of Cables and methods to improve the efficiency.
- To understand the different types of distribution system and substations with its layout.

UNIT - I INTRODUCTION TO POWER SYSTEM 9

Structure of electric power system - operating voltages of generation, transmission and distribution – advantage of higher operating voltage for AC transmission - Right of Way, Substation layout, Mechanical designs of transmission line: Sag and tension calculations- effect of ice and wind on sag.

UNIT - II TRANSMISSION LINE PARAMETERS 9

Resistance, inductance and capacitance calculations: single and three phase transmission lines - double circuits - solid, stranded and bundled conductors - symmetrical and unsymmetrical spacing – transposition of lines - concepts of GMR and GMD - skin and proximity effects.

UNIT - III MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Transmission line classification - short line, medium line and long line – equivalent circuits –Sending end voltage, current, voltage regulation and transmission efficiency- ABCD constants- real and reactive power flow in lines – surge impedance and surge-impedance loading - Ferranti effect -. Corona discharge characteristics – critical voltage and corona loss.

UNIT - IV INSULATORS AND UG CABLES 9

Insulators: Types - Characteristics and classification – voltage distribution in insulator string - improvement of string efficiency, Underground cables: constructional features of LT and HT cables – insulation resistance, capacitance, and dielectric stress – grading of UG cables.

UNIT - V DISTRIBUTION SYSTEMS 9

Feeders, distributors and service mains, DC 2-wire distributor – radial and ring main distribution, AC distribution – single phase (with concentrated loads) and three phase 3-wire and 4-wire distribution with balanced and unbalanced loads.

TOTAL: 45 PERIODS

OUTCOMES:

1. Understand the importance and the functioning of Power system.
2. Calculate the sag and tension of transmission lines
3. Estimate the line parameters for transmission lines.
4. Model and Predict the performance parameters of transmission lines
5. Analyze the voltage distribution in insulator strings and grading of cables in transmission lines.
6. Study the different types of distribution system.

TEXT BOOKS:

1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Second Edition, 2008.
2. C.L.Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, 2009.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011.

REFERENCES:

1. B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Fifth Edition, 2008.
2. V.K.Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi, 2013.
3. G.Ramamurthy, "Handbook of Electrical power Distribution," Universities Press,2013.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_ee17/preview
2. https://archive.nptel.ac.in/courses/108/105/108105104/
3. https://www.coursera.org/lecture/electric-utilities/1-10-transmission-and-distribution-gcjre

21EE1404	CONTROL SYSTEMS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand the use of transfer function models for analysis physical systems and introduce the control system components.
- To provide adequate knowledge in the time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- To introduce stability analysis and design of compensators.
- To introduce state variable representation of physical systems.

UNIT - I SYSTEMS AND REPRESENTATION 9+3

Basic elements in control systems: – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs.

UNIT - II TIME RESPONSE 9+3

Time response: – Time domain specifications – Types of test input – I and II order system response – Error coefficients – Generalized error series – Steady state error – Root locus construction- Effects of P, PI, PID modes of feedback control –Time response analysis.

UNIT - III FREQUENCY RESPONSE 9+3

Frequency response: – Bode plot – Polar plot – Determination of closed loop response from open loop response - Correlation between frequency domain and time domain specifications.

UNIT - IV STABILITY AND COMPENSATOR DESIGN 9+3

Characteristics equation – Routh Hurwitz criterion – Nyquist stability criterion- Performance criteria – Effect of Lag, lead and lag-lead compensation on frequency response-Design of Lag, lead and lag lead.

UNIT - V STATE VARIABLE ANALYSIS 9+3

Concept of state variables – State models for linear and time invariant Systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability.

TOTAL: 60 PERIODS

OUTCOMES:

1. Develop mathematical models of electrical and mechanical systems.
2. Compute the time domain specifications for LTI system.
3. Estimate the frequency domain parameters from frequency response analysis of LTI system.
4. Analyze the performance and stability of system through time domain and frequency domain approach.

5. Design the lag and lead compensators for desired system performance.
6. Develop the state space model and examine the controllability and observability of the system.

TEXT BOOKS:

1. Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers, 2017.
2. Benjamin C. Kuo, “Automatic Control Systems”, Wiley, 2014.

REFERENCES:

1. Katsuhiko Ogata, “Modern Control Engineering”, Pearson, 2015.
2. Richard C.Dorf and Bishop, R.H., “Modern Control Systems”, Pearson Education,2009.
3. John J.D., Azzo Constantine, H. and HoupisSttuart, N Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
4. RamesC.Panda and T. Thyagarajan, “An Introduction to Process Modelling Identification and Control of Engineers”, Narosa Publishing House, 2017.
5. M.Gopal, “Control System: Principle and design”, McGraw Hill Education, 2012.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_ee90/preview
2. https://archive.nptel.ac.in/courses/108106098/
3. https://www.classcentral.com/course/swayam-automatic-control-9850

21EE1405	DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To perform the numeric conversions and design of simple logic circuits.
- To understand the concepts of combinational circuits.
- To construct synchronous and asynchronous sequential circuits.
- To familiarize with programmable logic devices and logic families.
- To understand the fundamental concepts of VHDL programming.

UNIT - I NUMBER SYSTEM AND BOOLEAN ALGEBRA 9

Review of number system; Types and conversion of codes-BCD, Gray code, Excess 3 code; Error detection and correction codes; Boolean algebra: De-Morgan's theorem, Simplification of functions using K-maps- Quine McCluskey method.

UNIT - II COMBINATIONAL CIRCUITS 9

Design of functions using logic gates, Design of Adders, Subtractors, Comparators, Encoders, Decoders, Multiplexers and Demultiplexers.

UNIT - III SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS 9

Flip flops - SR, JK - MSJK , D and T, Analysis of synchronous and asynchronous sequential circuits, Design of synchronous sequential circuits-Counters, Moore and Melay model; state diagram; state reduction; state assignment.

UNIT - IV PROGRAMMABLE LOGIC DEVICES AND LOGIC FAMILIES 9

Logic families: RTL, DTL, TTL ECL NMOS and CMOS. Introduction to programmable Logic Devices, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

UNIT - V INTRODUCTION TO VHDL 9

Digital design process flow - Entities and Architecture - Concurrent statements - Sequential statements - Behavioural, Dataflow, and structural modelling - simple VHDL codes.

TOTAL: 45 PERIODS

OUTCOMES:

1. Apply Boolean algebra and gate level minimization to design digital circuits.
2. Design and realize the combinational circuits using logic gates.
3. Analyze the synchronous Sequential logic circuits using flip flops and counters.
4. Analyze and Design Asynchronous sequential logic circuits.
5. Examine the operation of various Programmable Logic Devices and logic families.
6. Develop simple programs in VHDL.

TEXT BOOKS:

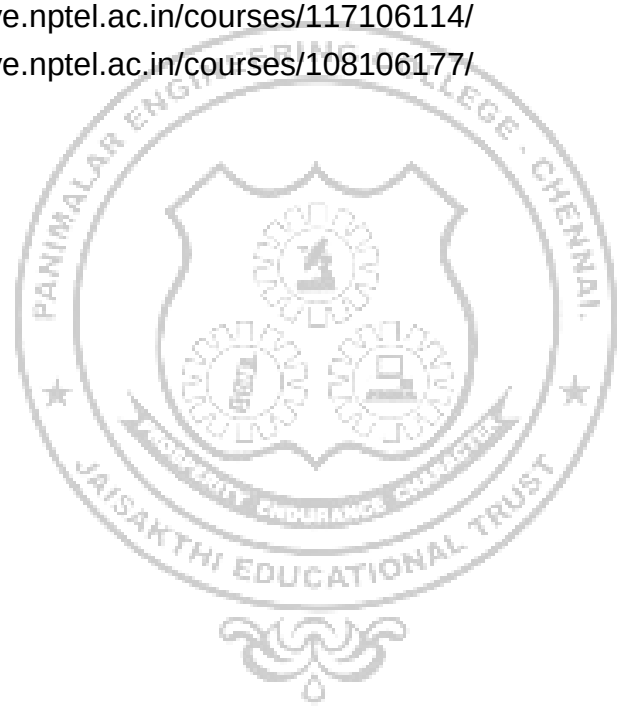
1. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, 2005.
2. Thomas L Floyd, ‘Digital fundamentals’, Pearson Education Limited, 1th Edition, 2015.

REFERENCES:

1. Mandal, "Digital Electronics Principles & Application", McGraw Hill Edu, 2013.
2. D.P.Kothari,J.S.Dhillon, ‘Digital circuits and Design’, Pearson Education, 2016.

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108105113/
2. https://archive.nptel.ac.in/courses/117106114/
3. https://archive.nptel.ac.in/courses/108106177/



21EE1411	ELECTRICAL MACHINES LABORATORY - I	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To determine the characteristics of DC machines by using simulation and experimental method.
- To enable the students to be familiar with the speed control of DC Motors.
- To know the performance characteristics of transformers based on various tests under no load, loading conditions, open circuit and short circuit conditions.
- To study the various connections in three phase transformers.

List of Experiments

1. Open circuit and load characteristics of DC shunt generator- critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulative connections.
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Swinburne's test and speed control of DC shunt motor.
7. Hopkinson's test on DC motor – generator set.
8. Load test on single-phase transformer and three phase transformers.
9. Open circuit and short circuit tests on single phase transformer.
10. Sumpner's test on single phase transformers.
11. Separation of no-load losses in single phase transformer.
12. Study of starters and 3-phase transformers connections.
13. Simulation on motoring and Braking operation of DC motor
14. Mini Project on application of PMBLDC and Stepper Motor.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. D.P. Kothari and B.S. Umre, "Laboratory Manual for Electrical Machines", 2ed, Wiley, 2020.

WEB REFERENCES:

1. https://ems-iitr.vlabs.ac.in/
2. https://ems-iitr.vlabs.ac.in/List%20of%20experiments.html

COURSE OUTCOME:

- Analyze the no load and load characteristics of DC Shunt and Compound generator.
- Illustrate the mechanical and electrical characteristics of Shunt, Series and Compound motor.
- Develop the equivalent circuit of Single phase Transformer and calculate the parameters of equivalent circuit.
- Demonstrate the indirect method of testing of DC machine to determine its efficiency.

- Analyze the different types of three phase transformer Connections.
- Analyze the characteristics of DC motor using Simulation software.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. DC Shunt Motor with Loading Arrangement – 3 nos
2. DC Series Motor with Loading Arrangement – 1 No.
3. DC compound Motor with Loading Arrangement – 1 No
4. Single Phase Transformer – 4 nos
5. Three phase Transformer-1nos
6. DC Shunt Motor Coupled with DC Compound Generator – 2 nos
7. DC Shunt Motor Coupled with DC Shunt Generator – 1 No.
8. DC Shunt Motor Coupled with Three phase Alternator – 1 No.
9. Tachometer -Digital/Analog – 8 nos
10. Single Phase Auto Transformer – 2 nos
11. Three Phase Auto Transformer – 1 No
12. Single Phase Resistive Loading Bank – 2 nos
13. Three Phase Resistive Loading Bank. – 2 nos
14. Starters-2point,3point & 4point- 1 Each
15. Personal Computer with simulation Software:4 nos

21EE1412	DIGITAL ELECTRONICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To impart the concept of Boolean reduction techniques and verify the output.
- To design and verify the output of combinational circuits.
- To realize the output of Synchronous and Asynchronous Sequential circuits.

LIST OF EXPERIMENTS:

1. Verification of Boolean laws using basic logic gates.
2. Design and implementation of Adder and Subtractor circuits.
3. Design and implementation Excess-3 to BCD and Binary to Gray code converter and vice-versa.
4. Design and implementation of Parity generator and parity checking
5. Design and implementation of Encoders and Decoders.
6. Design and implementation of 3-bit modulo counters as synchronous types using FF IC's and specific counter IC.
7. Design and implementation of 3-bit modulo counters and Asynchronous types using FF IC's and specific counter IC.
8. Design and implementation of simplified Boolean expressions using multiplexer and de multiplexer.
9. Design and implementation of Magnitude Comparators.
10. Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO modes using suitability IC's.
11. Study of clocked RS, D and JK Flip flops.
12. Mini project development using ICs.

TOTAL: 60 PERIODS

WEB REFERENCES:

1. https://da-iitb.vlabs.ac.in/List%20of%20experiments.html
2. https://dld-iitb.vlabs.ac.in/List%20of%20experiments.html

COURSE OUTCOME:

1. Formulate digital functions using Boolean Algebra and verify experimentally.
2. Develop the various combinational logic circuit using suitable IC's.
3. Design and implementation of synchronous Sequential logic circuits using flip flops and counters.
4. Design and implementation of Asynchronous sequential logic circuits.
5. Design and implementation of magnitude comparator.
6. Compare different types of shift registers using suitable IC's.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Dual ,(0-30V) variability Power Supply-10 Nos
2. Digital Multimeter-10 Nos
3. CRO(30MHz)-9 Nos
4. Bread board-10 Nos

Consumable (sufficient quantity)

- Digital IC -Types
- IC Trainer Kit
- Single Strand Wire

21EE1413	CONTROL AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To determine the transfer function of electrical systems.
- To infer knowledge about different types of bridges and transducers.
- To simulate the time response and frequency response of Second order linear system.
- To develop knowledge about signal conditioning systems.

LIST OF EXPERIMENTS:

1.CONTROL SYSTEM:

1. Digital Simulation of Second-order Systems for obtaining the time response of a system under various damping conditions.
2. Stability Analysis of Linear Systems using Bode, Root locus & Nyquist plots method using simulation software.
3. Determination of Transfer Function of Separately Excited DC Generator.
4. Determination of Transfer Function of Armature Controlled DC Motor.
5. DC Position Control Systems.
6. AC Position Control Systems.
7. Synchro-Transmitter- Receiver and Characteristics.
8. P, PI, and PID Controllers.

2. INSTRUMENTATION:

9. Bridge Networks –AC and DC Bridges.
10. Dynamics of Sensors/Transducers
    (a) Temperature
    (b) pressure
    (c) Displacement
    (d) Optical
    (e) Strain
    (f) Flow
11. Signal Conditioning
    (a) Instrumentation Amplifier
    (b) Analog – Digital and Digital –Analog converters (ADC and DACs)
12. Measurements of Three Phase Power.

TOTAL: 60 PERIODS

COURSE OUTCOME:

1. Analyze the time response and stability of second order linear System using simulation software.
2. Construct the transfer function of a DC Machines.
3. Infer the response of Position Control and Characteristics of Synchro Transmitter-Receiver.
4. Measure various electrical quantities using bridges.
5. Analyze the dynamics of Sensors / Transducers.
6. Interpret the basics of signal conditioning circuits and Familiar with measurement of three phase power.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CONTROL SYSTEMS:

1. Digital storage Oscilloscope for capturing transient- 1 No
2. Personal Computer with control system simulation packages - 10 Nos
3. DC motor –Generator test set-up for evaluation of motor parameters
4. CRO 30MHz – 1 No.
5. 2MHz Function Generator – 1No.
6. Position Control Systems Kit – 1 No., Tacho Generator Coupling set
7. AC Synchro transmitter& receiver – 1No.
8. P,PI,PID Controllers
9. Sufficient number of Digital multi meters, speed and torque sensors

INSTRUMENTATION:

10. R, L, C Bridge kit (with manual)
11. a) Electric heater – 1No.
    Thermometer – 1No.Thermistor (silicon type) RTD nickel type – 1No.
    b) 30 psi Pressure chamber (complete set) – 1No. Current generator (0 – 20mA) Air
    foot pump – 1 No. (with necessary connecting tubes)
    c) LVDT20mm core length movability type – 1No. CRO 30MHz – 1No.
    d) Optical sensor – 1 No. Light source
    e) Strain Gauge Kit with Handy lever beam – 1No.
    100gm weights – 10 Nos
    f) Flow measurement Trainer kit – 1 No.
    (1/2 HP Motor, Water tank, Digital Milli ammeter, complete set)
12. Single phase Auto transformer – 1No.
    wattmeter– 2No. Ammeter, Voltmeter, Rheostat, Stop watch, Connecting wires
13. Instrumentation Amplifier kit-1 No
14. Analog – Digital and Digital –Analog converters (ADC and DACs) - 1 No

21EE1501	POWER SYSTEM ANALYSIS	L	T	P	C
		2	1	0	3

OBJECTIVES:

- To understand the concepts of power systems and various power system components.
- To understand and apply iterative techniques for power flow analysis.
- To model and carryout short circuit studies in power system
- Evaluate fault currents for different types of faults
- To model and analyse stability problems in power system

UNIT - I BASIC CONCEPTS OF POWER SYSTEM 9

Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids. Need for system planning and operational studies, Per phase analysis of symmetrical three phase system, single line diagram, per unit representation; different models for generator, load and transmission lines based on the analysis of interest – π equivalent circuit of transformer with off nominal-tap ratio.

UNIT - II POWER FLOW ANALYSIS 9

Analysis of Power Flows: Primitive network and its matrices, bus admittance matrix formation by inspection method. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

UNIT - III SYMMETRICAL FAULT ANALYSIS 9

Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level - Current limiting reactors.

UNIT - IV UNSYMMETRICAL FAULT ANALYSIS 9

Symmetrical components - Sequence impedances - Sequence networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG - unsymmetrical fault occurring at any point in a power system - computation of post fault currents in symmetrical component and phasor domains.

UNIT - V STABILITY ANALYSIS 9

Classification of power system stability – Rotor angle stability - Swing equation - Swing curve - Power-Angle equation - Equal area criterion - Critical clearing angle and time - Classical step-by-step solution of the swing equation – modified Euler method.

TOTAL: 45 PERIODS

OUTCOMES:

1. Ability to Understand the concepts of power systems and various power system components

2. Ability to understand and apply iterative techniques for power flow analysis
3. Ability to model and carryout short circuit studies in power system
4. Ability to evaluate fault currents for different types of faults.
5. Ability to model and analyse stability problems in power system
6. Ability to model various components of the power system

TEXT BOOKS:

1. John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', McGraw Hill Education (India) Private Limited, New Delhi, 2015.
2. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, Second Edition, 2008
3. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

REFERENCES:

1. Pai M A, 'Computer Techniques in Power System Analysis', Tata McGraw Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.
2. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012
3. Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, 2001.
4. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.

WEB REFERENCES:

1. https://nptel.ac.in/content/storage2/courses/108101040/download/Lec-1.pdf
2. https://www.ijert.org/research/load-flow-solution-u-sing-simplified-newton-raphson-method-IJERTV2IS121281.pdf

ONLINE COURSES / RESOURCES:

1. http://nptel.ac.in/courses.php?disciplineId=108

21EE1502	MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the addressing modes & instruction set of 8085 &8051.
- To develop skills in simple program writing in assembly languages
- To introduce commonly used peripheral/interfacing ICs.
- To study and understand typical applications of micro-processors.
- To study and understand the typical applications of micro-controllers

UNIT - I INTRODUCTION TO 8085 ARCHITECTURE 9

Functional block diagram – Memory interfacing–I/O ports and data transfer concepts – Timing Diagram – Interrupt structure.

UNIT - II 8085 INSTRUCTION SET AND PROGRAMMING 9

Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing - Look up table - Subroutine instructions, stack.

UNIT - III INTERFACING BASICS AND ICS 9

Study of Architecture and programming of ICs: 8255 PPI, 8259PIC, 8251USART, 8279 Keyboard display controller and 8254 Timer/Counter – Interfacing with 8085 - A/D and D/A converter interfacing.

UNIT - IV INTRODUCTION TO 8051 MICROCONTROLLER 9

Functional block diagram - Instruction format and addressing modes – Interrupt structure – Timer – I/O ports – Serial communication, Simple programming – keyboard and display interface –Temperature control system –stepper motor control - Usage of IDE for assembly language programming.

UNIT - V INTRODUCTIONTO RISC BASED ARCHITECTURE 9

PIC16 /18 architecture, Memory organization – Addressing modes – Instruction set - Programming techniques – Timers – I/O ports – Interrupt programming.

TOTAL: 45 PERIODS

OUTCOMES:

1. Ability to understand the architecture and working operation of microprocessors and microcontrollers.
2. Ability to write assembly language program for microprocessor and microcontroller.
3. Ability to design and implement interfacing of peripheral with microprocessor and microcontroller.
4. Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring.
5. Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

6. Ability to understand and appreciate advanced architecture evolving microprocessor field.

TEXT BOOKS:

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Pen ram International (P)ltd., Mumbai, 6th Education, 2013.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The 8051 Micro Controller and Embedded Systems', Pearson Education, Second Edition 2011.
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The PIC Micro Controller and Embedded Systems', 2010.

REFERENCES:

1. Douglas V. Hall, "Micro-processors & Interfacing", Tata McGraw Hill 3rd Edition, 2017.
2. Krishna Kant, "Micro-processors & Micro-controllers", Prentice Hall of India, 2007.
3. Mike Predko, "8051 Micro-controllers", McGraw Hill, 2009.
4. Kenneth Ayala, 'The 8051 Microcontroller', Thomson, 3rd Edition 2004.

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/105/108105102/
2. https://technobyte.org/microprocessors-course-8085/
3. https://technobyte.org/?s=8051

21EE1503	ELECTRICAL MACHINES - II	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Construction and performance of salient and non – salient type synchronous generators.
- Principle of operation and performance of synchronous motor.
- Construction, principle of operation and performance of induction machines.
- Starting and speed control of three-phase induction motors.
- Construction, principle of operation and performance of single phase induction motors and special machines.

UNIT - I SYNCHRONOUS GENERATOR 9

Principle of Operation - Construction - Types of rotor - EMF equation - Armature reaction – Regulation of alternator: EMF, MMF and ZPF method - Capability curve of alternator - Permanent Magnet Synchronous Generator.

UNIT - II SYNCHRONOUS MOTOR 9

Principle of operation – Torque equation – Phasor diagram -V and Inverted V curves – Power input and power developed equations – Starting methods –-Hunting – damper windings- synchronous condenser.

UNIT - III THREE PHASE INDUCTION MOTOR 9

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling- Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses – Double cage induction motors –Induction generators.

UNIT - IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR 9

Need for starters – Types of starters – DOL, Rotor resistance, Autotransformer and Star- delta starters Rotor resistance starter – Speed control – Voltage control, Frequency control and pole changing -V/f control – Slip power recovery scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

UNIT - V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- - Linear induction motor -Universal motor.

TOTAL: 45 PERIODS

OUTCOMES:

1. Ability to understand the construction and working principle of Synchronous Generator
2. Ability to understand MMF curves and armature windings.

3. Ability to acquire knowledge on Synchronous motor.
4. Ability to understand the construction and working principle of Three phase Induction Motor
5. Ability to understand the construction and working principle of Special Machines
6. Ability to predetermine the performance characteristics of Synchronous Machines.

TEXT BOOKS:

1. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Mc Graw Hill publishing Company Ltd, 2003
2. B.L.Theraja & A.K.Theraja, "Electrical Technology Volume II AC & DC Machines", S.Chand and Company Limited,2005.
3. D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 2002.

REFERENCES:

1. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2003.
2. M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2009.
3. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers,3rd Edition ,Reprint 2015.
4. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, 2002.
5. R.K. Rajput " Electrical Machines", Laxmi Publications (P) Ltd, 2008
6. Alexander S. Langsdorf, 'Theory of Alternating-Current Machinery', McGraw Hill

   Publications, 2001.

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108105131
2. https://www.youtube.com/watch?v=3W7oSN_zHjQ
3. https://www.youtube.com/watch?v=NPm646lC8VI

21EE1504	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Different types of power semiconductor devices and their switching.
- Operation, characteristics and performance parameters of controlled rectifiers.
- Operation, switching techniques and basics topologies of DC-DC switching regulators.
- Different modulation techniques of pulse width modulated inverters and tounderstand harmonic reduction methods.
- Operation of AC voltage controller and various configurations.

UNIT - I POWER SEMI-CONDUCTOR DEVICES 9

Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCR- Introduction to Driver and snubber circuits.

UNIT - II PHASE-CONTROLLED CONVERTERS 9

2-pulse, 3-pulse and 6-pulseconverters – performance parameters – Effect of source inductance — Firing Schemes for converter – Dual converters, Applications-light dimmer, Excitation system, Solar PV systems.

UNIT - III DC TO DC CONVERTERS 9

Step-down and step-up chopper-control strategy – Introduction to types of choppers - A, B, C, D and E -Switched mode regulators - Buck, Boost, Buck- Boost regulator, Introduction to Resonant Converters, Applications-Battery operated vehicles.

UNIT - IV INVERTERS 9

Single phase and three phase voltage source inverters (both120^0 mode and 180^0 mode) – Voltage& harmonic control -- PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation – Current source inverter, Applications-Induction heating, UPS.

UNIT - V AC TO AC CONVERTERS 9

Single phase and Three phase AC voltage controllers – Control strategy - Power Factor Control – Multistage sequence control - single phase and three phase cyclo converters – Introduction to Matrix converters, Applications –welding.

TOTAL: 45 PERIODS

OUTCOMES:

1. Identify and select the switching devices for different power converter applications..
2. Design and analyze different DC-DC converter with various loads.
3. Design a suitable power converter for given dc load specification from AC input.
4. Design and analyze the single phase inverter and three phase inverters.

5. Explain the concepts of AC-AC converters.
6. Choose the suitable converters for real time applications

TEXT BOOKS:

1. M.H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, Third Edition, New Delhi, 2004.
2. P.S.Bimbra "Power Electronics" Khanna Publishers, Third Edition, 2003.
3. Ashfaq Ahmed 'Power Electronics for Technology', Pearson Education, Indian reprint, 2003.

REFERENCES:

1. Joseph Vithayathil,' Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2013.
2. Philip T. Krein, "Elements of Power Electronics" Oxford University Press, 2004 Edition.
3. L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
4. Ned Mohan Tore. M. Undel and, William. P. Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and sons, third edition, 2003.
5. S.Rama Reddy, 'Fundamentals of Power Electronics', Narosa Publications, 2014.
6. M.D. Singh and K.B. Khanchandani, "Power Electronics," Mc Graw Hill India, 2013.
7. JP Agarwal," Power Electronic Systems: Theory and Design" 1e, Pearson Education, 2002.

21EE1511	MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8085 &8051.
- To develop skills in simple program writing in assembly languages.
- To write an assembly language program to convert Analog input to Digital output and digital input to Analog output.
- To perform interfacing experiments with µP8085.
- To perform interfacing experiments with µC8051.

LIST OF EXPERIMENTS:

PROGRAMMING EXERCISES / EXPERIMENTS WITH µP8085:

1. Simple arithmetic operations: Multi precision addition /subtraction /multiplication /division.
2. Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
3. Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller
4. Stepper motor controller interface.
5. Displaying a moving/ rolling message in the student trainer kit's output device.

PROGRAMMING EXERCISES / EXPERIMENTS WITH µC8051:

6. Simple arithmetic operations with 8051: Multi precision addition / subtraction / multiplication /division.
7. Programming with control instructions and subroutines: Rotate instructions, Subroutine Program Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller
8. Stepper motor controller interface.
9. Displaying a moving / rolling message in the student trainer kit's output device.
10. Programming PIC architecture with software tools.
11. Programming 8051 with Keil Software.

TOTAL: 60 PERIODS

OUTCOMES:

1. Ability to write assembly language program for microprocessor.
2. Ability to write assembly language program for microcontroller.
3. Ability to design and implement interfacing of peripheral with microprocessor and microcontroller.
4. Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring.

5. Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.
6. Ability to program with software tools.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. 8085 Microprocessor Trainer with Power Supply - 15 Nos
2. 8051 Micro Controller Trainer Kit with power supply - 15 Nos
3. 8255 Interface board – 5 Nos
4. 8279 Keyboard / Display Interface board – 5 Nos
5. ADC – 5 Nos
6. DAC – 5 Nos
7. Stepper Motor – 5 Nos
8. Traffic Light Controller – 5 Nos
9. System.

21EE1512	ELECTRICAL MACHINES LABORATORY – II	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To understand the operation of synchronous machines.
- To understand the analysis of power angle curve of a synchronous machine.
- To understand the equivalent circuit of a single phase transformer and single phase
  induction motor.
- To understand the circle diagram of an induction motor by conducting a blocked rotor
  test.

LIST OF EXPERIMENTS:

1. Regulation of three phase alternator by EMF and MMF methods.
2. Regulation of three phase alternator by ZPF and ASA methods.
3. Regulation of three phase salient pole alternator by slip test.
4. Measurements of negative sequence and zero sequence impedance of alternators.
5. V and Inverted V curves of Three Phase Synchronous Motor.
6. Load test on three-phase induction motor.
7. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
8. Separation of No-load losses of three-phase induction motor.
9. Load test on single-phase induction motor.
10. No load and blocked rotor test on single-phase induction motor.
11. Study of Induction motor Starters.

TOTAL: 60 PERIODS

WEB REFERENCES:

- https://em-coep.vlabs.ac.in/List%20of%20experiments.html

OUTCOMES:

1. Ability to understand and analyze EMF and MMF methods.
2. Ability to analyze the characteristics of V and Inverted V curves.
3. Ability to understand the importance of Synchronous machines.
4. Ability to understand the importance of Induction Machines.
5. Ability to acquire knowledge on separation of losses.
6. Ability to understand the circle diagram of an induction motor

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Synchronous Induction motor 3HP – 1 No.
2. DC Shunt Motor Coupled with Three phase Alternator – 4 Nos
3. DC Shunt Motor Coupled with Three phase Slip ring Induction motor – 1 No.
4. Three Phase Induction Motor with Loading Arrangement – 2 Nos
5. Single Phase Induction Motor with Loading Arrangement – 2 Nos
6. Tachometer -Digital/Analog – 8 Nos
7. Single Phase Auto Transformer – 2 Nos
8. Three Phase Auto Transformer – 3 Nos
9. Single Phase Resistive Loading Bank – 2 Nos
10. Three Phase Resistive Loading Bank – 2 Nos
11. Capacitor Bank – 1 No.

21EE1513	INDUSTRIAL AUTOMATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

- To provide adequate knowledge in PLC, SCADA and DCS.
- To identify the differences between various PLCs.
- Exposure to different PLC programming.
- To provide adequate knowledge in DCS programming.
- Sensor data acquisition, data processing and visualization.
- Interfacing the various field devices with PLC.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Study of PLC field device interface modules (AI,AO,DI,DO modules).

2. Programming Logic Gates Function in PLC.

3. Implementing Mathematical Operations in PLC.

4. Programming Jump-to-subroutine & return operations in PLC.

5. PLC Exercises:- 1. Traffic Light Control and Filling/Draining Control Operation

6. PLC Exercise: 1. Reversal of DC Motor Direction 2. ON/OFF Controller for Thermal Process.

7. PC based control of Level Process.

8. On-line Monitoring and Control of a Pilot plant using DCS.

9. PLC based Control of Flow Process.

10. Study of Foundation Fieldbus / IOT/Wireless HART Enabled Transmitter.

TOTAL: 60 PERIODS

OUTCOMES:

1. Ability to understand and Programming of PLC, SCADA and DCS.

2. Ability to working with industrial automation system.

3. Ability to design and implement control schemes in PLC & DCS.

4. Ability to interface field devices with PLC.

5. Use timers and counter functions of PLC to construct simple applications.

6.Integrate and control process station with DCS.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Programmable Logic Controller 5 Nos.
2. Programmable Logic Controller Software 10 User License.
3. DAQ card 2 Nos.
4. Filling /Draining System 1 No.
5. Traffic Light Controller 2 Nos.
6. DC Motor 5 Nos.
7. Personal computer- 10 Nos.
8. DCS along with Interface modules 1 set.
9. Thermal Process, Level Process , Flow and Pressure process stations – 1 set each.
10. Smart Transmitter - 1 No.

21EE1601	ELECTRICAL DRIVES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Steady state operation and transient dynamics of a motor load system.
- Analyze the operation of the converter/chopper fed dc drive, both qualitatively and quantitatively.
- Operation and performance of AC motor drives.
- Operation and performance of drives in industrial applications.
- Select suitability drive for the given application.

UNIT - I DRIVE CHARACTERISTICS 9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

UNIT - II CONVERTER / CHOPPER FED DC MOTOR DRIVE 9

Steady state analysis of the single and three phase converter fed separately excited DC motor drive– continuous conduction – Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive-Applications.

UNIT - III INDUCTION MOTOR DRIVES 9

Stator voltage control–V/f control– Rotor Resistance control-qualitative treatment of slip power recovery drives-closed loop control—– vector control- Applications.

UNIT - IV SYNCHRONOUS MOTOR DRIVES 9

V/f control and self-control of synchronous motor: Margin angle control and power factor control- Three phase voltage/current source fed synchronous motor-Applications.

UNIT - V DIGITAL CONTROL AND DRIVE APPLICATIONS 9

Digital techniques in speed control - Advantages and limitations - Microprocessor/Microcontroller and PLC based control of drives, networking of drives - Selection of drives and control schemes for Steel rolling mills, Paper mills, Cement mills, Machine tools, Lifts and Cranes. Solar and battery powered drives.

TOTAL: 45 PERIODS

OUTCOMES:

1. Ability to understand steady state and transient dynamics operation of a motor load system
2. Ability to select suitable DC drive for the given application
3. Ability to understand the operation and performance of Induction motor drives.
4. Ability to analyze the operation and performance of synchronous motor drives.
5. Ability to understand and suggest a converter feed drives for Industrial Applications

6. Ability to apply digital control technique in Electric drives.

TEXT BOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 1992.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002.
3. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson, 2001
4. N.K. De., P.K. SEN" Electric drives" PHI, 2012.

REFERENCES:

1. Shaahin Felizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis Group), 2013.
2. Vedam Subramanyam, " Electric Drives Concepts and Applications ", 2nd edition, McGraw Hill, 2016
3. John Hindmarsh and Alasdain Renfrew, "Electrical Machines and Drives System", Elsevier 2012.
4. Theodore Wildi, "Electrical Machines, Drives and power systems", 6th edition, Pearson Education, 2015.

WEB REFERENCES:

1. http://en.wikipedia.org/wiki/Industrial drives Control
2. http://en.wikibooks.org/wiki/Drives
3. http://en.wikipedia.org/wiki/Electric motors

ONLINE COURSES / RESOURCES:

1. NPTEL –FUNDAMENTALS OF ELECTRIC DRIVES-Prof. Shyama Prasad Das
2. https://www.classcentral.com/course/swayam-fundamentals-of-electric-drives-14073
3. https://drive.google.com/file/d/11mTcwHIcUfBFbKSG6XJdmrXvx_d7hhKo/view?ts=6090c8e6

21EE1602	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Significance of power system operation and control.
- Real power-frequency interaction and design of power-frequency controller.
- Reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
- Economic operation of power system.
- SCADA and its application for real time operation and control of power systems.

UNIT - I PRELIMINARIES ON POWER SYSTEM OPERATION AND CONTROL 9

Power scenario in Indian grid – National and Regional load dispatching centres – requirements of good power system - necessity of voltage and frequency regulation - real power vs frequency and reactive power vs voltage control loops - system load variation, load curves and basic concepts of load dispatching - load forecasting - Basics of speed governing mechanisms and modeling - speed load characteristics - regulation of two generators in parallel.

UNIT - II REAL POWER - FREQUENCY CONTROL 9

Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases - LFC of two area system - tie line modeling - block diagram representation of two area system - static and dynamic analysis - tie line with frequency bias control – state variability model - integration of economic dispatch control with LFC.

UNIT - III REACTIVE POWER – VOLTAGE CONTROL 9

Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop - static and dynamic analysis – stability compensation – voltage drop in transmission line - methods of reactive power injection - tap changing transformer, SVC (TCR + TSC) and STATCOM for voltage control.

UNIT - IV ECONOMIC OPERATION OF POWER SYSTEM 9

Statement of economic dispatch problem - input and output characteristics of thermal plant - incremental cost curve - optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) - base point and participation factors method - statement of unit commitment (UC) problem - constraints on UC problem - solution of UC problem using priority list. (Numerical problems only in priority-list method using full-load average production cost).

UNIT – V COMPUTER CONTROL OF POWER SYSTEMS 9

Need of computer control of power systems-concept of energy control centers and functions – PMU - system monitoring, data acquisition and controls - System hardware configurations - SCADA and EMS functions - state estimation - weighted least square estimation - various operating states - state transition diagram.

TOTAL: 45 PERIODS

OUTCOMES:

1. Understand the day-to-day operation of electric power system.
2. Analyze the control actions to be implemented on the system to meet the minute-to-minute variation of system demand.
3. Model the singe and multi area load frequency control to analyse the performance of power system.
4. Model the AVR for maintaining the voltage profile against varying system load.
5. Analyze the optimal dispatch problems and unit commitment in various power plants.
6. Study the computer control of power system.

TEXT BOOKS:

1. Olle.I.Elgerd, 'Electric Energy Systems theory - An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
2. Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2016.
3. Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

REFERENCES:

1. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, Second Edition, 2008.
2. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
3. Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108101040

21EE1603	EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Building Blocks of Embedded System.
- Various Embedded Development Strategies.
- Bus Communication in processors, Input/output interfacing.
- Various processor scheduling algorithms.
- Basics of Real time operating system and example tutorials to discuss on one real time operating system tool.

UNIT - I INTRODUCTION TO EMBEDDED SYSTEMS 9

Introduction to Embedded Systems –Structural units in Embedded processor , selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

UNIT - II EMBEDDED NETWORKING 9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I^2C) –need for device drivers.

UNIT - III EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT 9

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.

UNIT - IV RTOS BASED EMBEDDED SYSTEM DESIGN 9

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance.

UNIT - V EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT 9

Case Study of Washing Machine- Automotive Application- Smart card System Application-ATM machine –Digital camera.

TOTAL: 45 PERIODS

OUTCOMES:

1. Ability to understand and analyze Embedded systems.
2. Ability to suggest an embedded system for a given application.
3. Ability to operate various Embedded Development Strategies.
4. Ability to study about the bus Communication in processors.
5. Ability to acquire knowledge on various processor scheduling algorithms.
6. Ability to understand basics of Real time operating system.

TEXT BOOKS:

1. Peckol, “Embedded system Design”, John Wiley & Sons, 2010.
2. Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2013.
3. Shibu. K.V, “Introduction to Embedded Systems”, 2e, Mc graw Hill, 2017.

REFERENCES:

1. Raj Kamal, ‘Embedded System-Architecture, Programming, Design’, Mc Graw Hill, 2013.
2. C.R.Sarma, “Embedded Systems Engineering”, University Press (India) Pvt. Ltd, 2013.
3. Tammy Noergaard, “Embedded Systems Architecture”, Elsevier, 2006.
4. Han-Way Huang, “Embedded system Design Using C8051”, Cengage Learning, 2009.
5. Rajib Mall “Real-Time systems Theory and Practice” Pearson Education, 2007.

21EE1611	POWER ELECTRONICS AND DRIVES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To provide hands on experience with power electronic converters and testing.

LIST OF EXPERIMENTS:

1. Gate Pulse Generation using R, RC and UJT.
2. Characteristics of SCR and TRIAC.
3. Characteristics of MOSFET and IGBT.
4. AC to DC half controlled converter.
5. AC to DC fully controlled Converter.
6. Step down and step up MOSFET based choppers.
7. IGBT based single phase PWM inverter.
8. IGBT based three phase PWM inverter.
9. AC Voltage controller.
10. Switched mode power converter.
11. Simulation of PE circuits (1Φ & 3Φ Semiconverter, 1Φ & 3Φ \ Full converter, DC-DC Converters, AC Voltage Controllers).
12. Characteristics of GTO & IGCT.
13. Characteristics of PMBLDC Motor.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

1. Analyze the device characteristics and gate pulse generation and characteristics SCR.
2. Study the characteristics of MOSFET and IGBT.
3. Design and analyze the choppers and chopper fed dc drives.
4. Analyze the inverter operation and inverter fed induction motor drives.
5. Design and analyze the single phase and three phase controlled rectifiers fed DC drives.
6. Analyze the performance of AC-AC converters.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Device characteristics (for SCR, MOSFET, TRIAC, GTO, IGCT and IGBT kit with built-in / discrete power supply and meters) - 2 each
2. SinglephaseSCRbasedhalfcontrolledconverterandfullycontrolledconverteralong with built-in/separate/firing circuit/module and meter – 2 each
3. MOSFET based step up and step-down choppers (Built in/ Discrete) – 1 each
4. IGBT based single phase PWM inverter module/Discrete Component – 2
5. IGBT based three phase PWM inverter module/Discrete Component – 2
6. Switched mode power converter module/Discrete Component – 2
7. SCR &TRIAC based 1 phase AC controller along with lamp or rheostat load - 2
8. Cyclo converter kit with firing module – 1
9. Dual regulated DC power supply with common ground
10. Cathode ray Oscilloscope –10
11. Isolation Transformer – 5
12. Single phase Auto transformer –3
13. Components (Inductance, Capacitance) 3 set for each
14. Multimeter – 5
15. LCR meter – 3
16. Rheostats of various ranges – 2 sets of 10 value
17. Work tabilitys – 10
18. DC and AC meters of required ranges – 20
19. Component data sheets to be provided

21EE1612	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To simulate and to analyze the power system network
- To know and study about the transmission line parameters.
- To apply iterative techniques for power flow analysis.
- To model the singe and multi area load frequency control to analyse the performance of power system
- To Impart Knowledge on Economic Load dispatch and power system stability

LIST OF EXPERIMENTS:

1. Computation of Transmission Line Parameters.
2. Formation of Bus Admittance and Impedance Matrices and Solution of Networks.
3. Power Flow Analysis using Gauss-Seidel Method.
4. Power Flow Analysis using Newton Raphson Method.
5. Symmetric and unsymmetrical fault analysis.
6. Transient stability analysis of SMIB System.
7. Economic Dispatch in Power Systems.
8. Load Frequency control of a single area system with and without PI controller.
9. Load Frequency control of a tie line area network
10. State estimation: Weighted least square estimation.
11. Electromagnetic Transients in Power Systems: Transmission Line Energization.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. TharangikaBambaravanage, Asanka Rodrigo, SisilKumarawadu, “Modeling, Simulation, and Control of a Medium-Scale Power System”, Springer Nature Singapore Pte Ltd, 2018.

2. Pai M. A., “Computer Techniques in Power System Analysis”, 3rd Ed., Tata McGraw-Hill Publishing Company Limited. 2014.

3. Kothari D. P and Nagrath I. J., “Modern Power System Analysis”,3rdEd., Tata McGraw-Hill Publishing Company Limited, 2011.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108105067

2. https://www.vlab.co.in/broad-area-electrical-engineering

3. https://www.youtube.com/watch?v=HcMh7ahJxfo

4. https://www.power-analysis.com/

COURSE OUTCOME:

1. Construct the bus admittance and impedance matrices.
2. Analyze the power system under steady state condition using GS and NR method.
3. Classify the types of faults and analyze the power system on different faulted conditions.
4. Perform optimal dispatch scheduling for the given power networks.
5. Analyze the load frequency control of power systems.
6. Illustrate the concepts of transient and steady state stability in power systems.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Personal computers (Intel i3, 80GB, 2GBRAM) – 30 Nos.
2. Printer laser- 1 No.
3. Dot matrix- 1 No.
4. Server (Intel i5, 80GB, 2GBRAM) (High Speed Processor) – 1 No.
5. Software: any power system simulation software with 5 user license.
6. Compliers: C, C++, VB, VC++ - 30 users.

21EE1701	PROTECTION AND SWITCHGEAR	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Importance of protection, protection schemes and earthing.
- Characteristics and functions of relays and protection schemes.
- Apparatus protection, static and numerical relays.
- Problems associated with circuit breaking.
- Functioning of circuit breaker.

UNIT - I PROTECTION SCHEMES 9

Principles and need for protective schemes – nature and causes of faults– Methods of Grounding - Zones of protection and essential qualities of protection – surge absorbers, surge diverters, Protective scheme.

UNIT - II ELECTROMAGNETIC RELAYS 9

Operating principles of relays - Electromagnetic Relays – Over current, Directional and Non Directional , Distance, Differential, Negative sequence and Under frequency relays.

UNIT - III APPARATUS PROTECTION 9

Protection of transformer, generator, motor, bus bars and transmission line, Current transformers and Potential transformers and their applications in protection schemes.

UNIT - IV STATIC RELAYS AND NUMERICAL PROTECTION 9

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, distant protection of transmission lines.

UNIT - V CIRCUIT BREAKERS 9

Physics of arcing phenomenon and arc interruption– re-striking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching - current chopping - Types of circuit breakers – air blast, air break, oil, SF6, MCBs, MCCBs and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of Circuit breakers-Recent developments in protective relays.

TOTAL: 45 PERIODS

OUTCOMES:

1. Analyze the causes of different types of faults and choose a suitable protection scheme.
2. Understand and analyze Electromagnetic, Numerical and Static Relays.
3. Elucidate various protection schemes for various power system components.
4. Suggest the types of relays for specific applications.
5. Examine the circuit interruption schemes for power systems.
6. Select circuit breaker based on application requirements.

TEXT BOOKS:

1. Sunil S.Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi, 2008.
2. B.Rabindranath and N.Chander, ‘Power System Protection and Switchgear’, New Age International (P) Ltd., First Edition 2011.
3. ArunIngole, ‘Switch Gear and Protection’ Pearson Education, 2017.

REFERENCES:

1. BadriRam, B.H. Vishwakarma, ‘Power System Protection and Switchgear’, New Age International Pvt Ltd Publishers, Second Edition, 2011.
2. Y.G.Paithankar and S.R.Bhide, ‘Fundamentals of power system protection’, Second Edition,Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
3. C.L.Wadhwa, ‘Electrical Power Systems’, 6th Edition, New Age International (P) Ltd., 2010.
4. Ravindra P.Singh, ‘Switchgear and Power System Protection’, PHI Learning Private Ltd., New Delhi, 2009.
5. VK Metha, "Principles of Power Systems", S. Chand, 2005.
6. Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,’Protection and Switchgear’ Oxford University Press, 2011.

ONLINE COURSES / RESOURCES:

1. https://www.digimat.in/nptel/courses/video/108107167/L01.html
2. http://nptel.ac.in/courses/Webcourse contents/IIT%20Bombay/Power%20System%20Protection/TOC_M1.html
3. http://www.idc-online.ac.za/electrical-engineering/electrical-power-system-protection.html

21EE1702	RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To create awareness about renewable Energy Sources and technologies.
- To outline the various forms of wind energy conversion systems.
- To analyze topology of the stand-alone and grid connected photo-voltaic systems.
- To facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of Biomass and Alternative Sources of Energy
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT - I CONVENTIONAL AND RENEWABLE ENERGY (RE) SOURCES 9

Over View of Conventional Power Plants - Importance of Sustainable energy source - Types of Sustainable Energy sources - Limitations of Sustainable Energy sources - Present Indian and international energy scenario of conventional and sustainable energy sources – Kyotoprotocol - Concept of clean development mechanism and proto type carbon funds - Integrated resource plan.

UNIT - II WIND ENERGY 9

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit- Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid Integration.

UNIT - III SOLAR PV AND THERMAL SYSTEMS 9

Solar thermal Systems – Types of collectors – Collection systems – Solar Photovoltaic systems: Basic Principle of SPV conversion – I-V Characteristics, Cells, Module and array types - series and parallel connections - Maximum power point tracking, grid interactive solar PV systems -– Grid integration issues.Application.

UNIT - IV OTHER ENERGY SOURCES 9

Biomass – Conversion of biomass in other form of energy – solid, liquid and gases – Hydro energy – Feasibility of small, mini and micro hydel plants – Tidal and wave energy – Geothermal and Ocean-Thermal Energy Conversion (OTEC) systems – Schemes, feasibility and viability.

UNIT - V ENERGY STORAGE AND HYBRID SYSTEM CONFIGURATIONS 9

Energy storage – Battery – Types – Equivalent circuit- Battery storage modeling – Performance characteristics – design –charge regulators – Battery management – Fly wheel - Fuel cell - Ultra capacitors – Benefits over battery. Introduction to vehicle to grid systems -overview of standalone and grid connected Photovoltaic with Wind hybrid system.

TOTAL: 45 PERIODS

OUTCOMES:

1. Categorize the various renewable energy sources.
2. Analyze the different configurations of the wind energy conversion systems.
3. Illustrate the working of solar thermal power plant.
4. Explain the overview of solar photovoltaic systems and implement a maximum power point tracking in the PV system.
5. Acquire knowledge about biomass and geothermal energy.
6. Understand the concepts of the various Energy storage system.

TEXT BOOKS:

1. Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt. Ltd, New Delhi, 2011.
2. D. P. Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt. Ltd, New Delhi, 2013.
3. Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.

REFERENCES:

1. Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.
2. Rai. G.D, "Non-conventional energy sources", Khanna publishes, 1993.
3. Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.
4. A.K.Mukerjee and Nivedita Thakur," Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011.

WEB REFERENCES:

1. http://unfccc.int/kyoto_protocol/items/2830.php
2. https://www.coursera.org/learn/wind-energy
3. https://www.edx.org/course/solar-energy-delftx-et3034x-0

21EE1703	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand over voltage phenomenon and protection methods in electrical Power systems.
- To impart knowledge on breakdown mechanisms of different dielectrics.
- To learn about high voltage and high current generation techniques.
- To study the different measurements techniques of high voltages & currents.
- To learn how to conduct dielectric tests on various electrical equipment and to study about insulation coordination in electrical power systems.

UNIT - I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 6

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages –- Estimation of over voltages- Reflection and Refraction of Travelling waves- Bewley lattice diagram - Protection against over voltages.

UNIT - II DIELECTRIC BREAKDOWN 12

Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Characteristics, Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics.

UNIT - III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9

Generation of High DC, AC, impulse voltages - generation of impulse currents - Triggering and control of impulse generators.

UNIT - IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS 9

High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers -Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.

UNIT - V HIGH VOLTAGE TESTING OF EQUIPMENT AND INSULATION COORDINATION 9

High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, bushing, cables, circuit breakers and transformers - Insulation coordination.

TOTAL: 45 PERIODS

OUTCOMES:

1. Explain the over voltage phenomenon and protection methods in electrical power systems
2. Explicate the different breakdown mechanisms in solid, liquid, gaseous & vacuum.
3. Illustrate different methods of generation of high voltages and high currents

4. Summarize the various measurement techniques of high voltages & currents with their relative merits and demerits
5. Suggest suitable testing methods to test various high voltage equipments
6. Explain the different aspects of insulation design and insulation co-ordination adopted for EHV systems.

TEXT BOOKS:

1. M. S. Naidu and V. Kamaraju, High Voltage Engineering, 5th Edition Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2013.
2. E.Kuffel and W.S. Zaengl, J.Kuffel, High voltage Engineering fundamentals, Newnes Second Edition, Elsevier, New Delhi 2005.
3. C.L.Wadhwa, High voltage Engineering, New Age International Publishers, Third Edition,2010.

REFERENCES:

1. L.L.Alston, High Voltage Technology, Oxford University Press, First Indian Edition 2011.
2. Rakosh Das Begamudre, High Voltage Engineering, Problems and Solutions, New Age International Publishers, New Delhi, 2010.
3. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice, Second Edition Marcel Dekker, Inc., 2010.
4. Subir Ray, An Introduction to High Voltage Engineering, PHI Learning Private Limited, New Delhi, Second Edition, 2011.

ONLINE COURSES / RESOURCES:

1. www.digimat.in/nptel/courses/video/108104013/L19.html
2. https://nptel.ac.in/courses/108/104/108104048/

21EE1711	RENEWABLE ENERGY SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To train the students in Renewable Energy Sources and technologies.
- To provide adequate inputs on a variety of issues in harnessing Renewable Energy.
- To train the students Simulation and hardware study on hybrid systems.
- To provide a better understanding of the renewable energy system through digital simulation.
- To recognize the current and possible future role of Renewable energy.

LIST OF EXPERIMENTS:

1. Simulation study on Solar PV Energy System.
2. Experiment on “VI-Characteristics and Efficiency of 1kWp Solar PV System”.
3. Experiment on “Shadowing effect & diode based solution in 1kWp Solar PV System”.
4. Experiment on Performance assessment of Grid connected and Standalone 1kWp Solar Power System.
5. Simulation study on Wind Energy Generator.
6. Experiment on Performance assessment of micro Wind Energy Generator.
7. Simulation study on Hybrid (Solar-Wind) Power System.
8. Experiment on Performance Assessment of Hybrid (Solar-Wind) Power System.
9. Simulation study on Hydel Power.
10. Experiment on Performance Assessment of 100W Fuel Cell.
11. Simulation study on “Shadowing effect & diode based solution in 1kWp Solar PV System”.

TOTAL: 60 PERIODS

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc20_ph14/

COURSE OUTCOME:

1. Identify the Various renewable energy sources and technologies.
2. Create a simulation circuit for solar power generation systems that includes a control circuit.
3. Design and simulate the circuit diagram for hybrid energy systems.
4. Analyze the circuit diagram by conducting the hardware experiment on various renewable energy systems.
5. Discuss about Simulation study on Hydel Power.

6. Examine a control circuit for fuel cell power production systems.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Name of the equipments / Components	Quantity Required	Remarks
1.	Personal computers (Intel i3, 80GB, 2GBRAM) -	15	-
2.	CRO	9	30MHz
3	Digital Multimeter	10	Digital
4	PV panels - 100W, 24V	1	
5	Battery storage system with charge and discharge control 40Ah	1	
6	PV Emulator	1	
7	Micro Wind Energy Generator module	1	
8	Potentiometer	5	
9	Step-down transformer	5	230V / 12-0-12V
10	Component data sheets to be provided		

21EE1712	MINI PROJECT	L	T	P	C
		0	0	4	2

OBJECTIVES:

1. To develop their own innovative prototype of ideas.
2. To train the students in preparing mini project reports and examination.

The students in a group of 5 to 6 works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 PERIODS

OUTCOMES:

1. On Completion of the mini project work students will be in a position to take up their final year project work and find solution by formulating proper methodology.

21EE1811	PROJECT WORK	L	T	P	C
		0	0	16	8

OBJECTIVES:

The student should be made to learn methodology to select a good project and able to work in a team leading to development of hardware/software product. Gain Motivation to present the ideas behind the project with clarity.

A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The aim of the project work is to deepen Comprehension of principles by applying them to a new problem which may be the design /fabrication of any power component / circuit / sensor / Activator / Controller, a research investigation, a computer or management project or a design problem. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

TOTAL: 240 PERIODS

OUTCOMES:

1. Ability to identify, formulate, design, interprete, analyze and provide solutions to complex engineering and societal issues by applying knowledge gained on basics of science and Engineering.
2. Ability to choose, conduct and demonstrate a sound technical knowledge of their selected project topics in the field of power components, protection, high voltage, electronics, process automation, power electronics and drives instrumentation and control by exploring suitable engineering and IT tools..
3. Ability to understand, formulate and propose new learning algorithms to solve engineering and societal problems of moderate complexity through multidisciplinary projects understanding commitment towards sustainable development..
4. Ability to demonstrate, prepare reports, communicate and work in a team as a member/leader by adhering to ethical responsibilities.
5. Ability to acknowledge the value of continuing education for oneself and to stay up with technology advancements.
6. Ability to take up any challenging practical problems and find solution by formulating proper methodology

VERTICAL I: POWER ENGINEERING

21EE1901	UNDER GROUND CABLE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- Understanding Power Cable Characteristics and Applications.
- Cable Manufacturing.
- Installation of underground power cables
- Underground cable System Fault Locating.
- Testing and maintenance of Underground cable system.
- Cable Performance and Field Assessment of Power Cables

UNIT - I INTRODUCTION TO ELECTRICAL POWER CABLES (7+2 SKILL) 9

Development of Underground Cables - Electric Lighting- Distribution of Energy for Lighting- - Paper Insulated Cables - Underground Residential Distribution Systems- Medium Voltage Cable Development.

UNIT - II CABLE ARCHITECHTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS (7+2 SKILL) 9

Architecture of Underground Cabling System - Basic Dielectric Theory of Cable – Conductors -Armour and Protective Finishes - Cable Characteristics: Electrical- Fundamentals of Electrical Insulation Materials - Electrical Properties of Cable Insulating Materials - Cable Standards and Quality Assurance - Cable design parameters- Current Carrying Capacity - Short-circuit Ratings.

UNIT - III SUPPLY DISTRIBUTION SYSTEMS AND CABLES (7+2 SKILL) 9

Supply Distribution Systems - Distribution Cable Types, Design and Applications – Paper Insulated Distribution Cables - PVC Insulated Cables - Polymeric Insulated Distribution Cables for 6-30 kV - Manufacture of Distribution Cables - Joints and Terminations for Distribution Cables - Testing of Distribution Cables.

UNIT - IV TRANSMISSION SYSTEMS AND CABLES (7+2 SKILL) 9

Basic Cable Types for A.C. Transmission - Self-contained Fluid-filled Cables – Gas Pressure Cables - High Pressure Fluid-filled Pipe Cables - Polymeric Insulated Cables for Transmission Voltages - Techniques for Increasing Current Carrying Capacity - Transmission Cable Accessories and Jointing for Pressure-assisted and Polymeric Cables.

UNIT - V CABLE INSTALLATION, TESTING, MAINTENANCE (7+2 SKILL) 9

Installation of Transmission Cables -Splicing, Terminating, and Accessories – Sheath Bonding and Grounding-Testing of Transmission Cable Systems - Underground System\Fault Locating - Field Assessment of Power Cable Systems- Condition monitoring tests – PD measurements.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Demonstration of cable architecture with cable samples of all types.
2) Understanding the cable manufacturing process through factory visit.
3) Familiarization of the cable laying procedure through field visits.
4) Familiarization of cable jointing / end termination techniques.
5) Understanding and familiarization of cable fault locating techniques through field visit to local distribution company or in house laboratory.
6) Understanding testing procedures and condition monitoring tests.

OUTCOMES:

On successful completion of the course student will be able to:

1. Ability to understand the fundamental of underground cable system.
2. Ability to gain knowledge on the architecture of UG cable and physical and electrical characteristics of the UG cable.
3. Ability to understand different types of cable used in distribution system.
4. Ability to acquire knowledge on Underground cables used in transmission system
5. Ability to understand the cable installations procedures and practices.
6. Ability to understand the theory / methodology of cable fault detection and rectification, testing and maintenance.

TEXT BOOKS:

1. William Thue, 'Electrical Power Cable Engineering', CRC Press Taylor & Francis Group., 6000 Broken Sound Parkway NW, Suite 300Boca Raton, FL 33487-2742, 3rd Edition 2017.
2. G. F. Moore, 'Electric Cables Handbook' -Third edition, Blackwell Science Ltd, 9600 Garsington Road, Oxford OX4 2DQ, U.K., January 2017.

REFERENCES:

1. Leonard L. Grigsby, 'Electrical Power Cable Engineering' - CRC Press, Marcel Dekker, 3rd Edition 2012.
2. Christian Flytkjaer Jensen, Online Location of Faults on AC Cables in Underground
   Transmission Systems (Springer Theses), 2014, March.

WEB REFERENCES:

1. https://kafactor.com/content/technical-resources/kerite-underground-cable-engineering-handbook.pdf
2. Handbook on Cable Fault Localization (April 2020)
   https://rdso.indianrailways.gov.in/works/uploads/File/Handbook%20on%20Cable%20Fault%20Localization(2).pdf
3. K. H. Ali et al.: Industry Practice Guide for Underground Cable Fault-Finding in the LVDN:
   https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279, June 2022.

4. R. W. Deltenre, J. J. Schwarz, and H. J. Wagnon, ‘‘Underground cable fault location: A handbook to TD-153,’’ BDM Corp., Albuquerque, NM, USA, Final Rep. EPRI EL-363, 1977.https://www.osti.gov/servlets/purl/7233049, doi: 10.2172/7233049, January 1997

ONLINE COURSES / RESOURCES:

1. http://nitttrc.edu.in/nptel/courses/video/108102047/L18.html

21EE1902	SUBSTATION ENGINEERING AND AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design.
- The course aims to give an exposure to the students to the requirements of practical aspects including an overview of civil and mechanical aspects.
- Course aims to enhance the knowledge, and give the practical guidelines for site selection, construction, protection along with maintenance, safety in a substation.
- It also aims at providing knowledge about state-of-the-art technology in substation automation system

UNIT - I SUBSTATION DESIGN DEVELOPMENT (7+2 SKILL) 9

Substation Introduction and Classifications, Different bus bar switching schemes for Substation. Standards and Practices, Factors Influencing Substation Design - Altitude, Ambient Temperature, Earthquake and seismic zones, pollution and corrosion etc., Testing of Electrical Equipment, Concept and development of Single Line Diagram. Requirement of substation calculation.

UNIT - II SUBSTATION EQUIPMENT (7+2 SKILL) 9

Selection and sizing of main substation equipment: Transformer, Isolator, Circuit Breaker, surge arrestor, Instrument transformers, classification of equipment with a practical overview, and the performance parameters. Classifications of MV Switchgear and Key Design Parameters, MV/LV Switchgear construction and design of control scheme. Station Auxiliary equipment: Diesel Generator System, Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Introduction to gas insulated substation: Operating principle of GIS, Advantage over AIS, construction of GIS.

UNIT - III PROTECTION AND SUBSTATION AUTOMATION (7+2 SKILL) 9

Power System protection, Overcurrent and Earth Fault protection and coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Familiarization of NUMERICAL Relays, distance/differential protection for transmission line. Substation Automation: Evolution of Substation Automation, Communication System Fundamentals-Protocol fundamental and choosing the right protocol. Substation integration and automation functional architecture, Substation signal list - DI, DO, AI, AO– Bay Control Unit (BCU), Remote Terminal Unit RTU.

UNIT - IV SUBSTATION DESIGN & LAYOUT ENGINEERING (7+2 SKILL) 9

Layout aspects of Outdoor Air Insulated Substation and GIS: Statutory Clearances, Equipment Layout engineering aspects for Outdoor Substation/GIS and related calculations, and guide lines, Cable routing layout, Erection Key Diagram (EKD), switchyard earthing design as per IEEE80, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Direct stroke Lightning Protection for switchyard with IS/ IEC 62305. LV Cables - Power & Control, MV Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable accessories, Illumination System Design.

UNIT - V INTERFACE ENGINEERING (7+2 SKILL) (7+2 SKILL) 9

Civil & Structural Engineering - Familiarization of site development plan, equipment supports structures, foundation for equipment, familiarization of control building and substation building, infrastructure development, Mechanical System- Fire Detection, Alarm System and Fire Suppression System for transformer, Heating, Ventilation and Air-conditioning (HVAC) for Substation.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Battery sizing for a substation with a load cycle based on IEEE 1115 Ni-cd - A case study

OR

2) DG and auxiliary transformer sizing for a substation auxiliary power supply- A case study
3) Overcurrent Relay coordination in a substation- A case study
4) Earth mat sizing calculation for an outdoor substation based on IEEE80- A case study

OR

5) Direct stroke lightning protection calculation for outdoor switchyard based on IEC 62305- A case study

OUTCOMES:

On successful completion of the course student will be able to:

1. Understand the key deciding factors involved in substation design and operation
2. Know about the sizing and selection of equipment which forms part of substation
3. Know about composite layout design aspects of the substation with different services and the challenges including statutory clearances.
4. Understand about Interdisciplinary aspects involved in substation design
5. Understand different protection and control scheme involved in substation design
6. Know about substation automation system and different communication protocol involved for efficient operation of a substation

TEXT BOOKS:

1. Electrical substation and engineering & practice by S.Rao, 3rd Edition, Khanna Publishers 2015
2. Manual on Substation by Central Board of irrigation and Power (CBIP) Publication No 342, 2006.
3. Substation automation system Design and implementation by Evelio Padilla by Wiley Publications, 1st Edition, 2015 November.

REFERENCES:

1. McDonald John D, “Electric Power Substations Engineering”, CRC Press, 3rd Edition, 2012
2. Partap Singh Satnam, P.V. Gupta, “Sub-station Design and Equipment”, Dhanpat Rai Publications, 1st Edition, 2013.
3. Sunil S. Rao, “Switchgear Protection and Power Systems (Theory, Practice & Solved Problems)”, Khanna Publications, 14th Edition, 2019.

WEB REFERENCES:

1. https://www.rtu.cz/en/home/solutions/vdip-new-approach-to-earth-fault-detection-on-mv-lines
2. https://www.sciencedirect.com/topics/engineering/substation-automation

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117107148

21EE1903	SMART GRID	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To understand the evolution of Smart and Interconnected energy systems.
- To understand the various challenges and benefits of smart grid and the national and international initiatives taken
- To understand the concepts related with transmission and distribution in smart grid technologies.
- To get an insight of the various smart measurement technologies.
- To understand the various computing technologies for Smart Operation of the Grid.

UNIT - I INTRODUCTION (7+2 SKILL) 9

Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional & Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Micro grid, National and International Initiatives in Smart Grid.

UNIT - II SMART METERING (7+2 SKILL) 9

Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor Measurement Unit (PMU).

UNIT - III SMART GRID TECHNOLOGIES (7+2 SKILL) 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, Wide area Monitoring, Protection and control.

UNIT - IV SMART GRID TECHNOLOGIES (Distribution) (7+2 SKILL) 9

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High- Efficiency Distribution Transformers, Phase Shifting Transformers, Electric Vehicles.

UNIT - V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS (7+2 SKILL) 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Assignment-Familiarization of National and International Initiatives in Smart Grid
2) Simulation of smart meter using (MATLAB/ ETAP/SCILAB/ LABVIEW/ Proteus/Equivalent open source software).
3) Visit to a substation for analysing the Automation Technologies like Monitoring, Protection and control.
4) Awareness about High- Efficiency Distribution Transformers, Phase Shifting Transformers in a substation.
5) Introduction to recent technologies in electric vehicles and understanding the operation of EV, HEV and PHEV.
6) Simulation of IoT based digital communication system for smart grid applications.

OUTCOMES:

After completion the above subject, students will be able to:

1. Understand the importance and objectives of Power System Grid.

2. Understand the concept of a smart grid;

3. Identify and discuss smart metering devices and associated technologies.

4. Get an overview of Microgrid and Electric Vehicle Technology.

5. Acquire knowledge on the various computing technologies.

6. Understand the role of Big Data and IoT for effective and efficient operation of Smart Grid.

TEXT BOOKS:

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase, CRC, 2018.

2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley, 2012.

3. James Momoh, Smart Grid Fundamentals of Design and Analysis, IEEE press 2012.

REFERENCES:

1. Ahmed F. Zobaa, Trevor J. Bihl, Big data analytics in future power systems, 1st Edition, CRC press 2018.

2. C. Gungor et al., "Smart Grid Technologies: Communication Technologies and Standards," in IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529-539, Nov. 2011.doi: 10.1109/TII.2011.2166794.

3. X. Fang, S. Misra, G. Xue and D. Yang, "Smart Grid — The New and Improved Power Grid: A Survey," in IEEE Communications Surveys & Tutorials, vol. 14, no. 4, pp. 944- 980, Fourth Quarter 2012. doi: 10.1109/SURV.2011.101911.00087.

4. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press 2012.

WEB REFERENCES:

1. https://www.smartgrid.gov/the_smart_grid/smart_grid.html

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc23_ee60/preview

21EE1904	ENERGY MANAGEMENT AND AUDITING	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To study the concepts behind economic analysis and Load management.
- To understand the basics of materials and energy balance.
- To analyze the energy efficiency in thermal utilities.
- To know the concept of compressed air system.
- To illustrate the concept of lighting systems and cogeneration.

UNIT - I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT (7+2 SKILL) 9

Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector - Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, and its features - electricity tariff - Thermal Basics - need and types of energy audit – Energy management/audit approach-understanding energy costs - maximizing system efficiencies - optimizing the input energy requirements - energy audit instruments - Case study.

UNIT - II MATERIAL AND ENERGY BALANCE (7+2 SKILL) 9

Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager – employees training and planning- Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return – Case Study.

UNIT - III ENERGY EFFICIENCY IN THERMAL UTILITIES (7+2 SKILL) 9

Introduction to fuels - properties of fuel oil, coal and gas - principles of combustion - combustion of oil, coal and gas - Boilers: Types, combustion in boilers, performances evaluation, analysis of losses - energy conservation opportunities - FBC boilers - Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings - Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery – Refractory : types, selection and application of refractories, heat loss - Cogeneration: classification and saving potentials - Case Study.

UNIT - IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM (7+2 SKILL) 9

Compressed Air System: Types of air compressors - efficient compressor operation – Compressed air system components - leakage test - savings opportunities - Refrigeration System: Vapour compression refrigeration cycle – refrigerants - coefficient of performance - factors affecting Refrigeration and Air conditioning system - savings opportunities - Vapour absorption refrigeration system: working principle - types and comparison with vapour compression system – saving potential - Cooling Tower: Types and performance evaluation, efficient system operation – flow control strategies and energy saving - Diesel Generating system: Factors affecting selection - energy performance assessment of diesel conservation avenues - Case Study.

UNIT - V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES (7+2 SKILL) 9

Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient motors - soft starters with energy saver - variable speed drives – Fans and blowers: Types - efficient system operation – flow control strategies -Pumps and Pumping System: Types - system operation - flow control methods - Lighting System: Light source, choice of lighting, luminance requirements – ballast – occupancy sensors - energy efficient lighting controls - energy conservation avenues - Case Study.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Study of energy conservation and audit.
2) Performance study of Electric Motors.
3) Analysis on fan characteristic curves at different operating points.
4) Case study of illumination system.
5) Performance analysis of Compressors.

OUTCOMES:

Upon completion of the course, students will be able to:

1. Acquire knowledge in the field of energy management and auditing process.
2. Learned the about basic concepts of economic analysis and load management.
3. Able to design the effective thermal utility system.
4. Able to improve the efficiency in compressed air system.
5. Acquired the design concepts in the field of lighting systems and light sources.
6. Acquired the design concepts in various forms of cogeneration.

TEXT BOOKS:

1. Mehmet Kanoglu, Yunus A Cengel, "Energy Efficiency and Management for Engineers", McGraw-Hill Education, First Edition, 2020.

REFERENCES:

1. Moncef Krati, 'Energy Audit of Building Systems: An Engineering Approach', Third Edition, CRC Press, Dec.2020.
2. Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.
3. Michael P.Deru, Jim Kelsey, 'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011.
4. Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990, 1st Edition.
5. 'Energy Managers and Energy Auditors Guide book', Bureau of Energy Efficiency, 2006.
6. Larry C. Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.

WEB REFERENCES:

1. https://www.sciencedirect.com/science/article/pii/S2212827114004491

ONLINE COURSES / RESOURCES:

1. http://lab.fs.uni-lj.si/kes/erasmus/Energy%20Management%20Handbook.pdf
2. https://mppolytechnic.ac.in/mp-staff/notes_upload_photo/CS595EnergyEfficiencyinElectricalUtilities-5391.pdf
3. http://knowledgeplatform.in/wp-content/uploads/2017/03/1.3-Energy-management-Audit.pdf

21EE1905	POWER QUALITY	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To learn the basic definitions in Power Quality.
- To study the power quality issues in Single Phase and Three Phase Systems.
- To understand the principles of Power System Harmonics.
- To know the way to use DSTATCOM for Harmonic Mitigation.
- To learn the concepts related with Series Compensation.

UNIT - I INTRODUCTION (7+2 SKILL) 9

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT - II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM (7+2 SKILL) 9

Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.

UNIT - III MITIGATION OF POWER SYSTEM HARMONICS (7+2 SKILL) 9

Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters – damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design – Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.

UNIT - IV LOAD COMPENSATION USING DSTATCOM (7+2 SKILL) 9

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode.

UNIT - V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM (7+2 SKILL) 9

Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Harmonic analysis of single phase power converters (Semi converters and Full Converters) with R and RL load via simulation.
2) Harmonic analysis of three phase power converters (Semi converters and Full Converters) with R and RL load via simulation.
3) Harmonic analysis of single phase inverters with R and RL load via simulation.
4) Harmonic analysis of three phase inverters with R and RL load via simulation.
5) Mitigation of Harmonics using Tuned Filter.

OUTCOMES:

Upon completion of the course, students will be able to:

1. Use various definitions of power quality for power quality issues.
2. Describe the concepts related with single phase / three phase, linear / nonlinear loads.
3. Describe the concepts related with single phase / three phase, sinusoidal, non-sinusoidal source.
4. Solve problems related with mitigation of Power System Harmonics.
5. Use DSTATCOM for load compensation.
6. Demonstrate the role of DVR, SAFs UPQC in power distribution systems.

TEXT BOOKS:

1. Arindam Ghosh and Gerad Ledwich “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, First Edition, 2002.
2. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, Second Edition, 2011.
3. George J. Wakileh, “Power System Harmonics – Fundamentals, Analysis and Filter Design”, Springer – Verlag Berlin Heidelberg, New York, 2019.

REFERENCES:

1. R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition, 2012.
2. Arrillga “Power System Harmonics”, John Wiely and Sons, 2003 2nd Edition.
3. Derek A.Paice “Power Electronic Converter Harmonics” IEEE Press, 1995, Wiley – IEE Press 1999, 18th Edition.

WEB REFERENCES:

1. https://www.cde.com/resources/technical-papers/Mitigation-of-Harmonics.pdf

ONLINE COURSES / RESOURCES:

1. http://nptel.iitm.ac.in/courses.php
2. https://old.amu.ac.in/emp/studym/2442.pdf
3. https://www.intechopen.com/books/6214
4. https://www.academia.edu/43237017/Use_Series_Compensation_in_Distribution_Networks_33_KV

21EE1906	HVDC AND FACTS	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- The problems in AC transmission systems and DC transmission systems.
- The operation and control of SVC and TCSC.
- The concepts of IGBT based FACTS controllers.
- The basic operation Line Commutated Converter (LCC) based HVDC links.
- The features of voltage source converter based HVDC link.

UNIT - I INTRODUCTION (7+2 SKILL) 9

Reactive power control in electrical power transmission lines–load & system compensation, Uncompensated transmission line–shunt and series compensation. Need for HVDC Transmission, Comparison between AC & DC Transmission, , Types of HVDC transmission System.

UNIT - II STATIC VAR COMPENSATOR (SVC) AND THYRISTOR CONTROLLED SERIES COMPENSATOR (TCSC) (7+2 SKILL) 9

VI characteristics of FC+TSR, TSC+TSR, Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator, Thyristor Controlled Series Compensator (TCSC), Concept of TCSC, Operation of the TCSC– Different modes of operation, Applications.

UNIT - III VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS (7+2 SKILL) 9

Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC VI characteristics, Enhancement in Power transfer capability – UPSC – Operation Principle Applications.

UNIT - IV LINE COMMUTATED HVDC TRASMISSION (7+2 SKILL) 9

Operation of Gratz bridge - Effect of delay in Firing Angle – Effect of commutation overlap - Equivalent circuit. Basic concept of HVDC transmission. Model of operations and control of power flow CC and CIA mode of operation.

UNIT - V VSC BASED HVDC TRANSMISSION (7+2 SKILL) 9

Basic 2 level IGBT inverter operation - 4 Quadrant operation- phase angle control-dq control- Control of power flow in VSC based HVDC Transmission, Topologies of MTDC system.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Simulation of FC+TSR connected to IEEE 5 bus system.
2) Realization of reactive power, support by SVC in open loop and closed loop control in simulation.
3) Regulation of line flows employing TCSC and TSSC in closed loop control in simulation.
4) Simulation of two terminal HVDC Link, closed loop control in CC and CIA mode in simulation.
5) Realization of four quadrant operation of VSC in open loop mode in simulation.

OUTCOMES:

After completion the above subject, students will be able:

1. To Identify and understand the problems in AC transmission systems.
2. To Identify and understand the need for Flexible AC transmission systems and HVDC Transmission
3. To understand the operation and control of SVC and TCSC and its applications to enhance the stability and damping.
4. To Analyze basic operation and control of voltage source converter based FACTS controllers
5. To demonstrate basic operation and control of Line Commutated HVDC Transmission.
6. To explain the d-q control based operation of VSC based HVDC Transmission.

TEXT BOOKS:

1. R.Mohan Mathur, Rajiv K.Varma,“Thyristor–Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons,Inc, 2002.
2. Narain G.Hingorani, “Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi-110006, 2011.

REFERENCES:

1. K.R.Padiyar,”FACTS Controllersin Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008.
2. A.T.John, “Flexible A.C. Transmission Systems”, Institution of Electrical and Electronic Engineers (IEEE), 1999.
3. V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004, Kluwer Academic Publishers, 2004.

WEB REFERENCES:

1. https://www.accessengineeringlibrary.com/content/book/9780071771917/chapter/chapter11?implicit-login=true

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108104013

21EE1907	RESTRUCTURED POWER MARKET	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- Describe various types of deregulated markets in power system.
- Describe the technical and non-technical issues in deregulated power industry.
- Classify different market mechanisms and summarize the role of various entities in the market.
- Analyze the energy and ancillary services management in deregulated power industry.
- Understand the restructuring framework US and Indian power sector.

UNIT - I INTRODUCTION (7+2 SKILL) 9

Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior – Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture.

UNIT - II TRANSMISSION CONGESTION MANAGEMENT (7+2 SKILL) 9

Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

UNIT - III LOCATIONAL MARGINAL PRICES(LMP) AND FINANCIAL TRANSMISSION RIGHTS (7+2 SKILL) 9

Fundamentals of locational marginal pricing - Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation - ACOPF model for LMP calculation – Risk Hedging Functionality Of financial Transmission Rights - FTR issuance process - Treatment of revenue shortfall - Secondary trading of FTRs - Flow Gate rights - FTR and market power.

UNIT - IV ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK (7+2 SKILL) 9

Types of ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services - International comparison. Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm – Composite pricing paradigm - loss allocation methods.

UNIT - V MARKET EVOLUTION (7+2 SKILL) 9

US markets: PJM market - The Nordic power market - Reforms in Indian power sector: Framework of Indian power sector - Reform initiatives - availability based tariff (ABT) - The Electricity Act 2012 - Open Access issues - Power exchange.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Analysis of ATC calculations using any one of the relevant software tool.
2) DCOPF based LMP calculations using any one of the relevant software tool.
3) ACOPF based LMP calculations using any one of the relevant software tool.
4) Analysis of social welfare maximization with different objectives.
5) Analysis of ABT components.

OUTCOMES:

After completion the above subject, students will be able to:

1. Describe the requirement for deregulation of the electricity market and the philosophy of various market models.
2. Analyze the various methods of congestion management in deregulated power system.
3. Analyze the locational marginal pricing and financial transmission rights.
4. Analyze the ancillary service management.
5. Analyze transmission pricing paradigm.
6. Understand the evolution of deregulation in Indian power sector.

TEXT BOOKS:

1. Mohammad Shahidehpour, Muwaffaq Alomoush, “Restructured electrical power systems: operation, trading and volatility” Marcel Dekker Pub., 2001, 1st Edition.
2. Kankar Bhattacharya, MathH.J.Boolen, and Jaap E.Daadler, "Operation of restructured power systems”, Kluwer Academic Pub., 2001, 1st Edition.

REFERENCES:

1. Sally Hunt, "Making competition work in electricity”, JohnWilley and Sons Inc. 2002.
2. Steven Stoft, Power System Economics: Designing Markets for Electricity”, Wiley-IEEE Press, 2002.
3. Allen. J. Wood and Bruce F. Wollen berg, ‘Power Generation, Operation and Control’, John Wiley & Sons, Inc., 2016, 3rd Edition.

WEB REFERENCES:

1. https://www.sciencedirect.com/topics/engineering/restructured-electricity-market

ONLINE COURSES / RESOURCES:

1. S.A. Khaparde, A.R. Abhyankar, "Restructured Power Systems", NPTEL Course,
https://nptel.ac.in/courses/108101005/.

21EE1908	UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know various electric drives and traction motors with applications
- To introduce the energy saving concept by different ways of illumination.
- To understand the different methods of electric heating and electric welding.
- To know the conversion of solar and wind energies into electrical energy for different applications.
- To study the domestic utilization of electrical energy.

UNIT - I ELECTRIC DRIVES AND TRACTION (7+2 SKILL) 9

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.

UNIT - II ILLUMINATION (7+2 SKILL) 9

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED.

UNIT - III HEATING AND WELDING (7+2 SKILL) 9

Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding - radiation welding.

UNIT - IV ENERGY CONSERVATION AND ITS IMPORTANCE (7+2 SKILL) 9

Energy conservation act 2001 and its Features-Review of Industrial Energy Conservation-Energy conservation in electrical Industries-Simulation study of energy conservation using power factor controller. (Three phase circuit simulation with and without capacitor).

UNIT - V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY (7+2 SKILL) 9

House wiring - working principle of air conditioning system, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving Problems)

1. Choosing electrical motors for drives and traction applications.
2. A general design procedure for lighting schemes.
3. Design of heating element and study of welding methods.
4. Practical case studies of energy conservation.
5. Power requirement for different domestic appliances.

OUTCOMES:

At the end of this course, the students will have the

1. Ability to choose suitable electric drives for different applications
2. Ability to design the illumination systems for energy saving
3. Ability to demonstrate the utilization of electrical energy for heating and welding purposes
4. Ability to know the effective usage of solar and wind energies for electrical applications
5. Ability to do electric connection for any domestic appliance like refrigerator, battery charging circuit for a specific household application
6. To illustrate the need for energy conservation and to simulate three phase power control.

TEXT BOOKS:

1. N.V. Suryanarayana, “Utilisation of Electric Power”, Wiley Eastern Limited, New Age International Limited, 1994 & Second Edition 2017 Feb.
2. J.B.Gupta, “Utilisation Electric power and Electric Traction”, S.K.Kataria and sons, 2000 2012th Edition, 2013, January.
3. G.D.Rai,”Non-Conventional Energy sources”,Khanna publications Ltd.,New Delhi 1998
4. D.P.Kothari, K.C.Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learing Private Limited, 3rd Edition 2022.
5. Industrial Energy Conservation, Volume I-II, S C Bhatia, Sarvesh Devraj, Energy conservation and Managment by Akshay A pujara1st edition, June 2018.

REFERENCES:

1. R.K.Rajput, Utilisation of Electric Power, Laxmi publications 2nd Edition 2016.
2. H.Partab, Art and Science of Utilisation of Electrical Energy”, Edition, Dhanpat Rai and Co., New Delhi-2004.
3. C.L.Wadhwa, “Generation, Distribution and Utilisation of Electrical Energy”, New Age international Pvt.Ltd., 3rd Edition, 2015 January.

WEB REFERENCES:

1. https://inis.iaea.org/search/search.aspx?orig_q=RN:24045386

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/115103123
2. https://nptel.ac.in/courses/112105221

VERTICAL II: CONVERTERS AND DRIVES

21EE1909	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To understand the working of special machines like stepper motor, switched reluctance motor, BLDC motor & PMSM.
- To derive torque equation and study the characteristics of special machines.
- To design the controller for special machines.
- To study the working principle of synchronous reluctance motor.
- To simulate closed loop operation of BLDC motor.

UNIT - I STEPPER MOTORS 6

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control – Applications.

UNIT - II SWITCHED RELUCTANCE MOTORS 6

Constructional features –Principle of operation- Torque prediction–Characteristics- Power controllers – Control of SRM drive- Speed control-current control-design procedures- Sensor less operation of SRM – Current sensing-rotor position measurement and estimation methods- sensor less rotor position estimation-inductance based estimation –applications.

UNIT - III PERMANENT MAGNET BRUSHLESS DC MOTORS 6

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller design-Transfer function –Machine, Load and Inverter-Current and Speed Controller.

UNIT - IV PERMANENT MAGNET SYNCHROUNOUS MOTORS 6

Permanent Magnet ac Machines, Machine Configurations, PMSM - Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characteristics – evaluation of control characteristics- design of current and speed controllers- Constructional features, operating principle and characteristics of synchronous reluctance motor.

UNIT - V STUDY OF OTHER SPECIAL ELECTRICAL MACHINES 6

Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

Using electromagnetic software

1) Simulation of BLDC motor.
2) Simulation of SRM motor.
3) Simulation of stepper motor.
4) Simulation of PMSM motor.
5) Simulation of any other special machines.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

Students will be able to:

1. Acquire Knowledge on Construction and operation of stepper motor
2. Acquire Knowledge on construction, operation and performance of switched reluctance motors based on sensor less operation
3. Understand the operation and characteristics of Permanent Magnet Brushless DC Motor.
4. Understand the operation and characteristics of Permanent Magnet Synchronous Motor.
5. Select a special machine for a particular application.
6. Model and Simulate BLDC, SRM, PMSM and special machines

TEXT BOOKS:

1. Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008.
2. Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.

REFERENCES:

1. Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009.
2. T.Kenjo, ‘ Stepping motors and their microprocessor controls’, Oxford University press, New Delhi, 2000 Dekker 2009.
3. T.J.E. Miller, ‘Brushless magnet and Reluctance motor drives’, Clarendon press, London, 1989.
4. R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017.

WEB REFERENCES:

1. http://www.faadooengineers.com/online-study/subject/eee/special-electrical-machines

ONLINE COURSES / RESOURCES:

1. http://nitttrc.edu.in/nptel/courses/video/108102156/L21.html

21EE1910	ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To model & simulate all types of DC machines.
- To develop reference frame equations for various elements like R, L and C.
- To model an induction (three phase and 'n' phase) and synchronous machine.
- To drive reference frame equations for induction and synchronous machine.
- To study the need and working of multiphase induction and synchronous machine.

UNIT - I MODELING OF BRUSHED-DC ELECTRIC MACHINERY 6

Fundamentals of Operation – Introduction – Governing equations and modeling of Brushed DC-Motor – Shunt, Series and Compound – State model derivation – Construction of Model of a DC Machine using state equations- Shunt, Series and Compound.

UNIT - II REFERENCE FRAME THEORY 6

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame.

UNIT - III INDUCTION MACHINES 6

Three phase induction machine - equivalent circuit– free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no load and load conditions- Machine variable form, arbitrary reference variable form.

UNIT - IV SYNCHRONOUS MACHINES 6

Three phase synchronous machine - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations).

UNIT - V MULTIPHASE (MORE THAN THREE-PHASE) MACHINES CONCEPTS 6

Preliminary Remarks - Necessity of Multiphase Machines - Evolution of Multiphase Machines- Advantages of Multiphase Machines - Working Principle - Multiphase Induction Machine, Multiphase Synchronous Machine -Modeling of 'n' phase machine. Applications of Multiphase Machines.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Modeling of DC machines.
2) Simulation under no-load and loaded conditions for a PMDC motor.
3) Simulation of smooth starting for DC motor.
4) Simulation under no-load and load conditions of a three phase induction machine in machine variable form and arbitrary reference variable form.
5) Simulation under no-load and load conditions of a three phase synchronous machine in machine variable form and arbitrary reference variable form.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of the course, students should be able to:

1. Find the modeling for a brushed DC-Motor (Shunt, Series, Compound and separately excited motor) and to simulate DC motors using state models.
2. Apply reference frame theory for, resistive and reactive elements (three phase).
3. Compute the equivalent circuit and torque of three phase induction motor and synchronous motor in machine variable arbitrary reference frame variable.
4. Find the need and advantages of multiphase machines.
5. Demonstrate the working of multiphase induction and synchronous machine.
6. Compute the model of three phase and multiphase induction and synchronous machine.

TEXT BOOKS:

1. Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7th Edition, 2020.
2. Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011, 1st Edition.

REFERENCES:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, “Analysis of Electric Machinery and Drive Systems”, 3rd Edition, Wiley-IEEE Press, 2013.
2. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015, 1st Edition.
3. R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k.International Publishing House Pvt. Ltd, 2018.
4. Atif Iqbal,Shaikh Moinoddin, Bhimireddy Prathap Reddy, Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Wiley, 2021, 1st Edition.

WEB REFERENCES:

1. https://library.oapen.org/bitstream/handle/20.500.12657/43857/external_content.pdf?sequence=1&isAllowed=y

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/106/108106023/

21EE1911	MULTILEVEL POWER CONVERTERS	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To learn multilevel topology (Symmetry & Asymmetry) with common DC bus link.
- To study the working of cascaded H Bridge, Diode Clamped and Flying Capacitor MLI.
- To study the working of MLI with reduced switch count.
- To simulate three level diode clamped MLI and three level flying capacitor based MLI with resistive and reactive load.
- To simulate the MLI with reduced switch count.

UNIT - I MULTILEVEL TOPOLOGIES 6

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

UNIT - II CASCADED H-BRIDGE MULTILEVEL INVERTERS 6

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level- Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes-Staircase Modulation.

UNIT - III DIODE CLAMPED MULTILEVEL CONVERTER 6

Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters – Performance results.

UNIT - IV FLYING CAPACITOR MULTILEVEL CONVERTER 6

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.

UNIT - V MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT 6

Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Simulation of Fixed PWM, Sinusoidal PWM for an inverter.
2) Simulation of H bridge inverter with R load.
3) Simulation of three level diode clamped MLI with R load.
4) Simulation of three level capacitor clamped MLI with R load.
5) Simulation of MLI with reduced switch configuration.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of the course, students should be able to:

1. Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.
2. Examine the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation.
3. Demonstrate the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count.
4. Analyze the voltage balancing performance in Diode clamped MLI.
5. Simulate three level, capacitor clamed and diode clamped MLI with R and RL load.
6. Simulate MLI with reduced switch configuration using fundamental switching scheme.

TEXT BOOKS:

1. Rashid M.H,"Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4th Edition.
2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla, "Multilevel Converters for Industrial Applications", CRC Press, 22-Jul-2013, 2017, 1st Edition.
3. BinWu, Mehdi Narimani,High Power Converters and AC drives by IEEE press 2017, 2nd Edition.

REFERENCES:

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1st Edition.
2. Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 22-Jan-2013, 2017, 1st Edition.
3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1st Edition.
4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc,2021, 1st Edition.
5. Iftekhar Maswood, Dehghani Tafti,Advanced Multilevel Converters and Applications in Grid Integration, Wiley, 2018, 1st Edition.

WEB REFERENCES:

1. https://www.sciencedirect.com/science/article/abs/pii/B978012382036500173

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/102/108102157/

21EE1912	EMBEDDED CONTROL FOR ELECTRIC DRIVES	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To provide the control concept for electrical drives.
- To emphasize the need of embedded systems for controlling the electrical drives.
- To provide knowledge about various embedded system-based control strategies for electrical drives.
- To Impart the knowledge of optimization and machine learning techniques used for electrical drives.
- To familiarize the high-performance computing for electrical drives.

UNIT - I INTRODUCTION TO ELECTRIC DRIVES 6

Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives.

UNIT - II EMBEDDED SYSTEM FOR MOTOR CONTROL 6

Embedded Processors choice for motor control- Sensors and interface modules for Electric drives- IoT for Electrical drives applications.

UNIT - III INDUCTION MOTOR CONTROL 6

Speed control methods-PWM techniques- VSI fed three-phase induction motor-Fuzzy logic Based speed control for three-phase induction motor- Embedded processor based three phase induction motor speed control.

UNIT - IV BLDC MOTOR CONTROL 6

Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BDLC motor speed control.

UNIT - V SRM MOTOR CONTROL 6

Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Laboratory exercise: Use any System level simulator/MATLAB/open source platform to give hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phase inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package
2) Seminar: IoT-based Control and Monitoring for DC Motor/ any Electric drives.
3) Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of the course, students should be able to:

1. Interpret the significance of embedded control of electrical drives.

2. Develop knowledge of Machine learning and optimization techniques for motor control.

3. Deliver insight to various control strategies for electrical drives.

4. Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.

5. Improve Employability and entrepreneurship capacity on recent trends in embedded system.

6. Model and simulate the various electric drive applications.

TEXT BOOKS:

1. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010, 1st Edition.

2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1st Edition.

REFERENCES:

1. VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2nd Edition.

2. K. Venkataratnam, Special Electrical Machines, Universities Press, 2014, 1st Edition.

3. Steve Furber, ‘ARM system on chip architecture’, Addision Wesley, 2nd Edition 2015

4. Ron Sass and AnderewG.Schmidt, “Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010, 1st Edition.

5. Tim Wescott, Applied Control Theory for Embedded Systems, Elsevier, 2006, 1st Edition.

WEB REFERENCES:

1. https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/104/108104140/
2. https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/
3. https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html
4. http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

21EE1913	SMPS AND UPS	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To learn the working of isolated & non-isolated DC-DC converters.
- To design isolated & non-isolated DC-DC converters.
- To drive the equations related with converter dynamics.
- To design and simulate P, PI & PID controller for buck, boost and buck-boost converters.
- To identify and study different configurations of the UPS.

UNIT - I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 6

Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships – Introduction to discontinuous conduction mode.

UNIT - II ANALYSIS OF ISOLATED DC-DC CONVERTERS 6

Introduction - classification- forward- flyback- pushpull – half bridge – full bridge topologies- C'uk converter as cascade combination of boost followed by buck – isolated version of C'uk converter - design of SMPS – Introduction to design of magnetic components for SMPS, using relevant software- Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.

UNIT - III CONVERTER DYNAMICS 6

AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

UNIT - IV CONTROLLER DESIGN 6

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost and buck-boost converters.

UNIT - V POWER CONDITIONERS AND UPS 6

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Simulation of Basic topologies.
2) Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.
3) Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.
4) Simulation study of controller design for basic topologies.
5) Simulation of battery charger for EV applications.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of the course, students should have the following capabilities:

1. Demonstrate the working of buck boost and buck- boost converters in continuous and discontinuous conduction mode.
2. Build buck/boost converters using suitable design method.
3. Analyze the behaviors of isolated DC-DC converters and to design SMPS for battery operated vehicle.
4. Compute state space averaged model and transfer function for buck, boost and buck boost converters.
5. Demonstrate the P, PI and PID controller performance analytically and by simulation for buck boost and buck- boost converters.
6. Compare the different topologies of UPS and also simulate them.

TEXT BOOKS:

1. Robert W. Erickson & Dragon Maksimovic, " Fundamentals of Power Electronics", Third Edition, 2020.
2. Ned Mohan, "Power Electronics: A First Course", Johnwiley, 2013.
3. Marian K. Kazimierczuk and Agasthya Ayachit,"Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters", Wiley, 2016.

REFERENCES:

1. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002.
2. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition, 2017.

WEB REFERENCES:

1. https://www.engineersgarage.com/introduction-to-smps-switched-mode-power-supply/

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/108/108108036/

21EE1914	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To learn the various types of renewable sources of energy.
- To understand the electrical machines to be used for wind energy conversion systems.
- To learn the principles of power converters used in solar PV system.
- To study the principle of power converters used in Wind system.
- To simulate the AC-DC, AC-AC Converters, Matrix Converters and PWM Inverters.

UNIT - I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 6

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantages and disadvantages of conventional energy sources - Environmental aspects of energy - Impacts of renewable energy generation on the environment - Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

UNIT - II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 6

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT - III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 6

Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT - IV POWER CONVERTERS FOR WIND SYSTEMS 6

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

UNIT - V HYBRID RENEWABLE ENERGY SYSTEMS 6

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind-PV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Simulation on modelling of Solar PV System- V I Characteristics.
2) Simulation on modelling of fuel cell- V I Characteristics.
3) Simulation of self- excited Induction Generator.
4) Simulation of DFIG/ PMSG based Wind turbine.
5) Simulation on Grid integration of RES

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of the course, students should be able to:

1. Examine the available renewable energy sources.
2. Demonstrate the working principles of electrical machines and power converters used for wind energy conversion system.
3. Demonstrate the principles of power converters used for solar PV systems.
4. Examine the available hybrid renewable energy systems.
5. Simulate AC-DC converters and buck/boost converters.
6. Simulate AC-AC converters and PWM inverters.

TEXT BOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009, 7th impression.
2. Rashid .M. H “Power electronics Hand book”, Academic press, 2nd Edition, 2006 4th Edition, 2017.

REFERENCES:

1. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017.
2. Rai. G.D, “Solar energy utilization”, Khanna publishers, 5th Edition, 2008.
3. Gray, L. Johnson, “Wind energy system”, prentice hall of india, 2nd Edition, 2006.
4. H.Khan "Non-conventional Energy sources", Tata McGraw-hill Publishing Company, New Delhi, 2017, 3rd Edition

WEB REFERENCES:

1. https://www.fuelcellstore.com/blog-section/power-electronics-for-renewable-energy-systems

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108107128

21EE1915	CONTROL OF POWER ELECTRONICS CIRCUITS	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To learn the basics of control system simulation.
- To do symbolic calculation.
- To study the principles of sliding mode control and the way of apply smc for buck converter.
- To learn the concept of power factor correction.
- To design simulate smc for buck converter and power factor correction circuit with controller.

UNIT - I SIMULATION BASICS IN CONTROL SYSTEMS 6

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT - II SYMBOLIC CALCULATIONS 6

Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions - Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices - Other Symbolic Matrix Operations.

UNIT - III SLIDING MODE CONTROL BASICS 6

Introduction- Introduction to Sliding-Mode Control- Basics of Sliding-Mode Theory-Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter.

UNIT - IV POWER FACTOR CORRECTION CIRCUITS 6

Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

UNIT - V CONTROLLER DESIGN FOR PFC CIRCUITS 6

Power factor correction circuit using other SMPS topologies: Cuk and SEPIC converter – PFC circuits employing bridgeless topologies.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1) Simulation exercises on zero, first and second order basic blocks.
2) Simulation exercises based on symbolic calculations.
3) Simulation of Sliding mode control based buck converter.
4) Simulation of Single-Phase PFC circuit employing boost converter.
5) Simulation of Single-Phase PFC circuit employing C'uk converters.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of the course, students should be able to:

1. To calculate transfer function for constant, differential, integral, First order and Second order factors.
2. To illustrate the effect of poles and zero's in the 's' plane.
3. To select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.
4. To compute the control expression for DC – DC buck converter using sliding mode control theory.
5. To determine the controller expression for power factor correction circuits.
6. To simulate sliding mode control of buck converter and power factor correction circuit.

TEXT BOOKS:

1. Feedback Control problems using MATLAB and the Control system tool box By Dean Frederick and Joe Chow, 2000, 1st Edition, Cengage Learning.
2. Ned Mohan, "Power Electronics: A First Course", Johnwiley, 2013, 1st Edition.
3. Marian K. Kazimierczuk and Agasthya Ayachit,"Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters", Wiley, 2016.
4. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002 ,1st Edition.

REFERENCES:

1. Sliding mode control for Switching Power Converters, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1st Edition, CRC Press.
2. Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.
3. MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.

WEB REFERENCES:

1. https://digital-library.theiet.org/content/books/po/pbpo072e

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/102/108102145/

VERTICAL III: EMBEDDED SYSTEMS

21EE1916	EMBEDDED PROCESSORS	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To introduce the architecture of the ARM processor.
- To train students in ARM programming.
- To discuss memory management, append location development with an ARM processor.
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts.
- To impart the knowledge on single board embedded processors.

UNIT - I ARM ARCHITECTURE 6

Architecture – Memory Organization – addressing modes -Registers – Pipeline - Interrupts –
Coprocessors – Interrupt Structure.

UNIT - II ARM MICROCONTROLLER PROGRAMMING 6

ARM general Instruction set – Thumb instruction set –Introduction to DSP on ARM-basic programming.

UNIT - III PERIPHERALS OF ARM 6

ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing-stepper motor interfacing.

UNIT - IV ARM COMMUNICATION 6

ARM With CAN, I^2C, and SPI protocols.

UNIT - V INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR 6

Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands -Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Laboratory exercise:
    a. Programming with IDE - ARM microcontroller.
    b. Advanced Timer Features, PWM Generator.
    c. RTC interfacing with ARM using Serial communication programming, Stepper motor control.
    d. ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.
2) Seminar:
    a. ARM and GSM/GPS interfacing.
    b. Introduction to ARM Cortex Processor.
3) Raspberry Pi based Mini project.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of the course, students will have the ability to:

1. Interpret the basics and functionality of processor functional blocks.
2. Observe the specialty of RISC processor Architecture.
3. Incorporate the I/O hardware interface of processor with peripherals.
4. Emphasis the communication features of the processor.
5. Acquire Knowledge on single board embedded processor.
6. Apply programming knowledge on various applications. Improved employability and entrepreneurship capacity on recent trends in commercial embedded processors

TEXT BOOKS:

1. Steve Furber, 'ARM system on chip architecture', Addisonn Wesley, 2nd Edition, 2015.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield's ARM System Developer's Guide Designing and Optimizing System Software', Elsevier, 2004, 1st Edition.

REFERENCES:

1. William Hohl, 'ARMAssebly Language' Fundamentals and Techniques, CRC Press, 2nd Edition 2014.
2. Rajkamal," Microcontrollers Architecture, Programming, Interfacing, & System Design, Pearson,2012, 2nd Edition.
3. ARM System Developer's Guide: Designing and Optimizing System Software 1st Edition (Designing and Optimizing System Software) Publisher: Morgan Kaufmann Publishers, 2011.

WEB REFERENCES:

1. ARM Architecture Reference Manual, LPC214x User Manual www.Nuvoton.com/websites on Advanced ARM Cortex Processors.

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117106111
2. https://onlinecourses.nptel.ac.in/noc20_cs15/preview

3. https://www.csie.ntu.edu.tw/~cyy/courses/assembly/12fall/lectures/handouts/lec08_ARMarch.pdf
4. https://maxembedded.com/2013/07/introduction-to-single-board-computing/
5. https://www.youtube.com/watch?v=J4fhE4Pp55E&list=PLGs0VKk2DiYypuwUUM2wxzcI9BJHK4Bfh

21EE1917	EMBEDDED C- PROGRAMMING	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To expose the students to the fundamentals of embedded Programming.
- To Introduce the GNU C Programming Tool Chain.
- To study the basic concepts of embedded C.
- To teach the basics of 8051 Programming.
- To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT - I BASIC C PROGRAMMING 6

Typical C Program Development Environment - Introduction to C Programming – Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT - II EMBEDDED C 6

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

UNIT - III 8051 PROGRAMMING IN C 6

Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051 Accessing code ROM space in 8051, Data serialization using 8051.

UNIT - IV 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C 6

Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051 interrupts and programming, Programming for timer configuration.

UNIT - V 8051 INTERFACING 6

8051: ADC interfacing, DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor interfacing.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Laboratory exercise: Use 8051 microcontroller/Embedded processor/IDE/open source platform to give hands-on training on Embedded C- programming.
    a. Introduction to IDE (like code blocks, vscode, etc) and Programming Environment (like Keililu vision, Proteus).
    b. Configuring an I/O port using bitwise programming.
    c. Configuring timer for generating hardware delay.
    d. Flashing an LED using an interrupt.
    e. Serial communication using UART port of 8051.
    f. Interfacing an ADC with 8051.
    g. Interfacing an analog sensor with 8051.
    h. Interfacing 16x2 LCD with 8051.
    i. Configuring timer for generating PWM signal.
    j. Interfacing a stepper motor with 8051.
2) Assignment: Introduction to Arduino IDE, Raspberry Pi
3) Embedded C-Programming -based Mini project.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of this course, students will have the ability to:

1. Deliver insight into embedded C programming and its salient features for embedded systems.
2. Illustrate the software and hardware architecture for distributed computing in embedded systems.
3. Develop a solution for problems by using the concept learned in programming using the embedded controllers.
4. Develop simple applications with 8051 by using its various features and interfacing with various external hardware.
5. Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.
6. Configure and Interface Analog, Digital with 8051.

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, “C How to Program”, 9th Edition, Pearson Education Limited, 2022, 1st Edition.
2. Michael J Pont, “Embedded C”, Addison-Wesley, An imprint of Pearson Education, 2002.
3. William von Hagen, “The Definitive Guide to GCC”, 2nd Edition, Apress Inc., 2006.
4. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.

REFERENCES:

1. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015, 1st Edition.
2. Steve Oualline, "Practical C programming", O'Reilly Media, 1997, 3rd Edition.
3. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall, 2nd Edition, 2007.
4. Myke Predko, “Programming and customizing the 8051 microcontrollers”, McGraww Hill 2000, 1st Edition

WEB REFERENCES:

1. https://www.allaboutcircuits.com/technical-articles/introduction-to-the-c-programming-language-for-embedded-applications/

ONLINE COURSES / RESOURCES:

1. https://www.hackerrank.com/
2. https://www.cprogramming.com/
3. https://onlinecourses.nptel.ac.in/noc19_cs42/preview
4. https://microcontrollerslab.com/8051-microcontroller-tutorials-c/
5. https://www.circuitstoday.com/getting-started-with-keil-uvision

21EE1918	EMBEDDED SYSTEM DESIGN	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To introduce the Building Blocks of an embedded System and Software Tools.
- To emphasize the role of Input/output interfacing with Bus Communication protocol.
- To illustrate the ISR and scheduling for the multitasking process.
- To explain the basics of a Real-time operating system.
- To analyze the applications based on embedded design approaches.

UNIT - I INTRODUCTION TO EMBEDDED SYSTEMS 6

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA — Memory management methods- Timer and Counting devices, Real Time Clock, In-circuit emulator, Target Hardware Debugging.

UNIT - II EMBEDDED NETWORKING 6

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS485 – CAN Bus- Serial Peripheral Interface (SPI) – Inter- Integrated Circuits (I^2C).

UNIT - III INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER 6

Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept interrupt sources – multiple interrupts – context and periods for context switching, interrupt latency and deadline – Introduction to Device Drivers.

UNIT - IV RTOS-BASED EMBEDDED SYSTEM DESIGN 6

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication- shared memory, message passing- Interprocess Communication- Introduction to process synchronization using semaphores.

UNIT - V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 6

Embedded Product Development Life Cycle - Case Study: Precision Agriculture- Autonomous car.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1. Laboratory exercise: Use any Embedded processor/IDE/open source platform to give hands-on training on basic concepts of embedded system design:
   a) Introduction to IDE and Programming Environment.
   b) Configure timer block for signal generation (with given frequency).
   c) Interrupts programming example using GPIO.

d) I^2C communication with peripherals.
e) Master-slave communication between processors using SPI.
f) Networking of processor using Wi-Fi.
g) Basic RTOS concept and programming.

2. Assignment: Introduction to VxWorks, ЧC/OS-II, RT Linux
3. Embedded systems-based Mini project.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

After completion of the above subject, students will be able to understand:

1. The hardware functionals and software strategies required to develop various Embedded systems.
2. The basic differences between various Bus communication standards.
3. The incorporation of the interface as Interrupt services.
4. The various scheduling algorithms through a Real-time operating system.
5. The various embedded concepts for developing automation applications.
6. Analyze the programming concept of various embedded system applications

TEXT BOOKS:

1. Rajkamal, 'Embedded System-Architecture, Programming, Design', McGraw-Hill Edu, 3rd Edition 2017.
2. Peckol, "Embedded system Design", John Wiley & Sons, 2010.

REFERENCES:

1. Shibu. K.V, "Introduction to Embedded Systems", Tata McGraw Hill, 2nd Edition 2017.
2. Lya B.Das, "Embedded Systems" , Pearson Education, 1st Edition, 2012.
3. Parag H.Dave,Himanshu B.Dave, "Embedded Systems-Concepts, Design and Programming", Pearson Education, 2015, 1st Edition.
4. Elicia White, "Making Embedded systems", O'Reilly Series , SPD, 2011, 1st Edition
5. Jonathan W. Valvano, 'Embedded Microcomputer Systems Real-time Interfacing', Cengage Learning, 3rd Edition 2010.
6. Tammy Noergaard, "Embedded Systems Architecture", Newnes, 2nd Edition, 2013.

WEB REFERENCES:

1. https://www.theengineeringprojects.com/2016/11/examples-of-embeddedsystems.html#:~:text=Embedded%20Product%3A%20Automatic%20Washing%20Machine,done%20by%20your%20machine%20itself.

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108102045
2. https://ece.uwaterloo.ca/~dwharder/icsrts/Lecture_materials/A_practical_introduction_to_real-time_systems_for_undergraduate_engineering.pdf
3. https://www.tutorialspoint.com/embedded_systems/es_interrupts.htm

21EE1919	SMART SYSTEM AUTOMATION	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To introduce the smart system technologies and its role in real time applications.
- To teach the architecture and requirements of Home Automation.
- To provide an insight into smart appliances and energy management concepts.
- To familiarize the design and needs of smart wearable devices.
- To teach the basics of robotics and its role for automation.

UNIT - I INTRODUCTION 6

Overview of a smart system - Hardware and software selection - Smart sensors and Actuators –Communication protocols used for smart systems.

UNIT - II HOME AUTOMATION 6

Home Automation – System Architecture - Essential Components- Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.

UNIT - III SMART APPLIANCES AND ENERGY MANAGEMENT 6

Significance of smart appliances for energy management -Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.

UNIT - IV SMART WEARABLE DEVICES 6

Body Area Networks - Sensors– communication protocol for Wearable devices- Application of Smart Wearable in Healthcare & Activity Monitoring.

UNIT - V EMBEDDED SYSTEMS AND ROBOTICS 6

Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Laboratory exercise: Use Arduino/ R pi/ any other embedded processors to give hands on training to understand concepts related to smart automation.
    a. Hands on experiments based on Ubidots & Thing speak / Open-source Analytics Platform
    b. Design and implementation of a smart home system.
    c. Bluetooth Based Home Automation Project using Android Phone
    d. GSM Based Home Devices Control
    e. Pick and place robots using Arduino/ any suitable Embedded processor
2) Assignment: Revolution of Smart Automation system across the world and its current scope available in India.
3) Mini project: Design of a Smart Automation system (for any application of students choice)

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of this course, the students will have the ability to:

1. Understand the concepts of smart system design and its present developments.
2. Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.
3. Acquire knowledge on different platforms and Infrastructure for Smart system design.
4. Infer about smart appliances and energy management concepts.
5. Understand the basics of robotics and its role for automation
6. Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

TEXT BOOKS:

1. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer, 2013, 1st Edition.
2. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition.
3. NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016, 1st Edition.

REFERENCES:

1. Thomas Bräunl, Embedded Robotics, Springer, 2003.
2. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008.
3. Karim Yaghmour, Embedded Android, O'Reilly, 2013.
4. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress, 2013
5. C.K. Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.

6. Anna Ha´c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003
7. J. J. Craig, “Introduction to Robotics Mechanics and Control”, Pearson Education.
8. Y. Koren, “Robotics for Engineers”, McGraw-Hill.
9. Robert Faludi, Wireless Sensor Networks, O’Reilly, 2011.

WEB REFERENCES:

1. http://www.robot.bmstu.ru/files/books/(Ebook%20-%20English)%20Mcgraw-Hil,%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf

ONLINE COURSES / RESOURCES:

1. https://microcontrollerslab.com/home-automation-projects-ideas/
2. https://www.learnrobotics.org/blog/simple-robot/
3. https://robolabor.ee/homelab/en/iot
4. https://electrovolt.ir/wpcontentuploads/2018/03/Exploring_Raspberry_Pi_Molloy_Derek_ElectroVolt.ir_.pdf

21EE1920	EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To teach on sensor functional components for vehicles.
- To discuss on programmable controllers for vehicles management systems.
- To teach logics of automation & communication techniques for vehicle communication.
- To introduce the infotainment system development.

UNIT - I INTRODUCTION TO AUTOMOTIVE SYSTEMS 6

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control Unit– open-source ECU.

UNIT - II SENSORS AND ACTUATORS FOR AUTOMOTIVES 6

Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.

UNIT - III VEHICLE MANAGEMENT SYSTEMS 6

Energy Management system -Adaptive cruise control - anti-locking braking system - Safety and Collision Avoidance.

UNIT - IV ONBOARD DIAGONSTICS AND COMMUNICATION 6

OBD, Vehicle communication protocols- Bluetooth, CAN, LIN, FLEXRAY and MOST.

UNIT - V RECENT TRENDS 6

Navigation- Autonomous car- Role of IoT in Automotive systems.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1) Laboratory exercise: Use MATLAB SIMULINK /equivalent simulation /open source tools
    a. Simulation study of automotive sensors and actuators components.
    b. Adaptive cruise control, Anti-Lock Braking System.
    c. CAN Connectivity in an Automotive Application using vehicle network toolbox.
    d. Interfacing a sensor used in car with microcontroller.
    e. Establishing connection between Bluetooth module and microcontroller.
2) Assignment: AUTOSAR
3) Mini project: Battery Management system for EV batteries.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of this course, the students will have the ability in:

1. Insight into the significance of the role of embedded system for automotive applications.
2. Illustrate the need, selection of sensors and actuators and interfacing with ECU.
3. Develop the Embedded concepts for vehicle management and control systems.
4. Develop the infotainment system for EV application.
5. Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs.
6. Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

TEXT BOOKS:

1. William B. Ribbens, "Understanding Automotive Electronics", Elseiver, 8th Edition, 2017.
2. Jurgen, R., Automotive Electronics Hand Book, McGraw Hill, 2nd Edition, 1999.
3. L.Vlacic, M.Parent, F.Harahima, "Intelligent Vehicle Technologies", SAE International, 2001, 1st Edition, 2017.

REFERENCES:

1. Ali Emedi, Mehrdedehsani, John M Miller, "Vehicular Electric power system-land, Sea, Air and Space Vehicles" Marcel Decker, 2004, 1st Edition.
2. Jack Erjavec, JeffArias, "Alternate Fuel Technology-Electric, Hybrid & Fuel Cell Vehicles", Cengage, 2012, 2nd Edition.
3. Automotive Electricals / Electronics System and Components, Tom Denton, 5th Edition, 2017.
4. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle", Springer; 1st Edition, 2005.
5. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5th Edition, 2014.
6. Automotive Hand Book, Robert Bosch, Bently Publishers, 10th Edition, 2018.

WEB REFERENCES:

1. https://www.synopsys.com/automotive/what-is-autonomous-car.html

ONLINE COURSES / RESOURCES:

1. https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2. https://microcontrollerslab.com/can-communication-protocol/
3. https://ackodrive.com/car-guide/different-types-of-car-sensors/
4. https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/
5. https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/

21EE1921	MEMS AND NEMS	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To introduce the diverse technological and functional approaches of MEMS/NEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro and nano sensors, actuators.
- To emphasis the need for NEMS technology.
- To update the ongoing trends and real time applications of MEMS and NEMS technology.

UNIT - I INTRODUCTION TO MEMS and NEMS 6

Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling- Materials for MEMS and NEMS - Applications of MEMS and NEMS.

UNIT - II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES 6

Photolithography- Micro manufacturing, Bulk micro machining, surface micro machining, LIGA.

UNIT - III MICRO SENSORS AND MICRO ACTUATORS 6

Micromachining: Capactive Sensors- Piezoresistive Sensors- Piezoelectric actuators.

UNIT - IV NEMS TECHNOLOGY 6

Atomic scale precision engineering- Nano Fabrication techniques – NEMS for sensors and actuators.

UNIT - V MEMS and NEMS APPLICATION 6

Bio MEMS- Optical NEMS- Micro motors- Smart Sensors - Recent trends in MEMS and NEMS.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1) Laboratory experiment: Simulation of MEMS sensors and actuators using Multi physics tool.
    a. Simulation of a typical piezo resistive sensor.
    b. Simulation of a typical Piezoelectric actuator.
    c. Simulation study of a bio sensor.
    d. Simulation study of a micro motor.
2) Assignment: Role of MEMS AND NEMS devices for Industry Standard 5.0.
3) Mini project: Design and analysis of any MEMS/NEMS device using multi physics tool.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of this course, the students will have the ability to:

1. Explain the material properties and the significance of MEMS and NEMS for industrial automation.
2. Demonstrate knowledge delivery on micromachining and micro fabrication.
3. Apply the fabrication mechanism for MEMS sensor and actuators.
4. Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.
5. Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.
6. Model and Simulate sensors and actuators using Multi physics tool.

TEXT BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2011, 2nd Edition.
2. Tai-.Ran Hsu, "MEMS and Microsystems: design , manufacture, and Nanoscale"- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
3. Lyshevski, S.E. "Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering", (2nd ed.). CRC Press, 2005.
4. Julian W Gardner and Vijay K Varadan, "Microsensors, MEMS and Smart Devices", John Wiley and Sons Ltd, 2001, 1st Edition.

REFERENCES:

1. Marc F madou "Fundamentals of micro fabrication" CRC Press 2002 2nd Edition Marc Madou.
2. M.H.Bao "Micromechanical transducers: Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 16 Oct 2000, 1st Edition.
3. Maluf, Nadim "An introduction to Micro Electro-mechanical Systems Engineering", AR Tech house, Boston, June 30 2004, 2nd Edition.
4. Mohamed Gad – el – Hak "MEMS Handbook", Edited CRC Press 2001, 1st Edition.

WEB REFERENCES:

1. https://www.academia.edu/Lectures_on_MEMS_and_MICROSYSTEMS_DESIGN_AND_MANUFACTURE

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses
2. https://www.iitk.ac.in/me/mems-fabrication
3. http://mems.iiti.ac.in/
4. https://onlinecourses.nptel.ac.in/noc22_ee36/preview

21EE1922	DIGITAL SIGNAL PROCESSING SYSTEM DESIGN	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To introduce the concept of analyzing discrete time signals & systems in the time and frequency domain through mathematical representation.
- To study the various time to frequency domain transformation techniques.
- To Understand the computation algorithmic steps for Fourier Transform.
- To study about filters and their design for digital implementation.
- To introduce the programmable digital signal processor & its application.

UNIT - I INTRODUCTION 6

Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.

UNIT - II DISCRETE TIME SYSTEM ANALYSIS 6

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution –Introduction to Fourier Transform– Discrete time Fourier transform.

UNIT - III DISCRETE FOURIER TRANSFORM & COMPUTATION 6

DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm –DIT & DIF - FFT using radix 2 – Butterfly structure.

UNIT - IV DESIGN OF DIGITAL FILTERS 6

FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. IIR design: Analog filter design – Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation -Warping, prewarping - Frequency transformation.

UNIT - V DIGITAL SIGNAL PROCESSORS 6

Introduction – Architecture of one DSP processor for motor control – Features – Addressing Formats– Functional modes - Introduction to Commercial Processors.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Laboratory exercise: Use any DSP processor/MATLAB/open source platform to give hands on training on basic concepts of Digital Signal Processing.
    a. To determine impulse and step response of two vectors.
    b. To perform convolution between two vectors.
    c. To compute DFT and IDFT of a given sequence.
    d. To perform linear convolution of two sequence using DFT.
    e. Design and Implementation of FIR Filter.
    f. Design and Implementation of IIR Filter.
    g. To determine z-transform from the given transfer function and its ROC.
2) Assignment: Implementation of FIR/IIR filter with FPGA.
3) DSP processors based Mini project.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

At the end of this course, the students will have the ability to:

1. Explain the concepts of digital signal processing.
2. Illustrate the system representation using transforms.
3. Learn the transformation techniques for time to frequency conversion.
4. Design suitable digital FIR, IIR algorithm for the given specification.
5. Use digital signal processor for application development.
6. Design and implement DSP processor for various applications

TEXT BOOKS:

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, 4th Edition 2007.
2. Robert J.Schilling & Sandra L.Harris ,' Introduction to Digital Signal Processing using MATLAB', Cengage Learning, 2nd Edition 2013.

REFERENCES:

1. Emmanuel C Ifeachor and Barrie W Jervis , "Digital Signal Processing – A Practical approach" Pearson Education, Second edition, 2002.
2. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, 'Discrete – Time Signal Processing', Pearson Education, New Delhi, 2nd Edition 2012.
3. SenM.kuo, Woonseng…s.gan, "Digital Signal Processors, Architecture, Implementations & Applications", Pearson, 1st Edition, 2004.
4. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', Tata McGraw Hill, New Delhi, 4th Edition 2013.
5. B. Venkataramani, M. Bhaskar, 'Digital Signal Processors, Architecture, Programming and Applications', Tata McGraw Hill, New Delhi, 2003, 1st Edition.

WEB REFERENCES:

1. https://www.sciencedirect.com/topics/computer-science/digital-signal-processingalgorithm#:~:text=Digital%20signal%20processing%20algorithms%20are,known%20as%20operations%20or%20ops.

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117102060
2. https://www.tutorialspoint.com/digital_signal_processing/index.htm
3. https://www.elprocus.com/digital-signal-processor/

VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY

21EE1923	ELECTRIC VEHICLE ARCHITECTURE	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To learn the structure of Electric Vehicle, Hybrid Electric Vehicle.
- To study about the EV conversion components.
- To know about the details and specifications for Electric Vehicles.
- To understand the concepts of Plug-in Hybrid Electric Vehicle.
- To model and simulate all types of DC motors.

UNIT - I VEHICLE ARCHITECTURE and SIZING (7+2 Skill) 9

Electric Vehicle History and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

UNIT - II VEHICLE MECHANICS (7+2 Skill) 9

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT - III POWER COMPONENTS AND BRAKES (7+2 Skill) 9

Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.

UNIT - IV HYBRID VEHICLE CONTROL STRATEGY (7+2 Skill) 9

Vehicle supervisory controll, Mode selection strategy, Modal Control strategies.

UNIT - V PLUG-IN HYBRID ELECTRIC VEHICLE (7+2 Skill) 9

Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz/ Surprise Test / etc) Basics of MATLAB simulation

1) Variables and Expressions Formats, Vectors and Matrices,
2) Arrays, Vectors,
3) Matrices, Built-in functions, Trigonometric functions,
4) Data types and Plotting.
5) Simulation of drive cycles.

OUTCOMES:

Upon completion of the course, students will be able to:

1. Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs
2. Describe the various EV components.
3. Describe the concepts related in the Plug-In Hybrid Electric Vehicles.
4. Analyse the details and Specifications for the various EVs developed.
5. Describe the hybrid vehicle control strategy.
6. Model and simulate various electric vehicle drive applications.

TEXT BOOKS:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.

REFERENCES:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
2. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.
3. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021.
4. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020.

WEB REFERENCES:

1. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León, Christian Montaleza, José Luis Maldonado, Marcos Tostado-Véliz and Francisco Jurado, Thermo, 2021, 1, 134–150. https://doi.org/10.3390/thermo1020010
2. https://e-vehicleinfo.com/electric-vehicle-architecture-ev-powertrain-components/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108106170

21EE1924	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To review the drive cycles and requirements of EVs.
- To know the working of motors used in Electric Vehicle.
- To analyze and model the buck/boost converter operation and to design the same.
- To learn the simulation basics of control systems.
- To derive transfer functions for DC-DC converters.

UNIT - I ELECTRIC VEHICLE DYNAMICS 6

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

UNIT - II MOTORS FOR ELECTRIC VEHICLES 6

Introduction – Speed and Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

UNIT - III BASICS OF SIMULATION IN CONTROL SYSTEMS 6

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT - IV MODELING OF DC-DC CONVERTERS 6

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling – Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter.

UNIT - V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS 6

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Simple simulation exercises of basic control systems.
2) Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.
3) Design of buck converter.
4) Design of boost converter.
5) Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to:

1. To use appropriate electric machine for electric vehicle application.
2. To compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators).
3. To compute transfer function from state models.
4. To design buck, boost and buck-boost converter.
5. To compute a power stage transfer functions for DC-DC converters.
6. To simulate DC-DC converters and to obtain gain margin and phase margin.

TEXT BOOKS:

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition, 2017.
2. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications.

REFERENCES:

1. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.
2. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.
3. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition.
4. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press, 2021, 1st Edition.
5. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC Press, Taylor & Francis Group, Third Edition 2021.

WEB REFERENCES:

1. https://www.intechopen.com/chapters/19583

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc23_ee38/preview

21EE1925	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To learn the basics of EV and vehicle mechanics.
- To know the EV architecture.
- To study the energy storage system concepts.
- To derive model for batteries and to know the different types of batteries and its charging methods.
- To learn the control preliminaries for DC-DC converters.

UNIT - I INTERNAL COMBUSTION ENGINES 6

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

UNIT - II ELECTRIC VEHICLES AND VEHICLE MECHANICS 6

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT - III BATTERY MODELING, TYPES AND CHARGING 6

Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

UNIT - IV CONTROL PRELIMINARIES 6

Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

UNIT - V CONTROL OF AC MACHINES 6

Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1) Develop a model that could estimate Soc and SoH of Li-Ion Battery.
2) Modelling and thermal analysis of Li-Ion Battery.
3) Simulation of boost converter and calculating gain and phase margin from the transfer function.
4) Simulation of vector control of induction motor.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to:

1. To describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles.
2. To find gain margin & phase margin for various types of transfer functions of boost converter.
3. To demonstrate the control of AC Machines.
4. To explain the concepts related with batteries and parameters of battery.
5. To module the battery and to study the research and development for batteries.
6. Model and simulate vector control of induction motor.

TEXT BOOKS:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. Power Electronic Converters, Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.

REFERENCES:

1. Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.
2. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.
3. Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017, 2nd Edition.
4. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall, 1997, 1st Edition.
5. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition.

WEB REFERENCES:

1. https://www.c3controls.com/white-paper/understanding-the-design-and-manufacture-of-electric-vehicles/

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/106/108106170/

21EE1926	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To know the charging station and standards.
- To learn the concepts of power converters in charging.
- To find the charging scheme in renewable based EV charging.
- To demonstrate the wireless power transfer technique.
- To design & simulate power factor correction circuits.

UNIT - I CHARGING STATIONS AND STANDARDS 6

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations.

UNIT - II POWER ELECTRONICS FOR EV CHARGING 6

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT - III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 6

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVCHSP system - fast-charging infrastructure with solar PV and energy storage.

UNIT - IV WIRELESS POWER TRANSFER 6

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs - Charging Modes in EVs – Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363.

UNIT - V POWER FACTOR CORRECTION IN CHARGING SYSTEM 6

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1) Simulation and analysis for bi-directional charging V2G and G2V.
2) Design and demonstrate solar PV based EV charging station.
3) Simulate and infer wireless power charging station for EV charging.
4) Simulation of boost converter based power factor correction.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to:

1. To illustrate various charging techniques and to know charging standards and regulations.
2. To demonstrate the working DC-DC converters used for charging systems and principles.
3. To illustrate the advantages of renewable system based charging systems.
4. To demonstrate the principles of wireless power transfer.
5. To analyze the standards for wireless charging.
6. To design and simulate boost converter based power factor correction.

TEXT BOOKS:

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.
2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition, 2020.

REFERENCES:

1. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.
2. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.
3. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.
4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

WEB REFERENCES:

1. https://www.electronicsforu.com/electronics-projects/electronics-design-guides/electric-vehicle-battery-charging-solutions

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/106/108106182/

21EE1927	TESTING OF ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To know various standardization procedures.
- To learn the testing procedures for EV & HEV components.
- To know the functional safety and EMC.
- To realize the effect of EMC in EVs.
- To study the effect of EMI in motor drives and in DC-DC converter system.

UNIT - I EV STANDARDIZATION 6

Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

UNIT - II TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES 6

Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

UNIT - III FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC 6

Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management – Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles.

UNIT - IV EMC IN ELECTRIC VEHICLES 6

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements.

UNIT - V EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM 6

Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path.

30 PERIODS

LAB COMPONENTS: **30 PERIODS**

1) Design and simulate motor controller for hybrid electric vehicle applications.
2) Simulation of EMC analysis for Wireless power transfer EV charging.
3) Design and simulation of EMI filter.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to:

1. To describe the status and other details of standardization of EVs.
2. To illustrate the testing protocols for EVs and HEV components.
3. To analyze the safety cycle and need for functions safety for EVs.
4. To analyze the problems related with EMC for EV components.
5. To evaluate the EMI in motor drive and DC-DC converter system.
6. Design and simulate EMC analysis in Wireless Power transfer.

TEXT BOOKS:

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.
2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.

REFERENCES:

1. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1st Edition.
2. EMI/EMC Computational Modeling Handbook, Druce Archam beault, colin branch, Omar M.Ramachi ,Springer 2012, 2nd Edition.
3. Automotive EMC, Mark Steffika, Springer 2013, 1st Edition.
4. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition.

WEB REFERENCES:

1. https://www.dekra.com/en/passive-safety/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108106182

21EE1928	GRID INTEGRATION OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To know the basic details of V2G.
- To study the benefits & challenges of V2G.
- To learn EV & V2G on the smart grids renewable energy systems.
- To know the grid integration.

UNIT - I DEFINITION, And STATUS Of V2G (7+2 Skill) 9

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications. Electricity Markets and V2G Suitability, Long-Term Storage, Renewable Energy, and Other Grid Applications, Beyond the Grid: Other Concepts Related to V2G.

UNIT - II BENEFITS AND CHALLENGES OF V2G (7+2 Skill) 9

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.

UNIT - III CHALLENGES TO V2G (7+2 Skill) 9

Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues, EV Costs and Benefits, Adding V2G Costs and Benefits, Additional V2G Costs, The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G, V2G and Regulatory Frameworks, Market Design Challenges. Other V2G Regulatory and Legal Challenges.

UNIT - IV IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS (7+2 Skill) 9

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

UNIT - V GRID INTEGRATION AND MANAGEMENT OF EVS (7+2 Skill) 9

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz/ Surprise Test / etc) Basics of MATLAB simulation

1) Simulation of connecting three phase inverter to the grid.
2) Simulate and analyse the power quality issues of V2G systems.
3) Design and simulate battery management system for smart grid with distributed generation.

OUTCOMES:

Upon completion of the course, students will be able to:

1. Explain the concepts related with V2G.
2. Study the grid connection of 3 phase Q inverter.
3. Explain the technical, economics. business, regulatory & political challenges related with V2G.
4. Demonstrate the impact of EV and V2G on smart grid and renewable energy system.
5. Explain the concept of grid integration and management of EVs.
6. Simulate battery management system for smart grid for distributed generation

TEXT BOOKS:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2. Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna , Farhad Shahnia and Arindam Ghosh,Springer, 2015, 1st Edition.

REFERENCES:

1. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy, IET 2020, 1st Edition.
2. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET, 2015, 1st Edition.
3. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle-to-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

WEB REFERENCES:

1. https://www.iea.org/reports/grid-integration-of-electric-vehicles

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108106182

21EE1929	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

OBJECTIVES: To impart Knowledge on the following topics:

- To design and drive the mathematical model of a BLDC motor and its characteristics.
- To learn the different control schemes for BLDC motor.
- To study the basics of fuzzy logic.
- To study the FPGA & VHDL basics.
- To implement fuzzy logic control of BLDC motor in real time.

UNIT - I MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR 6

Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients.

UNIT - II SPEED CONTROL FOR ELECTRIC DRIVES 6

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

UNIT - III FUZZY LOGIC 6

Membership functions: features, fuzzification, methods of membership value assignments Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system-fuzzy decision making.

UNIT - IV FPGA AND VHDL BASICS 6

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors-Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

UNIT - V REAL TIME IMPLEMENTATION 6

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

30 PERIODS

LAB COMPONENTS: 30 PERIODS

1) Design and simulate speed controller for induction motors in EV for both dynamic and steady state performance
2) Simulate a fuzzy logic controller based energy storage system for EV.
3) Fuzzy logic control of BLDC motor using FPGA in real time.

TOTAL: 30 + 30 = 60 PERIODS

OUTCOMES:

Upon the successful completion of the course, students will be able to:

1. To design the mathematical model of a BLDC motor and to discuss about its characteristics.
2. To demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor.
3. To illustrate the basics of fuzzy logic system.
4. To describe the basics of VHDL & FPGA applied to control of EVs.
5. To design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.
6. Design and simulate controllers for induction motors in EV for steady sate and transient conditions.

TEXT BOOKS:

1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition, 2018.
2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition, 2015.

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 2021, 1st Edition.
2. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley, 2012, 1st Edition.
3. M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
4. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley, 2017, 2nd Edition.
5. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele
   Crisostomi • Robert Shorten, Sonja Stüdli • Fabian Wirth, CRC Press, 1st Edition, 2018.

WEB REFERENCES:

1. https://www.sciencedirect.com/science/article/pii/S1474667017421872

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108104049

VERTICAL V: AUTOMATION

21EE1930	PLC PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To know about the basics of PLC and Automation.
- To understand the importance of Automation.
- To explore various types and manufactures of PLCs.
- To introduce types of programming languages of PLC and some exercise few programs.

UNIT - I INTRODUCTION (7+2 Skill) 9

Programmable Logic Controller (PLC)- Block diagram of PLC- Programming languages of PLC Basic instruction sets- Design of alarm and interlocks- Networking of PLC- Overview of safety of PLC with case studies- Process Safety Automation: Levels of process safety through use of PLCs- IEC 61131-3 Standard - Application of international standards in process safety control.

UNIT - II IEC 61131-3 (7+2 Skill) 9

Rails- Rungs- Relay Logic- Latch switch- Timers- Counters- Boolean logics- Math Instructions- Data manipulation Instructions- Requirement of communication networks for PLC, PLC to PC Communication to computer- FBD equivalent to LL-FBD Programming- IL- SFC-ST.

UNIT - III SCADA (7+2 Skill) 9

Elements of SCADA system- History of SCADA, Remote Terminal Unit- Discrete control- Analog control, Master Terminal Unit- Operator interface.

UNIT - IV HART AND FIELD BUS (7+2 Skill) 9

Introduction- Evolution of signal standards- HART communication protocol- communication modes- HART networks- HART commands- HART and OSI model- Field bus- Architecture- Basic requirements of field Busstandard- Field bus Topology- Interoperability- Interchangeability.

UNIT - V PLC PROGRAMMING (7+2 Skill) 9

Exercise in Programming Languages from IEC 61131-3: Traffic Light Control- Two way- Four way – Water Level Control- Automatic Material Sorting System- Automatic Bottle Filling System, Code Converters- DC motor Control- Alarm Circuit.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Taking Local area to implement simple closed loop system for any system using PLC.
2) Making a complete automated control loop with Supervisory and HMI system.
3) Implementing an Alarm based control scheme and run in a simulated environment.
4) Designing an entire PLC logic for filling and draining water tank automatically.

OUTCOMES:

Upon completion of the course, students will be able to:

1. Understand the basics and need for Automation in industries (L2).
2. Explain the logic and flow of any particular programming written for a process (L2).
3. Apply the knowledge to design or improve an existing program to increase productivity of any process (L3).
4. Breakdown SCADA architecture and communication protocols (L4).
5. Build and logic in any of the programming languages from IEC- 61131- 3 standard (L3).
6. Design and Implement PLC programming logic for various applications.

TEXT BOOKS:

1. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw-Hill, New York, 2019.
2. Stuart Boyer A, “SCADA: Supervisory control and data Acquisition”, Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society, 2010.

REFERENCES:

1. Bolton. W, “Programmble Logic Controllers”, Elsevier Newnes, 6th Edition, 2015.

WEB REFERENCES:

1. https://new.siemens.com/global/en/products/automation/systems/industrial/plc/logo/logosoftware.html

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108105062
2. https://nptel.ac.in/courses/108105088
3. http://www.nitttrc.edu.in/nptel/courses/video/105105201/lec56.pdf
4. https://nptel.ac.in/courses/108106022
5. https://componentsearchengine.com/library/proteus?gclid=CjwKCAjw_ISWBhBkEiwAdqxb9okU2ZZHcQoa9fSRK2Uq41Rq0GZxdGUP6_6GlBv77p4JqGt_iDAljhoCksEQAvD_BwE

21EE1931	ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To study the various parts of robots and fields of robotics.
- To study the various kinematics & inverse kinematics of robots, the Euler & Lagrangian formulation of Robot dynamics.
- To study the trajectory planning and the control of robots for some specific applications.
- To educate on various path planning techniques and introduce the dynamics & control of manipulators.

UNIT - I BASICT CONCEPTS (7+2 Skill) 9

Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Robot classifications and specifications- Asimov's laws of robotics – dynamic stabilization of robots.

UNIT - II POWER SOURCES, SENSORS AND ACTUATORS (7+2 Skill) 9

Hydraulic, pneumatic and electric drives: Design and control issues – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.

UNIT - III MANIPULATORS AND GRIPPERS DIFFERENTIAL MOTION (7+2 Skill) 9

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

UNIT - IV KINEMATICS AND PATH PLANNING (7+2 Skill) 9

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints– Inverse -Wrist andarm singularity - Static analysis - Force and moment BalanceSolution kinematics problem – robot programming languages.

UNIT - V DYNAMICS AND CONTROL AND APPLICATIONS (7+2 Skill) 9

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model –

Manipulator control problem-Linear control schemes - PID control scheme-Force control of robotic manipulator. Multiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Learn any one programming language (C/C++, Python, Java etc.)
2) Kinds of sensors for industrial robot applications.
3) Familiarization with relevant software tool (MATLAB) and programming language.
4) Controlling Arduino Robot using Android Smartphone
5) Real time robotics projects (Soccer robots, line follower etc).

OUTCOMES:

Upon completion of the course, students will be able to:

1. Understand the evolution of robot technology and mathematically represent different types of robot (L2).
2. Get exposed to the case studies and design of robot machine interface (L3).
3. Analyze various control schemes of Robotics control (L4).
4. Ability to select appropriate configuration of rotor for a specific application. (L3).
5. Ability to choose actuator/sensor for robot. (L1).
6. Apply appropriate programming logic to various robotics applications

TEXT BOOKS:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 2015.
2. Saeed B Niku, Introduction to Robotics, Analysis, Systems, Applications Prentice Hall, 3rd Edition 2104.

REFERENCES:

1. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 2nd edition (2017).
2. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An integrated approach, Prentice Hall of India, New Delhi, 1994.
3. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
4. JohnJ.Craig, Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.

WEB REFERENCES:

1. http://site.ieee.org/scv-css/files/2015/04/IEEE-Robotics-Talk.pdf

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/112105249
2. https://nptel.ac.in/courses/112101098
3. https://www.intel.com/content/www/us/en/robotics/types-and-applications.html

21EE1932	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To offer learners an introduction to Industry 4.0 and its applications.
- To gain deep insights into how smartness is being harnessed from data.
- To understand what needs to be done in order to overcome the challenges.
- To familiarize in Industry 4.0 in healthcare services.

UNIT - I INTRODUCTION (7+2 Skill) 9

Introduction to Industry 4.0 The Various Industrial Revolutions - Digitalization and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

UNIT - II INTEGRATED IoT (7+2 Skill) 9

Road to Industry 4.0 - Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing - Smart Devices and Products - Smart Logistics – Smart Cities - Predictive Analytics.

UNIT - III ROBOTICS AND SECURITY (7+2 Skill) 9

System, Technologies for enabling Industry 4.0 – Cyber Physical Systems – Robotic Automation and Collaborative Robots - Support System for Industry 4.0 - Mobile Computing - Cyber Security.

UNIT - IV CLOUD COMPUTING (7+2 Skill) 9

Role of data, information, knowledge and collaboration in future organizations – Resource based view of a firm - Data as a new resource for organizations - Harnessing and sharing knowledge in organizations - Cloud Computing Basics - Cloud Computing and Industry 4.0

UNIT - V CASE STUDY AND APPLICATIONS (7+2 Skill) 9

Industry 4.0 IIoT case studies - Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world – Society 5.0

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) A Seminar on case studies, cloud computing, security and IoT.
2) Quiz on different types of industrial 4.0 applications.
3) Familiarization with relevant software tool (MATLAB, AR/VR, PLM)
4) Creating a cloud computing platform and work on it.
5) Introduction to other industry and security not covered in the above syllabus.

OUTCOMES:

Upon completion of the course, students will be able to:

1. Understand the drivers and enablers of Industry 4.0 (L2).
2. Appreciate the smartness in smart factories, smart cities, smart products and smart services (L2).
3. Outlines the various systems used in a manufacturing plant and their role in an Industry 4.0 world (L1).
4. Describe a strategic framework to exploit new technologies to enable Healthcare 4.0 (L1).
5. Ability to apply industry 4.0 concepts to real time applications. (L4).
6. Familiarize Industry 4.0 in various software tool

TEXT BOOKS:

1. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2016.
2. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.

REFERENCES:

1. ArsheepBahga, Internet of Things: A Hands on Approach,Orient Blackswan Private Limited - New Delhi, 2015.
2. 3Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.
3. J. Chanchaichujit, A.Tan, Meng, F., Eaimkhong, S. “Healthcare 4.0 Next Generation Processes with the Latest Technologies”, Palgrave Pivot, 2019.

WEB REFERENCES:

1. https://www.iare.ac.in/sites/default/files/IoT_LECTURE_NOTES_MODIFIED_0.pdf

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/106105167
2. https://nptel.ac.in/courses/106105195
3. https://nptel.ac.in/courses/108108123
4. https://www.epicor.com/en-in/blog/learn/what-is-industry-4-0/
5. ttps://nptel.ac.in/courses/106106147.

21EE1933	INTELLIGENT AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To identify potential areas for automation and justify need for automation.
- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Apply the concept of AI to attain industrial automation.

UNIT - I INTRODUCTION TO AUTOMATION (7+2 Skill) 9

Introduction to Industrial Automation - Automation in Production System- Principles and Strategies of Automation - Basic Elements of an Automated System- Advanced Automation Functions- Levels of Automations- Production Economics - Methods of Evaluating Investment Alternatives- Costs in Manufacturing- Break Even Analysis- Unit cost of production- Cost of Manufacturing Lead time and Work-in-process.

UNIT - II INTRODUCTION TO ARTIFICAL INTELLIGENCE (7+2 Skill) 9

Introduction to Artificial Intelligence -Introduction-Foundations of AI- History of AI- Intelligent agents: Agents and Environment- Reactive agent- deliberative- goal driven- utility driven and learning agents -Artificial Intelligence programming techniques. Introduction to ML and DL Concepts.

UNIT - III KNOWLEDGE AND REASONING (7+2 Skill) 9

Knowledge Representation and Reasoning - Ontologies-foundations of knowledge representation and reasoning-representing and reasoning about objects- relations-events-actions- time- and space- predicate logic-situation calculus- description logics-reasoning with defaults-reasoning about knowledge-sample applications-Representing Knowledge and reasoning in an Uncertain Domain- Bayes rule-Bayesian networks-probabilistic inference sample applications- Planning: planning as search- partial order planning- construction and use of planning graphs.

UNIT - IV EXPERT SYSTEMS (7+2 Skill) 9

Expert systems - Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge- Heuristics. Typical expert systems – MYCIN – ART-XOON.

UNIT - V AI IN CONTROL SYSTEMS (7+2 Skill) 9

Industrial AI applications and Case studies - Applications of Industrial AI in Monitoring-optimization and control- AI applications in Industry Automation using - natural language processing-computer vision-speech recognition-computer vision.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) A seminar on detailed study about existing control methods using AI.
2) Designing an AI to recognize face and to authenticate.
3) Train an AI to read alarm codes and take action.

OUTCOMES:

Upon completion of the course, students will be able to:

1. Understand the basics AI algorithms (L2).
2. Identify appropriate AI methods to solve a given problem (L1).
3. Illustrate about AI/ML/DL techniques in Industrial Automation (L3).
4. Summarize the levels of automation (L2).
5. Ability to apply AI concepts for industrial optimization and control. (L4).
6. Design the AI for various applications

TEXT BOOKS:

1. Rich and Knight, "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2014.
2. M.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 5th edition, Pearson Education, 2009.

REFERENCES:

1. Anuradha Srinivasaraghavan, Vincy Joseph "Machine Learning", Wiley, 2019.
2. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 2nd Edition, Prentice Hall, 2003.
3. Rajiv Chopra, "Deep Learning", 1st Edition, Khanna Publishing House, 2018.

WEB REFERENCES:

1. https://www.tensorflow.org/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/106102220
2. https://nptel.ac.in/courses/108105063
3. https://aws.amazon.com/free/machine-learning

21EE1934	SMART MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To introduce students to fundamentals of Manufacturing.
- To familiarize with selection of sensors for various application.
- To learn the basics of agent-based manufacturing.
- Understand Cyber physical systems.

UNIT - I SENSORS IN SMART MANUFACTURING (7+2 Skill) 9

Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. Automatic identification techniques for shop floor control – optical character and machine vision sensors – smart / intelligent sensors – integrated sensors, Robot sensors, Micro sensors, Nano sensors.

UNIT - II DATA ANALYTICS (7+2 Skill) 9

Introduction to Data and Analytics in a Digital Context (Internet of Things), Product Data Management for Design and Manufacturing (PLM Tools), Typical data challenges (data quality, enrichment, integration of ERP & PLM data), Preparing data for analytics (techniques to improve data quality, integration - ETL) Advances in data visualization & related tools- Statistical Techniques for Analytics, Descriptive Statistics, Inferential statistics, Regression and ANOVA.

UNIT - III CYBER PHYSICAL SYSTEMS (7+2 Skill) 9

Concept of Cyber Physical Systems (CPS) and Cyber Physical Production System (CPPS), System Architecture for implementation of CPPS, Components for CPPS, Communication for CPPS.

UNIT - IV E- MANUFACTURING (7+2 Skill) 9

Introduction of Agent based manufacturing- agent based Manufacturing, Cloud Based Manufacturing Information technology-based Supply chain, Concept of agile manufacturing and E-manufacturing.

UNIT - V INDUSTRY 4.0 (7+2 Skill) 9

Evaluation of industries, Introduction to Industry 4.0, Challenges in industry 4.0, Impact of Industry 4.0, Case studies on industry 4.0, Introduction to Internet of Things (IoT) and its applications, Smart supply chain and Case studies.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Learn any one programming language (C/C++, Python, Java etc.).
2) Kinds of sensors for industrial robot applications.
3) Familiarization with relevant software tool (MATLAB) and programming language.
4) Controlling Arduino Robot using Android Smartphone.
5) Real time robotics projects (Soccer robots, line follower etc).

OUTCOMES:

Students able to:

1. Appraise concepts and basic framework necessary for smart manufacturing (L5).
2. Discuss current trends at system level in manufacturing organizations (L2).
3. Selection of sensors for various applications (L4).
4. Dramatise IoT based manufacturing systems (L3)
5. Describe industry 4.0 concepts at manufacturing systems (L1).
6. Apply fundamental programming language to various applications.

TEXT BOOKS:

1. Bahga and V. Madisetti, Internet of Things, A hands-on approach, Create Space Independent Publishing Platform, 1st Edition, 2014, ISBN: 978-0996025515.
2. Bahga and V. Madisetti, Cloud Computing, A hands-on approach, Create Space Independent Publishing Platform, 1st edition, 2013, ISBN: 978-1494435141.
3. M. Skilton and F. Hovsepian, The 4th Industrial Revolution: Responding to the Impact of Artificial Intelligence on Business, Springer Nature, 2017, ISBN: 978-3-319-62479-2.

REFERENCES:

1. Gilchirst, Industry 4.0: The Industrial Internet of Things, Apress (Springer), 1st Edition, 2016, ISBN: 978-1-4842-2046-7
2. T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 1st edition, 2013, ISBN: 978-0133387520.
3. N. Viswanandham, Y. Narhari “Performance Modeling of Automated Manufacturing Systems” Prentice-Hall, 1st Edition, 1994, ISBN: 978-8120308701
4. S. K. Saha, Introduction to Robotics, Tata Mcgraw Hill Education Private Limited, 2nd Edition, ISBN: 978-9332902800
5. M. P. Grover “Automation, Production Systems and Computer-Integrated Manufacturing” Pearson Education, 4th Edition, 2016, ISBN: 978-0133499612
6. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas and G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2017 ISBN: 978-1259006210

WEB REFERENCES:

1. https://professional.mit.edu/course-catalog/smart-manufacturing-moving-static-dynamicmanufacturing-operations

ONLINE COURSES / RESOURCES:

1 https://nptel.ac.in/courses/106105195

21EE1935	CYBER SECURITY	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To understand the Industrial security environment and cyber attacks.
- To analyze and assess risks in the industrial environment.
- To access, design and implement cyber security.
- To test and troubleshoot the industrial network security system.

UNIT - I INTRODUCTION (7+2 Skill) 9

Industrial security environment-Industrial automation and control system (IACS) culture Vs IT Paradigms-Cyber attacks: Threat sources and steps to successful cyber attacks.

UNIT - II RISK ANALYSIS (7+2 Skill) 9

Risk identification, classification and assessment, Addressing risk: Cyber security Management System (CSMS), organizational security, physical and environmental security, network segmentation, access control, risk management and implementation.

UNIT - III ACCESSING THE CYBERSECURITY OF IACS (7+2 Skill) 9

Identifying the scope of the IACS- generation of cyber security information- identification of vulnerabilities- risk assessment-evaluation of realistic threat scenarios- Gap assessment-capturing Ethernet traffic- documentation of assessment results.

UNIT - IV CYBERSECURITY DESIGN AND IMPLEMENTATION (7+2 Skill) 9

Cyber security lifecycle- conceptual design process- detailed design process- firewall design- remote access design- intrusion detection design.

UNIT - V TESTING AND MAINTENANCE (7+2 Skill) 9

Developing test plans- cyber security factory acceptance testing- site acceptance testing-network and application diagnostics and troubleshooting- cyber security audit procedure- IACS incident response.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Analysis of various security tools.
2) Standards in cyber security.
3) Study the steps to remove Passwords from Microsoft Word.
4) Steps to ensure Security of any one web browser (Mozilla Firefox/Google Chrome).
5) Analysis the security vulnerabilities of E-Mail Application.

OUTCOMES:

Students able to:

1. Apply basis of science and engineering to understand Industrial security environment and cyberattacks (L3).
2. Analyze and assess risks in the industrial environment (L4).
3. Access the cybersecurity of IACS (L3).
4. Design and implement cyber security (L3).
5. Identify the tests and troubleshoots of industrial network security system (L1).
6. Understand, investigate and explore feasible solution for a moderate industrial problem (L2).

TEXT BOOKS:

1. Ronald L and Krutz, Industrial Automation and Control System Security Principles, ISA, 2013.
2. David J.Teumim, Network Security, Second edition, ISA, 2010.

REFERENCES:

1. Edward J.M. Colbert and Alexander Kott, Cyber-security of SCADA and other industrial control systems, Springer, 2016.
2. Perry S. Marshalland John S. Rinaldi, Industrial Ethernet, Second edition, ISA, 2004.
3. Christopher Hadnagy and Seth Schulman, Human Hacking,Win Friends, Influence People, and Leave Them Better Off for Having Met You, Harper Buisness. January 2021.

WEB REFERENCES:

1. https://ocw.mit.edu/courses/6-857-network-and-computer-security-spring-2014/resources/mit6_857s14_lec01/

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/106106129
2. https://www.cisco.com/c/en_in/products/security/what-is-cybersecurity.html
3. https://www.techtarget.com/searchsecurity/definition/cybersecurity
4. https://www.simplilearn.com/tutorials/cyber-security-tutorial/what-is-cyber-security

21EE1936	BUILDING AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To brief students with origin and evolution of building automation.
- To train them with architecture and operation of BAS.
- To facilitate them for designing automation system for intelligent building.
- Develop technique for preparation of various documents required for design requirement of safety building.

UNIT - I INTRODUCTION (7+2 Skill) 9

Intelligent Buildings - Definitions of intelligent building, Intelligent architecture and structure, Facilities management vs. intelligent buildings, Technology systems and evolution of intelligent buildings Features, Characteristics, Drawbacks of Building Automation system. Various Systems of Building Automation – Building Management System, Energy Management System, Security System, Safety System, Video Management System.

UNIT - II HVAC SYSTEM (7+2 Skill) 9

Introduction, HVAC, Sensors & Transducers – Temperature, Pressure, Level, Flow, RH. Meaning of Analog & Digital Signals, Valves and Actuators, Valve & Actuator Selection, Various Controllers, Concept of Controller IOs, Std Signals, Signal Compatibility between Controller & Field Devices. AHU – Concept, Components, Working Principle. AC Plant Room – Concept, Components, Refrigeration Cycle Working Principle, Chiller Sequencing, AC Plant Sequencing. Feedback Control Loops, Heat – Types, Heat Transfer Principles, Measurement of Heat Transfer. Psychrometry –Concept, ASHRAE Psychrometric Chart, Meaning of Various Terms – DBT, WBT, ST, RH, DPT, Sensible & Latent Cooling & Heating, Numericals. Job IO Summary Calculation, Controller Sizing, AI to DI Conversion, Cable Selection, Earthing – Meaning, Importance, Panel Earthing, EMI & Tackling EMI. Logic Examples, CL Programming.

UNIT - III ENERGY MANAGEMENT SYSTEM (7+2 Skill) 9

Concept, Energy Meters, Types, Meter Networking, Monitoring Energy Parameters, Analysis of Power Quality – Instantaneous Power, Active Power, Reactive Power, Power Factor, Voltage, Current. Effect of Power Quality on Energy Consumption, Energy Reports, Energy Conservation, Importance of Energy Saving.

UNIT - IV SAFETY SYSTEM (7+2 Skill) 9

Introduction, Fire –Meaning, Fire Development Stages, Fire Sensors & Detectors, Detector Placement, Detectors Required For Various Applications. Fire Extinguishing Principles, Fire Extinguishers & Its Classification. Fire Alarm System – Controllers, Components, Features, Concept of Fire Loop & Fire Devices, 2-Wire & 4-Wire Loops, Working Principle, System Description, Pre-alarm, Alarm, Trouble, Fault, Differences, Cable Selection, Installation Guidelines Best Installation Practices, Logic Example. NFPA and IS2189 Stds, System Programming.

UNIT - V INTEGRATED SYSTEMS (7+2 Skill) 9

Introduction, Integration of Building Management System, Energy Management System, Safety System, Security Systems & Video Management, Benefits of Integrated Systems, Challenges, Future Prospects of Integrated Systems.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) A Seminar on case studies and other security systems.
2) Quiz on different types of industrial 4.0 applications.
3) Familiarization with relevant software tool (MATLAB, AR/VR, PLM).
4) Creating a cloud computing platform and work on it.
5) Introduction to other industry and security not covered in the above syllabus.

OUTCOMES:

Students able to:

1. Explain the concept of intelligent building and BAS (L2).
2. Select the hardware and design of HVAC in building automation system (L4).
3. Discuss the concept of energy management system (L2).
4. Design the automation system for intelligent building
5. Illustrate the safety system for building (L3).
6. Design and integrate the different system in BAS (L5).

TEXT BOOKS:

1. Shengwei Wang, Intelligent Buildings and Building Automation, 2009.
2. Reinhold A. Carlson Robert A. Di Giandomenico, Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security Access Control, Lighting, Building,1st edition (R.S. Means Company Ltd), (1991).

REFERENCES:

1. Roger W. Haines, "HVAC system Design Handbook", fifth edition.
2. National Joint Apprenticeship & Training Committee, Building Automation System Integration With Open Protocols: System Integration With Open Protocols.

3. John I. Levenhagen and Donald H. Spethmann, HVAC Controls and Systems (Mechanical Engineering), 1992.
4. James E.Brumbaugh, "HVAC fundamentals", vol: 1 to 3.

WEB REFERENCES:

1. https://www.designingbuildings.co.uk/wiki/Building_Automation_and_Control_System_BACS

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/105/102/105102176/
2. https://www.resonai.com/blog/what-are-intelligent-buildings
3. https://nexusintegra.io/features-smart-buildings/
4. http://www.inogate.org/documents/Lecture%20Building%20EE%203%20ENG.pdf

21EE1937	SMART FARMING	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

- To know about the basics of sensing and control algorithm in farming.
- To understand the efficiency of farming through technology.
- To explore image processing and Machine learning for agriculture.
- To introduce types of sensors and software to implement in field.

UNIT - I INTRODUCTION (7+2 Skill) 9

History of Precision farming- Sensing Technology- Control Algorithm- Yield Monitoring- Soil Property Sensing- Acquisition through Remote Sensing- Crop Information- Farmland Data- Spatial Sensing- Temporal Sensing- Feedback Control.

UNIT - II MACHINE LEARNING IN AGRICULTURE (7+2 Skill) 9

Machine Learning in Agriculture- Deep Learning in Agriculture- Yield prediction- Weed Detection- Irrigation Management- Discrimination between Weed and Crop- Forecasting stages.

UNIT - III IoT IN AGRICULTURE (7+2 Skill) 9

Need of IoT- IoT in Agriculture- Case study: Protection of Agricultural land from Elephants- Irrigation and Water Quality Management- Monitoring- Farm- Soil- Aquaponics- Agricultural Machinery- Disease and Pest Control- Challenges and Issues.

UNIT - IV DRONES IN AGRICULTURE (7+2 Skill) 9

Drones in Agriculture- Agricultural Drones- Types of Drones and Classifications – Definitions and Terminologies- Study of Natural Resources and Vegetation- Mapping and Monitoring.

UNIT - V AGRICULTURE 5.0 (7+2 Skill) 9

Introduction to Agriculture 4.0- Remote Sensing- Application of Nanotechnology in Agriculture- Role of Big data- Hurdles faced by Farmers in Adopting- Current Policy Trends and Regulation.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar / Mini Project / Assignment / Content Preparation / Quiz / Surprise Test / Solving GATE questions / etc)

1) Taking Local area to implement simple closed loop system for irrigation and water management.
2) Using Machine Learning to forecast weather and predicting yield for particular field with previous data.
3) Mapping and Monitoring of particular area.
4) Drafting a policy and protocol to adopt farmers to new technologies.

OUTCOMES:

Students able to:

1. Relate to farming with industrial problem and solving it (L2).
2. Explain the process in growing a particular crop varieties and challenges associated with it. (L5).
3. Apply the knowledge to select suitable sensors and software for particular test case (L3).
4. Analyze anomaly and weather change beforehand (L4).
5. Build an exclusive irrigation and harvest plan for particular zone (L3).
6. Explore machine learning in farming for irrigation and water management.

TEXT BOOKS:

1. Latief Ahmad, Firasath Nabi, “Agriculture 5.0 – Artificial Intelligence, IoT and Machine learning”, CRC Press, 2021.
2. Qin Zhang, “Precision Agriculture Technology for Crop Farming”, CRC Press, 2016.

REFERENCES:

1. Govind Singh Patel, “Smart Agriculture”, CRC Press, 2021.
2. Ajith Abraham, Sujata Dash, Joel J.P.C.Rodrigues, “AI Edge and IoT based smart agriculture”, 2021, Elsevier.
3. Amitava Choudhury, Arindam Biswas, T.P.Singh, Santanu Kumar Ghosh, “Smart Agriculture Automation using Advanced Technologies”, 2021, Springer.

WEB REFERENCES:

1. https://www.intechopen.com/chapters/76652

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_bt25/preview
2. https://1lib.in/book/5402770/65c33e?dsource=recommend
3. https://1lib.in/book/3581147/d6c544?dsource=recommend
4. https://archive.nptel.ac.in/courses/126/104/126104002/

VERTICAL VI: COMPUTER

21IT1913	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of Blockchain
- To learn Different protocols and consensus algorithms in Blockchain
- To learn the Blockchain implementation frameworks
- To understand the Blockchain Applications
- To experiment the Hyperledger Fabric, Ethereum networks

UNIT I INTRODUCTION TO BLOCKCHAIN 9

Blockchain- Public Ledgers, Blockchain as Public Ledgers - Block in a Blockchain, Transactions- The Chain and the Longest Chain - Permissioned Model of Blockchain, Cryptographic -Hash Function, Properties of a hash function-Hash pointer and Merkle tree

UNIT II BITCOIN AND CRYPTOCURRENCY 9

A basic crypto currency, Creation of coins, Payments and double spending, FORTH – the precursorfor Bitcoin scripting, Bitcoin Scripts , Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay

UNIT III BITCOIN CONSENSUS 9

Bitcoin Consensus, Proof of Work (PoW)- Hashcash PoW , Bitcoin PoW, Attacks on PoW ,monopolyproblem- Proof of Stake- Proof of Burn - Proof of Elapsed Time - Bitcoin Miner, Mining Difficulty, Mining Pool-Permissioned model and use cases.

UNIT IV HYPERLEDGER FABRIC & ETHEREUM 9

Architecture of Hyperledger fabric v1.1- chain code- Ethereum: Ethereum network, EVM, Transaction fee, Mist Browser, Ether, Gas, Solidity.

UNIT V BLOCKCHAIN APPLICATIONS 9

Smart contracts, Truffle Design and issue- DApps- NFT. Blockchain Applications in Supply Chain Management, Logistics, Smart Cities, Finance and Banking, Insurance, etc- Case Study.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Understand emerging abstract models for Blockchain Technology

CO2: Identify major research challenges and technical gaps existing between theory and practicein the crypto currency domain.

CO3: Understand the function of Blockchain as a method of securingdistributed ledgers, how consensus on their contents is achieved, and the new applications that they enable.

CO4: Apply hyper ledger Fabric and Ethereum platform to implement the Block chain Application.

TEXT BOOKS

1. Bashir and Imran, Mastering Blockchain: Deeper insights into decentralization, cryptography,Bitcoin, and popular Blockchain frameworks, 2017.
2. 2.Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O’Reilly, 2014.

REFERENCES:

1. Daniel Drescher, “Blockchain Basics”, First Edition, Apress, 2017.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton UniversityPress, 2016.
3. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O’Reilly, 2015
4. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contractsfor Ethereum and Blockchain”, Packt Publishing, 2018.
5. Handbook of Research on Blockchain Technology, published by Elsevier Inc. ISBN: 9780128198162, 2020.

21CS1908	AUGMENTED REALITY/VIRTUAL REALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in thedevelopment of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

UNIT I INTRODUCTION 9

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories andHybrid Space-Three I's of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices –3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human VisualSystem – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human AuditorySystem**.**

UNIT II VR MODELING 9

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

UNIT III VR PROGRAMMING 9

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

UNIT IV APPLICATIONS 9

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR andSociety-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications– Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics– Information Visualization – VR in Business – VR in Entertainment – VR in Education.

UNIT V AUGMENTED REALITY 9

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

TOTAL:45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to:

CO1: Understand the basic concepts of AR and VR

CO2: Understand the tools and technologies related to AR/VR

CO3: Know the working principle of AR/VR related Sensor devices

CO4: Design of various models using modeling techniques

CO5: Develop AR/VR applications in different domains

TEXTBOOKS:

1. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create compelling VRexperiences for mobile”, Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, “Augmented Reality: Principles & Practice”, AddisonWesley, 2016
3. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application,Design”, Morgan Kaufmann, 2003.

21CS1903	CLOUD SERVICES MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Introduce Cloud Service Management terminology, definition & concepts
- Compare and contrast cloud service management with traditional IT service management
- Identify strategies to reduce risk and eliminate issues associated with adoption of cloudservices
- Select appropriate structures for designing, deploying and running cloud-based services ina business environment
- Illustrate the benefits and drive the adoption of cloud-based services to solve real worldproblems

UNIT I CLOUD SERVICE MANAGEMENT FUNDAMENTALS 9

Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, CloudService Deployment Models

UNIT II CLOUD SERVICES STRATEGY 9

Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture

UNIT III CLOUD SERVICE MANAGEMENT 9

Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service OperationsManagement

UNIT IV CLOUD SERVICE ECONOMICS 9

Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models

UNIT V CLOUD SERVICE GOVERNANCE & VALUE 9

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership.

TOTAL : 45 PERIODS

OUTCOMES:

On Completion of the course, the students should be able to:

CO1: Understand Cloud Service Management terminology, definition & concepts

CO2: Compare and contrast cloud service management with traditional IT service management

CO3: Build and automate business solutions using cloud technologies.

CO4: Identify strategies to reduce risk and eliminate issues associated with adoption of Cloud services

CO5: Select appropriate structures for designing, deploying and running cloud-based services In business environment

CO6: Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems

TEXT BOOKS

1. Cloud Service Management and Governance: Smart Service Management in Cloud Era byEnamul Haque, Enel Publications,2020.
2. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini,Zaigham Mohammad ,2013.
3. Cloud Computing Design Patterns by Thomas Erl, Robert Cope, Amin Naserpour,2017.

REFERENCES

1. Economics of Cloud Computing by Praveen Ayyappa, LAP Lambert Academic Publishing,2011
2. Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya,Christian Vechhiola, S. Thamarai Selvi,2013

21AD1921	COMPUTER VISION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamental concepts related to Image formation and processing.
- To learn feature detection, matching and detection
- To become familiar with feature based alignment and motion estimation
- To develop skills on 3D reconstruction
- To understand image based rendering and recognition

UNIT I INTRODUCTION TO IMAGE FORMATION AND PROCESSING 9

Computer Vision - Geometric primitives and transformations - Photometric image formation - Thedigital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms- Pyramids and wavelets - Geometric transformations - Global optimization.

UNIT II FEATURE DETECTION, MATCHING AND SEGMENTATION 9

Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shiftand mode finding - Normalized cuts - Graph cuts and energy-based methods.

UNIT III FEATURE-BASED ALIGNMENT & MOTION ESTIMATION 9

2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation- Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure andmotion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layeredmotion.

UNIT IV 3D RECONSTRUCTION 9

Shape from X - Active range finding - Surface representations - Point-based representations- Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos.

UNIT V IMAGE-BASED RENDERING AND RECOGNITION 9

View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition - Categoryrecognition - Context and scene understanding- Recognition databases and test sets.

TOTAL : 45 PERIODS

OUTCOMES:

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

CO1: To understand basic knowledge, theories and methods in image processing and computervision.

CO2: To implement basic image processing techniques in OpenCV.

CO3: To implement some advanced image processing techniques in OpenCV.

CO4: To apply 2D feature-based image alignment, segmentation and motion estimations.

CO5: To apply 3D image reconstruction techniques
CO6: To design and develop innovative image processing and computer vision applications.

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard Eugene Woods," Digital Image Processing", Pearson,2018.
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer- Texts inComputer Science, Second Edition, 2022.
3. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, SecondEdition, 2015.

REFERENCES:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision,Second Edition, Cambridge University Press, March 2004.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

21AD1924	OPTIMIZATION TECHNIQUES IN MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To formulate and solve linear programming problems
- To understand and analyze how to deal with changing data.
- To identify and interpret potential unintended effects in the project.
- To understand and define procedures to operationalize the machine learning model
- To maintain the applied machine learning model.

UNIT I INTRODUCTION 9

What is optimization, Formulation of LPP, Solution of LPP: Simplex method, Basic Calculus for optimization: Limits and multivariate functions, Derivatives and linear approximations: Single variate functions and multivariate functions.

UNIT II MACHINE LEARNING STRATEGY 9

ML readiness, Risk mitigation, Experimental mindset, Build/buy/partner, setting up a team, Understanding and communicating change.

UNIT III RESPONSIBLE MACHINE LEARNING 9

AI for good and all, Positive feedback loops and negative feedback loops, Metric design and observing behaviours, Secondary effects of optimization, Regulatory concerns.

UNIT IV MACHINE LEARNING IN PRODUCTION AND PLANNING 9

Integrating info systems, users break things, time and space complexity in production, when to retain the model- Logging ML model versioning, Knowledge transfer, Reporting performance to stakeholders.

UNIT V CARE AND FEEDING OF MACHINE LEARNING MODEL 9

MLPL Recap, Post deployment challenges, QUAM monitoring and logging, QUAM Testing, QUAM maintenance, QUAM updating, Separating Datastack from Production, Dashboard Essentials and Metrics monitoring.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will able to

CO1: Formulate and solve linear programming problems.
CO2: Understand and analyze how to deal with changing data.
CO3: Understand and interpret potential unintended effects in their project.
CO4: Understand and define procedures to operationalize the applied machine learning model.
CO5: Understand and define procedures to maintain the applied machine learning model.
CO6: Understand how to optimize the use of Machine Learning in real-life problems.

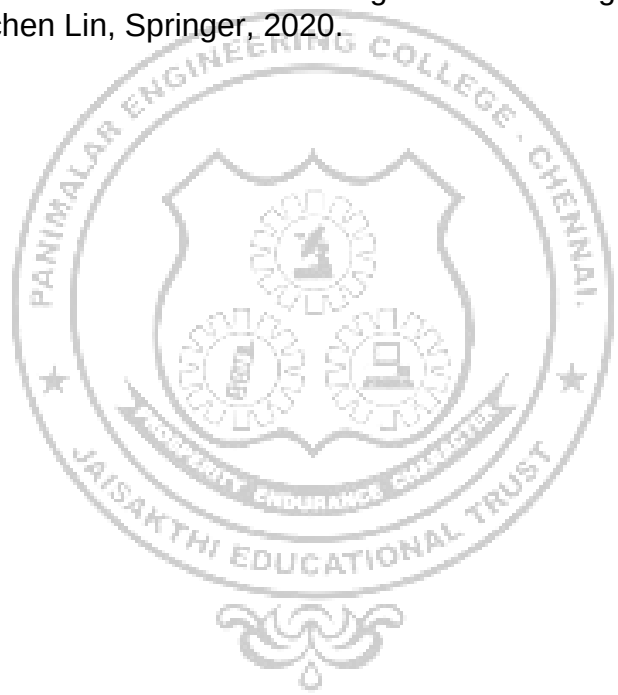
TEXT BOOK:

1. Hamdy A Taha, Operations Research: An Introduction, Pearson, 10th Edition, 2017.
2. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing, 2020.
3. Optimization in Machine Learning and Applications, Suresh Chandra Satapathy, Anand J. Kulkarni, Springer, 2019.

REFERENCES:

1 Hiller F.S, Liberman G.J, Introduction to Operations Research, 10th Edition McGraw Hill,2017.

2. Optimization for Machine Learning, Suvrit Sra, Sebastian Nowozin and Stephen J. Wright, MIT Press, 2011.
3. Algorithms for Optimization by Mykel J. Kochenderfer and Tim A. Wheeler, MIT Press, 2019.
4. Accelerated Optimization for Machine Learning: First-Order Algorithms by Cong Fang, Huan Li, and Zhouchen Lin, Springer, 2020.



21AD1918	NEURAL NETWORKS AND DEEP LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics in deep neural networks
- To understand the basics of associative memory and unsupervised learning networks
- To apply CNN architectures of deep neural networks
- To analyze the key computations underlying deep learning, then use them to build and traindeep neural networks for various tasks.
- To apply autoencoders and generative models for suitable applications.

UNIT I INTRODUCTION 9

Neural Networks-Application Scope of Neural Networks-Artificial Neural Network: An Introduction- Evolution of Neural Networks-Basic Models of Artificial Neural Network-Important Terminologies of ANNs-Supervised Learning Network.

UNIT II ASSOCIATIVE MEMORY AND UNSUPERVISED LEARNING NETWORKS9

Training Algorithms for Pattern Association-Autoassociative Memory Network-Heteroassociative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Iterative Autoassociative Memory Networks-Temporal Associative Memory Network-Fixed Weight Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Counter propagation Networks-Adaptive Resonance Theory Network.

UNIT III THIRD-GENERATION NEURAL NETWORKS 9

Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation –Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Neuroscientific Basis – Applications: Computer Vision, Image Generation,Image Compression.

UNIT IV DEEP FEEDFORWARD NETWORKS 9

History of Deep Learning- A Probabilistic Theory of Deep Learning- Gradient Learning – Chain Rule and Backpropagation - Regularization: Dataset Augmentation – Noise Robustness -Early Stopping, Bagging and Dropout - batch normalization- VC Dimension and Neural Nets.

UNIT V RECURRENT NEURAL NETWORKS 9

Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Applications: Image Generation, Image Compression, Natural Language Processing. Complete Auto encoder, Regularized Autoencoder, Stochastic Encoders and Decoders,Contractive Encoders,LSTM networks.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to:

CO1: Apply Convolution Neural Network for image processing.

CO2: Understand the basics of associative memory and unsupervised learning networks.

CO3: Apply CNN and its variants for suitable applications.

CO4: Analyze the key computations underlying deep learning

CO5: Use the key computations to build and train deepneural networks for various tasks.

CO6: Apply auto encoders and generative models for suitable applications.

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2. Francois Chollet, “Deep Learning with Python”, Second Edition, Manning Publications,2021.

REFERENCES:

1. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, Oreilly,2018.
2. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O’Reilly Media,2017.
3. Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook”, SpringerInternational Publishing, 1st Edition, 2018.
4. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
5. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
6. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017.
7. S Rajasekaran, G A Vijayalakshmi Pai, “Neural Networks, FuzzyLogic and GeneticAlgorithm, Synthesis and Applications”, PHI Learning, 2017.
8. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017
9. James A Freeman, David M S Kapura, “Neural Networks Algorithms, Applications, andProgramming Techniques”, Addison Wesley, 2003.

21AD1920	BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the Analytics Life Cycle.
- To comprehend the process of acquiring Business Intelligence
- To understand various types of analytics for Business Forecasting
- To model the supply chain management for Analytics.
- To apply analytics for different functions of a business

UNIT I INTRODUCTION TO BUSINESS ANALYTICS 9

Analytics and Data Science – Analytics Life Cycle – Types of Analytics – Business Problem Definition – Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration

UNIT II BUSINESS INTELLIGENCE 9

Data Warehouses and Data Mart - Knowledge Management –Types of Decisions - Decision Making Process - Decision Support Systems – Business Intelligence –OLAP – Analytic functions

UNIT III BUSINESS FORECASTING 9

Introduction to Business Forecasting and Predictive analytics - Logic and Data Driven Models –Data Mining and Predictive Analysis Modelling –Machine Learning for Predictive analytics.

UNIT IV HR & SUPPLY CHAIN ANALYTICS 9

Human Resources – Planning and Recruitment – Training and Development - Supply chain network

- Planning Demand, Inventory and Supply – Logistics – Analytics applications in HR & Supply Chain
- Applying HR Analytics to make a prediction of the demand for hourly employees for a year.

UNIT V MARKETING & SALES ANALYTICS 9

Marketing Strategy, Marketing Mix, Customer Behaviour –selling Process – Sales Planning – Analytics applications in Marketing and Sales - predictive analytics for customers' behaviour in marketing and sales.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the students will be able to

CO1: Explain the real world business problems and model with analytical solutions.

CO2: Identify the business processes for extracting Business Intelligence

CO3 : Apply predictive analytics for business fore-casting

CO4: Apply analytics for supply chain and logistics management

CO5: Use analytics for marketing and sales.

TEXT BOOKS

1. R. Evans James, Business Analytics, 2nd Edition, Pearson, 2017.
2. N Prasad, Seema Acharya, Fundamentals of Business Analytics, 2nd Edition, Wiley,2016.

REFERENCES

1. Philip Kotler and Kevin Keller, Marketing Management, 15th edition, PHI, 2016
2. VSP RAO, Human Resource Management, 3rd Edition, Excel Books, 2010.
3. Mahadevan B, “Operations Management -Theory and Practice”,3rd Edition,Pearson Education,2018.