PANIMALAR
ENGINEERING COLLEGE

An Autonomous Institution

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

CURRICULUM & SYLLABUS

REGULATION 2023

for the students admitted during 2024-25

B.E - ELECTRICAL AND ELECTRONICS ENGINEERING

www.panimalar.ac.in

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-2023

(For the Students admitted during 2024-25)

VISION AND MISSION OF THE DEPARTMENT

Vision

To be a centre of excellence in Electrical and Electronics Engineering education, fostering innovation and technical expertise to meet the evolving needs of society with credibility, integrity, and ethical values.

Mission

M1: To achieve excellence in curricular and co-curricular activities by providing quality education through dedicated faculty and effective teaching methods.

M2: To equip students with technical competence and practical skills through research-driven learning and industry-focused training.

M3: To nurture dedicated Electrical and Electronics Engineers who take pride in

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1: Core Industry Employment and Leadership: To pursue a career in Electrical and Electronics sectors while honing leadership to **propel** organizations toward success.

PEO2: Advanced Studies and Engineering Expertise: Pursue higher education to become an erudite scholar and provide expert solutions to engineering challenges.

PEO3: Entrepreneurship and Innovation in Electrical Engineering: Develop entrepreneurial skills and establish ventures in Electrical and Electronics product and service industries.

PROGRAM OUTCOMES (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Apply fundamental scientific principles to analyse and develop innovative solutions for challenges in the Electrical and Electronics Engineering field.

PSO2: Design and implement innovative hardware and software solutions in the electrical domain, focusing on emerging energy technologies and sustainability to meet evolving industrial needs.

PSO3: To take up roles in a team, develop managerial skills, and contributes towards the electrical community globally.

B.E.-Electrical and Electronics Engineering

CHOICE BASED CREDIT SYSTEM (CBCS)

I - VIII SEMESTERS CURRICULUM AND SYLLABI (REGUALTION 2023)

(For the Students admitted during 2024-25)

Semester I

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
Theory Courses							
1.	23MA1101	Matrices and Calculus	BS	3/1/0	4	4	60/40
2.	23ES1106	Programming in C	ES	3/0/0	3	3	60/40
Theory Cum Practical Courses							
3.	23HS1103	Communicative English and Language Skills I	HS	2/0/2	4	3	50/50
4.	23PH1103	Engineering Physics	BS	2/0/2	4	3	50/50
Laboratory Courses							
5.	23ES1113	Programming in C Laboratory	ES	0/0/4	4	2	40/60
6.	23ES1115	Computer Aided Engineering Graphics	ES	0/0/4	4	2	40/60
Mandatory Course							
7.	23TA1101	தமிழர் மரபு / Heritage of Tamils	HS	1/0/0	1	1	60/40
8.	23HS1104	Interpersonal Communication skills I	EEC	0/0/2	2	0	0/100
9.	23HS1105	Quantitative Aptitude Practices I	EEC	0/0/1	1	0	0/100
			TOTAL		**27**	**18**	

Semester II							
S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
Theory Courses							
1.	23MA1201	Complex Variables and Laplace Transform	BS	3/1/0	4	4	60/40
2.	23ES1206	Programming in Python	ES	3/0/0	3	3	60/40
3.	23ES1202	Basic Civil and Mechanical Engineering	ES	3/0/0	3	3	60/40
Theory Cum Practical Courses							
4.	23HS1203	Communicative English and Language Skills II	HS	2/0/2	4	3	50/50
5.	23EE1201	Electric Circuit Analysis	PC	3/0/2	5	4	50/50
Laboratory Courses							
6.	23EE1211	Engineering Practices Laboratory	ES	0/0/4	4	2	40/60
7.	23ES1215	Programming in Python Laboratory	ES	0/0/4	4	2	40/60
8.	23ES1212	Technical Skill Practices I	EEC	0/0/2	2	0	0/100
Mandatory Course							
9.	23TA1201	தமிழரும் தொழில் நுட்பமும் /Tamils and Technology	HS	1/0/0	1	1	60/40
10.		Mandatory Course I	MC	2/0/0	2	0	0/100
11.	23HS1204	Interpersonal Communication skills II	EEC	0/0/2	2	0	0/100
12.	23HS1205	Quantitative Aptitude Practices II	EEC	0/0/1	1	0	0/100
TOTAL					**35**	**22**	

Semester III							
S.No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1	23MA1303	Transforms and Partial Differential Equations	BS	3/1/0	4	4	60/40
2	23EE1301	Electromagnetic Theory	PC	3/0/0	3	3	60/40
3	23EE1302	Signals and Systems	PC	3/0/0	3	3	60/40
4	23CS1304	Object Oriented Programming using Java	ES	3/0/0	3	3	60/40
Theory Cum Practical Courses							
5	23EE1303	Analog Electronics	PC	3/0/2	5	4	50/50
Laboratory Course							
6	23CS1313	Object Oriented Programming using Java Laboratory	ES	0/0/4	4	2	40/60
7	23ES1312	Coding Practices I	EEC	0/0/2	2	0	0/100
Mandatory Course							
8		Mandatory Course II	MC	2/0/0	2	0	0/100
9	23HS1301	Skills for Career Building and Development I	EEC	0/0/2	2	0	0/100
10	23HS1302	Quantitative Aptitude Practices III	EEC	0/0/1	1	0	0/100
TOTAL					**29**	**19**	

Semester IV							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1	23MA1403	Numerical Methods	BS	3/1/0	4	4	60/40
2	23EE1401	Measurements and Instrumentation	PC	3/0/0	3	3	60/40
3	23EE1402	Electrical Machines I	PC	3/0/0	3	3	60/40
4	23EE1403	Transmission and Distribution	PC	3/0/0	3	3	60/40
5	23EE1404	Control Systems	PC	3/0/0	3	3	60/40
Theory Cum Practical Courses							
6	23EE1405	Digital Electronics	PC	3/0/2	5	4	50/50
Laboratory Course							
7	23EE1411	Electrical Machines Laboratory I	PC	0/0/4	4	2	40/60
8	23EE1412	Control and Instrumentation Laboratory	PC	0/0/4	4	2	40/60
9	23ES1412	Coding Practices II	EEC	0/0/2	2	0	0/100
Mandatory Course							
10	23HS1401	Skills for Career Building and Development II	EEC	0/0/2	2	0	0/100
11	23HS1402	Quantitative Aptitude Practice IV	EEC	0/0/1	1	0	0/100
			TOTAL		**34**	**24**	

Semester V

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
Theory Courses							
1	23EE1501	Power System Analysis	PC	3/0/0	3	3	60/40
2	23EE1502	Electrical Machines II	PC	3/0/0	3	3	60/40
3	23EE1503	Power Electronics	PC	3/0/0	3	3	60/40
4		Professional Elective - I	PE	3/0/0	3	3	60/40
5		Open Elective - I	OE	3/0/0	3	3	60/40
Theory Cum Practical Courses							
6	23EE1504	Microcontroller and Embedded System	PC	3/0/2	5	4	50/50
Laboratory Course							
7	23EE1511	Electrical Machines Laboratory II	PC	0/0/4	4	2	40/60
8	23EE1512	Industrial Automation Laboratory	PC	0/0/4	4	2	40/60
9	23ES1512	Coding Practices III	EEC	0/0/2	2	0	0/100
			TOTAL		**30**	**23**	

Semester VI							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1	23EE1601	Electrical Drives	PC	3/0/0	3	3	60/40
2	23EE1602	Power System Operation and Control	PC	3/0/0	3	3	60/40
3		Professional Elective - II	PE	3/0/0	3	3	60/40
4		Professional Elective - III	PE	3/0/0	3	3	60/40
5		Open Elective - II	OE	3/0/0	3	3	60/40
Theory Cum Practical Courses							
6	23EE1603	Artificial Intelligence for Electrical Engineers	PC	3/0/2	5	4	50/50
Laboratory Course							
7	23EE1611	Power Electronics and Drives Laboratory	PC	0/0/4	4	2	40/60
8	23EE1612	Power System Simulation Laboratory	PC	0/0/4	4	2	40/60
9	23ES1612	Coding Practices IV	EEC	0/0/2	2	0	0/100
			TOTAL		**30**	**23**	

Semester VII							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1	23EE1701	Protection and Switchgear	PC	3/0/0	3	3	60/40
2	23EE1702	Renewable Energy Systems	PC	3/0/0	3	3	60/40
3	23EE1703	High Voltage Engineering	PC	3/0/0	3	3	60/40
4		Professional Elective - IV	PE	3/0/0	3	3	60/40
5		Professional Elective - V	PE	3/0/0	3	3	60/40
Laboratory Courses							
6	23EE1711	Renewable Energy Systems Laboratory	PC	0/0/4	4	2	40/60
7	23EE1712	Mini-Project	EEC	0/0/4	4	2	40/60
Employability Enhancement Course							
8	23EE1704	Industrial training/ Internship#	EEC	-	-	2	0/100
			TOTAL		**23**	**21**	

Two weeks summer Internship carries one credit, and it will be done between III to VI semester summer vacation and same will be evaluated in VII semester. To earn the credits, students must complete for week internship program, either 2 two weeks internship or 1 four week internship program.

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Semester VIII							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1		Professional Elective - VI	PE	3/0/0	3	3	60/40
2		Professional Elective - VII	PE	3/0/0	3	3	60/40
Laboratory Course							
3	23EE1811	Project Work	EEC	0/0/16	16	8	40/60
			TOTAL		**22**	**14**	

TOTAL NO. OF CREDITS: 164

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 23EE1901	Special Electrical Machines 23EE1909	Embedded Processors 23EE1916	Electric Vehicle Architecture 23EE1923	PLC Programming 23EE1930	Crypto currency and Block chain Technologies 23IT1913
2.	Substation Engineering and Automation 23EE1902	Analysis of Electrical Machines 23EE1910	Embedded C-Programming 23EE1917	Design of Motor and Power Converters for Electric Vehicles 23EE1924	Smart System Automation 23EE1931	Augmented Reality and Virtual Reality 23CS1908
3.	Smart Grid 23EE1903	Multilevel Power Converters 23EE1911	Embedded System Design 23EE1918	Design of Electric Vehicle Charging System 23EE1925	Industry 4.0 23EE1932	Cloud Services Management 23CS1903
4.	Energy Management and Auditing 23EE1904	Embedded Control for Electrical Drives 23EE1912	Robotics and Automation 23EE1919	Testing of Electric Vehicles 23EE1926	Intelligent Automation 23EE1933	Optimization Techniques in Machine Learning 23AD1924
5.	Power Quality 23EE1905	SMPS and UPS 23EE1913	Embedded System for Automotive Applications 23EE1920	Electric Vehicle Design, Mechanics and Control 23EE1927	Smart Manufacturing 23EE1934	Computer Vision Techniques 23AD1921
6.	HVDC and FACTS 23EE1906	Power Electronics for Renewable Energy Systems 23EE1914	MEMS and NEMS 23EE1921	Grid Integration of Electric Vehicles 23EE1928	Cyber Security 23EE1935	Neural Networks and Deep Learning 23AD1918
7.	Utilization And Conservation of Electrical Energy 23EE1907	Control of Power Electronics Circuits 23EE1915	Digital Signal Processing System Design 23EE1922	Intelligent control of Electric Vehicles 23EE1929.	Smart Farming 23EE1936	Business Analytics 23AD1920
8.	Restructured Power Market 23EE1908				Building Automation 23EE1937	

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.

VERTICAL – I: POWER ENGINEERING

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23EE1901	Under Ground Cable Engineering	PE	3/0/0	3	3	60/40
2	23EE1902	Substation Engineering and Automation	PE	3/0/0	3	3	60/40
3	23EE1903	Smart Grid	PE	3/0/0	3	3	60/40
4	23EE1904	Energy Management and Auditing	PE	3/0/0	3	3	60/40
5	23EE1905	Power Quality	PE	3/0/0	3	3	60/40
6	23EE1906	HVDC and FACTS	PE	3/0/0	3	3	60/40
7	23EE1907	Utilization and Conservation of Electrical Energy	PE	3/0/0	3	3	60/40
8	23EE1908	Restructured Power Market	PE	3/0/0	3	3	60/40

VERTICAL – II: CONVERTERS AND DRIVES

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23EE1909	Special Electrical Machines	PE	2/0/2	4	3	60/40
2	23EE1910	Analysis of Electrical Machines	PE	2/0/2	4	3	60/40
3	23EE1911	Multilevel Power Converters	PE	2/0/2	4	3	60/40
4	23EE1912	Embedded Control for Electrical Drives	PE	2/0/2	4	3	60/40
5	23EE1913	SMPS and UPS	PE	2/0/2	4	3	60/40
6	23EE1914	Power Electronics for Renewable Energy Systems	PE	2/0/2	4	3	60/40
7	23EE1915	Control of Power Electronics Circuits	PE	2/0/2	4	3	60/40

VERTICAL – III: EMBEDDED SYSTEMS

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23EE1916	Embedded Processors	PE	2/0/2	4	3	60/40
2	23EE1917	Embedded C-programming	PE	2/0/2	4	3	60/40
3	23EE1918	Embedded System Design	PE	2/0/2	4	3	60/40
4	23EE1919	Robotics and Automation	PE	3/0/0	4	3	60/40
5	23EE1920	Embedded System for Automotive Applications	PE	2/0/2	4	3	60/40
6	23EE1921	MEMS and NEMS	PE	2/0/2	4	3	60/40
7	23EE1922	Digital Signal Processing System Design	PE	2/0/2	4	3	60/40

VERTICAL – IV: ELECTRIC VEHICLE TECHNOLOGY

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23EE1923	Electric Vehicle Architecture	PE	3/0/0	3	3	60/40
2	23EE1924	Design of Motor and Power Converters for Electric Vehicles	PE	2/0/2	4	3	60/40
3	23EE1925	Design of Electric Vehicle Charging System	PE	2/0/2	4	3	60/40
4	23EE1926	Testing of Electric Vehicles	PE	2/0/2	4	3	60/40
5	23EE1927	Electric Vehicle Design, Mechanics and Control	PE	2/0/2	4	3	60/40
6	23EE1928	Grid Integration of Electric Vehicles	PE	3/0/0	3	3	60/40
7	23EE1929	Intelligent Control of Electric Vehicles	PE	2/0/2	4	3	60/40

VERTICAL – V: AUTOMATION

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23EE1930	PLC Programming	PE	3/0/0	3	3	60/40
2	23EE1931	Smart System Automation	PE	2/0/2	3	3	60/40
3	23EE1932	Industry 4.0	PE	3/0/0	3	3	60/40
4	23EE1933	Intelligent Automation	PE	3/0/0	3	3	60/40
5	23EE1934	Smart Manufacturing	PE	3/0/0	3	3	60/40
6	23EE1935	Cyber Security	PE	3/0/0	3	3	60/40
7	23EE1936	Smart Farming	PE	3/0/0	3	3	60/40
8	23EE1937	Building Automation	PE	3/0/0	3	3	60/40

VERTICAL – VI: COMPUTER

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23IT1913	Cryptocurrency and Blockchain Technologies	PE	3/0/0	3	3	60/40
2	23CS1908	Augmented Reality/Virtual Reality	PE	3/0/0	3	3	60/40
3	23CS1903	Cloud Services Management	PE	3/0/0	3	3	60/40
4	23AD1924	Optimization Techniques in Machine Learning	PE	3/0/0	3	3	60/40
5	23AD1921	Computer Vision Techniques	PE	3/0/0	3	3	60/40
6	23AD1918	Neural Networks and Deep Learning	PE	3/0/0	3	3	60/40
7	23AD1920	Business Analytics	PE	3/0/0	3	3	60/40

OPEN ELECTIVE – I

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23CE1008	Recent Trends in Water Treatment	OE	3/0/0	3	3	60/40
2	23IT1001	Web Design and Management	OE	3/0/0	3	3	60/40
3	23CB1002	Mobile Application Development	OE	3/0/0	3	3	60/40
4	23CS1001	Fundamentals of Data BaseManagement Systems	OE	3/0/0	3	3	60/40
5	23ME1937	Industrial Safety and Maintenance	OE	3/0/0	3	3	60/40
6	23EC1011	IoT Concepts and Applications	OE	3/0/0	3	3	60/40
7	23IT1003	Ethical Hacking	OE	3/0/0	3	3	60/40
8	23ME1702	Power Plant Engineering	OE	3/0/0	3	3	60/40
9	23EE1009	Energy storage systems	OE	3/0/0	3	3	60/40
10	23EC1010	Drone Technologies	OE	3/0/0	3	3	60/40
11	23GE1001	Principles of Management	OE	3/0/0	3	3	60/40

OPEN ELECTIVE – II

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23CB1001	Introduction to C programming	OE	3/0/0	3	3	60/40
2	23AD1402	Basics of Data Science	OE	3/0/0	3	3	60/40
3	23AM1001	Data Structures and Algorithms	OE	3/0/0	3	3	60/40
4	23EC1001	VLSI Design	OE	3/0/0	3	3	60/40
5	23EE1008	Energy Conservation and Management	OE	3/0/0	3	3	60/40
6	23EE1002	Hybrid Energy Technology	OE	3/0/0	3	3	60/40
7	23AD1003	Business Intelligence	OE	3/0/0	3	3	60/40
8	23GE1002	Human Resource Management	OE	3/0/0	3	3	60/40
9	23ME1934	Industrial Engineering	OE	3/0/0	3	3	60/40
10	23CS1003	Cloud Computing	OE	3/0/0	3	3	60/40
11	23CE1010	Air Pollution and Control Engineering	OE	3/0/0	3	3	60/40

MANDATORY COURSES

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23MC1201	Environmental Science	MC	2/0/0	2	0	0/100
2	23MC1002	Constitution of India	MC	2/0/0	2	0	0/100
3	23MC1003	Human Values	MC	2/0/0	2	0	0/100
4	23MC1004	Energy Studies	MC	2/0/0	2	0	0/100
5	23MC1005	Essence of Indian Traditional Knowledge	MC	2/0/0	2	0	0/100
6	23MC1006	Soft Skills and Personality Development	MC	2/0/0	2	0	0/100
7	23MC1007	Value Education, Human Rights & Legislature Procedure	MC	2/0/0	2	0	0/100

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23HS1103	Communicative English and Language Skills I	HS	2/0/2	4	3	50/50
2	23TA1101	தமிழர்மரபு/ Heritage of Tamils	HS	1/0/0	1	1	60/40
3	23HS1203	Communicative English and Language Skills II	HS	2/0/2	4	3	50/50
4	23TA1201	தமிழரும் ததொழில் நுட்பமும்/Tamils and Technology	HS	1/0/0	1	1	60/40
			TOTAL		10	8	

BASIC SCIENCES (BS)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23MA1101	Matrices and Calculus	BS	3/1/0	4	4	60/40
2	23PH1103	Engineering Physics	BS	2/0/2	4	3	50/50
3	23MA1201	Complex Variables and Laplace Transform	BS	3/1/0	4	4	60/40
4	23MA1303	Transforms and Partial Differential Equations	BS	3/1/0	4	4	60/40
5	23MA1403	Numerical Methods	BS	3/1/0	4	4	60/40
			TOTAL		20	19	

ENGINEERING SCIENCES (ES)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23ES1106	Programming in C	ES	3/0/0	3	3	60/40
2	23ES1115	Computer Aided Engineering Graphics	ES	0/0/4	4	2	40/60
3	23ES1113	Programming in C Laboratory	ES	0/0/4	4	2	40/60
4	23ES1206	Programming in Python	ES	3/0/0	3	3	60/40
5	23ES1202	Basic Civil and Mechanical Engineering	ES	3/0/0	3	3	60/40
6	23EE1211	Engineering Practices Laboratory	ES	0/0/4	4	2	40/60
7	23ES1215	Programming in Python Laboratory	ES	0/0/4	4	2	40/60
8	23CS1304	Object Oriented Programming using Java	ES	3/0/0	3	3	60/40
9	23CS1313	Object Oriented Programming using Java Laboratory	ES	0/0/4	4	2	40/60
TOTAL					**32**	**22**	

PROFESSIONAL CORE (PC)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23EE1201	Electric Circuit Analysis	PC	3/0/2	5	4	50/50
2	23EE1301	Electromagnetic Theory	PC	3/0/0	3	3	60/40
3	23EE1302	Signals and Systems	PC	3/0/0	3	3	60/40
4	23EE1303	Analog Electronics	PC	3/0/2	5	4	50/50
5	23EE1401	Measurements and Instrumentation	PC	3/0/0	3	3	60/40
6	23EE1402	Electrical Machines I	PC	3/0/0	3	3	60/40
7	23EE1403	Transmission and Distribution	PC	3/0/0	3	3	60/40
8	23EE1404	Control Systems	PC	3/0/0	3	3	60/40
9	23EE1405	Digital Electronics	PC	3/0/2	5	4	50/50
10	23EE1411	Electrical Machines Laboratory I	PC	0/0/4	4	2	40/60
11	23EE1412	Control and Instrumentation Laboratory	PC	0/0/4	4	2	40/60
12	23EE1501	Power System Analysis	PC	3/0/0	3	3	60/40
13	23EE1502	Electrical Machines II	PC	3/0/0	3	3	60/40
14	23EE1503	Power Electronics	PC	3/0/0	3	3	60/40

15	23EE1504	Microcontroller and Embedded System	PC	3/0/2	5	4	50/50
16	23EE1511	Electrical Machines Laboratory II	PC	0/0/4	4	2	40/60
17	23EE1512	Industrial Automation Laboratory	PC	0/0/4	4	2	40/60
18	23EE1601	Electrical Drives	PC	3/0/0	3	3	60/40
19	23EE1602	Power System Operation and Control	PC	3/0/0	3	3	60/40
20	23EE1603	Artificial Intelligence for Electrical Engineers	PC	3/0/2	5	4	50/50
21	23EE1611	Power Electronics and Drives Laboratory	PC	0/0/4	4	2	40/60
22	23EE1612	Power System Simulation Laboratory	PC	0/0/4	4	2	40/60
23	23EE1701	Protection and Switchgear	PC	3/0/0	3	3	60/40
24	23EE1702	Renewable Energy Systems	PC	3/0/0	3	3	60/40
25	23EE1703	High Voltage Engineering	PC	3/0/0	3	3	60/40
26	23EE1711	Renewable Energy Systems Laboratory	PC	0/0/4	4	2	40/60
			TOTAL		**95**	**76**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1	23HS1104	Interpersonal Communication skills I	EEC	0/0/2	2	0	0/100
2	23HS1105	Quantitative Aptitude Practices I	EEC	0/0/1	1	0	0/100
3	23ES1212	Technical Skill Practices I	EEC	0/0/2	2	0	0/100
4	23HS1204	Interpersonal Communication skills II	EEC	0/0/2	2	0	0/100
5	23HS1205	Quantitative Aptitude Practices II	EEC	0/0/1	1	0	0/100
6	23ES1312	Coding Practices I	EEC	0/0/2	2	0	0/100
7	23HS1301	Skills for Career Building and Development I	EEC	0/0/2	2	0	0/100
8	23HS1302	Quantitative Aptitude Practices III	EEC	0/0/1	1	0	0/100
9	23ES1412	Coding Practices II	EEC	0/0/2	2	0	0/100
10	23HS1401	Skills for Career Building and Development II	EEC	0/0/2	2	0	0/100

11	23HS1402	Quantitative Aptitude Practice IV	EEC	0/0/1	1	0	0/100
12	23ES1512	Coding Practices III	EEC	0/0/2	2	0	0/100
13	23ES1612	Coding Practices IV	EEC	0/0/2	2	0	0/100
14	23EE1712	Mini-Project	EEC	0/0/4	4	2	40/60
15	23EE1704	Industrial training/ Internship#	EEC	0/0/0	-	2	0/100
16	23EE1811	Project Work	EEC	0/0/16	16	8	40/60
			TOTAL		**42**	**12**	

CREDIT DISTRIBUTION

S. No	Subject Area	Credit Per Semester								Credits	
	Subject	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**Percentage %**
1	Humanities and Social Sciences (HS)	4	4							8	4.78
2	Basic Sciences (BS)	7	4	4	4					19	11.58
3	Engineering Sciences (ES)	7	10	5						22	13.41
4	Professional Core (PC)		4	10	20	17	14	11		76	46.34
5	Professional Electives (PE)					3	6	6	6	21	12.80
6	Open Electives (OE)					3	3			6	3.66
7	Project Work (PR/EEC)	0	0	0	0	0	0	4	8	12	7.32
8	Non-Credit / Mandatory	0	0	0						0	0
	Total	**18**	**22**	**19**	**24**	**23**	**23**	**21**	**14**	**164**	**100**

SEMESTER I

		L	T	P	C
23MA1101	**MATRICES AND CALCULUS**	**3**	**1**	**0**	**4**

COURSE OBJECTIVE:

- To comprehend matrices as mathematical structures used to represent data, equations, and transformations in various engineering applications
- To introduce the concepts of limits, continuity, derivatives and maxima and Minima.
- To familiarize the functions of two variables and finding its extreme points.
- To provide understanding of various techniques of integration.
- To introduce integral ideas in solving areas, volumes and other practical problems.

UNIT - I MATRICES 9+3

Eigen values and Eigenvectors of a real matrix - Characteristic equation -Properties of Eigen values and Eigenvectors -Cayley Hamilton theorem -Diagonalization of matrices- Reduction of a quadratic form to canonical form by orthogonal 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 and its applications.

UNIT - III FUNCTIONS OF SEVERAL VARIABLES 9+3

Partial differentiation - Total derivative - Change of variables –Jacobian's- 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- Integration of rational functions by partial fraction - Improper integrals - Applications: Hydrostatic force and pressure, moments and centres of mass.

UNIT - V MULTIPLE INTEGRALS 9+3

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

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

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

CO1	Able to apply matrix operations to solve engineering problems efficiently
CO2	Apply limit definition and rules of differentiation to differentiate functions.
CO3	Understand familiarity in the knowledge of Maxima and Minima, Jacobian,Taylor series and apply the problems involving Science and Engineering.
CO4	Understand the knowledge of Integration by parts, Integration of rational functions by partial fraction.
CO5	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, New Delhi, 44th Edition, 2018.
2. James Stewart, "Calculus: Early Transcendental", Cengage Learning, 9th Edition, New Delhi, 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, 2015.

REFERENCE BOOKS:

1. Narayanan, S. and Manicavachagam Pillai, T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt.Ltd.Chennai, 2007.
2. Srimanta Pal and Bhunia,S.C, "Engineering Mathematics" Oxford University Press,2015.
3. B.V. Ramana “Higher Engineering Mathematics”, McGraw Hill Education, India.
4. Erwin Kreyzig, Advanced Engineering Mathematics, John Wiley sons, 10th Edition, 2015.
5. Sivaramakrishna Dass, C. Vijayakumari, “Engineering Mathematics”, Pearson Education India, 4th Edition 2019.
6. Sundar Raj. M and Nagarajan. G , “Engineering Mathematics-I”,3rd Edition, Sree Kamalamani Publications, Chennai, 2020.

ONLINE COURSES / RESOURCES:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3									1			
CO2	3	3									1			
CO3	3	3									1			
CO4	3	3									1			
CO5	3	3									1			

<table>
<tr><th colspan="4">Internal Assessment</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
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</table>

23ES1106	PROGRAMMING IN C	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

To impart Knowledge on the following topics

- Syntax for C programming
- Develop C Programs using basic programming constructs
- Develop C Programs using arrays and strings
- Develop applications in C using functions, pointers
- Develop applications using structures and union

UNIT - I BASICS OF C PROGRAMMING 9

Introduction to programming paradigms – Algorithms – Flowchart - Structure of C program - C programming: Data Types – Storage classes - Constants – Enumeration Constants - Type Conversion Keywords – Operators: Precedence and Associativity - Expressions – Input / Output statements, Format specifiers, Assignment statements – Decision making statements - Switch statement – Break – Continue - Goto statement - Looping statements – Pre-processor directives - Compilation process.

UNIT - II ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization – One dimensional array – Example Program: Computing Mean, Median and Mode - Two dimensional arrays – Example Program: Matrix Operations (Addition, Multiplication, Determinant and Transpose) – String operations: length, compare, concatenate, copy, Reverse and Palindrome – Selection sort, Insertion sort - linear and binary search.

UNIT - III FUNCTIONS AND POINTERS 9

Introduction to functions: Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion – Example Program: Computation of Sine series, Scientific calculator using built-in functions, Binary Search using recursive functions – Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Example Program: Sorting of names – Parameter passing: Pass by value, Pass by reference – Example Program: Swapping of two numbers and changing the value of a variable using pass by reference.

UNIT - IV STRUCTURES AND UNION 9

Structure - Nested structures– Pointer and Structures– Array of structures – Example Program using structures and pointers – Self-referential structures – Dynamic memory allocation – Singly linked list– type def and Union.

UNIT - V FILE PROCESSING 9

Files – Types of file processing: Sequential access, Random access – Sequential access file - Example Program: Finding average of numbers stored in sequential access file - Random access file - Example Program: Transaction processing using random access files– Command line arguments.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Learn the syntax for C programming

CO2 Develop simple applications in C using basic constructs

CO3 Design and implement applications using arrays and strings

CO4 Develop and implement applications in C using functions and pointers.

CO5 Develop applications in C using structures and union.

CO6 Design applications using sequential and random access file processing.

TEXT BOOKS:

1. Reema Thareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006.

REFERENCE BOOKS:

1. Paul Deitel and Harvey Deitel, “C How to Program” Seventh edition, Pearson Publication, 2015.
2. Juneja, B. L and Anita Seth, “Programming in C”, CENGAGE Learning India pvt. Ltd., 2011.
3. Pradip Dey, Manas Ghosh, “Fundamentals of Computing and Programming in C”, First Edition, Oxford University Press, 2009.
4. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
5. Byron S. Gottfried, "Schism’s Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.

WEB REFERENCES:

1. https://github.com/tscheffl/ThinkC/blob/master/PDF/Think-C.pdf
2. https://freecomputerbooks.com/langCBooks.html

ONLINE COURSES / RESOURCES:

1. https://www.programiz.com/c-programming
2. https://www.tutorialspoint.com/cprogramming/index.htm
3. https://www.javatpoint.com/c-programming-language-tutorial
4. https://www.geeksforgeeks.org/c-programming-language/
5. https://en.wikibooks.org/wiki/C_Programming
6. https://www.cprogramming.com/tutorial/c-tutorial.html?inl=hp

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1		1								
CO2	2	1	1	1	2	1								
CO3	3	2	2	1	3	1								
CO4	3	2	2	1	3	1								
CO5	2	1	1	1	2	1								
CO6	2	1	1	1	2	1								

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23HS1103	COMMUNICATIVE ENGLISH AND LANGUAGE SKILLS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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 succour 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 INFORMAL COMMUNICATION 6

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 One-self – Introducing a Friend/ Family. **Reading:** Descriptive Passages (From Newspapers / Magazines). **Writing:** Autobiographical Writing, Developing Hints. **Grammar:** Noun, Pronoun & Adjective. **Vocabulary Development:** One Word Substitution

ACTIVITY: Listening to self -introduction before the interview committee after listening modules.

UNIT II CONVERSATIONAL PRACTICE 6

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, Regular and Irregular Verbs. **Vocabulary Development:** Prefix &Suffix, Word formation.

ACTIVITY: Listening to conversation and performing role play and Writing dialogues on various work context.

UNIT III OFFICIAL COMMUNICATIONS 6

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 Permission Letters/Editor, Complaint, and Invitation. Emails and Review Writing-Books, Films. **Grammar:** Adverb, Prepositions & Conjunctions. **Vocabulary Development:** Collocations – Fixed Expressions.

ACTIVITY: Preparing Permission letters and short talks and presentation on various topics related to professions

UNIT IV COMMUNICATION AT WORK PLACE 6

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. **Grammar:** Subject-Verb Agreement, Framing Questions. **Vocabulary Development:** Infinitives and Gerunds, Reference Words, Technical Vocabulary.

ACTIVITY: Listening to Group Discussion and sharing recommendation.

UNIT V DEFINITIONS AND PRODUCT DESCRIPTION 6

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

ACTIVITY: Reading about the modern gadgets and describing them.

TOTAL :30 PERIODS

COURSE OUTCOME

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

CO1 Comprehend conversation and short talks delivered in English.

CO2 Participate effectively in informal conversation; introduce themselves and their friends and express opinions English.

CO3 Read articles of a general kind in magazines and newspaper

CO4 Write short essays of a general kind and personal letters and emails in English.

CO5 Recognize the use of grammar in speech and writing.

TEXT BOOKS:

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

REFERENCE BOOKS:

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: (Only accessible Links)

1. https://learnenglishteens.britishcouncil.org/exams/grammar-and-vocabularyexams/wordformation
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018/02/20180316 21.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 **30 Hours**

LIST OF EXPERIMENTS

1. Listen to lectures- articulate a complete idea as opposed to producing fragmented utterances- Ted talks, Science Fiction- My Fair Lady
2. Listening – following, responding to explanations, giving directions and instructions in academic and business contexts- IELTS, TOEFL.
3. Listening to transcripts and answer to the questions.
4. Listening for specific information: accuracy and fluency – BEC.
5. Reading: Different Text Type.
6. Reading: Predicting Content using pictures and titles.
7. Reading: Use of Graphic Organizers to review.
8. Reading: Aid Comprehension
9. Reading: Speed Reading Techniques.
10. Reading and Comprehending the passages in the competitive exams like GATE, TOEFL, GRE, IELTS, and other exams conducted by Central and state governments.

REFERENCE BOOKS:

1. Suresh Kumar.E and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Blackswan: Hyderabad,2012
2. Davis, Jason and Rhonda Liss. Effective Academic Writing (level 3) Oxford University Press: Oxford,2006
3. With row, Jeans and et al. Inspired to write. Reading and Tasks to develop writing skills. Cambridge University Press: Cambridge,2004

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1								3	3		3			
CO2								3	3		3			
CO3								3	3		3			
CO4								3	3		3			
CO5								3	3		3			

<table>
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(40% weightage)
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(Laboratory Component)</th><th>End Semester Examination</th></tr>
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<tr><td colspan="4">100</td><td>100</td></tr>
<tr><td colspan="4">50 %</td><td>50 %</td></tr>
</table>

23PH1103	ENGINEERING PHYSICS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- To impart knowledge in basic concepts of physics relevant to engineering applications
- To introduce advances in technology for engineering applications

UNIT I PROPERTIES OF MATTERS 6

Elasticity: Stress, strain, Hooke's law and elastic moduli – stress-strain diagram – twisting couple per unit twist for solid cylinder – torsional pendulum (theory) – bending moment of beam – non-uniform and uniform bending (theory)– I-shape girder.

Thermal Physics: Mode of heat transfer: conduction, convection and radiation – thermal expansion of solids – bimetallic strips – thermal conductivity – Forbe's method and Lee's disc method; theory and experiment – thermal insulation – applications

UNIT II SEMICONDUCTING AND MAGNETIC MATERIALS 6

Semiconducting Materials: Intrinsic Semiconductors – energy band diagram – carrier concentration in intrinsic semiconductors – extrinsic semiconductors (N-type & P-type) – variation of carrier concentration with temperature – variation of Fermi level with temperature and impurity concentration –Zener and avalanche breakdown in p-n junctions – Ohmic contacts – Schottky diode – tunnel diode.

Magnetic Materials: Magnetism in materials – Basic definitions – Classifications of Magnetic Materials- Ferromagnetic Domain theory – M versus H behaviour - Hard and Soft Magnetic materials- Magnetic principle in Computer data storage – Magnetic Hard Disc and Embedded systems.

UNIT III MODERN OPTICS 6

Laser: Population of energy levels, Einstein's A and B coefficients derivation – optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction–.

Fiber Optics: 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 IV QUANTUM PHYSICS AND NANOSCIENCE 6

Quantum Physics: Blackbody radiation – Planck's hypothesis and derivation – wave particle duality of light: concepts of photon – de Broglie hypotheses – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations.

Nanoscience: Introduction – Classification of nanomaterials – preparation (bottom up and top down approaches), mechanical, optical and electrical properties – applications: NEMS and MEMS– carbon nanotubes: types.

UNIT V **ELECTROMAGNETIC WAVES** **6**

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 – properties of electromagnetic waves.

TOTAL :30 PERIODS

LIST OF EXPERIEMENTS

1. Determination of Moment of Inertia of the disc and Rigidity Modulus of the material of the wire – Torsional Pendulum
2. Determination of Young's Modulus – Non - Uniform Bending
3. Determination of Thermal Conductivity of the Bad Conductor – Lee's Disc Method
4. Determination of thickness of a thin wire – Air wedge method
5. (i) Determination of wavelength of Laser using Grating and Particle size determination

   (ii) Determination of Numerical Aperture and Acceptance angle of an Optical Fibre
6. Determination of Velocity of ultrasonic waves in a liquid and compressibility of the liquid – Ultrasonic Interferometer.
7. Determination of wavelength of Hg source using Grating by normal incidence method using spectrometer
8. Determine the band gap energy of a semiconductor.

TOTAL :30 PERIODS

TEXT BOOKS:

1. AjoyGhatak, Optics, 5th Ed., Tata McGraw Hill, 2012
2. Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, Concepts of Modern Physics, 6th Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2014
3. B. K. Pandey and S. Chaturvedi, Engineering Physics, 1st edition, Cengage Learning India Pvt Ltd., New Delhi, 2017
4. Karl F. Renk, Basics of laser physics: for students of science and engineering, 2017.

REFERENCE BOOKS:

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. Ruby Das, C.S. Robinson, Rajesh Kumar, Prashant Kumar Sahu, "A Textbook of Engineering Physics Practical", University Science Press, Delhi, II Edition (2016).

COURSE OUTCOME

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

CO1 Understand the basics properties of materials, especially elastic and thermal properties of materials.

CO2 Adequate knowledge on the concepts of semiconducting and magnetic materials and their applications in memory storage.

CO3 Acquire the knowledge on the concepts of lasers, fiber optics and their technological applications.

CO4 Knowledge on fundamental concepts of quantum theory, nanoscience its applications

CO5 Knowledge on the basics of electromagnetic waves and its properties.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1								
CO2	3	3	2	1	2	1								
CO3	3	3	2	2	2	1								
CO4	3	3	1	1	2	1								
CO5	3	3	1	1	2	1								

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<tr><td>40</td><td>60</td><td>75</td><td>25</td><td rowspan="2">100</td></tr>
<tr><td colspan="4">100</td></tr>
<tr><td colspan="4">50 %</td><td>50 %</td></tr>
</table>

23ES1113	PROGRAMMING IN C LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

To impart Knowledge on the following topics:

- Write, test, and debug simple C programs.
- Implement C programs with conditional and looping statement
- Develop applications in C using strings, pointers, functions.
- Implement C programs with structures and union.
- Develop applications in C using file processing
- Develop an application in real time situation

LIST OF EXPERIMENTS

1. Programs using I/O statements and expressions.
2. Programs using decision-making constructs.
3. Write a program to find whether the given year is leap year or Not? (Hint: not every centurion year is a leap. For example 1700, 1800 and 1900 is not a leap year)
4. Design a calculator to perform the operations, namely, addition, subtraction, multiplication, division and square of a number.
5. Check whether a given number is Armstrong number or not?
6. Given a set of numbers like <10, 36, 54, 89, 12, 27>, find sum of weights based on the following conditions
   a) if it is a perfect cube
   b) if it is a multiple of 4 and divisible by 6
   c) if it is a prime number
   d) Sort the numbers based on the weight in the increasing order as shown below <10, its weight>,<36,its weight>
7. Populate an array with height of persons and find how many persons are above the average height.
8. Given a string —a$bcd./fg find its reverse without changing the position of special characters. (Example input:a@gh%;j and output:j@hg%;a)
9. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions
10. From a given paragraph perform the following using built-in functions:
    a) Find the total number of words.
    b) Capitalize the first word of each sentence.
    c) Replace a given word with another word.
11. a) Sort the list of numbers using Selection sort and insertion sort
    b) Sort the list of numbers using pass by reference.
12. Search an element from an unsorted array using linear search
    Search an element in an array using Binary search recursion call.
13. Generate salary slip of employees using structures and pointers.

14. a) Programs using Pointers
    b) Pointer demonstration the use of & and *
    c) Access Elements of an Array Using Pointer
    d) Perform the string operations like Length of the String, Concatenation of string and compare the string using Pointer
    e) Count number of words, digits, vowels using pointers
    f) Add two matrices using Multidimensional Arrays with pointers
    g) Multiply two matrices using pointers
    h) Multiply two numbers using Function Pointers
15. Compute internal marks of students for five different subjects using structures and functions.
16. Program to demonstrate the difference between unions and structures
17. Insert, update, delete and append telephone details of an individual or a company into a telephone directory using random access file.
18. Count the number of account holders whose balance is less than the minimum balance using sequential access file.
19. **MINI PROJECT**
    Create a—Railway reservation system with the following modules
    a) Booking
    b) Availability checking
    c) Cancellation
    d) Prepare chart

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1	Write, test, and debug simple C programs.
CO2	Implement C programs with conditionals and loops.
CO3	Develop C programs for simple applications making use arrays and strings.
CO4	Develop C programs involving functions, recursion, pointers, and structures and union.
CO5	Design applications using sequential and random access file processing.
CO6	Perform task as an individual and / or team member to manage the task in time

WEB REFERENCES

1. https://www.programiz.com/c-programming/examples
2. https://beginnersbook.com/2015/02/simple-c-programs/
3. https://www.programmingsimplified.com/c-program-examples
4. https://www.tutorialgateway.org/c-programming-examples/
5. https://www.javatpoint.com/c-programs
6. https://www.tutorialspoint.com/learn_c_by_examples/simple_programs_in_c.htm

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2										
CO2	3	2	2	1	3									
CO3	3	3	3	2	3									
CO4	3	2	2	1	3									
CO5	3	3	3	2	3									
CO6	3	2	2	1	3									

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23ES1115	COMPUTER AIDED ENGINEERING GRAPHICS	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE:

- To familiarize students with technical drawing standards and drafting software for precise part modelling to enhance their skill set.
- To develop proficiency in orthographic and isometric projections for communicating engineering concepts, contributing to their technical expertise.
- To enhance drawing skills for clear and precise technical communication in engineering product design, enabling students to effectively convey their ideas.
- To utilize pictorial views proficiently for accurate isometric visualization of engineering objects, adding depth to their understanding of spatial relationships.
- To enable students to translate engineering concepts into tangible designs, fostering creativity and innovation in graphics and design to broaden their practical experience.

UNIT - I INTRODUCTION TO CONVENTIONS IN ENGINEERING DRAWING AND CONIC SECTIONS 12

Introduction to Engineering Drawing - Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout – Lettering and dimensioning.
Introduction to Drafting Packages – Coordinate Systems – Tools
Introduction to Conic curves - Ellipse, Parabola and Hyperbola by Eccentricity method.

List of Experiments:

1. Drawing of a title block with necessary text, projection symbol and lettering using drafting software.
2. Drafting of Conic curves - Ellipse, Parabola and Hyperbola

UNIT - II ORTHOGRAPHIC PROJECTION 12

Visualization concepts and Orthographic Projection - Layout of views – Orthographic Projection- Conversion of pictorial diagram into orthographic views.

List of Experiments:

1. Drawing orthographic view of simple solids like Prism, Pyramids, Cylinder, Cone, etc, and dimensioning.
2. Drawing of orthographic views from the given pictorial diagram like machine parts, electrical vehicle layout, PCB Diagrams.

UNIT - III PROJECTION OF PLANES 12

Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method.

List of Experiments:

1. Drawing of plane Surface inclined to HP.
2. Drawing of plane Surface inclined to VP.

UNIT - IV PROJECTION OF SOLIDS 12

Projection of simple solids like Prisms, Pyramids, Cylinder and Cone when the axis is inclined to HP by rotating object method

List of Experiments:

1. Drawing of simple solids like prism and pyramids when the axis is inclined to HP.
2. Drawing of simple solids like cylinder and cone when the axis is inclined to HP.

UNIT - V ISOMETRIC DRAWING 12

Principles of Isometric View – Isometric Views of simple solids – Prism, Pyramid, Cylinder and Cone.

List of Experiments:

1. Drawing Isometric View of simple solids.
2. Modeling of 2D to 3D objects using drafting software.

TOTAL :60 PERIODS

COURSE OUTCOME(S):

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

CO1 Draw the engineering curves, draw orthographic projections of lines and planes.
CO2 Draw orthographic views of 3D primitive objects.
CO3 Apply and draw the sections and development of the surfaces of objects.
CO4 Apply projection concepts and drafting tools for solid projections.
CO5 Analyse and sketch free hand sketching of basic geometrical shapes, multiple views of objects.

SOFTWARE TOOLS

- AutoCAD
- Solid Works

TEXT BOOKS:

1. Natarajan,K.V.,"AtextbookofEngineeringGraphics", 3 4 th Ed.,Dhanalakshmi Publishers, Chennai, 2021.
2. Venugopal, K. and Prabhu Raja, V., "Engineering Graphics", 14th Ed, New Age Publications, 2016

REFERENCE BOOKS:

1. Bhatt, N.D.,Panchal V M and Pramod R. Ingle, "Engineering Drawing", Charotar Publishing House, 54th Edition, 2023.
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, 3rd Edition 2019

WEB REFERENCES:

1. https://nptel.ac.in/courses/105/104/105104148/

ONLINE COURSES / RESOURCES:

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

CO –POMAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	1						1			
CO2	3	3	3	2	1						1			
CO3	3	3	3	2	1						1			
CO4	3	3	3	2	1						1			
CO5	3	3	3	2	1						1			

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23TA1101	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT–I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages — Tamil as a Classical Language - ClassicalLiterature in Tamil – Secular Nature of Sangam Literature – Distributive Justice inSangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land Bakthi Literature Azhwars and N ayanmars - Forms of minor Poetry - Development of Modernliterature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT–II HERITAGE-ROCK ART PAINTINGS TO MODERN ART–SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT–III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT–IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT–V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIANCULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India — Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

Total : 15 PERIODS

23TA1101	தமிழர் மரபு	L	T	P	C
		1	0	0	1

UNIT – I **மொழி மற்றும் இலக்கியம்** **3**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமய சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

UNIT – II **மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை** **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக்கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

UNIT – III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்** **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

UNIT –IV **தமிழர்களின் திணைக் கோட்பாடுகள்** **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்கப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

UNIT –V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு** **3**

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

Total : 15 PERIODS

TEXT-CUM REFERENCE BOOKS:

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர். இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை)
5. Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: InternationalInstitute of Tamil Studies
7. Historical by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation,Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23HS1104	INTERPERSONAL COMMUNICATION SKILLS I	L	T	P	C
		0	0	2	0

COURSE OBJECTIVE:

- 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
- To improve your English communication skills in a professional setting

CONTENTS

Listening: Listening to Specific Information – About various Professions, Professionals, Work Cultures, Demands of industry and expectation

Speaking: Sharing information with friends/colleagues/teachers/employers

Reading: Reading Comprehension – About the famous and leading personalities in the industry and various fields as motivation

Writing: Writing about personalities in one's own words

TOTAL :30 PERIODS

TEXT BOOKS:

1. Crucial Conversations: Tools for Talking When Stakes Are High by Kerry Patterson, Joseph Grenny, Ron McMillan, and Al Switzler, 2014
2. Simply Said: Communicating Better at Work and Beyond by Jay Sullivan, 2016

REFERENCE BOOKS:

1. Words That Work: It's Not What You Say, It's What People Hear by Dr. Frank Luntz,2011.
2. The Fine Art of Small Talk: How To Start a Conversation, Keep It Going, Build Networking Skills — and Leave a Positive Impression! By Debra Fine

WEB REFERENCES

1. ttps://teambuilding.com/blog/communication-books
2. https://unacademy.com/content/upsc/study-material/science-andtechnology/famous-personalities-in-science/

ONLINE COURSES / RESOURCES

1. https://www.krisamerikos.com/blog/phone-coversation-in-english
1. 2. https://blog.hubspot.com/service/phone-etiquette

COURSE OUTCOME

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

CO1 Comprehend conversation and short talks delivered in English.

CO2 Participate effectively in informal conversation; introduce themselves and their friends and express opinions English.

CO3 Read articles of a general kind in magazines and newspaper

CO4 Write short essays of a general kind and personal letters and emails in English.

CO5 Gain understanding of basic grammatical structures and use them in right context.

CO6 Use appropriate words in a professional context.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1								3	3		3			
CO2								3	3		3			
CO3								3	3		3			
CO4								3	3		3			
CO5								3	3		3			
CO6								3	3		3			

23HS1105	QUANTITATIVE APTITUDE PRACTICES I	L	T	P	C
		0	0	1	0

COURSE OBJECTIVE:

- To strengthen students understanding of number systems, algebra and assist them in developing their problem-solving skills.
- To get the abilities needed to address challenges with quantitative aptitude.

MODULE 1 NUMBER SYSTEM **3**

Numbers - HCF and LCM- simplification - square root - cube root.

MODULE 2 ALGEBRA **3**

Algebra - decimal fraction - arithmetic progression - geometric progression.

MODULE 3 BLOOD RELATIONS **3**

Blood relations - pattern sequence - alphabet test question – clocks-calenders.

MODULE 4 DATA INTERPRETATION **3**

Table chart- pie chart - bar chart - line charts

TOTAL :30 PERIODS

COURSE OUTCOME

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

CO1 Demonstrate solid understanding to address number system and algebraic problems.

CO2 Handle problems with the blood relations and data interpretation.

TEXT BOOKS:

1. Aggarwal. R.S.(2017).Quantitative Aptitude for Competitive Examinations 3rd edition New Delhi:S. Chand Publishing.
2. Abhijit guha (2016). Quantitative Aptitude for All Competitive Examinations, 6th edition. Noida: McGrawHill Education Pvt.Ltd.
3. FACE.(2016).Aptipedia Aptitude Encyclopedia1(Ed.).New Delhi: Wiley Publications.

REFERENCE BOOKS:

1. Sharma arun. (2016). Quantitative aptitude, 7th (Ed.).Noida : McGrawHill Education Pvt. Ltd.
2. Praveen. R.V 3rd edition, Quantitative aptitude and reasoning, PHI learning publication.

Mode of Evaluation: Online Test

SEMESTER II

23MA1201	COMPLEX VARIABLES AND LAPLACE TRANSFORM	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To solve the linear differential equations with constant coefficients.
- To understand the concepts of vectors as it gives the insight into how to trace along the different types of curves.
- To understand the standard technique of a complex variable theory in particular of analytics functions and its mapping property.
- Complex variable techniques have been used in a wide area of engineering.
- Apply the basic ideas of Laplace Transform to solve the problems in engineering and technology.

UNIT - I ORDINARY DIFFERENTIAL EQUATIONS 9+3

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 first order linear differential equations with constant coefficients.

UNIT - II VECTOR CALCULUS 9+3

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

UNIT - III ANALYTIC FUNCTIONS 9+3

Functions of a complex variable–Analytic functions –Cauchy-Riemann equations – Necessaryandsufficientconditions–Harmonicandorthogonalpropertiesofanalytic function – Harmonic conjugate – Construction of analytic functions by Milne Thomson method– Conformal mapping: w =z+c,cz,1/z and bilinear transformation.

UNIT - IV COMPLEX INTEGRATION 9+3

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 - V LAPLACE TRANSFORM 9+3

Laplace transform: Sufficient conditions 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 – Transforms of periodic functions– Initial and final value theorems. Inverse Laplace transforms: Convolution theorem–Solution of linear ODE of second order with constant coefficients using the techniques of Laplace transformation.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

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

CO1	Apply various techniques in solving differential equations.
CO2	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.
CO3	Understand the concepts of analytic functions, harmonic functions and conformal mapping.
CO4	Determine the types of singularities, residues and contour integration.
CO5	Able to solve differential equations using Laplace transform.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
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, 2015.

REFERENCE BOOKS:

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 Learning 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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3								1			
CO2	3	3	3								1			
CO3	3	3	3								1			
CO4	3	3	3								1			
CO5	3	3	3								1			

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23ES1206	PROGRAMMING IN PYTHON	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- Basic programming constructs and control structures in python
- Python data structures – Lists, Tuples and Dictionary
- Python functions and use Strings
- Input/output with files in Python.
- Python packages and GUI concepts

UNIT - I INTRODUCTION TO PYTHON PROGRAMMING AND CONTROL STRUCTURES 9

Introduction to Python, Demo of Interactive and script mode, Tokens in Python – Variables, Keywords, Comments, Literals, Data types, Indentation, Operators and its precedence, Expressions, Input and Print functions, Type Casting. Illustrative problems: find minimum in a list, guess an integer number in a range, Towers of Hanoi. Control Structures: Selective statements – if, if-else, nested if, if – elif ladder statements; Iterative statements - while, for, range functions, nested loops, else in loops, break, continue and pass statements. Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT - II FUNCTIONS AND STRINGS 9

Functions: Types, parameters, arguments: positional arguments, keyword arguments, parameters with default values, functions with arbitrary arguments, Scope of variables: Local and global scope, Recursion and Lambda functions. Illustrative programs: power of a number, sorting, Fibonacci series using lambda. Strings: Formatting, Comparison, Slicing, Splitting, Stripping, Negative indices, String functions, Regular expression: Matching the patterns, Search and replace. Illustrative programs: check whether the string is symmetrical, reverse a string, length of a string.

UNIT - III COLLECTIONS 9

List: Create, Access, Slicing, Negative Indices, List Methods, and comprehensions Tuples: Create, Indexing and Slicing, Operations on tuples. Dictionary: Create, add, and replace values, operations on dictionaries. Sets: Create and operations on set. Illustrative programs: Interchange first and last element in a list, maximum and minimum N elements in a tuple, sort dictionary by key or value, size of a set.

UNIT - IV FILES AND EXCEPTION HANDLING 9

Files: Open, Read, Write, Append and Close. Tell and seek methods. Illustrative programs: word count, copy file. Command line arguments, Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, Exception Chaining, User-defined Exceptions, Defining Clean-Up actions. Illustrative programs: prompt the user to input an integer and raises a Value Error exception if the input is not a valid integer, open a file and handles a File Not Found Error exception if the file does not exist, prompt the user to input two numbers and raises a Type Error exception if the inputs are not numerical, executes an operation on a list and handles an Index Error exception if the index is out of range.

UNIT - V **PACKAGES & GUI** **9**

Python packages: Simple programs using the built-in functions of packages matplotlib, numpy, pandas etc. Illustrative programs: create a pandas series using numpy, make a pandas data frame with 2D list.

GUI Programming: Tkinter introduction, Tkinter and Python Programming, Tk Widgets, Tkinter examples. Python programming with IDE. Illustrative programs: create a GUI marksheet, calendar, file explorer using Tkinter.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

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

CO1	Develop and execute simple Python programs using conditionals and loops for solving problems.
CO2	Express proficiency in the handling of strings and functions
CO3	Represent compound data using Python lists, tuples, dictionaries, set setc
CO4	Read and write data from/to files and handle exceptions in Python programs
CO5	Implement python packages in data analysis and design GUI
CO6	Examine various problem solving concepts in python to develop real time applications.

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. Reema Thareja, “Problem Solving and Programming with Python’’, 2nd edition, Oxford University Press, New Delhi, 2019.
3. Alan D. Moore, Python GUI Programming with Tkinter, Design and Build Functional and User-friendly GUI Applications, Packt Publishing, 2021.

REFERENCE BOOKS:

1. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018
2. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
3. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.

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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**	**3**	**3**	**1**	**2**						**1**				
CO2	**2**	**3**	**3**	**1**	**2**						**1**				
CO3	**2**	**3**	**3**	**1**	**2**						**1**				
CO4	**2**	**3**	**3**	**1**	**2**						**1**				
CO5	**2**	**3**	**3**	**1**	**2**						**1**				
CO6	**2**	**3**	**3**	**1**	**2**						**1**				

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23ES1202	BASIC CIVIL AND MECHANICAL ENGINEERING	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To provide basic knowledge about civil and mechanical concepts
- To understand the surveying method and usage of building materials
- To understand the basic of Internal combustion engine and power plant.
- To understand the basic of refrigeration and air conditioning system.

UNIT - I SCOPE OF MECHANICAL AND CIVIL ENGINEERING 9

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, and Energy Engineering – Interdisciplinary concepts in Civil and Mechanical Engineering.

UNIT - II SURVEYING AND CIVIL ENGINEERING MATERIALS 9

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 9

Foundations: Types of foundations – Bearing capacity and settlement – Requirement of good foundations. Civil Engineering Structures: Brick masonry – 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 9

Classification of Power Plants- 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, 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 - Introduction to Electric Vehicles and Hybrid Vehicles, Concept of hybrid engines. Industrial safety practices and protective Devices.

UNIT - V REFRIGERATION AND AIR CONDITIONING SYSTEM 9

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. Properties of air - water mixture, concepts of psychometric and its process.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Understanding overview of Mechanical and Civil Engineering

CO2 Understanding surveying and materials of constructions

CO3 Ability to explain the usage of construction material and use in building construction

CO4 Analyse various components of Internal Combustion Engine and Power plant.

CO5 Ability to use refrigeration and air-conditioning system as per requirement.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. Venugopal K. and Prahu Raja V., “Basic Mechanical Engineering”, Anuradha Publishers Kumbakonam,2016.
2. Seetharaman S., “Basic Civil Engineering”, Anuradha Agencies, 2005.
3. ShanthaKumar SRJ., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2020.

WEB REFERENCES:

1. cengagehttps://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. Top Free Online Courses Websites For Engineering Courses https://www.constructionplacements.com
2. Mechanical Engineering Courses Online | Courserahttps://www.coursera.org

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**		**3**											
CO2	**3**					**3**								
CO3	**3**		**3**											
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23HS1203	COMMUNICATIVE ENGLISH AND LANGUAGE SKILLS II	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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 improve the verbal ability skill and communicative skill of the students
- To enhance the analytical and problem solving skills of the students
- To prepare them for various public and private sector exams & placement drives.

UNIT I INTERPERSONAL COMMUNICATION 6

Listening: Listening to Telephone Etiquettes and 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:** Comparative Adjective, Numerical Expressions and Sentence pattern. **Vocabulary Development:** Idioms and Phrases.

ACTIVITY: Writing and speaking about achievements of eminent personalities

UNIT II TECHNICAL COMMUNICATION 6

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:** Prepositional Phrases and Relative Clauses. **Vocabulary Development:** Abbreviations and Acronyms.

ACTIVITY: Reading transcripts of TED Talks and presenting them

UNIT III PROCESS DESCRIPTION 6

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, Tenses, Impersonal Passive Voice and Phrasal verbs **Vocabulary Development:** Misspelt words. Homophones and Homonyms.

ACTIVITY: Reading Newspaper articles and presenting them

UNIT IV REPORT WRITING 6

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:** Reported Speech; Interrogatives- Question Tags and Articles – omission of articles **Vocabulary Development:** Technical Jargon.

ACTIVITY: Presentation on Technical and non-technical topics of interests with reference to IELTS

UNIT V INTERVIEW SKILLS 6

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

ACTIVITY: Preparing an effective Resume‘ and participating in Mock interview

TOTAL :30 PERIODS

COURSE OUTCOME

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

CO1 Recognise the need for life skills; apply them to different situations, the basic communication practices in different types of communication.

CO2 Gain confidence to communicate effectively in various situations to acquire employability skills.

CO3 Develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others.

CO4 Communicate effectively & appropriately in real life situation and enhance student’s problem solving skill.

CO5 Prepare for various public and private sector exams & placement drives.

TEXT BOOKS:

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

REFERENCE BOOKS:

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.

WEB REFERENCES

1. https://learnenglishteens.britishcouncil.org/exams/grammar-andvocabularyexams/word-formation.
2. https://cdn.s3waas.gov.in/s347d1e990583c9c67424d369f3414728e/uploads/2018.
3. http://xn--englishclub-ql3f.com/grammar/parts-of-speech.html.
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

LANGUAGE SKILLS LAB — 30 Hours

LIST OF EXPERIEMENTS

1. Speaking- sharing personal information- self introduction
2. Speaking- Group Discussion, Small talk or Peb Talk
3. Speaking- Presentation- Formal and Informal
4. Speaking- Mock Interview
5. Speaking- FAQ’s on Job Interview
6. Speaking – JAM
7. Speaking- Debate and Story Narration
8. Writing: Error Detection- Spotting and reasoning the errors from the passages in competitive exams.
9. Writing: Letter of recommendation
10. Writing: Elements of a good essay
11. Writing: Types of essays. Descriptive – Narrative-Issue based.

REFERENCE BOOKS

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.
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CO1								3	3		2			
CO2								3	3		2			
CO3								2	3		2			
CO4								2	3		2			
CO5								2	3		2			
CO6								3			3			

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23EE1201	ELECTRIC CIRCUIT ANALYSIS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

- 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.

UNIT I BASIC CIRCUITS ANALYSIS 9

Resistive elements - Ohms Law Resistors in series and parallel circuits – Kirchoff‟s 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-Thevenin‟s and Norton‟s Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity 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 & unbalanced – 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

COURSE OUTCOME

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

CO1 Explain circuit's behavior using circuit laws.

CO2 Apply mesh analysis/ nodal analysis / network theorems to determine behavior of the given DC and AC circuit.

CO3 Compute the transient response of first order and second order systems to step and sinusoidal input.

CO4 Compute power, line/ phase voltage and currents of the given three phase circuit.

CO5 Explain the frequency response of series and parallel RLC.

CO6 Explain the behaviour of magnetically coupled circuits.

TEXT BOOKS:

1. William H. HaytJr, 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.
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”, McGrawHill, 2015

REFERENCE BOOKS:

1. Chakrabarti A, “Circuits Theory (Analysis and synthesis)”, Dhanpath Ra i& 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, NewDelhi, 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/L17(NKD)(ET)%20((EE) NPTEL).pdf.

LIST OF EXPERIEMENTS

1. Experimental verification of Kirchhoff‟s current and voltage law
2. Simulation and Experimental verification of Thevenin's, Norton's and Maximum Power Transfer theorem
3. Simulation and Experimental verification of Superposition theorem
4. Experimental determination of time constant of series RL, RC circuits
5. Experimental determination of frequency response of RLC circuits
6. Design and Simulation of series and parallel resonant circuits
7. Simulation of three phases balanced and unbalanced star & delta connected networks

TOTAL :30 PERIODS

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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23EE1211	ENGINEERING PRACTICES LABOATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- Fabrication of pipe line with various pipe fittings and Making Simple Joints in woods.
- Making joints in wood materials used in common household wood work.
- Create simple mechanical operations like welding, machining and sheet metal fabrications.
- Identifying various parts of simple mechanical machines like centrifugal pump and Window Air conditioner and learning foundry operations.
- Understanding basics of Electrical and Electronics Engineering.

GROUP – A CIVIL & ELECTRICAL ENGINEERING

CIVIL ENGINEERING PRACTICES 15

Plumbing Work:

1) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.

2) Preparing plumbing line sketches.

3) Laying pipe connection to the suction side and delivery side of a pump

4) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

Wood Work:

1) Introduction to Tools and Equipments

2) Simple Planning and sawing practice

3) Making Half Lap, Dovetail, Mortise and Tenon joints

Wood Work Study:

1) Studying joints in door panels and wooden furniture

ELECTRICAL ENGINEERING PRACTICES 15

1) Residential house wiring using switches, fuse, indicator, lamp and energy meter.

2) Fluorescent lamp wiring.

3) Stair case wiring

4) Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.

5) Measurement of energy using single phase energy meter.

6) Soldering practice – Components Devices and Circuits – Using general purpose PCB.

GROUP – B MECHANICAL AND ELECTRONICS

MECHANICAL ENGINEERING PRACTICES **15**

Sheet Metal Work:

1) Demonstrating basic sheet metal operations

Basic Machining Work:

1) Introduction to Lathe, Dilling machine, Tools and Equipments
2) Simple Turning and facing
3) Step turning
4) Simple Drilling and Tapping of flat plate using drilling machine

Foundry Work:

1) Introduction to tools, equipments and basic operations used in Foundry

Welding Work:

1) Introduction to Arc welding and Gas welding Tools and Equipment.
2) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.

ELECTRONICS ENGINEERING PRACTICES **15**

1) Study of Electronic components and equipments – Resistor colour coding
2) Measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
3) Design of Half wave and Full Wave Rectifier.
4) 2D & 3D Electrical wiring Model using suitable Software.

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1	Understand the function of pipe fittings and use of Plumbing tools.
CO2	Understand the use of carpentry tools and fabrication of wooden joints.
CO3	Apply machining principles in lathe and drilling machines.
CO4	Analyse the basic electronic circuits and to solder simple components on PCB and test simple electronic circuits.
CO5	Design and Construction of basic Electrical wiring model.

TEXT BOOKS

1. Jeyapoovan T., Saravanapandian M. & Pranitha S., “Engineering Practices Lab Manual”, Vikas Puplishing House Pvt.Ltd, (2014)
2. Kannaiah P. & Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, (2011).
3. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, (2007).

REFERENCE BOOKS

1. K.C. John, "Mechanical workshop practice", Second edition, PHI learning Pvt Ltd, New Delhi.(2010)
2. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, (2017)

WEB REFERENCES

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3								3	2		1
CO2	3	3	3								3	2		
CO3	3	2			1	1					2	2	1	
CO4	3	2			1	1					2	2	1	
CO5	3	2			1	1					2		3	1

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23ES1215	PROGRAMMING IN PYTHON LABORATORY	L	T	P	C

		0	0	4	2

COURSE OBJECTIVE

To impart Knowledge on the following topics:

- 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 learn to implement string functions and file operations
- To understand python packages and GUI development.

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 built-in 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 programs to perform operations on Sets.
10. Develop python codes to perform matrix addition, subtraction and transpose of the given matrix
11. Develop python codes to demonstrate the concept of function composition and anonymous functions.
12. Demonstrate python codes to print try, except and finally block statements
13. Implement python programs to perform file operations
14. Write a python code to raise and handle various built in exceptions.
15. Implement python programs using packages numpy and pandas
16. UI development using tkinter

MINI PROJECT: Suggested Topics (but not limited to)

1. Dice roll simulator
2. Guess the number game
3. Random password generator

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1 Develop and execute simple Python programs

CO2 Implement programs in Python using conditionals and loops for solving problems.

CO3 Develop functions to decompose a Python program.

CO4 Compare various string operations in Python.

CO5 Experiment with Python packages in data analysis

CO6 Create GUI for python applications

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	1	2						1				
CO2	2	3	3	1	2						1				
CO3	2	3	3	1	2						1				
CO4	2	3	3	1	2						1				
CO5	2	3	3	1	2						1				
CO6	2	3	3	1	2						1				

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23ES1212	TECHNICAL SKILL PRACTICES I	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

To impart Knowledge on the following topics:

- Essential problem solving skills through general problem solving concepts.
- Basic knowledge on programming essentials using C as implementation tool.
- Introduce various programming methods using C.

LIST OF EXPERIMENTS

1. Data Types, Variables, Operators
2. Expressions, Precedence, Operators
3. Conditional Statements, Switch Statements
4. Looping, Nested Loops
5. Problems on Bit Manipulation
6. Patterns
7. Number Problems
8. Array Basics, Static vs Dynamic Array, Two-Dimensional Matrix
9. Structure, Union, Storage Classes
10. Function, Parameters passing.
11. Recursion
12. Strings
13. Pointers
14. Command Line Arguments, Pre-processors
15. File Handling & Exception Handling.

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

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

CO1	Propose solutions for a given problem
CO2	Infer the fundamental programming elements in C language and learn to apply basic control structures in C.
CO3	Demonstrate the applications of structures and unions.
CO4	Visualize the capabilities of modular programming approach in C.
CO5	Understand the basic principles of pointers and their association during implementations.
CO6	Apply various input, output and error handling functions in C.

TEXT BOOKS

1. Reema Thareja, ``Programming in C"", 2nd edition, OXFORD University Press, New Delhi, 2019.
2. Paul Deitel and Harvey Deitel, "C How to Program", Seventh edition, Pearson Publication, 2016.

REFERENCE BOOKS

1. Stephen G. Kochan, “Programming in C”, 3rd edition, Pearson Education, 2014.
2. Herbert Schildt, “C: The Complete Reference”, Fourth Edition, McGraw Hill, 2000.

ONLINE COURSES / RESOURCES

1. https://www.javatpoint.com/c-programming-language-tutorial
2. https://www.tutorialspoint.com/cprogramming/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3						3			
CO2	3	3	3	3	3						3			
CO3	3	3	3	3	3						3			
CO4	3	3	3	3	3						3			
CO5	3	3	3	3	3						3			
CO6	3	3	3	3	3						3			

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23TA1201	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT–I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age-Ceramic technology-Black and Red Ware Potteries(BRW) - Graffition Potteries.

UNIT–II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age -Building materials and Herostones of Sangam age- Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal -Chetti Nadu Houses,Indo – Saracenic architecture at Madras during British Period.

UNIT–III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads -Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT– IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry -Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries -Pearl-Conche diving-Ancient Knowledge of Ocean- Knowledge Specific Society.

UNIT– V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of ScientificTamil-Tamilcomputing-DigitalizationofTamilBooks- Development of Tamil Software - Tamil Virtual Academy - Tamil Digital Library - Online Tamil Dictionaries -Sorkuvai Project.

TOTAL : 15 PERIODS

24TA1201	தமிழரும் தொழில்நுட்பமும்	L	T	P	C
		1	0	0	1

UNIT – I **நெசவு மற்றும் பானைத் தொழில்நுட்பம்** **3**

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

UNIT – II **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்** **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசோனிக் கட்டிடக் கலை.

UNIT – III **உற்பத்தி தொழில்நுட்பம்** **3**

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத் துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

UNIT –IV **வேளாண்மை மற்றும் நீர்பாசனத் தொழில்நுட்பம்** **3**

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

UNIT –V அறிவியல் தமிழ் மற்றும் கணினித்தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி - கணினித்தமிழ் - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக் கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

Total : 15 PERIODS

TEXT-CUM REFERENCE BOOKS:

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை)
5. Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: InternationalInstitute of Tamil Studies
7. Historical by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation,Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23MC1001	ENVIRONMENTAL SCIENCE	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution.
- To familiarize the influence of societal use of resources on the environment and introduce the legal provisions, National and International laws and conventions for environmental protection

UNIT - I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers– energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids Introduction to biodiversity definition: genetic, species and ecosystem diversity – bio geographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In situ and exsitu conservation of biodiversity

UNIT - II ENVIRONMENTAL POLLUTION 6

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards– solid waste management: causes, effects and control measures of municipal solid wastes, biomedical wastes and e-wastes – role of an individual in prevention of pollution – pollution case studies.

UNIT - III NATURAL RESOURCES 6

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Land resources: Land as a source, land degradation, man induced landslides, soil erosion and desertification–role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

UNIT - IV SOCIAL ISSUES AND THE ENVIRONMENT 6

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of nongovernmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion. environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards Public awareness.

UNIT - V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare Programme– environment and human health – human rights – value education – HIV / AIDS - women and child welfare – role of information technology in environment and human health - case studies.

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

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

- **CO1** To recognize and understand the functions of environment, ecosystems, biodiversity and their conservation.
- **CO2** To identify the causes, effects and control measures of environmental pollution and to implement the preventive measures
- **CO3** To identify the various types of natural resources, their exploitation, consequences and to apply methodologies for its conservation.
- **CO4** To describe and analyse the concept of sustainable development, the fundamental key concepts of various social issues and environmental Acts.
- **CO5** To outline the reasons for human population and the role of information technology in environment and human health.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik‘s, “Perspectives in Environmental Studies”, 6th Edition, New Age International Publishers (2018).
2. Benny Joseph, “Environmental Science and Engineering”, Tata McGraw-Hill, New Delhi,(2016)
3. Gilbert M.Masters, “Introduction to Environmental Engineering and Science”, 2nd edition, Pearson Education (2004)..

REFERENCE BOOKS:

1. R.K. Trivedi, “Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards”, Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, “Environmental Encyclopedia”, Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, “Environmental law”, Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Erach Bharucha, “Textbook of Environmental Studies for Undergraduate Courses” Orient Blackswan Pvt. Ltd. (2013).

WEB REFERENCES:

1. https://www.nationalgrid.com/stories/energy-explained
2. https://www.conservationindia.org/articles/human-elephant-conflict
3. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/pollutantmonitoring
4. https://www.undp.org/sustainable-development-goals

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/105107213
2. https://nptel.ac.in/courses/105107181
3. https://nptel.ac.in/courses/103106162
4. https://nptel.ac.in/courses/103107212

23HS1204	INTERPERSONAL COMMUNICATION SKILLS II	L	T	P	C
		0	0	2	0

COURSE OBJECTIVE:

- To induce the basic reading and writing skills of the freshers.
- To enhance the active listening skills of the learners through practice 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
- To improve communication skills of the learners in a professional setting

CONTENTS

Listening: Listening to Telephonic Conversation- on various jobs, recruitments and processes and professional etiquette

Speaking: Answering Telephonic Calls Attending telephonic interviews Presenting Work Activities, Presentation on Business Ideas and Iconic Personalities

Reading: Inferring information from business/professional letters Newspaper activities (Skimming / scanning) acquiring knowledge related to leading successful personalities and business consultancies.

Writing: Art of Letter Writing – Business Letters and Emails – acknowledging the performances and promoting the base and superstructures.

TOTAL :30 PERIODS

TEXT BOOKS:

1. Crucial Conversations: Tools for Talking When Stakes Are High by Kerry Patterson, Joseph Grenny, Ron McMillan, and Al Switzler, 2014
2. Simply Said: Communicating Better at Work and Beyond by Jay Sullivan, 2016

REFERENCE BOOKS:

1. Words That Work: It's Not What You Say, It's What People Hear by Dr. Frank Luntz,2011.
2. The Fine Art of Small Talk: How To Start a Conversation, Keep It Going, Build Networking Skills — and Leave a Positive Impression! By Debra Fine

WEB REFERENCES

1. ttps://teambuilding.com/blog/communication-books
2. https://unacademy.com/content/upsc/study-material/science-andtechnology/famous-personalities-in-science/

ONLINE COURSES / RESOURCES

1. https://www.krisamerikos.com/blog/phone-coversation-in-english
2. https://blog.hubspot.com/service/phone-etiquette

COURSE OUTCOME

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

CO1 Comprehend conversation and short talks delivered in English.

CO2 Participate effectively in informal conversation; introduce themselves and their friends and express opinions English.

CO3 Read articles of a general kind in magazines and newspaper

CO4 Write short essays of a general kind and personal letters and emails in English.

CO5 Gain understanding of basic grammatical structures and use them in right context.

CO6 Use appropriate words in a professional context.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1								3	3		2			
CO2								3	3		2			
CO3								2	3		2			
CO4								2	3		2			
CO5								2	3		2			
CO6								3	3		2			

23HS1205	QUANTITATIVE APTITUDE PRACTICES II	L	T	P	C
		0	0	1	0

COURSE OBJECTIVE:

- To improve students comprehension of geometry and mensuration, average as well as help them hone their problem-solving abilities
- To develop students ability to use the techniques for resolving riddles, streams, boats, and coding problems.

MODULE 1 Geometry and Mensuration 3

Lines and angles – circles – triangles – quadrilaterals – polygons - coordinate geometry area &volume of 2D and 3D figures.

MODULE 2 Average, Time, Work 3

Logarithm - Average - time and work - time and distance

MODULE 3 Boats and streams 3

Relative speed – problems on trains – boats and streams – races and games

MODULE 4 Logical Reasoning - I 3

Odd man out and series – venn diagram - seating arrangement – decision making

TOTAL :30 PERIODS

COURSE OUTCOME

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

CO1 Acquire knowledge of solving geometry and mensuration, average, percentage, time and work questions effortlessly.

CO2 Understand and exhibit sound knowledge to the boats and streams, venn diagram and decision making.

TEXT BOOKS:

1. Aggarwal. R.S.(2017).Quantitative Aptitude for Competitive Examinations 3rd edition New Delhi:S. Chand Publishing.
2. Abhijit guha (2016). Quantitative Aptitude for All Competitive Examinations, 6th edition. Noida: McGrawHill Education Pvt.Ltd.
3. FACE.(2016).Aptipedia Aptitude Encyclopedia1(Ed.).New Delhi: Wiley Publications.

REFERENCE BOOKS:

1. Sharma arun. (2016). Quantitative aptitude, 7th (Ed.).Noida : McGrawHill Education Pvt. Ltd.
2. Praveen. R.V 3rd edition, Quantitative aptitude and reasoning, PHI learning publication.

Mode of Evaluation: Online Test

SEMESTER III

23MA1303	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To understand the concepts of solving partial differential equation.
- To understand the concepts of Fourier series analysis.
- To apply the concept of Fourier series techniques in wave and heat flow problems.
- To introduce the basic concepts of Fourier transform techniques.
- To introduce the 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 - Lagranges 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 intervalHalf range sine series–Half range cosine series–RMS values-Parseval's identity–Harmonic analysis

UNIT - III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

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

UNIT - IV FOURIER TRANSFORMS 9+3

Statement of Fourier integral theorem – Fourier transforms 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

COURSE OUTCOME(S):

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

CO1	Understand the concepts of partial differential equations and their solutions.
CO2	Utilise the principles of Fourier series in real life situation.
CO3	Develop one dimensional equation using Fourier series techniques.
CO4	Develop two dimensional equations using Fourier series techniques.
CO5	Understand the mathematical principles on Fourier transforms.
CO6	Apply the basic knowledge to solve difference equations using Z-transforms.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014
2. Narayanan S.,Manicavachagam Pillay.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.

REFERENCE BOOKS:

1. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications 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, 2018.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3									2	3		
CO2	3	3									2	3		
CO3	3	3									2	3		
CO4	3	3									2	3		
CO5	3	3									2	3		
CO6	3	3									2	3		

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<tr><th colspan="4">Internal Assessment</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
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23EE1301	ELECTROMAGNETIC THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To acquire a basic understanding of various coordinate systems, vector algebra and calculus.
- To impart knowledge of 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 magneto statics.
- 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 coordinate 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.

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, Energy density.

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

COURSE OUTCOME(S):

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

CO1	Apply vector calculus to static electric field.
CO2	Apply the basic concepts about electrostatic fields for the calculation of Electric field intensity, Electrical potential.
CO3	Explain Electric field in free space, conductors, dielectric and multiple dielectrics and apply the basic concepts in Capacitance calculations.
CO4	Determine the magnetic flux density, scalar potential, vector potential and energy density.
CO5	Derive Electromagnetic wave equation and apply the Poynting expression.
CO6	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. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2017.
3. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Fifth Edition (Schaum's Outline Series), McGraw Hill, 2019.
4. K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Sixteenth Publication :2023

REFERENCE BOOKS:

1. V.V.Sarwate, 'Electromagnetic fields and waves', Second Edition, New age Publishers, 2018
2. S.P.Ghosh, LipikaDatta, 'Electromagnetic Education(India) Private Limited, 2017.
3. William H. Hayt, John A. Buck, Jaleel M. Akhtar, 'Engineering Electromagnetics', McGraw Hill Special 9th edition, Published: February 18, 2020.

WEB REFERENCES: (Only accessible Links)

1. https://www.electrical4u.com/electromagnetic-theory/
2. https://clerkmaxwellfoundation.org/html/electromagnetic_theory.html

ONLINE COURSES / RESOURCES:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2									3	3	
CO2	3	3	3									3	3	
CO3	3	3	3	1								3	3	
CO4	3	3	3	3								3	3	
CO5	3	3	3	3								3	3	
CO6	3	3	3	1								3	3	

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<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1302	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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**

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**

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**

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**

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**

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 :45 PERIODS

COURSE OUTCOME

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

CO1 Distinguish between different types of signals and Systems.
CO2 Analyze the behaviour of continuous and discrete-time LTI systems.
CO3 Classify systems based on their properties and determine the response in frequency domain.
CO4 Analyze system properties based on impulse response and Fourier analysis.
CO5 Apply the Z- transform for analysis of continuous-time and discrete-time signals.
CO6 Understand the process of sampling and its implications during signal reconstruction.

TEXT BOOKS:

1. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2. 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3						1	3	3	
CO2	3	3	3	2	3						1	3	3	
CO3	3	3	3	2	3						1	3	3	
CO4	3	3	3	2	3						1	3	3	
CO5	3	3	3	2	3						1	3	3	
CO6	3	3	3	2	3						1	3	3	

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</table>

23CS1304	OBJECT ORIENTED PROGRAMMING USING JAVA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- Basic concepts of OOP
- Syntax, semantics classes, objects, invoking methods, etc.
- Principles of inheritance and interfaces.
- Exception handling and I/O mechanism
- 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.

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.

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 – Packages.

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.

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.

TOTAL :45 PERIODS

COURSE OUTCOME

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

CO1 Recall the OOP principles.

CO2 Understand the Fundamental Concepts of Java.

CO3 Develop Java Programs using the concepts of inheritance and interfaces.

CO4 Examine exception handling and multithreading in Java.

CO5 Compare and contrast between I/O and generic programming.

CO6 Design applications using Java which mimics the real word scenarios.

TEXT BOOKS:

1. Herbert Schildt, "Java The Complete Reference", 12^{th} Edition, McGraw Hill Education, 2021.
2. Prem Kumar ,"Getting Inside Java" (Beginner's Guide), 2021.
3. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3^{rd} Edition, Pearson, 2015.

REFERENCE BOOKS:

1. Cay S. Horstmann, Gary Cornell, "Core Java Volume – I Fundamentals", 9^{th} Edition, Prentice Hall, 2013.
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
2. https://www.tutorialspoint.com/java/index.htm
3. https://www.geeksforgeeks.org/java/

ONLINE COURSES / RESOURCES

1. https://www.udemy.com/topic/java/
2. https://www.coursera.org/courses?query=java

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	2		3						1			
CO2	1	2	2		3						1			
CO3	1	2	2		3						1			
CO4	1	2	2		3						1			
CO5	1	2	2		3						1			
CO6	1	2	2		3						1			

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EE1303	ANALOG ELECTRONICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

- 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 and application circuits using op-amp.
- To understand Functional blocks and applications of special ICs like 555 timer and voltage 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, Wien bridge, Crystal oscillators.

UNIT III OP-AMP AND CHARACTERISTICS 9

Op-amp characteristics - DC characteristics, AC characteristics. Basic applications of Opamp – 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 IC 9

Functional blocks, 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

COURSE OUTCOME

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

CO1 Acquire knowledge in Semiconductor devices like BJT, FET, MOSFET and UJT.

CO2 Design the amplifiers with various biasing circuits for FET and BJT and analyse the differential amplifier.

CO3 Interpret the different types of Power Amplifiers and Oscillators.

CO4 Summarize the characteristics of Op-Amp and analyse the various applications of Op-Amp.

CO5 Develop and correlate the various Non-linear applications of Op-amp and study the A/D converters and D/A converters.

CO6 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 Devices and Circuits", 5th edition, Oxford University Press, 2017.
2. D. Roy Choudhury, S.B. Jain, "Linear Integrated Circuits", 6th edition, New Age Publishers, 2023.

REFERENCE BOOKS:

1. Sedra and Smith, “Microelectronic circuits”, 7th edition, Oxford University Press, 2017.
2. Thomas L. Floyd, “Electronic Devices” 11th edition, Pearson Asia, 2017
3. Robert L. Boylestad, “Electronic Devices and Circuit theory”, 11th edition 2016.
4. Ramakant A. Gayakwad, "Op-amps and Linear Integrated Circuits", 4th edition, Pearson Education, 2021.

WEB REFERENCES

1. https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/resources/lecture -20/

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/

ANALOG ELECTRONICS LABORATORY

30 Hours

LIST OF EXPERIEMENTS

1. Digital Simulation and Experimental Verification of Characteristics of a NPN Transistor under common emitter, common collector and common base configurations.
2. Characteristics of JFET and UJT.
3. Design and plot the frequency response characteristics of a Common Emitter amplifier.
4. Design and testing of RC phase shift and LC oscillators.
5. Design the differential amplifier using FET
6. Simulation of Op-Amp application circuits using PSPICE.
7. Variable voltage regulator using IC LM317.

REFERENCES:

1. David A. Bell, "Laboratory manual for Electronic devices and circuits", 4th edition, PHI, 2007.
2. S Salivahanan, N Suresh Kumar, "Electronic Devices and Circuits", 5th edition, McGraw Hill, 2022.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2		1				1	3		
CO2	3	3	3	2	2		1				1	3	2	
CO3	3	3	2	2	2		1				1	2	2	
CO4	3	3	2	2	2		1				1	2	2	
CO5	3	3	2	2	2		1				1	2	3	
CO6	3	3	2	2	2		1				1	3	3	

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<tr><td colspan="2">Assessment
(40% weightage)
(Theory Component)</td><td colspan="2">Assessment
(60% weightage)
(Laboratory Component)</td><td>End Semester Examination</td></tr>
<tr><td>Individual Assignment / Case Study / Seminar / Mini Project</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record</td><td>Test</td><td>Written Examination</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td rowspan="2">100</td></tr>
<tr><td colspan="4">100</td></tr>
<tr><td colspan="4">50 %</td><td>50 %</td></tr>
</table>

23CS1313	OBJECT ORIENTED PROGRAMMING USING JAVA LABORATORY	L	T	P	C
		0	0	4	2

COURSE 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 OUTCOMES

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

- **CO1** Recall object oriented features and Java concepts.
- **CO2** Understand the key aspects of java Standard API libraries.
- **CO3** Experiment with the concepts of class, operator overloading and function.
- **CO4** Distinguish the various types of Inheritance in Java.
- **CO5** Assess exception handling and file handling mechanisms in Java.
- **CO6** Design and develop applications using Java for real time scenarios.

WEB REFERENCES

1. https://www.javatpoint.com/java
2. https://www.tutorialspoint.com/java/index.htm
3. https://www.geeksforgeeks.org/java/

ONLINECOURSES/RESOURCES

1. https://www.udemy.com/topic/java/
2. https://www.coursera.org/courses?query=java

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2		2						3			
CO2	3	2	2		2						3			
CO3	3	2	2		2						3			
CO4	3	2	2		2						3			
CO5	3	2	2		2						3			
CO6	3	2	2		2						3			

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23ES1312	CODING PRACTICES I	L	T	P	C
		0	0	2	0

COURSE OBJECTIVE

- To impart essential problem-solving skills through general problem-solving concepts.
- To provide basic knowledge on programming essentials using Python as implementation Tool.
- To introduce various Collection Data types and Exception handling using Python

LIST OF EXPERIMENTS

1. Data Types, Variables, Operators
2. Expressions, Precedence of Operators
3. Conditional Statements
4. Built-in Functions including Range, len, input, map and split
5. Looping, For and While
6. User Defined Functions
7. List
8. Tuple
9. Dictionary
10. Recursion and Lambda Functions
11. String Handling
12. Regular Expressions
13. Packages
14. Exception Handling.
15. GUI using TKinter

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1	Identify solutions for a given problem.
CO2	Summarize the fundamental programming elements in Python language and learn to apply basic control structures in Python.
CO3	Articulate the applications of Collection data types in Python.
CO4	Visualize the capabilities of String and Regular expressions.
CO5	Defend the basic principles of Exception Handling.
CO6	Design and Develop GUIs

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. Reema Thareja, “Problem Solving and Programming with Python”, 2nd edition, Oxford University Press, New Delhi, 2019.
3. Alan D. Moore, Python GUI Programming with Tkinter, Design and Build Functional and User-friendly GUI Applications, Packt Publishing, 2021.

REFERENCE BOOKS:

1. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018
2. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.

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/

23HS1301	SKILLS FOR CAREER BUILDING AND DEVELOPMENT I	L	T	P	C
		0	0	2	0

COURSE OBJECTIVE:

- To improve language accuracy through error spotting, sentence correction, and text completion.
- To build critical thinking by analysing arguments and organizing ideas.
- To create a strong personal brand and effective self-introduction using social media.
- To develop persuasion, negotiation, and business planning skills.
- To enhance teamwork, empathy, and feedback skills for better interpersonal relations.

UNIT - I **6**

Error Spotting- Sentence Correction (Advanced) - Sentence Equivalence and Text completion

UNIT - II **6**

Critical Reasoning – Facts – Inference – Judgement – Strengthening and Weakening an Argument – Para jumble – Para Completion.

UNIT - III **6**

Self-Introduction Personal Branding – Personal profiling – Role of social media in profile Building

UNIT - IV **6**

Persuasion and Negotiation Skills- Product Marketing / Business Plan

UNIT - V **6**

Interpersonal Skills- Synergy- Empathy- Feedback Circle

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

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

CO1 Proficiently spot and correct advanced errors, complete texts, and achieve sentence equivalence with accuracy

CO2 Demonstrate strong critical reasoning by analysing arguments, making judgments, and organizing coherent paragraphs.

CO3 Create impactful self-introductions and personal brands, leveraging social media for effective profiling.

CO4 Apply persuasion and negotiation skills to develop and market business plans successfully convince others and create solid business plans.

CO5 Exhibit strong interpersonal skills, empathy, and synergy, delivering constructive feedback to enhance team dynamics.

TEXT BOOKS:

1. Powers, L., and T. Knapp. The Official Guide to the GRE General Test. 3rd ed., McGraw-Hill Education, 2019.
2. Gallo, Carmine. Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds. St. Martin's Press, 2016.

REFERENCE BOOKS:

1. Manhattan Prep. (2021). GRE Reading Comprehension & Essays (7th ed.). Manhattan Prep Publishing.
2. Cialdini, R. B. (2021). Influence, New and Expanded: The Psychology of Persuasion. Harper Business.

WEB REFERENCES:

1. https://www.ets.org/gre/test-takers/general-test/prepare/practice-questions/verbal-reasoning.html
2. https://www.linkedin.com/learning/building-your-personal-brand

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/learn/critical-thinking-skills
2. https://www.coursera.org/learn/negotiation

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1								3	3		2			
CO2								3	3		2			
CO3								2	3		2			
CO4								2	3		2			
CO5								2	3		2			
CO6								3	3		2			

23HS1302	QUANTITATIVE APTITUDE PRACTICE III	L	T	P	C
		0	0	1	0

COURSE OBJECTIVE:

- Students can refine their problem solving skills by using ratio and proportion, simple and compound interest.
- To improve students ability to use strategies for addressing logical reasoning, surds and indices problems.

Module 1 Simple and Compound interest **3**

Simple interest - compound interest - problems on ages - simplification and approximation.

Module 2 Ratio and Proportion **3**

Chain rule – percentage - ratio and proportion - profit and loss

Module 3 Surds and Indices **3**

surds and indices – clock – cubes – dices – direction - sense.

Module 4 Logical Reasoning II **3**

Puzzles – series – coding - decoding – classifications.

TOTAL : 12 PERIODS

COURSE OUTCOME

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

CO1 Solve problems using ratio and proportion, simple and compound interest, and ease.

CO2 Comprehend and demonstrate solid knowledge for the surds and indices, as well as logical reasoning exercises.

TEXT BOOKS

1. AggarwalR.S.(2017). Quantitative Aptitude for Competitive Examinations 3rd edition New Delhi: S. Chand Publishing.
2. Abhijit guha(2016). Quantitative Aptitude for All Competitive Examinations, 6th edition. Noida: McGraw Hill Education Pvt.Ltd.
3. FACE.(2016).Aptipedia Aptitude Encyclopedia1(Ed.).New Delhi: Wiley Publications.

REFERENCE BOOK

1. Sharma arun.(2016).Quantitative aptitude,7th(Ed.).Noida : McGraw Hill Education Pvt. Ltd.
2. Praveen. R.V 3rd edition, Quantitative aptitude and reasoning, PHI learning publication.

Mode of Evaluation: Online Test

SEMESTER IV

23MA1403	NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVE:

- To introduce the basic concepts of solving algebraic and transcendental equations
- To introduce the numerical techniques of interpolation.
- To acquaint the student with understanding of numerical techniques of differentiation and integration.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial 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 method : 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 boundary value problems-Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson)methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

COURSE OUTCOME(S):

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

CO1 Understand the basic concepts and techniques of solving algebraic and transcendental equations.

CO2 Analyse the numerical techniques of interpolation and approximations in various intervals.

CO3 Apply the numerical techniques of differentiation for engineering problems.

CO4 Recognize the numerical techniques of integration for engineering problems.

CO5 Evaluate the numerical techniques of differentiation and integration for solving initial value problems.

CO6 Remember the partial and ordinary differential equations with initial and boundary conditions by using certain techniques.

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.

REFERENCE BOOKS:

1. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
2. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3										3		
CO2	3	3										3		
CO3	3	3										3		
CO4	3	3										3		
CO5	3	3										3		
CO6	3	3										3		

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EE1401	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To educate the fundamental concepts of measuring instruments.
- To understand the operation of various Analog instruments.
- To understand the operation of various 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 9 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

COURSE OUTCOME(S):

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

CO1 Understand the fundamental concepts of measurements and instruments.

CO2 Analyze the static and dynamic behaviour of a measurement system and compare with standard system.

CO3 Categorize the working principle of various Analog instruments.

CO4 Illustrate the characteristics and performance parameters of Digital instruments.

CO5 Explain the suitable bridge for the measurement of unknown resistance, Inductance and Capacitance

CO6 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”, Tata McGraw-Hill, New Delhi, 2007.

REFERENCE BOOKS:

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, 2^{nd} Edition, Prentice Hall of 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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3									3	3		
CO2	3	3	2								3	3		
CO3	3	3	2								3	3		
CO4	3	3									3	3		
CO5	3	3	2								3	3		
CO6	3	3									3	3		

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1402	ELECTRICAL MACHINES I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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, appropriate tests 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 TRANSFORMER 9

Construction - Principle of operation - Types - Equivalent circuit -Phasor Diagram-Voltage regulation -losses and efficiency-All Day Efficiency - Auto transformer: construction and Working -Comparison with two winding Transformers- Application.

UNIT - V TRANSFORMER TESTING 9

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

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1	Examine the electro-mechanical energy conversion process in rotating electrical machines.
CO2	Understand the construction, working principle of DC machines and analyse the performance of DC Generator.
CO3	Interpret the characteristics of various types of DC Motor
CO4	Analyze the performance of special electrical machines.
CO5	Interpret the constructional details of different types of transformers, working principle and their performance.
CO6	Compute various performance parameters of single and three phase transformers by conducting suitable tests.

TEXT BOOKS:

1. Nagrath, I.J. and Kothari.D.P, "Electric Machines", McGraw-Hill Education, 5th Edition, 2017.
2. Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, "Electric Machinery", 6th edition, McGraw Hill Books Company, 2017.
3. Theraja.B.L., Theraja.A.K. "A Text Book of Electrical Technology", Volume II AC & DC Machines", S.Chand & Company Ltd., 23rd Edition, 2005.
4. P. S. Bimbhra, "Electric Machinery", Khanna Publishers, 2nd Edition, 2021.

REFERENCE BOOKS:

1. Stephen J. Chapman, "Electric Machinery Fundamentals", 4th edition, McGraw Hill Education Pvt. Ltd, 2010.
2. B.R. Gupta, "Fundamental of Electric Machines", New age International Publishers, 3rd Edition, 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.

WEB REFERENCES: (Only accessible Links)

1. https://www.electrical4u.com/electric-machines/

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	1			1				1	3	2	
CO2	3	3	1	1			1				1	3	2	
CO3	3	3	1	1			1				1	3	2	
CO4	3	3	1	1			1				1	3	2	
CO5	3	3	1	1			1				1	3	2	
CO6	3	3	1	1			1				1	3	2	

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EE1403	TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 (T and π Model) 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

COURSE OUTCOME(S):

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

CO1	Understand the importance and the functioning of Power system.
CO2	Calculate the sag and tension of transmission lines.
CO3	Estimate the line parameters for transmission lines.
CO4	Model and Predict the performance parameters of transmission lines.
CO5	Analyze the voltage distribution in insulator strings and grading of cables in transmission lines.
CO6	Study the different types of distribution system.

TEXT BOOKS:

1. D.P.Kothari, I.J. Nagarath, “Power System Engineering”, McGraw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.
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.

REFERENCE BOOKS:

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 (LPSPE)’, S. Chand & Company Ltd, New Delhi, 2022.
3. G.Ramamurthy, “Handbook of Electrical power Distribution,” Universities Press, Second Edition, 2013.

ONLINE COURSES / RESOURCES

1. https://nptel.ac.in/courses/108105104

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3		1							3	3		
CO2	3	3	3	3							3	3		
CO3	3	3	3	3							2	3		
CO4	3	3	2	2							2	3		
CO5	3	3	2	2							3	3		
CO6	3	3	2	2							3	3		

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EE1404	CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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

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

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

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

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

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 : 45 PERIODS

COURSE OUTCOME(S):

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

CO1	Understand the basics of system to a find transfer function using BDR and SFG.
CO2	Interpret the conversion of mechanical model to Electrical Model and vice versa
CO3	Realize the concept of system response in time domain and also steady state error.
CO4	Understand the concept of system response in frequency domain with graphical approach such as bode & Polar.
CO5	Analyze the system stability using Routh criterion, Nyquist criterion and also perceive ideas regarding lead, lag, lead-lag compensators
CO6	Understand the concept of state space modelling

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.

REFERENCE BOOKS:

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.

WEB REFERENCES

1. https://www.geeksforgeeks.org/control-system/

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3		3				3	3	3	3
CO2	3	3	3	3			3				3	3	3	3
CO3	3	3	3	3	2						3	3	3	3
CO4	3	3	3	3	3						3	3	3	3
CO5	3	3	3	2	3						2	3	3	3
CO6	3	3	3	3	3						3	3	3	3

<table>
<tr><th colspan="4">Internal Assessment</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1405	DIGITAL ELECTRONICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

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

UNIT I NUMBER SYSTEM AND BOOLEAN ALGEBRA 9

Review of number systems, binary codes, error detection and correction codes (Parity and Hamming code) - Digital Logic Families - RTL, DTL, TTL, ECL and MOS families - operation, characteristics of digital logic family.

UNIT II COMBINATIONAL CIRCUITS 9

Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps - simplification and implementation of combinational logic – multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders.

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters - asynchronous and synchronous type - Modulo counters - Shift registers - design of synchronous sequential circuits – Moore and Mealy models- Counters, state diagram; state reduction; state assignment.

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS AND 9 PROGRAMMABILITY LOGIC DEVICES 9

Asynchronous sequential logic circuits- hazards &errors in digital circuits; analysis of asynchronous sequential logic circuits-Fundamental mode. Introduction to Programmability Logic Devices. PROM – PLA –PAL, CPLD-FPGA

UNIT V INTRODUCTION TO VHDL 9

Digital design process flow - Entities and Architecture - Behavioural, Dataflow, and structural modelling - Simple coding for combinational logic circuit and Sequential circuit (example: Adder, Counter, Flipflops, Multiplexer and De-multiplexer.

TOTAL :45 PERIODS

COURSE OUTCOME

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

CO1 Apply Boolean algebra and simplify the logical expressions using Boolean functions.

CO2 Design and realize the combinational circuits using logic gates.

CO3 Analyze the synchronous Sequential logic circuits using flip flops and counters.

CO4 Analyze and Design Asynchronous sequential logic circuits.

CO5 Examine the operation of various Programmable Logic Devices.

CO6 Develop simple programs in VHDL.

TEXT BOOKS:

1. Thomas L Floyd, "Digital fundamentals", Pearson Education Limited, 11th Edition, 2018
2. Morris Mano.M, "Introduction to the verilog HDL,VHDL and system", Prentice Hall of India, 6th Edition, 2018.

REFERENCE BOOKS:

1. S K Mandal, "Digital Electronics Principles & Application", McGraw Hill Edu, 2017.
2. D.P.Kothari,J.S.Dhillon, "Digital circuits and Design‟, Pearson Education, 2015.

WEB REFERENCES

1. https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter/theory.html
2. https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter

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/

DIGITAL ELECTRONICS LABORATORY **30 Hours**

LIST OF EXPERIEMENTS

1. Verification of Boolean laws using basic logic gates
2. Design and implementation of Adder and Subtractor circuits.
3. Design and implementation of Parity generator and parity
4. Design and implementation Excess-3 to BCD and Binary to Gray code converter and vice-versa.
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 simplified Boolean expressions using multiplexer and de multiplexer.
8. Design and implementation of Magnitude Comparators

REFERENCES:

1. https://de-iitr.vlabs.ac.in/exp/half-full-subtractor/ 2. https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3		1						2	3	2	
CO2	3	3	3		1						2	3	2	
CO3	3	3	3		1						2	3	2	
CO4	3	3	3		1						2	3	2	
CO5	3	3	3		1						2	3	2	
CO6	3	3	3		1						2	3	2	

<table>
<tr><th colspan="2">Assessment
(40% weightage)
(Theory Component)</th><th colspan="2">Assessment
(60% weightage)
(Laboratory Component)</th><th>End Semester Examination</th></tr>
<tr><td>Individual Assignment / Case Study / Seminar / Mini Project</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record</td><td>Test</td><td>Written Examination</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td rowspan="2">100</td></tr>
<tr><td colspan="4">100</td></tr>
<tr><td colspan="4">50 %</td><td>50 %</td></tr>
</table>

23EE1411	ELECTRICAL MACHINES LABORATORY I	L	T	P	C
		0	0	4	2

COURSE 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

COURSE OUTCOMES

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

CO1 Analyze the no load and load characteristics of DC Shunt and Compound generator.

CO2 Illustrate the mechanical and electrical characteristics of Shunt, Series and Compound motor.

CO3 Develop the equivalent circuit of Single phase Transformer and calculate the parameters of equivalent circuit.

CO4 Demonstrate the indirect method of testing of DC machine to determine its efficiency.

CO5 Analyze the different types of three phase transformer Connections.

CO6 Analyze the characteristics of DC motor using Simulation software.

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3			3	3	3	3	3	3	3	3
CO2	3	3	3	3			3	3	3	3	3	3	3	3
CO3	3	3	3	3			3	3	3	3	3	3	3	3
CO4	3	3	3	3			3	3	3	3	3	3	3	3
CO5	3	3	3	3			3	3	3	3	3	3	3	3
CO6	3	3	3	3			3	3	3	3	3	3	3	3

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23EE1412	CONTROL AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE 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. 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. Design of P, PI, and PID Controllers.
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 OUTCOMES

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

CO1 Demonstrate the types of controllers and stability analysis of linear system

CO2 Determine the Transfer Function of electro mechanical system and energy measuring devices.

CO3 Infer the response of Position Control and Characteristics of Synchro Transmitter and receiver

CO4 Compare the energy storage elements using AC & DC bridges and signal conditioning circuit.

CO5 Analyze the dynamics of Sensors / Transducers.

CO6 Interpret the basics of signal conditioning circuits

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3		2				2	3	3	3
CO2	3	3	3	3	3		2				2	3	3	3
CO3	3	3	3	3	3		2				2	3	3	3
CO4	3	3	3	3	3		2				2	3	3	3
CO5	3	3	3	3	3		2				2	3	3	3
CO6	3	3	3	3	3		2				2	3	3	3

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23ES1412	CODING PRACTICES II	L	T	P	C
		0	0	2	0

COURSE OBJECTIVE

- Understanding Java Fundamentals.
- Develop proficiency in flow control statements and Understand the usage of arrays and var-arg types
- Exploring Object-Oriented Programming Concepts through Java Programming
- Develop programs on Exception handling through Java Programming
- Understand the usage of wrapper classes and Utilizing Standard Java Libraries

LIST OF EXPERIMENTS

1. Java Tokens- Comments, Identifiers, Keywords, Separators, Data types
2. Scoping and Parameter passing (by value & by reference)
3. Flow Control Statements
4. Arrays and Var-arg types
5. Enums
6. Operators & their Precedence & Associativity
7. Conversions: Narrowing & Widening Conversions
8. Assignments and Initializations
9. Access Modifiers for Class & Class Members
10. Non Access Modifiers for Class & Class Members
11. Packages with Static imports
12. Creating Classes and Instances
13. Method and Types of methods
14. Inheritance
15. Polymorphism (Method Overloading & Overriding) Abstract classes and Interfaces
16. Constructors and Initialization
17. Reference Variable Casting
18. Static data and methods
19. Traditional Error Handling Techniques
20. Importance of Exception Handling
21. Exception Handling Framework
22. Stack-based Execution
23. Checked and Unchecked Exceptions
24. User defined Exceptions
25. Cautions When Using Exceptions
26. Java Thread Model
27. Thread Class & Runnable Interface
28. Types of Threads - User, Demon
29. Creating Your Own Threads
30. Threads States and Life cycle
31. Thread Methods: yield(), sleep(), current Thread() etc
32. Scheduling and Thread Priorities

33. Concurrency Control and Synchronization
34. Deadlocks
35. Inter-thread communication
36. Wrapper Classes
37. Autoboxing / Unboxing
38. Math Class
39. String and String Buffer Classes
40. Date and Calendar

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

CO1 Understand the fundamental programming elements of Java and learn to apply basic control structures in Java.

CO2 Apply scoping rules and demonstrate an understanding of parameter passing in Java

CO3 Analyze and create effective flow control statements in Java

CO4 Evaluate the usage of arrays, var-args, and enums in Java, based on program requirements and design considerations.

CO5 Develop Java programs to implement object-oriented design principles

CO6 Apply exception handling techniques in Java, including the creation of user-defined exceptions

TEXT BOOKS

1. Herbert Schildt, "Java The complete reference", 12th Edition, McGraw Hill Education, 2022.
2. Cay S. Horstmann, Gary Cornell, "Core Java Volume – I Fundamentals", 11th Edition, Prentice Hall, 2020.

REFERENCES BOOKS

1. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition Pearson, 2015
2. Timothy Budd, "Understanding Object-oriented programming with Java", Updated Edition, Pearson Education, 2000.

WEB REFERENCES

1. https://www.javatpoint.com/java-tutorial
2. https://www.tutorialspoint.com/java/index.htm

23HS1401	SKILLS FOR CAREER BUILDING AND DEVELOPMENT II	L	T	P	C
		0	0	2	0

COURSE OBJECTIVE:

- To equip students to develop profiles and understand the nuances of resume creation.
- To employ group discussion activities to exhibit expertise and abilities.
- To Gain insight into effective interview techniques and acquire hands-on experience through mock interviews.
- To improve presentation skills while exploring potential career opportunities.
- To foster networking skills and build professional connections to enhance career prospects and industry engagement.

UNIT - I **6**

Emotional Intelligence - Professionalism and Etiquette

UNIT - II **6**

Resume Building and Cover Letter - SOP – Video Profile.

UNIT - III **6**

Purpose and Role of GD in recruitment – GD preparation – Types of GD topics – Mock GDs

UNIT - IV **6**

Introduction to personal interview – Types of Interviews – PI preparation – Mock Interviews

UNIT - V **6**

Crafting STAR (Situation, Task, Action, Result) responses Panel interviews – Higher order challenging questions – Discussion – Ethics at workplace

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

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

CO1 Develop a distinctive personal brand and craft a compelling, impactful resume.
CO2 Engage actively in group discussions to maximize their value and outcomes.
CO3 Tackle personal and technical interviews with confidence and clear preparation.
CO4 Articulate ideas and perspectives in a structured, coherent manner.
CO5 Gain insight into industry expectations and explore potential career pathways.

TEXT BOOKS:

1. Carnegie, Dale. How to Win Friends and Influence People.Revised ed., Simon & Schuster, 2010.
2. Bolles, Richard N. What Color Is Your Parachute? 2021: A Practical Manual for Job-Hunters and Career-Changers. Ten Speed Press, 2021.

REFERENCE BOOKS:

1. Adler, L. (2013). The Essential Guide for Hiring & Getting Hired. Workbench Media.
2. Yate, M. (2020). Knock 'em Dead Job Interview: How to Turn Job Interviews into Job Offers (10th ed.). Adams Media.

WEB REFERENCES:

1. https://www.mindtools.com/pages/article/professionalism.html
2. https://www.themuse.com/advice/interviewing

ONLINE COURSES / RESOURCES:

1. https://www.linkedin.com/learning/developing-your-professional-presence-and-influence
2. https://www.coursera.org/learn/career-networking-interviewing

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1								3	3		2			
CO2								3	3		2			
CO3								2	3		2			
CO4								2	3		2			
CO5								2	3		2			

23HS1402	QUANTITATIVE APTITUDE PRACTICE IV	L	T	P	C
		0	0	1	0

COURSE OBJECTIVE:

- Students can improve their problem-solving abilities by applying permutation and combination, probability, alligation, and mixture.
- To improve students ability to use strategies for addressing day sequence and data sufficiency problems.

Module 1 Permutation and Combination, Probability **3**

Permutation – combination – probability – Partnership.

Module 2 Alligation, Mixture and Analogy 3

Alligation and mixture – stocks and shares – analogy – symbols and notations.

Module 3 Time and work (advanced) **3**

Relative speed - work equivalence - division of wages – multiple pipe problems.

Module 4 Day sequence and Data sufficiency **3**

Day sequence - decision making - statement and assumptions - data sufficiency.

TOTAL : 12 PERIODS

COURSE OUTCOME

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

CO1 Understand the basic concepts of permutation and combination, probability, alligation and mixture.

CO2 Assist in understanding and exhibiting strong understanding for the advanced problems in relative speed and data sufficiency tasks.

TEXT BOOKS

1. AggarwalR.S.(2017). Quantitative Aptitude for Competitive Examinations 3rd edition New Delhi: S. Chand Publishing.
2. Abhijit guha(2016). Quantitative Aptitude for All Competitive Examinations, 6th edition. Noida: McGraw Hill Education Pvt.Ltd.
3. FACE.(2016).Aptipedia Aptitude Encyclopedia1(Ed.).New Delhi: Wiley Publications.

REFERENCE BOOK

1. Sharma arun.(2016).Quantitative aptitude,7th(Ed.).Noida : McGraw Hill Education Pvt. Ltd.
2. Praveen. R.V 3rd edition, Quantitative aptitude and reasoning, PHI learning publication.

Mode of Evaluation: Online Test

SEMESTER V

23EE1501	POWER SYSTEM ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 analyze 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

COURSE OUTCOME(S):

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

CO1	Ability to Understand the concepts of power systems and various power system components
CO2	Ability to understand and apply iterative techniques for power flow analysis
CO3	Ability to model and carryout short circuit studies in power system
CO4	Ability to evaluate fault currents for different types of faults.
CO5	Ability to model and analyze stability problems in power system
CO6	Ability to model various components of the power system

TEXT BOOKS:

1. John J. Grainger, William D. Stevenson, Jr, ‘Power System Analysis’, Mc Graw 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.

REFERENCE BOOKS:

1. Pai M A, ‘Computer Techniques in Power System Analysis’, Tata Mc Graw-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: (Only accessible Links)

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-raphsonmethod-IJERTV2IS121281.pdf
3. https://nptel.ac.in/content/storage2/courses/108104051/chapter_9/9_4a.html
4. https://link.springer.com/book/10.1007/978-0-387-72853-7
5. https://nptel.ac.in/content/storage2/courses/108104051/chapter_9/9_4a.html

ONLINE COURSES / RESOURCES:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3										3		
CO2	3	3	3									3	1	
CO3	3	3	3	3								3	2	
CO4	3	3	3									3	2	
CO5	3	3	3									3	3	
CO6	3	3	3	3								3	2	

<table>
<tr><th colspan="4">Internal Assessment</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1502	ELECTRICAL MACHINES – II	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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

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

COURSE OUTCOME(S):

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

CO1	Ability to understand the construction and working principle of Synchronous Generator
CO2	Ability to understand MMF curves and armature windings.
CO3	Ability to acquire knowledge on Synchronous motor.
CO4	Ability to understand the construction and working principle of Three phase Induction Motor
CO5	Ability to understand the construction and working principle of Special Machines
CO6	Ability to predetermine the performance characteristics of Synchronous Machines.

TEXT BOOKS:

1. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, "Electric Machinery", 7th Edition, McGraw Hill publishing Company Ltd, 2017
2. B.L.Theraja & A.K.Theraja, "Electrical Technology Volume II AC & DC Machines", S.Chand and Company Limited, 2017.
3. D.P. Kothari and I.J. Nagrath, "Electric Machines", 5th Edition, McGraw Hill Publishing Company Ltd, 2017.

REFERENCE BOOKS:

1. M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning Pvt Ltd., New Delhi, 2009.
2. B.R.Gupta, "Fundamental of Electric Machines" New age International Publishers, 3rd Edition, Reprint 2015.
3. Murugesh Kumar, "Electric Machines", Vikas Publishing House Pvt. Ltd, 2010.
4. R.K. Rajput "Electrical Machines", 5th Edition, Laxmi Publications (P) Ltd, 2016.
5. Alexander S. Langsdorf, "Theory of Alternating-Current Machinery", McGraw Hill Publications, 2001.

WEB REFERENCES:

1. https://www.youtube.com/watch?v=3W7oSN_zHjQ3.
2. https://www.youtube.com/watch?v=NPm646lC8V.

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/1081051312.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2							3	3	
CO2	3	3	3	1	1							3		
CO3	3	3	3	3	2							3	2	
CO4	3	3	3									3		
CO5	3	3	3									3		
CO6	3	3	3	2	1							3	3	

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1503	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To learn Different types of power semiconductor devices and their switching.
- To learn Operation, characteristics and performance parameters of controlled rectifiers.
- To understand Operation, switching techniques and basics topologies of DC-DC switching regulators.
- To gain knowledge on Different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To understand 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-pulse converters– 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 INVERTER 9

Single phase and three phase voltage source inverters (both120° mode and 180°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

COURSE OUTCOME(S):

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

CO1	Identify and select the switching devices for different power converter applications.
CO2	Design and analyze different DC-DC converter with various loads.
CO3	Design a suitable power converter for given dc load specification from AC input
CO4	Design and analyze the single phase inverter and three phase inverters.
CO5	Explain the concepts of AC-AC converters.
CO6	Choose the suitable converters for real time applications

TEXT BOOKS:

1. M.H. Rashid, ‘Power Electronics: Circuits, Devices and Applications’, Pearson Education, Fifth Edition, New Delhi, 2022.
2. P.S.Bimbra “Power Electronics” Khanna Publishers, third Edition, 2003.
3. Ashfaq Ahmed ‘Power Electronics for Technology’, Pearson Education, Indian reprint, 2003.

REFERENCE BOOKS:

1. Joseph Vithayathil,’ Power Electronics, Principles and Applications’, McGraw Hill Series, 6^{th} 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.
8. P.C.Sen, Power Electronics, Tata McGraw-Hill, 30^{th} reprint, 2008..

WEB REFERENCES:

1. https://ece.ncsu.edu/research/pes/
2. https://www.tutorialspoint.com/power_electronics/index.htm

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108/105/108105066/
2. https://www.coursera.org/specializations/power-electronics
3. https://www.mooc-list.com/tags/power-electronics

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	1			1				1	3	2	
CO2	3	3	1	1			1				1	3	2	
CO3	3	3	1	1			1				1	3	2	
CO4	3	3	1	1			1				1	3	2	
CO5	3	3	1	1			1				1	3	2	
CO6	3	3	1	1			1				1	3	2	

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EE1504	MICROCONTROLLER AND EMBEDDED SYSTEMS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

- To study the addressing modes & instruction set of 8085 and develop skills in simple program writing in assembly languages using 8085.
- To study the addressing modes & instruction set of 8051 and develop skills in simple program writing in assembly languages using 8051.
- To study the building Blocks of Embedded System, various Embedded Development Strategies, Bus Communication in processors, Input / output interfacing.
- To study the various processor scheduling algorithms.
- To explain the basics of a Real-time operating system.
- To analyze the applications based on embedded design approaches

UNIT I INTRODUCTION TO 8085 ARCHITECTURE 9

Functional block diagram- 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 II INTRODUCTION TO 8051 MICROCONTROLLER 9

8051 Microcontroller - Functional block diagram - Instruction format and addressing modes – Interrupt structure – Timer – I/O ports – Serial communication.

UNIT III EMBEDDED SYSTEMS & EMBEDDED PRODUCT DEVELOPMENT LIFE CYCLE 9

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- Watchdog Timer, Real Time Clock, Embedded Product Development Life Cycle- objectives, different phases of EDLC , Modelling of EDLC.

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, Inter process Communication.

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

COURSE OUTCOME

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

CO1 Ability to understand the architecture, working operation, assembly language program using microprocessor and its interfacing with the peripheral devices.

CO2 Ability to understand the architecture, working operation, assembly language program using microcontroller and its interfacing with the peripheral devices.

CO3 Ability to understand the building blocks of Embedded System and various Embedded Product Development Lifecycle.

CO4 Ability to understand the basic concepts of Real time operating systems, various processor scheduling and Inter Process Communication.

CO5 Ability to understand some embedded system applications and its development.

CO6 To build a small low-cost embedded system using Arduino/ Raspberry Pi / open platform.

TEXT BOOKS:

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Pen ram International (P)ltd., Mumbai, 6^{th} Education, 2013.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, "The 8051 Micro Controller and Embedded Systems‟, Pearson Education, Second Edition 2011.
3. Raj Kamal, „Embedded System-Architecture, Programming, Design‟, Mc Graw Hill, 2013.
4. Krishna Kant, "Micro-processors & Micro-controllers", Prentice Hall of India, 2007
5. Peckol, "Embedded system Design", John Wiley & Sons, 2010.
6. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013.
7. Shibu. K.V, "Introduction to Embedded Systems", 2e, Mc graw Hill, 2017.

REFERENCE BOOKS:

1. C.R.Sarma, "Embedded Systems Engineering", University Press (India) Pvt. Ltd, 2013.
2. Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2006.
3. Han-Way Huang, "Embedded system Design Using C8051", Cengage Learning, 2009.
4. Rajib Mall "Real-Time systems Theory and Practice" Pearson Education, 2007.
5. Elicia White, "Making Embedded systems", O'Reilly Series, SPD,2011, 1^{st} edition.
6. Jonathan W. Valvano, 'Embedded Microcomputer Systems Real-time Interfacing', Cengage Learning, 3^{rd} edition 2010.
7. Tammy Noergaard, "Embedded Systems Architecture", Newnes, 2^{nd} edition, 2013

WEB REFERENCES: (Only accessible Links)

1. https://technobyte.org/?s=8051
2. https://www.circuitbasics.com/basics-of-the-i2c-communication-protocol/
3. https://www.tutorialspoint.com/embedded_systems/es_interrupts.html

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/117104072
2. https://nptel.ac.in/courses/108102045

LIST OF EXPERIMENTS

1. Assembly Language Programs with Arithmetic Instructions Using 8085.
2. Assembly Language Programs with Control Instructions Using 8085.
3. Assembly Language Programs with Code Conversions Using 8085.
4. Assembly Language Programs with Arithmetic Instructions Using 8051.
5. Assembly Language Programs with jumps, looping and subroutines Using 8051.
6. Assembly Language Programs to Interface Stepper Motor Interfacing with 8051.
7. Assembly Language Programs to Interface DAC with 8051.
8. Introduction to the programming Environment (like KEIL, PROTEUS, ARDUINO) software.
9. Simulation of the circuits using KEIL, PROTEUS and ARDUINO software.
10. To build a small low-cost embedded system using Arduino/Raspberry Pi/ open platform.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2		1				1	3	3	
CO2	3	3	3	2	2		1				1	3	3	
CO3	3	3	2	2	2		1				1	3	3	
CO4	3	3	2	2	2		1				1	3	3	
CO5	3	3	2	2	2		1				1	3	3	
CO6	3	3	2	2	2		1				1	3	3	

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(40% weightage)
(Theory Component)</th><th colspan="2">Assessment
(60% weightage)
(Laboratory Component)</th><th>End Semester Examination</th></tr>
<tr><td>Individual Assignment / Case Study / Seminar / Mini Project</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record</td><td>Test</td><td>Written Examination</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td rowspan="2">100</td></tr>
<tr><td colspan="4">100</td></tr>
<tr><td colspan="4">50 %</td><td>50 %</td></tr>
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23EE1511	ELECTRICAL MACHINES LABORATORY II	L	T	P	C
		0	0	4	2

COURSE 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
- To understand the operation of synchronous machines.

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
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. Speed control of three phase Slip ring induction motor
12. Study of Induction motor Starters

TOTAL: 60 PERIODS

COURSE OUTCOMES

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

CO1	Ability to understand and analyze EMF and MMF method.
CO2	Ability to analyze the characteristics of V and Inverted V curves
CO3	Ability to understand the importance of Synchronous machines
CO4	Ability to understand the importance of Induction Machines
CO5	Ability to acquire knowledge on separation of losses.
CO6	Ability to understand the circle diagram of an induction motor

TEXT BOOKS:

1. D. P. Kothari, B. S. Umre, “Laboratory Manual for Electrical Machines”, 2nd edition, Wiley, 2020

WEB REFERENCES

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3			3	3	3	3	3	3	3	3
CO2	3	3	3	3			3	3	3	3	3	3	3	3
CO3	3	3	3	3			3	3	3	3	3	3	3	3
CO4	3	3	3	3			3	3	3	3	3	3	3	3
CO5	3	3	3	3			3	3	3	3	3	3	3	3
CO6	3	3	3	3			3	3	3	3	3	3	3	3

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<tr><td>75</td><td>25</td><td>100</td></tr>
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</table>

23EE1512	INDUSTRIAL AUTOMATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE 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 EXPERIMENTS

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

COURSE OUTCOMES

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

CO1 Ability to understand and Programming of PLC, SCADA and DCS.

CO2 Ability to working with industrial automation system.

CO3 Ability to design and implement control schemes in PLC & DCS.

CO4 Ability to interface field devices with PLC.

CO5 Use timers and counter functions of PLC to construct simple applications.

CO6 Integrate and control process station with DCS.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3		3		3	3	3
CO2	3	3	3	3	3			3		3		3	3	3
CO3	3	3	3	3	3			3		3		3	3	3
CO4	3	3	3	3	3			3		3		3	3	3
CO5	3	3	3	3	3			3		3		3	3	3
CO6	3	3	3	3	3			3		3		3	3	3

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23ES1512	CODING PRACTICES III	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

- To understand the concepts of ADTs
- To design linear data structures–lists, stacks, and queues
- To understand sorting algorithms
- To understand the concept of searching and hashing algorithms
- To apply Tree and Graph structures

LIST OF EXPERIMENTS

1. Types of variables, types of methods
2. Data Structures – Definition, Linear Data Structures, Non-Linear Data Structures
3. Python Specific Data Structures: List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings
4. Arrays - Overview, Types of Arrays, Operations on Arrays, Arrays vs List.
5. Searching -Linear Search and Binary Search
6. Sorting - Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort.
7. Linked Lists – Implementation of Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists.
8. Stacks - Overview of Stack, Implementation of Stack (List & Linked list), Applications of Stack
9. Queues: Overview of Queue, Implementation of Queue (List & Linked list), Applications of Queues, Priority Queues.
10. Graphs -Introduction, Directed vs Undirected Graphs, Weighted vs Unweighted Graphs, Representations, Breadth First Search, Depth First Search.
11. Trees - Overview of Trees, Tree Terminology, Binary Trees: Introduction, Implementation, Applications. Tree Traversals, Binary Search Trees: Introduction, Implementation, AVL Trees: Introduction, Rotations, Implementation

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

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

CO1 Gain a comprehensive understanding of various data structures

CO2 Develop proficiency in using Python-specific data structures

CO3 Acquire the ability to implement and analyze various algorithms

CO4 Learn to implement and manipulate linked data structures including singly linked lists, doubly linked lists, and circular linked lists.

CO5 Understand the operations, applications, and implementations of stacks and queues using both list and linked list data structures.

CO6 Gain the ability to implement and perform various traversals on graph and tree data structures, and understand advanced concepts.

TEXTBOOKS

1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
2. "Data Structures and Algorithms in Python" by Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser
3. "Algorithms Unlocked" by Thomas H. Cormen

REFERENCES BOOKS

1. "Python Data Structures and Algorithms" by Benjamin Baka
2. "Data Structures and Algorithm Analysis in C++" by Mark Allen Weiss
3. "Algorithms in C, Parts 1-4: Fundamentals, Data Structures, Sorting, Searching" by Robert Sedgewick

WEB REFERENCES

1. GeeksforGeeks: https://www.geeksforgeeks.org/
2. Khan Academy – Algorithms: https://www.khanacademy.org/computing/computer-science/algorithms
3. Python Documentation: https://docs.python.org/3/tutorial/datastructures.html

SEMESTER VI

23EE1601	ELECTRICAL DRIVES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- Steady state operation and transient dynamics of a motor load system.
- Analyse 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 operations of converter / chopper fed drive - Applications. Bidirectional Converter.

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

COURSE OUTCOME(S):

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

CO1 Ability to understand steady state and transient dynamics operation of a motor load system

CO2 Ability to select suitable DC drive for the given application

CO3 Ability to understand the operation and performance of Induction motor drives.

CO4 Ability to analyze the operation and performance of synchronous motor drives.

CO5 Ability to understand and suggest a converter feed drives for Industrial Applications

CO6 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.

REFERENCE BOOKS:

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: (Only accessible Links)

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-electricdrives- 14073
3. https://drive.google.com/file/d/11mTcwHIcUfBFbKSG6XJdmrXvx_d7hhKo/view?ts=6090c8e6

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3		3		3		
CO2	3	3	3									3	3	
CO3	3	3	2									3	3	
CO4	3	3	3									3	3	
CO5	3	3	3									3	3	
CO6	3	3	3		3							3	3	

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<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1602	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 Centre – 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

COURSE OUTCOME(S):

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

CO1	Understand the day-to-day operation of electric power system.
CO2	Analyze the control actions to be implemented on the system to meet the inuteto-minute variation of system demand.
CO3	Model the singe and multi area load frequency control to analyse the performance of power system
CO4	Model the AVR for maintaining the voltage profile against varying system load.
CO5	Analyze the optimal dispatch problems and unit commitment in various power plants.
CO6	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.

REFERENCE BOOKS:

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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3		2								3		
CO2	3	3	3	3							2	3	2	
CO3	3	3	3	3							3	3	3	
CO4	3	3	2	2							3	3	3	
CO5	3	3	2	2							2	3	3	
CO6	3	3									2	3	2	

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<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1603	ARTIFICIAL INTELLIGENCE FOR ELECTRICAL ENGINEERS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVE:

- Understand the basics of the theory and practice of Artificial Intelligence as a discipline and about intelligent agents
- Understand search techniques and gaming theory
- The student will learn to apply knowledge representation techniques and problem solving strategies to common AI applications.
- Student should be aware of techniques used for classification and clustering.
- Student should aware of basics of pattern recognition and steps required for it.

UNIT I INTRODUCTION 9

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT II PROBLEM SOLVING METHODS 9

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems – Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning – Stochastic Games

UNIT III KNOWLEDGE REPRESENTATION 9

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information

UNIT IV SOFTWARE AGENTS 9

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V APPLICATIONS 9

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving

TOTAL :45 PERIODS

COURSE OUTCOME

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

CO1 Understand basic AI concepts, definitions, and intelligent agent functionalities.

CO2 Master problem-solving methods, search strategies, heuristics, and game playing techniques.

CO3 Represent knowledge using first-order logic, Prolog, and ontological engineering.

CO4 Understand architecture, communication, negotiation, and trust in multi-agent systems.

CO5 Explore applications in NLP, machine translation, speech recognition, and robotics.

CO6 Implement AI algorithms and critically analyze their performance in real-world scenarios.

TEXT BOOKS:

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Third Edition, 2009.
2. I. Bratko, “Prolog: Programming for Artificial Intelligence”, Fourth edition, Addison Wesley Educational Publishers Inc., 2011.
3. M. Tim Jones, “Artificial Intelligence: A Systems Approach (Computer Science)”, Jones and Bartlett Publishers, Inc. First Edition, 2008

REFERENCE BOOKS:

1. Nils J. Nilsson, “The Quest for Artificial Intelligence”, Cambridge University Press, 2009.
2. William F. Clocksin and Christopher S. Mellish, “Programming in Prolog: Using the ISO Standard”, Fifth Edition, Springer, 2003.
3. Gerhard Weiss, “Multi Agent Systems”, Second Edition, MIT Press, 2013.
4. David L. Poole and Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2010.

ARTIFICIAL INTELLIGENCE FOR ELECTRICAL ENGINEERS LAB 15 Hours

LIST OF EXPERIMENTS

1. Introduction to MATLAB and various tool boxes.
2. Use of MATLAB tool box for ANN.
3. Use of MATLAB tool box for Fuzzy Logic.
4. Use of MATLAB tool box for Optimization.
5. Use of MATLAB Programming for implementing NN.
6. Use of MATLAB Programming for generating different types of activation functions in ANN
7. Use of MATLAB Programming for training and testing of ANN.
8. Use of MATLAB for load forecasting using ANN
9. Use of MATLAB to get familiar with the deep learning toolbox.
10. Use of MATLAB to train a test of the load forecasting with the deep learning toolbox.
11. MATLAB program for generating different types of Fuzzy membership functions.
12. Use of MATLAB for DTC control using fuzzy logic approach

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2						2	3	2	
CO2	3	3	3	2	2						2	3	2	
CO3	3	3	2	2	2						2	2	2	
CO4	2	2	3	3	2						2		2	
CO5	3	3	3	3	2						2	2	3	
CO6	3	3	3	3	3						2	3	3	

Assessment (40% weightage) (Theory Component)		**Assessment** (60% weightage) (Laboratory Component)		**End Semester Examination**
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Evaluation of Laboratory Observation, Record**	**Test**	**Written Examination**
40	**60**	**75**	**25**	**100**
100				
50 %				**50 %**

23EE1611	POWER ELECTRONICS AND DRIVES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To learn gate pulse generation using resistor (R), resistor-capacitor (RC), and unijunction transistor (UJT) circuits.
- To analyze characteristics and operation of SCRs, TRIACs, MOSFETs, IGBTs, GTOs, and IGCTs.
- To understand the design and performance of half-controlled and fully controlled AC to DC converters.
- To explore step-up/step-down MOSFET-based choppers and IGBT-based PWM inverters.
- To develop skills to simulate various power electronic circuits including semi converters, full converters, DC-DC converters, and AC voltage controllers.

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 Semi converter, 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

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

CO1	Analyze the device characteristics and gate pulse generation and characteristics SCR.
CO2	Study the characteristics of MOSFET and IGBT.
CO3	Design and analyze the choppers and chopper fed dc drives
CO4	Analyze the inverter operation and inverter fed induction motor drives.
CO5	Design and analyze the single phase and three phase controlled rectifiers fed DC drives.
CO6	Analyze the performance of AC-AC converters.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3	3			3	2	
CO2	3	3	3	3	3			3	3			3	3	
CO3	3	3	3	3	3			3	3			3	3	
CO4	3	3	3	3	3			3	3			3	3	
CO5	3	3	3	3	3			3	3			3	3	
CO6	3	3	3	3	3			3	3			3	3	

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23EE1612	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- 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

COURSE OUTCOMES

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

CO1	Construct the bus admittance and impedance matrices
CO2	Analyze the power system under steady state condition using GS and NR method.
CO3	Classify the types of faults and analyze the power system on different faulted conditions.
CO4	Perform optimal dispatch scheduling for the given power networks
CO5	Analyze the load frequency control of power systems.
CO6	Illustrate the concepts of transient and steady state stability in power systems.

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”,3rd Ed., 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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3	3			3	2	
CO2	3	3	3	3	3			3	3			3	3	
CO3	3	3	3	3	3			3	3			3	3	
CO4	3	3	3	3	3			3	3			3	3	
CO5	3	3	3	3	3			3	3			3	3	
CO6	3	3	3	3	3			3	3			3	3	

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23ES1612	CODING PRACTICES IV	L	T	P	C
		0	0	2	1

COURSE OBJECTIVE:

- To develop programs in C using basic constructs.
- To develop applications in C using arrays
- To develop applications in C using strings, pointers.
- To develop applications in C using functions, structures
- To develop applications in C using file processing.

LIST OF EXPERIMENTS

1. Data Types
2. Constants
3. Keywords
4. Operators
5. Expressions
6. Input /Output statements
7. Assignment statements
8. Decision making statements
9. Switch statement
10. Looping
11. Function prototype
12. Function definition
13. Function call
14. Structures and Union
15. Pointers

TOTAL: 30 PERIODS

COURSE OUTCOME(S):

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

CO1 Write, test, and debug simple C programs

CO2 Implement C programs with conditionals and loops.

CO3 Develop C programs for simple applications making use arrays and strings.

CO4 Develop C programs involving pointers.

CO5 Develop C programs involving functions

CO6 Develop C programs involving structures and union.

TEXTBOOKS

1. Reema Thareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2006

REFERENCES BOOKS

1. Paul Deitel and Harvey Deitel, “C How to Program”, Seventh edition, Pearson Publication, 2015
2. Juneja, B. L and Anita Seth, “Programming in C”, CENGAGE Learning India pvt. Ltd., 2011
3. Pradip Dey, Manas Ghosh, “Fundamentals of Computing and Programming in C”, First Edition, Oxford University Press, 2009.
4. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
5. Byron S. Gottfried, "Schism’s Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.

WEB REFERENCES

1. https://github.com/tscheffl/ThinkC/blob/master/PDF/Think-C.pdf
2. https://freecomputerbooks.com/langCBooks.html

ONLINE COURSES / RESOURCES:

1. https://www.programiz.com/c-programming
2. https://www.tutorialspoint.com/cprogramming/index.htm
3. https://www.javatpoint.com/c-programming-language-tutorial
4. https://www.geeksforgeeks.org/c-programming-language/
5. https://en.wikibooks.org/wiki/C_Programming
6. https://www.cprogramming.com/tutorial/c-tutorial.html?inl=hp

SEMESTER VII

23EE1701	PROTECTION AND SWITCHGEAR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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

COURSE OUTCOME(S):

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

CO1 Analyze the causes of different types of faults and choose a suitable protection scheme

CO2 Understand and analyze Electromagnetic, Numerical and Static Relays.

CO3 Elucidate various protection schemes for various power system components.

CO4 Suggest the types of relays for specific applications

CO5 Examine the circuit interruption schemes for power systems.

CO6 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.

REFERENCE BOOKS:

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.

WEB REFERENCES: (Only accessible Links)

1. https://www.digimat.in/nptel/courses/video/108107167/L01.html
2. http://www.idc-online.ac.za/electrical-engineering/electrical-powersystemprotection.html

ONLINE COURSES / RESOURCES:

1. http://nptel.ac.in/courses/Webcoursecontents/IIT%20Bombay/Power%20System%20Protection/TOC_M1.htm

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3	3			3	3	3
CO2	3	3	3	3	3			3	3			3	3	3
CO3	3	3	3	3	3			3	3			3	3	3
CO4	3	3	3	3	3			3	3			3	3	3
CO5	3	3	3	3	3			3	3			3	3	3
CO6	3	3	3	3	3			3	3			3	3	3

<table>
<tr><th colspan="4">Internal Assessment</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1702	RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 – Kyoto protocol - 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 RatioSolidity-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

COURSE OUTCOME(S):

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

CO1	Categorize the various renewable energy sources.
CO2	Analyze the different configurations of the wind energy conversion systems.
CO3	Illustrate the working of solar thermal power plant resources and technologies and their applications.
CO4	Explain the overview of solar photovoltaic systems and implement a maximum power point tracking in the PV system
CO5	Acquire knowledge about biomass and geothermal energy.
CO6	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.

REFERENCE BOOKS:

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.

WEB REFERENCES: (Only accessible Links)

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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3				3					3		3	3	3
CO2	3	3	3	2		3					3		3	3	3
CO3	3	3	3			3					3		3	3	3
CO4	3	3		2		3					3		3	3	3
CO5	3	3	3			3					3		3	3	3
CO6	3	3	3	2		3					3		3	3	3

<table>
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<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1703	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To understand overvoltage 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 measurement techniques of high voltages and currents
- To learn how to conduct dielectric tests on various electrical equipment and to study about insulation coordination in electrical Power systems

UNIT - I OVERVOLTAGES IN ELECTRICAL POWER SYSTEMS 9

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

UNIT - II DIELECTRIC BREAKDOWN 9

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. Applications of High Voltage engineering in Industry.

TOTAL : 45 PERIODS

COURSE OUTCOME(S):

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

CO1 Explain the overvoltage phenomenon and protection methods in electrical power systems

CO2 Explicate the different breakdown mechanisms in solid, liquid, gaseous & vacuum.

CO3 Illustrate different methods of generation of high voltages and high currents

CO4 Summarize the various measurement techniques of high voltages & currents with their relative merits and demerits

CO5 Suggest suitable testing methods to test various high voltage equipments.

CO6 Explain the different aspects of insulation design and insulation coordination 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.

REFERENCE BOOKS:

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.

WEB REFERENCES: (Only accessible Links)

1. www.digimat.in/nptel/courses/video/108104013/L19.html

ONLINE COURSES / RESOURCES:

1. https://nptel.ac.in/courses/108/104/108104048

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1						3	2	
CO2	3	3	3	1	1	1						3	2	
CO3	3	3	3	1	1	1						3	2	
CO4	3	3	3	1	1	1						3	2	
CO5	3	3	3	1	1	1						3	2	
CO6	3	3	3	1	1	1						3	2	

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23EE1711	RENEWABLE ENERGY SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- 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

COURSE OUTCOMES

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

CO1	Identify the Various renewable energy sources and technologies
CO2	Create a simulation circuit for solar power generation systems that includes a control circuit.
CO3	Design and simulate the circuit diagram for hybrid energy systems.
CO4	Analyze the circuit diagram by conducting the hardware experiment on various renewable energy systems.
CO5	Discuss about Simulation study on Hydel Power.
CO6	Examine a control circuit for fuel cell power production systems

WEB REFERENCES

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3	3			3	3	
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CO3	3	3	3	3	3			3	3			3	3	
CO4	3	3	3	3	3			3	3			3	3	
CO5	3	3	3	3	3			3	3			3	3	
CO6	3	3	3	3	3			3	3			3	3	

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

23EE1712	MINI PROJECT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To develop their own innovative prototype of ideas.
- 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

COURSE OUTCOMES

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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

SEMESTER VIII

23EE1811	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: 60 PERIODS

COURSE 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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Internal Assessment		End Semester Examination
Evaluation of Laboratory Observation, Record	Test	Practical
75	25	100
60 %		40%

VERTICAL I: POWER ENGINEERING

23EE1901	UNDER GROUND CABLE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE: 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.

COURSE OUTCOME(S):

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

CO1	Ability to understand the fundamental of underground cable system.
CO2	Ability to gain knowledge on the architecture of UG cable and physical and electrical characteristics of the UG cable.
CO3	Ability to understand different types of cable used in distribution system.
CO4	Ability to acquire knowledge on Underground cables used in transmission system
C O5	Ability to understand the cable installations procedures and practices.
CO6	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 300 Boca 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2				2	1		3	2		3		
CO2	3	2				2	1		3	2		3		
CO3	3	2				2	1		3	2		2	2	
CO4	3	2				2	1		3	2		2	2	
CO5	3	2	3			2	1		3	2			2	2
CO6	3	3		3		2	1		3	2		2	2	

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<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
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<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

		L	T	P	C
23EE1902	**SUBSTATION ENGINEERING AND AUTOMATION**	**3**	**0**	**0**	**3**

COURSE OBJECTIVE:

- 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) 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

COURSE OUTCOME(S):

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

CO1 Understand the key deciding factors involved in substation design and operation

CO2 Know about the sizing and selection of equipment which forms part of substation

CO3 Know about composite layout design aspects of the substation with different services and the challenges including statutory clearances.

CO4 Understand about Interdisciplinary aspects involved in substation design

CO5 Understand different protection and control scheme involved in substation design

CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3	2		2	3	2				3	3	–	–
CO2	3	3	3	3	2	3	1	2			2	3	2	–
CO3	3	2	3	3	1	3	2	2			3	2	2	–
CO4	3	1	2			3	1	2			2	1	2	2
CO5	3	3	3	3		3	1	1			3	3	2	–
CO6		2	3	3		3	1				3	2	3	–

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<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1903	SMART GRID	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1	Understand the importance and objectives of Power System Grid.
CO2	Understand the concept of a smart grid;
CO3	Identify and discuss smart metering devices and associated technologies.
CO4	Get an overview of Microgrid and Electric Vehicle Technology.
CO5	Acquire knowledge on the various computing technologies.
CO6	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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	3		1				2	3		
CO2	3	3	2	3	3		1				2	3	2	
CO3	3	3	2	3	3		1				2	2	3	
CO4	3	3	2	3	3		1				2	2	3	
CO5	3	3	2	3	3		1				2	2	3	
CO6	3	3	2	3	3		1				2	2	3	

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1904	ENERGY MANAGEMENT AND AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1 Acquire knowledge in the field of energy management and auditing process.
CO2 Learned the about basic concepts of economic analysis and load management.
CO3 Able to design the effective thermal utility system.
CO4 Able to improve the efficiency in compressed air system.
CO5 Acquired the design concepts in the field of lighting systems and light sources.
CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	1	1		1	2		3	2	3
CO2	3	3				3					2	3		
CO3	3	3	1	1		-					2	3	1	
CO4	3	3				3					2	3	1	
CO5	3		3	1		3					2	3	1	
CO6	3		2	1		1					2	3	1	

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<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1905	POWER QUALITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1 Use various definitions of power quality for power quality issues.

CO2 Describe the concepts related with single phase / three phase, linear / nonlinear loads.

CO3 Describe the concepts related with single phase / three phase, sinusoidal, non-sinusoidal source.

CO4 Solve problems related with mitigation of Power System Harmonics.

CO5 Use DSTATCOM for load compensation.

CO6 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.

REFERENCE BOOKS:

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_Distrib ution_Networks_33_KV

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1		3				3					3	3		
CO2		3				3						3		
CO3		3	2			3						3	2	
CO4		3	2	2		3					3	3		
CO5		3				3						3		
CO6		3	2	1		3					3	3	3	

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23EE1906	HVDC AND FACTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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) ANDTHYRISTOR 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.

COURSE OUTCOME(S):

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

CO1 To Identify and understand the problems in AC transmission systems.

CO2 To Identify and understand the need for Flexible AC transmission systems and HVDC Transmission

CO3 To understand the operation and control of SVC and TCSC and its applications to enhance the stability and damping.

CO4 To Analyze basic operation and control of voltage source converter based FACTS controllers

CO5 To demonstrate basic operation and control of Line Commutated HVDC Transmission.

CO6 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.

REFERENCE BOOKS:

1. K.R.Padiyar, “FACTS Controllers in 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” , April 2004, 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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3				3						3		
CO2	3	3				3						3		
CO3	3	3			3							3	3	
CO4	3	3			3							3	3	
CO5	3	3			3							3	3	
CO6	3	3			3							3	3	

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23EE1907	UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 GATE questions / etc)

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.

COURSE OUTCOME(S):

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

CO1 Ability to choose suitable electric drives for different applications

CO2 Ability to design the illumination systems for energy saving

CO3 Ability to demonstrate the utilization of electrical energy for heating and welding purposes

CO4 Ability to know the effective usage of solar and wind energies for electrical applications

CO5 Ability to do electric connection for any domestic appliance like refrigerator, battery charging circuit for a specific household application

CO6 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 Learning 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1		2	3	3		3						3	3	
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23EE1908	RESTRUCTURED POWER MARKET	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1 Describe the requirement for deregulation of the electricity market and the philosophy of various market models.

CO2 Analyze the various methods of congestion management in deregulated power system.

CO3 Analyze the locational marginal pricing and financial transmission rights.

CO4 Analyze the ancillary service management.

CO5 Analyze transmission pricing paradigm.

CO6 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, Math H.J.Boolen, and Jaap E.Daadler, "Operation of restructured power systems”, Kluwer Academic Pub., 2001, 1st Edition.

REFERENCE BOOKS:

1. Sally Hunt, "Making competition work in electricity”, John Willey 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/.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3					3						3	2	
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VERTICAL II: CONVERTERS AND DRIVES

23EE1909	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Acquire Knowledge on Construction and operation of stepper motor

CO2 Acquire Knowledge on construction, operation and performance of switched reluctance motors based on sensor less operation

CO3 Understand the operation and characteristics of Permanent Magnet Brushless DC Motor.

CO4 Understand the operation and characteristics of Permanent Magnet Synchronous Motor.

CO5 Select a special machine for a particular application.

CO6 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.

REFERENCE BOOKS:

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:

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

CO-PO MAPPING

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CO3	3						1		1		1	3	2	
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23EE1910	ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Find the modeling for a brushed DC-Motor (Shunt, Series, Compound and separately excited motor) and to simulate DC motors using state models.

CO2 Apply reference frame theory for, resistive and reactive elements (three phase).

CO3 Compute the equivalent circuit and torque of three phase induction motor and synchronous motor in machine variable arbitrary reference frame variable.

CO4 Find the need and advantages of multiphase machines.

CO5 Demonstrate the working of multiphase induction and synchronous machine.

CO6 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.

REFERENCE BOOKS:

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.

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

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1. https://archive.nptel.ac.in/courses/108/106/108106023/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	1		3		2	3	3	
CO2	3	3	3	3	3	2	1		3		2	3	2	
CO3	3	3	3	3	3	2	1		3		2	3	3	
CO4	3				3	2	1		3		2	2	3	
CO5	3				3	2	1		3		2	2	3	
CO6	3	3	3	3	3	2	1		3		2	3	3	

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<tr><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Individual Assignment / Case Study / Seminar / Mini Project</th><th>Written Test</th><th>Written Examinations</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1911	MULTILEVEL POWER CONVERTERS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.

CO2 Examine the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation.

CO3 Demonstrate the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count.

CO4 Analyze the voltage balancing performance in Diode clamped MLI.

CO5 Simulate three level, capacitor clamed and diode clamped MLI with R and RL load.

CO6 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.

REFERENCE BOOKS:

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/B97801238203650001

ONLINE COURSES / RESOURCES:

1. https://archive.nptel.ac.in/courses/108/102/108102157/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	3		2	1		3		3	3	3	
CO2	3	2	2	3		2	1		3		3	3	3	
CO3	3	2	2	3		2	1		3		3	2	3	
CO4	3	3	3	3		2	1		3		3	3	3	
CO5	3	3	3	3	3	2	1		3		3	3	3	
CO6	3	3	3	3	3	2	1		3		3	3	3	

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1912	EMBEDDED CONTROL FOR ELECTRIC DRIVES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

30 PERIODS

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Interpret the significance of embedded control of electrical drives.

CO2 Develop knowledge of Machine learning and optimization techniques for motor control.

CO3 Deliver insight to various control strategies for electrical drives.

CO4 Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.

CO5 Improve Employability and entrepreneurship capacity on recent trends in embedded system.

CO6 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.

REFERENCE BOOKS:

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 Anderew G.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.e3sconferences.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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2	2	1							3	2	–
CO2	2	1	3	2	1							2	3	–
CO3	3	2	3	3	3							2	3	–
CO4	3	2	3	3	3							2	3	–
CO5	3	2	1	2	1			1				–	3	3
CO6	3	2	1	2	1			1				3	3	–

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EE1913	SMPS AND UPS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: **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

COURSE OUTCOME(S):

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

CO1 Demonstrate the working of buck boost and buck- boost converters in continuous and discontinuous conduction mode.

CO2 Build buck/boost converters using suitable design method.

CO3 Analyze the behaviors of isolated DC-DC converters and to design SMPS for battery operated vehicle.

CO4 Compute state space averaged model and transfer function for buck, boost and buck boost converters.

CO5 Demonstrate the P, PI and PID controller performance analytically and by simulation for buck boost and buck- boost converters.

CO6 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.

REFERENCE BOOKS:

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. ttps://archive.nptel.ac.in/courses/108/108/108108036/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3		3	3		2		3	3	2	
CO2	3	3	3	3		3	3		2		3	2	3	
CO3	3	3	3	3		3			3		3	3	3	
CO4	3	3	3	3					2		3	3	2	
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CO6	3	3	3	3		3	3		3		3	2	3	

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</table>

23EE1914	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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 disadvantage

s 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

LIST OF EXPERIMENTS: **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

COURSE OUTCOME(S):

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

CO1 Examine the available renewable energy sources.

CO2 Demonstrate the working principles of electrical machines and power converters used for wind energy conversion system.

CO3 Demonstrate the principles of power converters used for solar PV systems.

CO4 Examine the available hybrid renewable energy systems.

CO5 Simulate AC-DC converters and buck/boost converters.

CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3		2						2		2	3		
CO2	3		2						2		2	3	2	
CO3	3		2						2		2	3	2	
CO4	3		3						2		2	3	2	
CO5	3	3	2	3	3		3		2		3	2	3	
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</table>

23EE1915	CONTROL OF POWER ELECTRONICS CIRCUITS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: **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

COURSE OUTCOME(S):

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

CO1 To calculate transfer function for constant, differential, integral, First order and Second order factors.

CO2 To illustrate the effect of poles and zeros in the ‘s’ plane.

CO3 To select Symbolic equations for solving problems related with Matrices, Polynomial and vectors.

CO4 To compute the control expression for DC – DC buck converter using sliding mode control theory.

CO5 To determine the controller expression for power factor correction circuits.

CO6 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”, John wiley, 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.

REFERENCE BOOKS:

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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3		1		2		3	3		
CO2	3	3	3	3	3		1		2		3	3		
CO3	3	3	3	3	3		1		2		3	2		
CO4	3	3	3	3	3		1		2		3	2	3	
CO5	3	3	3	3	3		1		2		3	2	3	
CO6	3	3	3	3	3		1		2		3	2	3	

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<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

VERTICAL III: EMBEDDED SYSTEMS

23EE1916	EMBEDDED PROCESSORS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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 BOA 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Interpret the basics and functionality of processor functional blocks.

CO2 Observe the specialty of RISC processor Architecture.

CO3 Incorporate the I/O hardware interface of processor with peripherals.

CO4 Emphasis the communication features of the processor.

CO5 Acquire Knowledge on single board embedded processor.

CO6 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", Addison Wesley, 2nd Edition, 2015.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Ray field's, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier, 2004, 1st Edition.

REFERENCE BOOKS:

1. William Hohl, "ARM Assembly Language Fundamentals and Techniques", CRC Press, 2nd Edition 2014.
2. Raj Kamal, "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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2	2	1							3		
CO2	1	1	2	2	1							3		
CO3	3	2	3	2	3							2	3	
CO4	3	2	3	2	3							2	3	
CO5	3	2	3	2	3							2	3	
CO6	3	2	1	2	1			1				2	3	3

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</table>

23EE1917	EMBEDDED C- PROGRAMMING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Deliver insight into embedded C programming and its salient features for embedded systems.

CO2 Illustrate the software and hardware architecture for distributed computing in embedded systems.

CO3 Develop a solution for problems by using the concept learned in programming using the embedded controllers.

CO4 Develop simple applications with 8051 by using its various features and interfacing with various external hardware.

CO5 Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.

CO6 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.
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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2	3	1							3		
CO2	1	1	2	2	1							2	2	
CO3	2	2	3	2	3							2	3	
CO4	3	2	3	2	3							2	3	
CO5	3	2	1	2	1								2	3
CO6	3	2	1	2	1							2	3	

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23EE1918	EMBEDDED SYSTEM DESIGN	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 The hardware functionals and software strategies required to develop various Embedded systems.
CO2 The basic differences between various Bus communication standards.
CO3 The incorporation of the interface as Interrupt services.
CO4 The various scheduling algorithms through a Real-time operating system.
CO5 The various embedded concepts for developing automation applications.
CO6 Analyze the programming concept of various embedded system applications

TEXT BOOKS:

1. Raj kamal, "Embedded System-Architecture, Programming, Design", McGraw- Hill Edu, 3rd Edition 2017.
2. Peckol, "Embedded system Design", John Wiley & Sons, 2010.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1							3	2	
CO2	3	2	3	2	1							2	3	
CO3	3	3	2	3	1							2	3	
CO4	3	2	2	2	1								3	
CO5	3	2	1	2	1							1	3	2
CO6	3	2	1	2	1			1				2	3	

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EE1931	ROBOTICS AND AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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).

COURSE OUTCOME(S):

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

CO1 Understand the evolution of robot technology and mathematically represent different types of robot (L2).

CO2 Get exposed to the case studies and design of robot machine interface (L3).

CO3 Analyze various control schemes of Robotics control (L4).

CO4 Ability to select appropriate configuration of rotor for a specific application. (L3).

CO5 Ability to choose actuator/sensor for robot. (L1).

CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

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</table>

23EE1920	EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Insight into the significance of the role of embedded system for automotive applications.

CO2 Illustrate the need, selection of sensors and actuators and interfacing with ECU.

CO3 Develop the Embedded concepts for vehicle management and control systems.

CO4 Develop the infotainment system for EV application.

CO5 Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs.

CO6 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.

REFERENCE BOOKS:

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

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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/

CO-PO MAPPING

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Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EE1921	MEMS AND NEMS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Explain the material properties and the significance of MEMS and NEMS for industrial automation.

CO2 Demonstrate knowledge delivery on micromachining and micro fabrication.

CO3 Apply the fabrication mechanism for MEMS sensor and actuators.

CO4 Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.

CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.

CO6 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 Micro engineering", (2nd ed.). CRC Press, 2005.
4. Julian W Gardner and Vijay K Varadan, "Micro sensors, MEMS and Smart Devices", John Wiley and Sons Ltd, 2001, 1st Edition.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	1	1							3		
CO2	2	1	2	2	1							3		
CO3	2	2	2	1	3							2	3	
CO4	3	2	2	2	3								3	
CO5	3	2	3	3	3								2	2
CO6	3	2	3	3	3			1					3	

<table>
<tr><th colspan="4">Internal Assessment</th><th rowspan="2">End Semester Examinations</th></tr>
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23EE1922	DIGITAL SIGNAL PROCESSING SYSTEM DESIGN	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Explain the concepts of digital signal processing.
CO2 Illustrate the system representation using transforms.
CO3 Learn the transformation techniques for time to frequency conversion.
CO4 Design suitable digital FIR, IIR algorithm for the given specification.
CO5 Use digital signal processor for application development.
CO6 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.

REFERENCE BOOKS:

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. Sen M.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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3	2	2	1							3		
CO2	2	3	3	2	2							3		
CO3	3	3	3	3	3							3		
CO4	3	3	3	3	3								3	
CO5	3	3	3	2	1								3	
CO6	3	3	3	2	1		1						3	2

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VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY

23EE1923	ELECTRIC VEHICLE ARCHITECTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1	Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs
CO2	Describe the various EV components.
CO3	Describe the concepts related in the Plug-In Hybrid Electric Vehicles.
CO4	Analyse the details and Specifications for the various EVs developed.
CO5	Describe the hybrid vehicle control strategy.
CO6	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.

REFERENCE BOOKS:

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, Sanjeevi kumar 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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**					**3**						**3**		
CO2	**3**	**3**										**3**		
CO3	**3**	**3**										**3**		
CO4	**3**	**3**										**3**		
CO5	**3**	**3**										**3**		
CO6	**3**				**3**							**3**	**3**	

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23EE1924	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: **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

COURSE OUTCOME(S):

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

CO1 To use appropriate electric machine for electric vehicle application.

CO2 To compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators).

CO3 To compute transfer function from state models.

CO4 To design buck, boost and buck-boost converter.

CO5 To compute a power stage transfer functions for DC-DC converters.

CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1		2	1	2	1	1	1		1	2		3	2	3
CO2	3	2	1	2	1	1	1		1	2		3	2	3
CO3	3	2	1	2	1	1	1		1	2		3	2	3
CO4	3	2	1	2	1	1	1		1	2		3	2	3
CO5	3	2	1	2	1	1	1		1	2		3	2	3
CO6	3	2	1	2	1	1	1		1	2		3	2	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1925	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: **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

COURSE OUTCOME(S):

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

CO1 To illustrate various charging techniques and to know charging standards and regulations.

CO2 To demonstrate the working DC-DC converters used for charging systems and principles.

CO3 To illustrate the advantages of renewable system based charging systems.

CO4 To demonstrate the principles of wireless power transfer.

CO5 To analyze the standards for wireless charging.

CO6 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.

REFERENCE BOOKS:

1. Nil Patel, Akash Kumar Bhoi, Sanjeevi kumar 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, Sanjeevi kumar 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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3											3		
CO2	3	3	3		2							3	2	
CO3	3	2	2		2							3	2	
CO4	3	2	2		2							3	2	
CO5	3											3		
CO6	3	3	3		2							3	2	

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1926	TESTING OF ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 To describe the status and other details of standardization of EVs.

CO2 To illustrate the testing protocols for EVs and HEV components.

CO3 To analyze the safety cycle and need for functions safety for EVs.

CO4 To analyze the problems related with EMC for EV components.

CO5 To evaluate the EMI in motor drive and DC-DC converter system.

CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
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CO3						3						3		
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23EE1927	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 To describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles.

CO2 To find gain margin & phase margin for various types of transfer functions of boost converter.

CO3 To demonstrate the control of AC Machines.

CO4 To explain the concepts related with batteries and parameters of battery.

CO5 To module the battery and to study the research and development for batteries.

CO6 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.

REFERENCE BOOKS:

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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3							1	2		2	3		
CO2	3							1	3		2	3		
CO3	3					3		1	2		2		3	
CO4	3					3		1	2		2	3		
CO5	3					3		1	2		2	3		
CO6	3					3		1	2		2		3	

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23EE1928	GRID INTEGRATION OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1	Explain the concepts related with V2G.
CO2	Study the grid connection of 3 phase inverter.
CO3	Explain the technical, economics. business, regulatory & political challenges related with V2G.
CO4	Demonstrate the impact of EV and V2G on smart grid and renewable energy system.
CO5	Explain the concept of grid integration and management of EVs.
CO6	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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3					2	1		2		2	3		
CO2	3	3			3	2	1		2		2		3	
CO3	3					2	1		2		2	3		
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</table>

23EE1929	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: **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

COURSE OUTCOME(S):

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

CO1 To design the mathematical model of a BLDC motor and to discuss about its characteristics.

CO2 To demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor.

CO3 To illustrate the basics of fuzzy logic system.

CO4 To describe the basics of VHDL & FPGA applied to control of EVs.

CO5 To design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.

CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2			3		2		3	3		
CO2	3	3	2	2			3		2		3		3	
CO3	3	3	3	3					2		3	3		
CO4	3	3	3	3					2		3	3		
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</table>

VERTICAL V: AUTOMATION

		L	T	P	C
23EE1930	**PLC PROGRAMMING**	3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1	Understand the basics and need for Automation in industries.
CO2	Explain the logic and flow of any particular programming written for a process.
CO3	Apply the knowledge to design or improve an existing program to increase productivity of any process.
CO4	Breakdown SCADA architecture and communication protocols.
CO5	Build and logic in any of the programming languages from IEC- 61131- 3 standard.
CO6	Design and Implement PLC programming logic for various applications.

TEXT BOOKS:

1. Frank D. Petruzella, “Programmable Logic Controllers”, 5^{th} 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.

REFERENCE BOOKS:

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

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CO6	3	3	3	3								3		

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1931	SMART SYSTEM AUTOMATION	L	T	P	C
		2	0	2	3

COURSE OBJECTIVE:

- 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

LIST OF EXPERIMENTS: 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

COURSE OUTCOME(S):

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

CO1 Understand the concepts of smart system design and its present developments.

CO2 Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.

CO3 Acquire knowledge on different platforms and Infrastructure for Smart system design.

CO4 Infer about smart appliances and energy management concepts.

CO5 Understand the basics of robotics and its role for automation

CO6 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. Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007, 1st Edition.
3. Nilanjan Dey, Amartya Mukherjee, "Embedded Systems and Robotics with Open-Source Tools", CRC press, 2016, 1st Edition.

REFERENCE BOOKS:

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--

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

CO-PO MAPPING

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CO3	2	2	3	2	3							–	3	–
CO4	2	2	2	1	3							3	–	–
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23EE1932	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1	Understand the drivers and enablers of Industry 4.0 (L2).
CO2	Appreciate the smartness in smart factories, smart cities, smart products and smart services (L2).
CO3	Outlines the various systems used in a manufacturing plant and their role in an Industry 4.0 world (L1).
CO4	Describe a strategic framework to exploit new technologies to enable Healthcare 4.0 (L1).
CO5	Ability to apply industry 4.0 concepts to real time applications. (L4).
CO6	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.

REFERENCE BOOKS:

1. ArsheepBahga, "Internet of Things: A Hands on Approach", Orient Blackswan Private Limited - New Delhi, 2015.
2. Andreas 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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3										3		
CO2	3	3	1									3		
CO3	3	3	3		1							3		
CO4	3	3	2		1							3	1	
CO5	3	3	2		1							3	1	
CO6	3	3	2		1							3	1	

<table>
<tr><th colspan="4">Internal Assessment</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
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<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

23EE1933	INTELLIGENT AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1 Understand the basics AI algorithms.

CO2 Identify appropriate AI methods to solve a given problem.

CO3 Illustrate about AI/ML/DL techniques in Industrial Automation.

CO4 Summarize the levels of automation.

CO5 Ability to apply AI concepts for industrial optimization and control

CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	1	1	1	1	1	2	3		
CO2	1	1	1	1	1	1	1	1	1	1	2	3		
CO3	3	2	2	2	1	1	1	1	1	1	2		3	
CO4	2	1	2	2	1	1	1	1		1	2	3		
CO5	2	2	2	2	1	1	1	1	1	1	2		3	
CO6	2	2	2	2	1	1	1	1	1	1	2		3	3

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</table>

23EE1934	SMART MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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).

COURSE OUTCOME(S):

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

CO1 Appraise concepts and basic framework necessary for smart manufacturing.
CO2 Discuss current trends at system level in manufacturing organizations.
CO3 Selection of sensors for various applications.
CO4 Dramatise IoT based manufacturing systems.
CO5 Describe industry 4.0 concepts at manufacturing systems.
CO6 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	1	1	1	1	2	3		
CO2	2	2	2	2	1	1	1	1	1	1	2	3		
CO3	3	3	3	2	1	1	1	1	1	1	2	3	3	
CO4	3	2	2	2	1	1	1	1	1	1	2		3	
CO5	1	1	1	1	1	1	1	1	1	1	2		3	
CO6	1	1	1	1	1	1	1	1	1	1	2		3	3

Internal Assessment				**End Semester Examinations**
Assessment I (100 Marks)		**Assessment II (100 Marks)**		
Individual Assignment / Case Study / Seminar / Mini Project	**Written Test**	**Individual Assignment / Case Study / Seminar / Mini Project**	**Written Test**	**Written Examinations**
40	60	40	60	100
40%				**60 %**

23EE1935	CYBER SECURITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1 Apply basis of science and engineering to understand Industrial security environment and cyberattacks.

CO2 Analyze and assess risks in the industrial environment.

CO3 Access the cybersecurity of IACS.

CO4 Design and implement cyber security.

CO5 Identify the tests and troubleshoots of industrial network security system.

CO6 Understand, investigate and explore feasible solution for a moderate industrial problem.

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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	1	1	1	2	3	–	–
CO2	3	3	3	2	1	1	1	1	1	1	2	3	–	–
CO3	3	2	2	2	1	1	1	1	1	1	2	–	3	–
CO4	3	2	2	2	1	1	1	1	1	1	2	–	3	–
CO5	1	1	1	1	1	1	1	1	1	1	2	–	3	–
CO6	2	2	1	1	1	1	1	1	1	1	2	3	3	3

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1936	SMART FARMING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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.

COURSE OUTCOME(S):

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

CO1 Relate to farming with industrial problem and solving it.

CO2 Explain the process in growing a particular crop varieties and challenges associated with it.

CO3 Apply the knowledge to select suitable sensors and software for particular test case.

CO4 Analyze anomaly and weather change beforehand.

CO5 Build an exclusive irrigation and harvest plan for particular zone.

CO6 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.

REFERENCE BOOKS:

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/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1		2	3			3	2					3	3	
CO2			3		3	3	2					3	3	
CO3			3		3	3	2					3	3	
CO4		2	3	3	3	3	2		3			3	3	
CO5		2	2			3	3					3	2	
CO6		3	3	2	3	2						3	3	

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23EE1937	BUILDING AUTOMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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

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.

COURSE OUTCOME(S):

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

CO1 Explain the concept of intelligent building and BAS.

CO2 Select the hardware and design of HVAC in building automation system.

CO3 Discuss the concept of energy management system.

CO4 Design the automation system for intelligent building.

CO5 Illustrate the safety system for building.

CO6 Design and integrate the different system in BAS.

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).

REFERENCE BOOKS:

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

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%20EN G.pdf

CO-PO MAPPING

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CO3	2	1	1	1	1	1	1	1	1	1	2	3		
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CO6	3	3	3	3	1	1	1	1	1	1	2	3	3	

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<tr><td colspan="4">40%</td><td>60 %</td></tr>
</table>

VERTICAL VI: COMPUTER

23IT1913	CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 Hyper ledger 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

COURSE OUTCOME(S):

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

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. Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, O’Reilly, 2014.

REFERENCE BOOKS:

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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1			1			2			
CO2	3	3	3	3	1			2			2			
CO3	3	3	3	3	2			3			2			
CO4	3	2	3	2	3			3			2			

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				**60 %**

23CS1908	AUGMENTED REALITY AND VIRTUAL REALITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development 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

COURSE OUTCOME(S):

Upon completion of the course, 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

TEXT BOOKS:

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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2		3			2	2	1	2			
CO2	3	2	2	1	3			3	2	2	3			
CO3	3	3	2	2	3			3	2	1	2			
CO4	3	3	3	2	3			3	2	2	3			
CO5	3	3	3	3	3			3	3	3	3			

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<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td colspan="4">40%</td><td>60 %</td></tr>
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23CS1903	CLOUD SERVICES MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 cloud services
- Select appropriate structures for designing, deploying and running cloud-based services in a business environment
- Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems

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 Operations Management

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

COURSE OUTCOME(S):

Upon completion of the course, students will 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.

REFERENCE BOOKS:

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

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	1	1	1			2	1	3	2			
CO2	3	1	2	3	2			1	2	3	1			
CO3	1	1	3	1	3			3	3	1	1			
CO4	1	1	1	2	3			2	3	3	1			
CO5	1	3	3	2	2			1	3	1	2			
CO6	1	3	3	2	2			1	3	1	2			

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23AD1924	OPTIMIZATION TECHNIQUES IN MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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

COURSE OUTCOME(S):

Upon completion of the course, students will be 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 BOOKS:

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.

REFERENCE BOOKS:

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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1			2	1	1	2			
CO2	3	1	2	2	3			3	2	3	1			
CO3	2	3	3	2	2			3	3	1	3			
CO4	2	2	1	1	3			2	1	3	1			
CO5	2	1	1	3	2			3	3	1	3			
CO6	2	2	1	3	2			3	3	1	3			

Internal Assessment				End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		
Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Individual Assignment / Case Study / Seminar / Mini Project	Written Test	Written Examinations
40	60	40	60	100
40%				60 %

23AD1921	COMPUTER VISION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 – The digital 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 and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow – Layered motion.

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 - Category recognition - Context and scene understanding- Recognition databases and test sets.

TOTAL: 45 PERIODS

COURSE OUTCOME(S):

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

CO1 To understand basic knowledge, theories and methods in image processing and computer vision.

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.

REFERENCE BOOKS:

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.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1			2	1	3	2			
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CO4	2	3	3	2	3			2	1	2	3			
CO5	2	3	3	2	2	2		3	1	2	3			
CO6	2	3	3	2	2	2		3	1	2	3			

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23AD1918	NEURAL NETWORKS AND DEEP LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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 train deep neural networks for various tasks.
- To apply auto encoders 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 NETWORKS 9

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

COURSE OUTCOME(S):

Upon completion of the course, 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.

REFERENCE BOOKS:

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.

CO-PO MAPPING

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CO1	3	2	3	2	3	1		2	1					
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<tr><td colspan="4">40%</td><td>60 %</td></tr>
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23AD1920	BUSINESS ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

- 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

COURSE OUTCOME(S):

Upon completion of the course, 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.

REFERENCE BOOKS:

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.

CO-PO MAPPING

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