SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur-603203.

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

Under Graduate

CURRICULA AND SYLLABI

(Regulations 2019)

Programme: B.E. Electrical and Electronics Engineering

SRM VALLIAMMAI ENGINEERING COLLEGE

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B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATIONS – 2019

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To prepare the students have successful career in industry, Entrepreneur, Leadership, Communication skill and motivate for higher education.
2. To provide students with adequate technical knowledge and skills in using modern engineering tools to apply mathematics, science and engineering fundamentals to the modelling, analysis and solution of problems related to electrical and electronics engineering.
3. To provide an opportunity to work in inter disciplinary groups.
4. To promote student awareness for life-long learning and inculcate professional ethics.
5. To provide necessary foundation on computational platforms and software applications related to the electrical engineering.

2. PROGRAMME OUTCOMES (POs):

After going through the four years of study, our Electrical and Electronics Engineering Graduates will exhibit ability to:

PO#	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis

		and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Electrical and Electronics Engineering program the student will have following Program specific outcomes

1. Ability to understand and apply electrical science, circuit theory, electronics, instrumentation system, digital logic theory, Electromagnetic field theory, control theory and apply them to electrical engineering problems.
2. Ability to model, design and analysis of power system components.
3. Ability to understand and use of Power Electronics devices in Electrical system.
4. Ability to understand the Micro Controller, Embedded system, Discrete Time Systems and Signal Processing.

4. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES												PROGRAM SPECIFIC OUTCOMES			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
I	✓	✓	✓	✓	✓	✓			✓		✓			✓		
II							✓	✓	✓	✓	✓			✓	✓	
III	✓	✓		✓	✓	✓				✓	✓	✓			✓	
IV		✓	✓	✓	✓				✓	✓	✓					✓
V	✓	✓			✓	✓	✓		✓	✓			✓			

MAPPING – UG- ELECTRICAL AND ELECTRONICS ENGINEERING

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Year I	Sem I	Communicative English	3	3	2	2	2	1	1			3		1	1	1	1	1
		Engineering Mathematics - I	3	2	2	1								1	3			
		Engineering Physics	3	1	1			1	1					2	2	2	2	1
		Engineering Chemistry	2	1	2		1	1	1					2	2	2	2	1
		Problem Solving and Python Programming	1		1		1					1				1	1	1
		Basic Civil and Mechanical Engineering	3	2	2	1		1	1						2	1		2
		Physics and Chemistry Laboratory	3	2	2	2		1	1	1	1			1	1	1	1	
		Python Programming Laboratory	1				1							1	1	1		1
Year I	Sem II	Technical English	3	2	1	1					1	2		1	1	1	1	2
		Engineering Mathematics - II	3	2	1	1								1				
		Physics for Electronics Engineering	3	2	2			1	1						2			
		Environmental Science and Engineering	1	2	2			1	3		2			2	1	2	2	1
		Programming in C	2	1	1		1				1				1	1		1
		Engineering Graphics	2		3						1	3		1	2	1	1	1
		C Programming Laboratory	1		1					1					1			
		Engineering Practices Laboratory	1	1	1	1	1											
		Applied Physics and Environmental Chemistry Laboratory	3	2	2	2		2	2	1	1			1	1			
		NSS/NCC/YRC /NSO																

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Year II	Sem III	Transforms and Partial Differential Equations	3	3			1							1				
		Digital Electronics		1	1	1	1	1		1				1		1	1	1
		Electrical Machines – I	3	3	1	2								1	2	2		
		Analog Electronics	3	1	1		1				1		2		2		1	3
		Circuit Theory	1	1	1		1			1			1	1	1		1	1
		Analog Electronics Laboratory	2	2	1		1				2		2		2		2	
		Electrical Machines Laboratory – I	3	3		1								1	2	2		
		Electric Circuits Laboratory	1						1	1	1		1	1		1	1	1
Year II	Sem IV	Numerical Methods	3	3	3									1				
		Electrical Machines – II	3	3	3	3	2	3	3	2				1	3	2		
		Transmission and Distribution	3	3	2	3			1					2	3	3		
		Measurements and Instrumentation	1	1	1	1	1		1			1	1		1			1
		Electromagnetic Theory	2	1	1		2								2	2		
		Professional Ethics						2	2	2								
		Electrical Machines Laboratory–II	3	3	3	3	2	3	3	2	3				3	2		1
		Technical Seminar																
		Communication Skills Laboratory- Project based	3	3	1	1	1		1			3		1	2	1	1	2

Year	Sem	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Year III	Sem V	Power System Analysis	3	3	1	1	1		1					2	3	3		
		Microprocessors and Microcontrollers	2	2	2	2	2				1		2	1	1			2
		Power Electronics	1	2	2	2	2						2			1	2	
		Control Systems	1	1	1	1			1			1			1	1		
		Digital Signal Processing	1	2	2	1	1								2	1	1	3
		Open Elective I																
		Control and Instrumentation Laboratory		1	1	1	1	1				1	1		1		1	
		Microprocessors and Microcontrollers Laboratory	1	1	2	2	3				2				1	1	1	2
Year III	Sem VI	Solid State Drives	1	1	1	1					1				1	1	1	
		Power System Operation and Control	2	2	2	2	2	1					1		2	2		1
		Design of Electrical apparatus	3	2	2	2	2								2	1		
		Professional Elective I																
		Professional Elective II																
		Power Electronics Laboratory	1	2	2	1	2				2					1	2	
		Power System Simulation Laboratory	2	1	1	1	1					1	1	1	2	2		
		Mini Project	3	2	2	3	3						3		3	2	1	3
		Professional Communication	3	2	1	2	1		1			3		1	1	1	1	1

Year	Sem	Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
Year IV	Sem VII	High Voltage Engineering		1	1		1	1	1	1			1		1			
		Renewable Energy Systems	1	1	1	1	1	1		1	1			1	1	1		
		Protection and switchgear						1		1				1		1	1	1
		Professional Elective III																
		Professional Elective IV																
		Open Elective II*																
		Internship Training	3	2	2	3	3		1									
		Renewable Energy Systems Laboratory	1	2	1		1	1	1	1			1		1	1	1	1
		Project Work Phase I	3	2	2	3	3						3		3	2	1	3
Year IV	Sem VIII	Professional Elective V																
		Professional Elective VI																
		Project Work Phase II	3	2	2	3	3						3		3	2	1	3

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CHOICE BASED CREDIT SYSTEM

CURRICULA & SYLLABI (I TO VIII SEMESTERS)

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1919101	Communicative English	HS	3	3	0	0	3
2.	1918102	Engineering Mathematics – I	BS	4	3	1	0	4
3.	1920103	Engineering Physics	BS	3	3	0	0	3
4.	1921104	Engineering Chemistry	BS	3	3	0	0	3
5.	1901005	Problem solving and Python Programming	ES	3	3	0	0	3
6.	1901008	Basic Civil and Mechanical Engineering	ES	3	3	0	0	3
PRACTICAL								
7.	1901108	Physics and Chemistry Laboratory	BS	4	0	0	4	2
8	1901009	Problem solving and Python Programming Laboratory	ES	4	0	0	4	2
TOTAL				**27**	**18**	**1**	**8**	**23**

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	1919201	Technical English	HS	3	3	0	0	3
2.	1918202	Engineering Mathematics – II	BS	4	3	1	0	4
3.	1920203	Physics for Electronics Engineering	BS	3	3	0	0	3
4.	1921203	Environmental Science and Engineering	BS	3	3	0	0	3
5.	1901006	Programming in C	ES	3	3	0	0	3
6.	1901007	Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7.	1901010	C Programming Laboratory	ES	4	0	0	4	2
8.	1901208	Engineering Practices Laboratory	ES	4	0	0	4	2
9.	1901209	Applied Physics and Environmental Chemistry Laboratory	BS	4	0	0	4	2
10		NSS/NCC/YRC/NSO	PCD	1*	0	0	0	1
TOTAL				**34**	**17**	**1**	**16**	**27**

****conducted after college hours***

SEMESTER III

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	1918301	Transforms and Partial Differential Equations	BS	4	3	1	0	4
2	1905302	Digital Electronics	PC	3	3	0	0	3
3	1905303	Electrical Machines – I	PC	3	3	0	0	3
4	1905304	Analog Electronics	PC	3	3	0	0	3
5	1905305	Circuit Theory	PC	3	3	0	0	3
PRACTICAL								
6	1905306	Analog Electronics Laboratory	PC	4	0	0	4	2
7	1905307	Electrical Machines Laboratory–I	PC	4	0	0	4	2
8	1905308	Electric Circuits Laboratory	PC	4	0	0	4	2
TOTAL				**28**	**15**	**1**	**12**	**22**

SEMESTER IV

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	1918401	Numerical Methods	BS	4	3	1	0	4
2	1905402	Electrical Machines – II	PC	3	3	0	0	3
3	1905403	Transmission and Distribution	PC	3	3	0	0	3
4	1905404	Measurements and Instrumentation	PC	3	3	0	0	3
5	1905405	Electromagnetic Theory	PC	3	3	0	0	3
6	1915001	Professional Ethics	HS	3	3	0	0	3
PRACTICAL								
7	1905406	Electrical Machines Laboratory–II	PC	4	0	0	4	2
8	1905407	Technical Seminar	EEC	2	0	0	2	1
9	1919001	Communication Skills Laboratory-Project based	EEC	2	0	0	2	0
TOTAL				**27**	**18**	**1**	**8**	**22**

SEMESTER V

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	1905501	Power System Analysis	PC	3	3	0	0	3
2	1905502	Microprocessors and Microcontrollers	PC	3	3	0	0	3
3	1905503	Power Electronics	PC	3	3	0	0	3
4	1905504	Control Systems	PC	3	3	0	0	3
5	1905505	Digital Signal Processing	PC	3	3	0	0	3
6	19XXXXX	Open Elective I	OE	3	3	0	0	3
PRACTICAL								
7	1905506	Control and Instrumentation Laboratory	PC	4	0	0	4	2
8	1905507	Microprocessors and Microcontrollers Laboratory	PC	4	0	0	4	2
TOTAL				**26**	**18**	**0**	**8**	**22**

SEMESTER VI

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	1905601	Solid State Drives	PC	3	3	0	0	3
2	1905602	Power System Operation and Control	PC	3	3	0	0	3
3	1905603	Design of Electrical Apparatus	PC	3	3	0	0	3
4	19XXXXX	Professional Elective I	PE	3	3	0	0	3
5	19XXXXX	Professional Elective II	PE	3	3	0	0	3
PRACTICAL								
6	1905610	Power Electronics Laboratory	PC	4	0	0	4	2
7	1905611	Power System Simulation Laboratory	PC	4	0	0	4	2
8	1905612	Mini Project	EEC	4	0	0	4	2
9	1919002	Professional Communication	EEC	2	0	0	2	1
TOTAL				**29**	**15**	**0**	**14**	**22**

SEMESTER VII

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	1905701	High Voltage Engineering	PC	3	3	0	0	3
2	1905702	Renewable Energy Systems	PC	3	3	0	0	3
3	1905703	Protection and Switchgear	PC	3	3	0	0	3
4	19XXXXX	Professional Elective III	PE	3	3	0	0	3
5	19XXXXX	Professional Elective IV	PE	3	3	0	0	3
6	19XXXXX	Open Elective II	OE	3	3	0	0	3
PRACTICAL								
7	1905708	Renewable Energy Systems Laboratory	PC	4	0	0	4	2
8	1905709	Project Work - Phase I	EEC	4	0	0	4	2
9	1905710	Internship	EEC	0	0	0	0	1
TOTAL				**26**	**18**	**0**	**8**	**23**

SEMESTER VIII

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	19XXXXX	Professional Elective V	PE	3	3	0	0	3
2	19XXXXX	Professional Elective VI	PE	3	3	0	0	3
PRACTICAL								
3	1905811	Project Work-Phase II	EEC	12	0	0	12	6
TOTAL				**18**	**6**	**0**	**12**	**12**

TOTAL NO. OF CREDITS: 173

PROFESSIONAL ELECTIVE – I (VI SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1905604	Advanced Control System	PE	3	3	0	0	3
2	1905605	Power Systems Stability	PE	3	3	0	0	3
3	1905606	Modern Power Converters	PE	3	3	0	0	3
4	1908605	Visual Languages and Applications	PE	3	3	0	0	3
5	1904606	Intellectual Property Rights	PE	3	3	0	0	3
6	1903612	Disaster Management	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – II (VI SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1907608	Principles of Robotics	PE	3	3	0	0	3
2	1905608	Embedded Systems	PE	3	3	0	0	3
3	1905609	EHVAC Transmission	PE	3	3	0	0	3
4	1906004	Communication Engineering	PE	3	3	0	0	3
5	1920001	Fundamentals of Nanoscience	PE	3	3	0	0	3
6	1915002	Principles of Management	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – III (VII SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1915004	Human Rights	PE	3	3	0	0	3
2	1907704	Fibre Optics and Laser Instrumentation	PE	3	3	0	0	3
3	1905704	Special Electrical Machines	PE	3	3	0	0	3
4	1909003	Operations Research	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – IV (VII SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1905705	System Identification and Adaptive Control	PE	3	3	0	0	3
2	1908006	Computer Architecture	PE	3	3	0	0	3
3	1905706	Control of Electrical Drives	PE	3	3	0	0	3
4	1906005	VLSI Design	PE	3	3	0	0	3
5	1905707	Power Systems Transients	PE	3	3	0	0	3
6	1915003	Total Quality Management	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – V (VIII SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1905801	Flexible AC Transmission Systems	PE	3	3	0	0	3
2	1905802	Soft Computing Techniques	PE	3	3	0	0	3
3	1905803	Power Systems Dynamics	PE	3	3	0	0	3
4	1905804	SMPS and UPS	PE	3	3	0	0	3
5	1905805	Electric Energy Generation, Utilization and Conservation	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – VI (VIII SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1905806	Power Quality	PE	3	3	0	0	3
2	1905807	Energy Management and Auditing	PE	3	3	0	0	3
3	1905808	High Voltage Direct Current Transmission	PE	3	3	0	0	3
4	1905809	Microcontroller Based System Design	PE	3	3	0	0	3
5	1905810	Smart Grid	PE	3	3	0	0	3

OPEN ELECTIVE – I (V SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	Course offering Department	CONTACT PERIODS	L	T	P	C
1.	1902512	Environment and Agriculture	AGRI	3	3	0	0	3
2.	1902513	Production Technology of Agricultural Machinery	AGRI	3	3	0	0	3
3.	1903514	Air Pollution and Control Engineering	CIVIL	3	3	0	0	3
4.	1903515	Participatory Water Resources Management	CIVIL	3	3	0	0	3
5.	1904504	Geographic Information System	CSE	3	3	0	0	3
6.	1904007	Data Structures	CSE	3	3	0	0	3
7.	1904508	Database Management System	CSE	3	3	0	0	3
8.	1904509	Cloud computing	CSE	3	3	0	0	3
9.	1906507	Entertaintronics	ECE	3	3	0	0	3
10.	1906505	Photonic Networks	ECE	3	3	0	0	3
11.	1906506	Telecommunication Network Management	ECE	3	3	0	0	3
12.	1907503	Sensors and Transducers	EIE	3	3	0	0	3
13.	1907504	Instrumentation in Biomedical Engineering	EIE	3	3	0	0	3
14.	1908001	3D Printing and Design	IT	3	3	0	0	3

15.	1908002	Scripting Languages	IT	3	3	0	0	3
16.	1909510	Product Design and Development	MECH	3	3	0	0	3
17.	1909511	Vibration and Noise Control	MECH	3	3	0	0	3
18.	1909512	Industrial Safety Engineering	MECH	3	3	0	0	3
19.	1910504	Principles of Food Preservation	MEDICAL ELECTRONICS	3	3	0	0	3
20.	1920501	Nanotechnology	PHYSICS	3	3	0	0	3
21.	1920502	Microscopy	PHYSICS	3	3	0	0	3
22.	1921501	Advanced Engineering Chemistry	CHEMISTRY	3	3	0	0	3
23.	1921502	Industrial Nanotechnology	CHEMISTRY	3	3	0	0	3

OPEN ELECTIVE – II (VII SEMESTER)

SL NO.	COURSE CODE	COURSE TITLE	Course offering Department	CONTACT PERIODS	L	T	P	C
1.	1903706	Green Building Design	CIVIL	3	3	0	0	3
2.	1903716	Environmental and social impact assessment	CIVIL	3	3	0	0	3
3.	1904703	Tamil Computing	CSE	3	3	0	0	3
4.	1904010	Object Oriented Programming	CSE	3	3	0	0	3
5.	1904712	Software Engineering	CSE	3	3	0	0	3
6.	1906705	Acoustics	ECE	3	3	0	0	3
7.	1906706	Visual Communication	ECE	3	3	0	0	3
8.	1906707	MEMS and NEMS	ECE	3	3	0	0	3
9.	1907001	Transducers Engineering	EIE	3	3	0	0	3
10.	1907003	Process Modeling and Simulation	EIE	3	3	0	0	3
11.	1907708	State Variable Analysis and Design	EIE	3	3	0	0	3
12.	1908003	Software Quality Management	IT	3	3	0	0	3
13.	1908004	C # and .Net Programming	IT	3	3	0	0	3
14.	1908005	Virtual Reality	IT	3	3	0	0	3
15.	1909718	Robotics	MECH	3	3	0	0	3
16.	1909719	Testing of Materials	MECH	3	3	0	0	3
17.	1909720	Design of Electric Vehicles	MECH	3	3	0	0	3
18.	1910703	Clinical Trials	MEDICAL ELECTRONICS	3	3	0	0	3
19.	1910704	Regulatory requirements in pharmaceutical Industries	MEDICAL ELECTRONICS	3	3	0	0	3
20.	1910705	Microbiology	MEDICAL ELECTRONICS	3	3	0	0	3
21.	1920701	Analytical Methods and Instrumentation	PHYSICS	3	3	0	0	3
22.	1920702	Medical Physics	PHYSICS	3	3	0	0	3
23.	1920703	Electronic Materials	PHYSICS	3	3	0	0	3
24.	1921701	Waste Water Treatment	CHEMISTRY	3	3	0	0	3

HUMANITIES AND SOCIAL SCIENCES (HS)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1919101	Communicative English	HS	3	3	0	0	3
2	1919201	Technical English	HS	3	3	0	0	3
3	1915001	Professional Ethics	HS	3	3	0	0	3

BASIC SCIENCES (BS)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1918102	Engineering Mathematics – I	BS	4	3	1	0	4
2	1920103	Engineering Physics	BS	3	3	0	0	3
3	1921104	Engineering Chemistry	BS	3	3	0	0	3
4	1901108	Physics and Chemistry Laboratory	BS	4	0	0	4	2
5	1918202	Engineering Mathematics – II	BS	4	3	1	0	4
6	1920203	Physics for Electronics Engineering	BS	3	3	0	0	3
7	1921203	Environmental Science and Engineering	BS	3	3	0	0	3
8	1901208	Engineering Practices Laboratory	BS	4	0	0	4	2
9	1901209	Applied Physics and Environmental Chemistry Laboratory	BS	4	0	0	4	2
10	1918301	Transforms and Partial Differential Equations	BS	4	3	1	0	4
11	1918401	Numerical Methods	BS	4	3	1	0	4

ENGINEERING SCIENCES (ES)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1901005	Problem Solving and Python Programming	ES	3	3	0	0	3
2	1901008	Basic Civil and Mechanical Engineering	ES	3	3	0	0	3
3	1901009	Problem solving and Python Programming Laboratory	ES	4	0	0	4	2
4	1901006	Programming in C	ES	3	3	0	0	3
5	1901007	Engineering Graphics	ES	6	2	0	4	4
6	1901010	C Programming Laboratory	ES	4	0	0	4	2

PROFESSIONAL CORE (PC)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1905302	Digital Electronics	PC	3	3	0	0	3
3	1905303	Electrical Machines – I	PC	3	3	0	0	3
4	1905304	Analog Electronics	PC	3	3	0	0	3
5	1905305	Circuit Theory	PC	3	3	0	0	3
6	1905306	Analog Electronics Laboratory	PC	4	0	0	4	2
7	1905307	Electrical Machines Laboratory – I	PC	4	0	0	4	2
8	1905308	Electric Circuits Laboratory	PC	4	0	0	4	2
9	1905402	Electrical Machines – II	PC	3	3	0	0	3
10	1905403	Transmission and Distribution	PC	3	3	0	0	3
11	1905404	Measurements and Instrumentation	PC	3	3	0	0	3
12	1905405	Electromagnetic Theory	PC	3	3	0	0	3
13	1905406	Electrical Machines Laboratory–II	PC	4	0	0	4	2
14	1905501	Power System Analysis	PC	3	3	0	0	3
15	1905502	Microprocessors and Microcontrollers	PC	3	3	0	0	3
16	1905503	Power Electronics	PC	3	3	0	0	3
17	1905504	Control Systems	PC	3	3	0	0	3
18	1905505	Digital Signal Processing	PC	3	3	0	0	3
19	1905506	Control and Instrumentation Laboratory	PC	4	0	0	4	2
20	1905507	Microprocessors and Microcontrollers Laboratory	PC	4	0	0	4	2
21	1905601	Solid State Drives	PC	3	3	0	0	3
22	1905602	Power System Operation and Control	PC	3	3	0	0	3
23	1905603	Design of Electrical Apparatus	PC	3	3	0	0	3
24	1905610	Power Electronics Laboratory	PC	4	0	0	4	2
25	1905611	Power System Simulation Laboratory	PC	4	0	0	4	2
26	1905701	High Voltage Engineering	PC	3	3	0	0	3
27	1905702	Renewable Energy Systems	PC	3	3	0	0	3
28	1905703	Protection and Switchgear	PC	3	3	0	0	3
29	1905708	Renewable Energy Systems Laboratory	PC	4	0	0	4	2

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	1905407	Technical Seminar	EEC	2	0	0	2	1
2	1919001	Communication Skills Laboratory-Project based	EEC	2	0`	0	2	0
3	1905612	Mini Project	EEC	4	0	0	4	2
4	1919002	Professional Communication	EEC	2	0	0	2	1
5	1905709	Project Work- Phase I	EEC	8	0	0	4	2
6	1905710	Internship	EEC	0	0	0	0	1
7	1905811	Project Work- Phase II	EEC	8	0	0	12	6

PERSONALITY AND CHARACTER DEVELOPMENT (PCD)

SL NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1		NSS/NCC/YRC/NSO	PCD	1	0	0	0	1

SUMMARY

SL NO.	SUBJECT AREA	CREDITS PER SEMESTER								CREDITS TOTAL	%
		I	II	III	IV	V	VI	VII	VIII		
1	**HS**	3	3	-	3	-	-	-	-	09	5
2	**BS**	12	12	4	4	-	-	-	-	32	18.5
3	**ES**	8	11	-	-	-	-	-	-	19	11
4	**PC**	-	-	18	14	19	13	11	-	75	43
5	**PE**	-	-	-	-	-	6	6	6	18	10.5
6	**OE**	-	-	-	-	3	-	3	-	6	3
7	**EEC**	-	-	-	1	-	3	3	6	13	8
8	**PCD**	-	1	-	-	-	-	-	-	1	1
	Total	**23**	**27**	**22**	**22**	**22**	**22**	**23**	**12**	**173**	**100**
	Non Credit/ Mandatory	-	-	-	✓	-	-	-	-	-	

SEMESTER I

1919101 COMMUNICATIVE ENGLISH

(Common to all branches of B.E. / B.Tech. Programmes)

L	T	P	C
3	0	0	3

OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and understand
- Comprehend content-asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT-I: SHARING INFORMATION RELATED TO ONESELF/FAMILY & FRIENDS 9

Reading – short comprehension passages, practice in skimming-scanning and predicting –**Writing** – Blog/film review/quora/Twitter/Facebook– developing hints. **Listening** – short texts – short formal and informal conversations. **Speaking** – introducing oneself – exchanging personal information – **Language development** – Wh – Questions – asking and answering – yes or no questions – parts of speech. **Vocabulary development** – prefixes – suffixes – word formation: making sentences of your own.

UNIT-II: GENERAL READING AND FREE WRITING 9

Reading – Story with questions and answers – **Writing** – paragraph writing- topic sentence – main ideas – free writing, short narrative descriptions using some suggested vocabulary and structures – **Listening** – Listening to a speech – answering questions. **Speaking** –Presentation with PPT - **Language development** – prepositions, **Vocabulary development** – guessing meanings of words in contexts – articles.

UNIT-III: GRAMMAR AND LANGUAGE DEVELOPMENT 9

Reading – short texts (close reading) **Writing** – understanding text structure – use of reference words and discourse markers-coherence-jumbled sentences **Listening** – listening to stories to answer questions. **Speaking** – asking about routine actions and expressing opinions. **Language development** – Adjectives, degrees of comparison – conjunctions and connectives – **Vocabulary development** – single word substitutes- adverbs.

UNIT-IV: READING AND LANGUAGE DEVELOPMENT 9

Reading – Newspaper articles- answering questions – **Writing** – letter writing, informal or personal letters – congratulating/ thanking/requesting help e-mails – forward a mail to Staff on given topic – **Listening** – listen to different sounds and differentiate the sounds with different words. **Speaking** – speaking about oneself-speaking about one‘s friend –**Language development** – Modals – Tenses – **Vocabulary development** – synonyms –antonyms – phrasal verbs.

UNIT-V: EXTENDED WRITING 9

Reading – longer texts – close reading – **Writing**– brainstorming -writing short essays – developing an outline – identifying main and subordinate ideas – dialogue writing – **Listening** – listening to talks- Note taking – **Speaking** – participating in conversations – short group conversations – **Language development** - correction of errors – **Vocabulary development** – collocations – fixed and semi-fixed expressions.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations
- Introduce themselves and their friends and express opinions in English
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.

TEXT BOOKS:

1. Board of Editors. **"Using English – A Course book for Under graduate Engineers and Technologists"**, Orient BlackSwan Limited, Hyderabad, 2015.

2. Richards, C. Jack. **"Interchange Students' Book-2",** New Delhi, CUP, 2015.

REFERENCES:

1. Bailey, Stephen. **"Academic Writing: A practical guide for students",** New York: Rutledge, 2011.
2. Means, L. Thomas and Elaine Langlois, **"English & Communication for Colleges"**, Cengage Learning, USA, 2007.
3. Redston, Chris & Gillies, Cunningham **Face2Face (Pre-intermediate Student's Book& Workbook)** Cambridge University Press, New Delhi: 2005.
4. Comfort, Jeremy, et al. **"Speaking Effectively: Developing Speaking Skills for Business English",** Cambridge University Press, Cambridge: Reprint 2011.
5. Dutt P. Kiranmai and Rajeevan Geeta. **"Basic Communication Skills, Foundation Books"**, 2013.
6. Preliminary English Test – Cambridge University Press ESOL
7. Key English Test – Cambridge University Press ESOL.
8. Pronunciation Dictionary – Daniel Jones.

Course Outcomes	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	3	3	-	-	-	-	3	-	1	2	-	-	-
CO2	3	2	3	2	2	-	2	-	-	3	-	1	1	1	-	-
CO3	3	3	-	2	-	-	-	-	-	3	-	1	1	1	1	1
CO4	3	3	-	-	-	-	3	-	-	3	-	1	1	1	1	1
CO5	3	3	3	2	3	3	2	-	-	3	-	1	2	1	2	2

1918102 **ENGINEERING MATHEMATICS- I** **L T P C**
3 1 0 4

OBJECTIVES:

- To understand and apply matrix techniques for engineering applications.
- To familiarize the student with basic calculus and traditions of traditional calculus.
- To solve the problems in single and multivariable calculus and plays an important role in science, economics, engineering.
- To acquaint the student with mathematical tools needed in evaluating integrals.
- To familiarize the student with multiple integrals and their usage in find the area and volume of two and three dimensional objects.

UNIT-I: MATRICES 9L+3T

System of equations – consistency and inconsistency- Eigen values and Eigen vectors of a real matrix - Characteristic equation - Properties of Eigen values and Eigen vectors - Statement and Applications of Cayley-Hamilton Theorem - Reduction of a quadratic form into canonical form by orthogonal transformation

UNIT-II: DIFFERENTIAL CALCULUS FOR FUNCTIONS OF ONE VARIABLE 9L+3T

Limit of a function - Continuity – Differentiability - Differentiation rules – Rolle's theorem and Mean Value theorem – Taylor's series- Maxima and Minima of functions of one variable.

UNIT -III: FUNCTIONS OF SEVERAL VARIABLES 9L+3T

Partial derivatives - Total derivatives - Jacobians and properties - 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 FOR FUNCTION OF ONE VARIABLE 9L+3T

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration by partial fractions- Improper integrals

UNIT -V: MULTIPLE INTEGRALS 9L+3T

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

TOTAL: 45L+15T PERIODS

OUTCOMES:

- To apply the idea of reducing complex problems into simple form using matrix technique.
- Basic application of calculus in Engineering problems and to tackle for different geometries.
- This course equips the students to have basic knowledge and understanding of fundamental statistics to analyze and interpret data.
- To apply Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration by partial fractions in Engineering Problems.
- Basic application of Double and Triple integrals used in Engineering real life problems

TEXT BOOKS:

1. Grewal. B.S, **"Higher Engineering Mathematics",** 41st Edition, Khanna Publications, Delhi, 2011.
2. Veerarajan. T, **"Engineering Mathematics"**, McGraw Hill Education (India) Private Limited, 2019.
3. Gupta S.C and Kapoor V.K, **"Fundamentals of Mathematical Statistics"**, S.Chand Private Ltd., 11th Edition, 2005.

REFERENCE BOOKS:

1. Kreyszig Erwin, **"Advanced Engineering Mathematics"**, John Wiley and Sons, 10thEdition, New Delhi, 2016
2. Ramana B.V, **"Higher Engineering Mathematics"**, Tata McGraw Hill Publishing Company, New Delhi, 2008.
3. James Stewart, **"Calculus: Early Transcendentals"**, Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and7.8].

Course Outcomes	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	2	2	1	-	-	-	-	-	-	-	1	-	-	-	-
CO2	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-
CO3	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-
CO4	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-
CO5	3	2	2	1	-	-	-		-	-	-	1	-	-	-	-

1920103	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the stress, strain and the concept of Hooke's law for the modulus of elasticity values .
- To facilitate the knowledge about basics of laser, optical fiber sources and transmission techniques.
- To enrich the idea of transfer and measurement of heat and uses of heat exchangers.
- To explore the basics of quantum theory and atomic and subatomic particles.
- To enhance the fundamental knowledge crystal Physics and its applications

UNIT- I: PROPERTIES OF MATTER 9

Elasticity – Hooke's law-Stress-strain diagram and its uses –Poisson ratio-factors affecting elastic modulus and tensile strength – twisting couple - torsion pendulum: theory and experiment (regular body) - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders.

UNIT-II: LASERS AND FIBER OPTICS 9

Lasers: population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Nd-YAG laser-Semiconductor lasers: homojunction and heterojunction – Applications. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, and mode) – losses associated with optical fibers–Fiber optic communication-fibre optic sensors: pressure and displacement- Endoscope.

UNIT-III: THERMAL PHYSICS 9

Transfer of heat energy – thermal conduction, convection and radiation – Newton's law cooling (qualitative) -heat conductions in solids – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT-IV: QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation)- deduction of Wien's and Rayleigh jeans law – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional - three dimensional potential box– tunnelling (qualitative) - scanning tunnelling microscope.

UNIT-V: CRYSTAL PHYSICS 9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances- coordination number and packing factor for SC, BCC, FCC, HCP and diamond structure (qualitative) - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – growth of single crystals: solution and melt growth techniques - Importance of crystal physics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course,

- The students will gain knowledge on the basics of properties of matter and its applications,
- The students will acquire knowledge on the concepts of optical devices and their applications in fibre optics,
- the students will have adequate knowledge on the concepts of thermal properties of material and their applications in heat exchanger and electrical appliances,
- the students will get knowledge on advanced physics concepts of quantum theory and its applications in tunnelling microscopes, and
- the students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

1. Bhattacharya, D.K. & Poonam, T. “Engineering Physics”. Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. “Engineering Physics”. Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. &Chaturvedi, S. “Engineering Physics”. Cengage Learning India, 2012.
4. Brijlal and Subramanyam, “Properties of Matter”, S .Chand publishing, 2002.

REFERENCE BOOKS:

1. Halliday, D., Resnick, R. & Walker, J. “Principles of Physics”. Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. “Physics for Scientists and Engineers”. Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. “Physics for Scientists and Engineers with Modern Physics’. W.H.Freeman, 2007.
4. Shatendra Sharma & Jyotsna Sharma, “Engineering Physics”. Pearson, 2018.

Course Outcomes	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO 1	3	1	1			1	1	-	-	-	-	1	2	-	-	-
CO 2	3	1	1		1	1	1	-	-	-		1	3	-	-	-
CO 3	3		1			1		-	-	-	-	1	3	-	-	-
CO 4	3	1		1		1	1	-	-	-	-	1	3	-	-	-
CO 5	3	1		1			1	-	-	-		1	2	-	-	-

1921104 ENGINEERING CHEMISTRY L T P C
3 0 0 3

COURSE OBJECTIVES

- To make the students acquainted with boiler feed water requirements, related problems and domestic water treatment techniques.
- To understand the basic mechanism of surface phenomenon.
- To acquaint the student with the principles of electrochemical reactions, methods for corrosion prevention and protection of materials.
- To make the student conversant with the basics of polymers, cement and glass.
- To acquaint the students with the basics of nanomaterials, their properties and applications.

UNIT-I: WATER AND ITS TREATMENT 9

Hardness of water – types – expression of hardness – units - Boiler feed water-boiler troubles - scale and sludge, priming and foaming, caustic embrittlement, boiler corrosion. Treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning). External treatment – Ion exchange process – domestic water treatment (break point chlorination) – Desalination of brackish water – Reverse Osmosis.

UNIT-II: SURFACE CHEMISTRY AND CATALYSIS 9

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms. Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – Contact theory. Kinetics of surface reactions, unimolecular reactions, Langmuir – applications of adsorption on pollution abatement. Catalysis: Catalyst – types of catalysis – Criteria – Autocatalysis – Catalytic poison and catalytic promoters – Acid base catalysis – Applications (3 way catalytic convertor) – Enzyme catalysis– Michaelis – Menten equation.

UNIT-III: ELECTROCHEMISTRY, CORROSION AND PROTECTIVE COATINGS 9

Electrochemical cell - redox reaction, electrode potential - origin of electrode potential - oxidation potential - reduction potential, measurement and applications - Electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion – causes – factors – types - chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control – material selection and design aspects – Electrochemical protection – sacrificial anode method and impressed current cathodic method. Protective coatings: Metallic coatings – Electroplating of Cu - electroless plating of Ni. Organic coatings: Paints - constituents and function.

UNIT-IV: ENGINEERING MATERIALS 9

Cement: Definition – classification of cement – Portland cement - manufacture and properties - setting and hardening of cement - special cement, water proof, white and sorel cement – properties and uses – Glass: Manufacture, types, properties and uses (laminated, safety and flint glass) - Polymers: Classification - types of polymerization - mechanism - methods of polymerization - Engineering polymers: Nylon-6, Nylon-6,6, Teflon, Kevlar and PEEK - preparation, properties and uses - Plastic and its types - Conducting polymers: Types and applications - Polymers in medicine and surgery (applications).

UNIT-V: NANOCHEMISTRY 9

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties (surface to volume ratio, melting point, optical and electrical). Nanoparticles, Nanocluster, Nanorods, Nanotube (CNT: SWNT and MWNT) and Nanowire, Synthesis - precipitation, thermolysis, hydrothermal, electrodeposition, chemical vapour deposition, laser ablation, sol-gel process and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Gain idea about various methods available for water treatment.
- Explain the materials surface engineering.
- Understand the process of electrochemistry and its application to corrosion.
- Appreciate the nature and novelty of engineeringmaterials.
- Ability to understand the nature and uses ofnanomaterials.

TEXT BOOKS:

1. Shikha Agarwal, “Engineering Chemistry”-Fundamentals and Applications, Cambridge University Press, Delhi, 2015.
2. P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015.
3. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India PVT, LTD, New Delhi, 2013.

REFERENCE BOOKS:

1. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
2. S.S. Dara and S.S. Umare, “A Text Book of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015.
3. B. Sivasankar, “Engineering Chemistry”, Tata McGraw-Hill Publishing Company LTD, 2012.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO 1	3	1	2	1	1	1	1					3	1	2	1	1
CO 2	2	1	3		1	1	1					2	1	1	1	1
CO 3	2		1			1						1	3	3	3	2
CO 4	1	1	2	1	1		1					2	2	3	3	1
CO 5	2		1		1	1						1	2	3	3	2

1901005 PROBLEM SOLVING AND PYTHON PROGRAMMING

(Common to all branches of B.E. / B.Tech. Programmes)

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures – lists, tuples, dictionaries.

UNIT-I: ALGORITHMIC PROBLEM SOLVING, DATA TYPES 9

Algorithms: building blocks of algorithms (statements, control flow, functions), notation (pseudo code, flow chart). Python interpreter and interactive mode; **values and types:** int, float, Boolean, string, and list; variables, operators and expressions, statements, tuple assignment, precedence of operators, comments, Illustrative programs: Algorithm for Arithmetic expression (addition and subtraction).

UNIT-II: CONTROL FLOW STATEMENTS AND FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); **Iteration:** state, while, for, break, continue, pass; functions, function definition and use. **Fruitful functions:** return values, parameters, local and global scope, recursion. Illustrative programs: exchange the values of two variables square root, printing n numbers iteratively

UNIT-III: LIST& TUPLES 9

Lists: list operations, list slices, list methods, list loop, mutability, list parameters; **Tuples:** tuple assignment, tuple as return value. Comparison of Lists and tuples. Illustrative programs: selection sort, insertion sort, Quick sort.

UNIT-IV: STRINGS, DICTIONARIES & SET 9

Strings: string slices, immutability, string functions and methods, string module. **Dictionaries:** Operations (create, access, add, remove) and methods. (insert, delete).Set operation (Access, Add, Remove).Comparison of dictionary and set.

UNIT-V: FILES, MODULES & PACKAGES **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Develop algorithmic solutions to simple computational problems.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, Set and dictionaries.
- Read and write data from/to files in Python Programs.

TEXT BOOKS:

1. Reema Thareja, **"Python Programming using Problem solving Approach"** ,Oxford Higher Education,2017
2. Allen B. Downey, **"Think Python: How to Think Like a Computer Scientist"**, 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
3. Guido van Rossum and Fred L. Drake Jr, **"An Introduction to Python**" – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. Charles Dierbach, **"Introduction to Computer Science using Python: A Computational Problem-Solving Focus**", Wiley India Edition, 2013.
2. John V Guttag, **"Introduction to Computation and Programming Using Python''**, Revised and expanded Edition, MIT Press , 2013
3. Kenneth A. Lambert, **"Fundamentals of Python: First Programs"**, CENGAGE Learning, 2012.
4. Paul Gries, Jennifer Campbell and Jason Montojo, **"Practical Programming: An Introduction to Computer Science using Python 3"**, Second edition, Pragmatic Programmers,LLC,2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, **"Introduction to Programming in Python: An Inter-disciplinary Approach"**, Pearson India Education Services Pvt. Ltd., 2016.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3	2	3				1					2	2			3
CO 2					2									2	3	
CO 3				2	3									2		
CO 4					2	2				2				2		
CO 5										2	2				1	

1901008 BASIC CIVIL AND MECHANICAL ENGINEERING **L T P C**

(Common to CSE, EEE, ECE, EIE, IT & Medical Electronics) **3 0 0 3**

COURSE OBJECTIVES:

- To impart basic knowledge on Civil and Mechanical Engineering.
- To familiarize the materials and measurements used in Civil Engineering.
- To provide the exposure on the fundamental elements of civil engineering structures and construction methods
- To enable the students to distinguish the components and working principle of power plant units, boilers and IC engines.
- To understand the concepts and working principle of refrigeration and air conditioning system

A – OVER VIEW

UNIT-I: SCOPE OF CIVIL AND MECHANICAL ENGINEERING 7

Overview of Civil Engineering: Civil Engineering contributions to the welfare of Society – Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering.

Overview of Mechanical Engineering: Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Civil and Mechanical Engineering.

B – CIVIL ENGINEERING

UNIT-II: SURVEYING AND CIVIL ENGINEERING MATERIALS 7

Surveying: Objects – classification – principles – measurements of distances – angles – leveling – determination of areas– contours - examples.

Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel - timber – modern materials.

UNIT-III: BUILDING COMPONENTS AND STRUCTURES 11

Foundations: Types of foundations - Bearing capacity and settlement – Requirement of good foundations.

Civil Engineering Structures: Brickmasonry – stonemasonry – beams – columns – lintels – roofing– flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams – water supply - sources and quality of water - Rain water harvesting - introduction to high way and railway.

C – MECHANICAL ENGINEERING

UNIT-IV: INTERNAL COMBUSTION ENGINES AND POWER PLANTS 11

Classification of Power Plants - Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines.

Working principle of steam, Gas, Diesel, Hydro – electric and Nuclear Power plants – working principle of Cochran, La-mont, Benson Boilers, Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Knowledge of basics in various sub-disciplines of civil and mechanical engineering.

- Use the basics of surveying for calculation of area and volume in basic construction works
- Fundamental elements of civil engineering structures and construction methods.
- Understand the energy sources and working principle of power plants and apply the knowledge of power plants to diagonize and solve the Engineering problem and the working principle of IC Engines
- Understand the function of refrigeration and air conditioning system.

TEXT BOOKS:

1. Shanmugam G and Palanichamy MS, **"Basic Civil and Mechanical Engineering"**, Tata McGraw Hill Publishing Co., New Delhi, 2018.
2. Satheesh Gopi, **"Basic Civil Engineering"**, Pearson publications, 2009.
3. Basant Agrawal and C.M.Agrawal, **"Basic Mechanical Engineering"**, Wiley Publications Pvt Ltd., New Delhi, 2018.

REFERENCE BOOKS:

1. Ramamrutham S., **"Basic Civil Engineering"**, Dhanpat Rai Publishing Co.(P) Ltd, 2015.
2. Rajput R.K., **"Thermal Engineering"**, Laxmi Publications (P) Ltd, 10th Edition, 2018.
3. Kothandaraman C.P., Domkundwar S., Dhanpat Rai, **"Thermal Engineering"**, Publishing Co.(P) Ltd., 6th Edition, 2015.

Course Outcomes	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3	1	2	-	-	3	2	1	-	-	-	1	1	-	1	2
CO 2	3	3	2	1	-	1	-	-	-	-	-	-	2	1	-	2
CO 3	3	1	2	1	-	1	1	-	-	-	-	-	2	1	-	2
CO 4	3	2	2	1	-	1	-	-	-	-	-	1	2	1	1	2
CO 5	3	2	2	1	-	-	-	-	-	-	-	-	1	-	-	1

1901108	PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
	(Common to all branches of B.E. / B.Tech. Programmes)	0	0	4	2

PHYSICS LABORATORY

COURSE OBJECTIVES:

- To study the behaviour of material under shear stress.
- To learn the basics concept understanding the deformation due to linear stress
- To explore the photons to measure the physical parameters.
- To introduce experiments to test thermal conductivity of bad conductor.
- To study the spectrum of white light.

LIST OF EXPERIMENTS: (Any 5 Experiments)

1. Determination of rigidity modulus – Torsion pendulum.
2. Determination of Young's modulus by non-uniform bending method.
3. (a) Determination of wavelength and particle size using Laser.

   (b) Determination of acceptance angle and numerical aperture in an optical Fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid and Solid – Ultrasonic Interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

- Measure the rigidity modulus of the material.
- Calculate the deformation due to linear stress and Young's Modulus
- Use laser to measure the physical parameters.
- Calculate the thermal conductivity of bad conductor by lees disc.
- Measure the wavelength of the mercury the spectrum.

REFERENCE BOOKS:

1. Wilson J.D. and Hernaandez Hall C.A. – “Physics Laboratory Experiments”, Houghton Mifflin Company, New York, 2005.
2. S. Srinivasan, “A Text Book of Practical Physics”, S. Sultan Chand publications. 2005
3. R. Sasikumar, “Practical Physics”, PHI Learning Pvt. Ltd, New Delhi, 2011.

Course Outcomes	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3	1	1	1	-	1	-	1	1	-	-	-	1	-	-	-
CO 2	3	1	1	1	-	1	-	1	1	-	-	-	1	-	-	-
CO 3	3	1	1	1	-	2	-	1	1	-	-	-	2	-	-	-
CO 4	3	1	1	1	-	1	-	1	1	-	-	-	2	-	-	-
CO 5	3	1	1	1	-	1	-	1	1	-	-	-	1	-	-	-

CHEMISTRY LABORATORY

COURSE OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometery.
- To make the student conversant with the corrosion defects experimentally.
- To develop and understand the basic concepts of acidic and basic nature using pH.
- To make the student familiar with the properties and nature of alloys experimentally.

LIST OF EXPERIMENTS: (Any 5 Experiments)

1. Estimation of HCl using Na_2CO_3 as primary standard and determination of alkalinity in water sample.
2. Estimation of copper content of the given solution by iodometry.

3. Determination of strength of given hydrochloric acid using pH meter.
4. Determination of strength of acids in a mixture of acids using conductivity meter.
5. Estimation of iron content of the given solution using potentiometer.
6. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
7. Pseudo first order kinetics-ester hydrolysis.
8. Corrosion experiment-weight loss method.
9. Conductometric titration of strong acid Vs strong base.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- Obtain the hands-on knowledge in the quantitative chemical analysis of water quality related parameters.
- Understand the experimental concepts in the mixture of acids and bases.
- Appreciate the need of iodometry in the estimation of metals.
- Explore the drawbacks of corrosion by weight loss method.
- Design and carry out the scientific experiments related to boiler troubles.

TEXTBOOKS:

1. Vogel's Textbook of Quantitative Chemical Analysis (8th Edition, 2014)

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	2	2	1	2			2					1				
CO 2	3	2	2	2			2					1				
CO 3	2	2	1	2		1	2					1	2	3	2	1
CO 4	3	2	3	2		1	2					1	2	3	2	1
CO 5	2	2	1	2		1	2					1	2	3	2	1

1901009 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Represent compound data using Python lists, tuples, and dictionaries.
- Use functions for structuring Python programs.
- Read and write data from/to files in Python.

LIST OF PROGRAMS

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton‘s method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. How to create, slice, change, delete and index elements using Tuple.
8. Find First n prime numbers
9. How to create, slice, change, add, delete and index elements using list.
10. Write a program to calculate the length of a string.
11. Write a program to reverse the string
12. How to change, delete, add and remove elements in Dictionary
13. Find the most frequent words in a text read from a file
14. Simulate elliptical orbits in Pygame
15. Simulate bouncing ball using Pygame

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able to:

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.

- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3							1				3	2	3		
CO 2		2	2			2					2			3		
CO 3				1									2			
CO 4					2										2	
CO 5					3											3

SEMESTER II

1919201 TECHNICAL ENGLISH **L T P C**

(Common to all branches of B.E. / B.Tech. Programmes) **3 0 0 3**

OBJECTIVES:

The Course prepares Second semester Engineering & Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations,
- Participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.

UNIT-I: INTRODUCTION 9

Listening – Listening to talks mostly of a scientific/technical nature and completing information – gap exercises- **Speaking** – Asking for and giving directions – **Reading** – reading short technical texts from journals- newspapers – **Writing**– purpose statements – Technical Jargons, homophones – issue – writing instructions – checklists-recommendations-**Vocabulary Development** – technical vocabulary **Language Development** – subject verb agreement – compound words.

UNIT-II: READING AND STUDY SKILLS 9

Listening – Listening to a technical conversation and filling the gaps – **Speaking** – describing a process – **Reading** – reading longer technical texts- identifying the various transitions in a text- paragraphing – Writing – interpreting charts, graphs – **Vocabulary Development** – vocabulary used in formal letters/emails and reports **Language Development** – impersonal passive voice, numerical adjectives.

UNIT-III: TECHNICAL WRITING AND GRAMMAR 9

Listening – Listening to classroom lectures/ talks on engineering/technology – **Speaking** – mechanics of presentations – **Reading** – longer texts both general and technical, practice in speed reading; **Writing** – Describing a process, use of sequence words – **Vocabulary Development** – Misspelt words. **Language Development** – homonyms.

UNIT-IV: REPORT WRITING 9

Listening – Listening to documentaries and making notes. **Speaking** – introduction to technical presentations – **Reading** – reading for detailed comprehension – **Writing** – Product description – job application – cover letter – Résumé preparation (via email and hard copy)- Issue based essays and official circulars – **Vocabulary Development** – finding suitable synonyms – paraphrasing – **Language Development** – clauses – if conditionals.

UNIT-V: GROUP DISCUSSION AND JOB APPLICATIONS 9

Listening – TED/INK talks, answering the questions; **Speaking** – participating in a group discussion – **Reading** – reading and understanding technical articles. **Writing** – Writing reports – minutes of a meeting – Letter Writing- Letter to the Editor – Letter seeking permission for an Industrial visit/ Internship – Business Letters, asking for quotation/clarification – seeking orders, thanking for the order given, Complaint letters – **Vocabulary Development** – **verbal analogies Language Development** – reported speech.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Participate in group discussions
- Write reports and winning job applications.

TEXT BOOKS:

1. Board of Editors. **"Fluency in English – A Course book for Engineering and Technology"**, Orient BlackSwan Limited, Hyderabad: 2016.
2. Sudharshana. N.P and Saveetha. C. **"English for Technical Communication"**, Cambridge University Press: New Delhi, 2016.

REFERENCES:

1. Raman, Meenakshi and Sharma, Sangeetha – "**Technical Communication Principles and Practice"**, Oxford University Press: New Delhi, 2014.
2. Kumar, Suresh. E. "**Engineering English"**. Orient Blackswan: Hyderabad, 2015.
3. Booth-L. Diana, "**Project Work"**, Oxford University Press, Oxford: 2014.
4. Grussendorf, Marion, "**English for Presentations"**, Oxford University Press, 2007.
5. Means, L. Thomas and Elaine Langlois, "**English & Communication For Colleges"**.
6. IELTS - Cambridge University Press.
7. BEC - Cambridge University Press.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO 1	3	2	-	-	-	-	-	-	-	3	-	1	2	1	-	
CO 2	3	2	2	-	-	-	-	-	-	-	-	2	2	1	-	
CO 3	3	-	-	-	-	-	-	-	3	3	-	1	2	1	1	1
CO 4	3	2	2	2	-	-	-	-	-	3	-	1	1	1	1	1
CO 5	3	2	-	2	-	-	-	-	-	3	2	1	2	1	1	

1918202	ENGINEERING MATHEMATICS – II	L	T	P	C
	(Common to all branches of B.E. / B.Tech. Programmes)	3	1	0	4

OBJECTIVES:

- This course is designed to cover topics such as Ordinary Differential equation, Vector Calculus, Complex Analysis and Laplace Transform.
- ODE is the powerful tools to solve practical problems in the field of engineering.
- Vector calculus can be widely used for modeling the various laws of physics.
- The various methods of complex analysis helps us to evaluate contour integration.
- Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering.

UNIT-I: ORDINARY DIFFERENTIAL EQUATIONS 9L+3T

First order linear Differential equations- Exact differential equations- Second order linear differential equations with constant coefficients – Method of variation of parameters – Homogenous equation of Euler's and Legendre's type.

UNIT-II: VECTOR CALCULUS 9L+3T

Gradient and directional derivative – Divergence and curl– Irrotational and Solenoidal vector fields – Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT-III: LAPLACE TRANSFORMS 9L+3T

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems - Transforms of derivatives and integrals – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients

UNIT-IV: ANALYTIC FUNCTIONS 9L+3T

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian coordinates – Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by functions $w = Cz, C + z, \frac{1}{z}, z^2$ Bilinear transformation

UNIT-V: COMPLEX INTEGRATION 9L+3T

Complex integration – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour

TOTAL: 45L+15T PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Apply complex variables in finding ,Gradient, divergence,curl of a vector point function.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Analytic functions, conformal mapping and complex integration are evaluated.
- Laplace transform and inverse transform of simple functions, properties, are studied.

- Apply various techniques in solving Ordinary differential equations with constant coefficients

TEXT BOOKS:

1 Grewal. B.S, **"Higher Engineering Mathematics",** Khanna Publishers, New Delhi, 43rd Edition, 2014.

2 Veerarajan. T, **"Engineering Mathematics"**, McGraw Hill Education (India) Private Limited, 2019.

REFERENCES:

1 Kreyszig Erwin, **"Advanced Engineering Mathematics"**, John Wiley andSons, 10th Edition, New Delhi, 2016.

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.

CO	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	2	2	1	-	-	-	-	-	-	-	1	-	-	-	-
CO2	3	2	1	-	-	-	-		-	-	-	1	-	-	-	-
CO3	3	1	2	1	-	-	-		-	-	-	1	-	-	-	-
CO4	3	2	1	-	-	-	-		-	-	-	1	-	-	-	-
CO5	3	1	1	1	-	-	-		-	-	-	1	-	-	-	-

1920203	**PHYSICS FOR ELECTRONICS ENGINEERING**	**L**	**T**	**P**	**C**
	(Common to EEE, ECE, EIE & Medical Electronics)	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the concept of conductivities in the conducting material .
- To facilitate the knowledge about basics of doping, types of semiconductors.

- To enrich the idea of magnetism and dielectric properties.
- To explore the basics of interaction of photon with materials.
- To enhance the fundamental knowledge nano materials and its applications.

UNIT-I: ELECTRICAL PROPERTIES OF MATERIALS 9

Classical free electron theory - Expression for electrical conductivity and Thermal conductivity - Wiedemann-Franz law - Success and failures – Quantum Free electron theory - Fermi Distribution function – Density of energy states – Energy bands in solids; conductors, semiconductors and insulators.

UNIT-II: SEMICONDUCTOR PHYSICS 9

Direct and indirect semiconductors - Intrinsic Semiconductors –Carrier concentration in intrinsic semiconductors – Extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Carrier transport– Drift and Diffusion transport – Hall effect - Theory and Experiment – Applications.

UNIT-III: MAGNETIC AND DIELECTRIC PROPERTIES OF MATERIALS 9

Magnetism in materials – magnetic field and induction - magnetic permeability and susceptibility–classification of magnetic materials - types of magnetic materials - Ferromagnetism: origin and exchange interaction- saturation magnetization and Curie temperature – Energy involved in Domain Theory. Dielectric material: Polarization processes – dielectric loss – internal field – Clausius -Mosotti relation- dielectric breakdown – high-k dielectrics.

UNIT-IV: OPTICAL PROPERTIES OF MATERIALS 9

Classification of optical materials – carrier generation and recombination processes - excitons - Absorption emission and scattering of light in metals, insulators and Semiconductors (concepts only) - photo current in a P- N diode – solar cell –photo detectors - LED – Organic LED.

UNIT-V NANOELECTRONIC DEVICES 9

Introduction - Size dependence of Fermi energy– quantum confinement – quantum structures - Density of states in quantum well, quantum wire and quantum dot structures – quantum interference effects – Coulomb blockade effects - Single electron phenomena and Single electron Transistor - quantum dot laser – magnetic semiconductors– spintronics - Carbon nanotubes: Properties and applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- gain knowledge in classical and quantum electron theories and energy band structures,
- acquire knowledge on basics of semiconductor physics and its applications in various devices,
- get knowledge on magnetic and dielectric properties of materials,
- have the necessary understanding on the functioning of optical materials for optoelectronics,
- understand the basics of quantum structures and their applications in spintronics and nano electronics.

TEXT BOOKS:

1. Kasap, S.O., “Principles of Electronic Materials and Devices”, McGraw-Hill Education, 2007.
2. Umesh K Mishra & Jasprit Singh, “Semiconductor Device Physics and Design”, Springer, 2008.
3. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”. Narosa Publishing House, 2009.
4. Kittel, C., “Introduction to Solid State Physics”, Wiley, 2005.

REFERENCE BOOKS:

1. Garcia, N. & Damask, A. “Physics for Computer Science Students”, Springer-Verlag, 2012.
2. Hanson, G.W. “Fundamentals of Nano electronics”, Pearson Education, 2009.
3. Rogers, B., Adams, J. & Pennathur, S. “Nanotechnology: Understanding Small Systems”, CRC Press, 2014.

CO	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3	2	2	-	1	1	1	-	-	-	-	-	3	-	-	-
CO 2	3	2	2	-	-	1	1	-	-	-	-	-	3	-	-	-
CO 3	3	2	2	-	-	1	1	-	-	-	-	-	1	-	-	-
CO 4	3	2	2	-	-	1	1	-	-	-	-	-	2	-	-	-
CO 5	3	2	2	-	1	1	1	-	-	-	-	-	3	1	-	-

1921203 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.

UNIT-I: ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

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, types, characteristic features, structure and function of the grassland ecosystem, aquatic ecosystems (lakes, oceans) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – 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 ex-situ conservation of biodiversity. Field study of an ecosystems.

UNIT-II: ENVIRONMENTAL POLLUTION 8

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 – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial/Agricultural.

UNIT-III: NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, soil erosion and desertification, 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– 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– role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT-IV: SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy –water conservation, rain water harvesting and watershed management – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production 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 : 45 PERIODS

COURSE OUTCOMES

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

- Gain knowledge on ecosystem, environment and biodiversity.
- Understand the process and disadvantages of environmental pollution.
- Analyze the ill effects of over exploitation of natural resources.
- Explain the social issues from unsustainable to sustainable development.
- Outline the need for decrease in population growth and its measures.

TEXT BOOKS:

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCE BOOKS:

1. Dharmendra S. Sengar, "Environmental law", Prentice Hall of India PVT LTD, New Delhi, 2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press (I) PVT, LTD, Hydrabad, 2015.
3. Rajagopalan, R, "Environmental Studies - From Crisis to Cure"', Oxford University Press, 2005.
4. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO 1	1	1				1	2		2			1	1	1	1	1
CO 2	2	2	3			2	3		1			3	1	3	3	2
CO 3	2	1	2			2	3		2			3	1	1	1	1
CO 4	1	3	2				3		3			2	2	3	3	1
CO 5	1	1	1			1	2					1	1	1	1	1

1901006 PROGRAMMING IN C L T P C

3 0 0 3

COURSE OBJECTIVES:

- To develop C Programs using basic programming.
- To develop C programs using arrays
- To develop C programs using strings.
- To develop applications in C using functions
- To develop C program using structures and union

UNIT –I: BASICS OF C PROGRAMMING 9

Introduction to algorithm: Flowchart-Pseudo code- Introduction to programming paradigms- C programming: Data Types -Keywords-Variables and Constants–Operators and Expressions: Expressions -precedence,-associativity-Input/Output statements-Decision making and looping: Branching statement, Iterative statement -Compilation process.

UNIT –II: ARRAYS AND STRINGS 9

Introduction to Arrays: One dimensional array: Assigning an array to another array –Equating an array with another array-Two dimensional Arrays: Declaration-usage of two dimensional array-reading, storing and accessing elements in two dimensional array-memory representation-String operations: String library functions- list of strings-command line arguments.

UNIT –III: FUNCTIONS 9

Introduction to functions: Classification of functions- function definition-function call-function with inputs and outputs-recursive function-library functions-scope of variables.

UNIT –IV: STRUCTURES AND UNIONS **9**

Introduction to Structures: Array of structures – Nested structure-functions and Structures-Introduction to union-: practical applications of union —typedef and structures-enumerated data type.

UNIT-V: STORAGE CLASS AND PREPROCESSOR DIRECTIVE **9**

Introduction to storage classes: Types of storage classes- C preprocessor Directives: Types of preprocessor directives-Pragma Directive-conditional directive.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Develop simple applications in C using basic constructs.
- Design and implement applications using arrays and strings
- Develop and implement applications in C using functions
- Develop applications in C using structures and unions
- Design applications using preprocessor to stimulate functions

TEXT BOOKS:

1. Anita Goel and Ajay Mittal, —Computer Fundamentals and Programming in C, Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. ReemaThareja, —Programming in C, Oxford University Press, Second Edition, 2016.

REFERENCE BOOKS:

1. Paul Deitel and Harvey Deitel, —C How to Program, Seventh edition, Pearson Publication.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO 1	3		3		2							1		2		
CO 2	3	3			2		1						3			
CO 3	2	1		2	3										2	
CO 4			2						2		1			1		
CO 5		3				1			2							3

		L	T	P	C
1901007	**ENGINEERING GRAPHICS**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B.Tech. Programmes)	**2**	**0**	**4**	**4**

OBJECTIVES:

The main learning objective of this course is to impart knowledge

- To draw the conics curves and special curves.
- To draw the orthographic projection of lines and plane surfaces.
- To draw the projections and solids and Isometric projection of simple solids.
- To draw projections of Section of Solids and development of surfaces.
- To draw free hand sketching of basic geometrical constructions, multiple views of objects and Perspective Projection of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT-I: PLANE CURVES AND SPECIAL CURVES 10

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid (Rolling Circle rolls on flat surface only). Construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

UNIT-II: PROJECTION OF POINTS, LINES AND PLANE SURFACES 16

Orthographic projection- Principles-Principal planes - First angle projection-projection of points at First Quadrant only. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) which inclined to both the principal planes by rotating object method.

UNIT-III: PROJECTION OF SOLIDS AND ISOMETRIC PROJECTION 16

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is Inclined to one of the principal planes by rotating object method. Principles of isometric projection – isometric scale – Isometric projections of simple solids - Prisms, pyramids, cylinders, cones.

UNIT-IV: PROJECTION OF SECTIONED SOLIDS & DEVELOPMENT OF SURFACES 16

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

UNIT-V: FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS 16

Free Hand sketching: Visualization principles – Representation of Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects. Perspective projection of simple solids-Prisms and pyramids by visual ray method.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

Upon Completion of this course, the students will be able to:

- To draw the conics curves and special curves.
- To draw the orthographic projection of lines and plane surfaces.
- To draw the projections and solids and Isometric projection of simple solids.
- To draw projections of Section of Solids and development of surfaces.
- To draw free hand sketching of basic geometrical constructions, multiple views of objects and Perspective Projection of simple solids.

TEXT BOOKS:

1. N.D.BHATT, “**Engineering Drawing (Plane and Solid Geometry)”**, Charotar Publishing House PVT. LTD. 53rd Edition : 2018 (Reprint)
2. Venugopal K. and Prabhu Raja V., **“Engineering Graphics”**, New Age International (P) Limited, 2018.

REFERENCES:

1. T. Jeyapoovan, **“Engineering Graphics Using Auto CAD”**, Vikas Publishing House Pvt. LTD, seventh Edition, 2015.
2. Luzzader, Warren.J. and Duff, John M., **“Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production”**, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3. Shah M.B., and Rana B.C., **“Engineering Drawing”**, Pearson, 2nd Edition, 2011.
4. Natrajan K.V., **“A text book of Engineering Graphics”**, Dhanalakshmi Publishers, Chennai, 2009.
5. Basant Agarwal and Agarwal C.M., **“Engineering Drawing”**, Tata McGraw Hill Publishing Company Limited, New Delhi, 2013.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.

2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO 1	2	-	3	-	-	-	-	-	1	3	-	1	2	1	1	1
CO 2	2	-	3	-	-	-	-	-	1	3	-	1	2	1	1	1
CO 3	2	-	3	-	-	-	-	-	1	3	-	1	2	1	1	1
CO 4	2	-	3	-	-	-	-	-	1	3	-	1	2	1	1	1
CO 5	2	-	3	-	-	-	-	-	1	3	-	1	2	1	1	1

1901010 C PROGRAMMING LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To develop programs in C using basic constructs.
- To develop applications in C using arrays and functions.
- To develop applications in C using Strings and Structures.
- To develop various applications using array concepts
- To develop various application using function concept.

LIST OF PROGRAMS:

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. Write a program to perform the Calculator operations, namely, addition, subtraction, multiplication, division and square of a number.
5. Check whether a given number is Armstrong number or not?
6. Check whether a given number is odd or even?
7. Write a program to perform factorial of a number.
8. Write a C program to find out the average of 4 integers.
9. Show how to display array elements using two dimensional array.
10. Write a C program to perform swapping using function.
11. Display all prime numbers between two intervals using functions.
12. Reverse a sentence using recursion.
13. Write a program in C to get the largest element of an array using the function.
14. Write a C program to concatenate two string.
15. Write a C program to find the length of String.
16. Find the frequency of a character in a string.
17. Write a C program to Store Student Information in Structure and Display it.
18. The annual examination is conducted for 10 students for five subjects. Write a program to read the data and determine the following:
    (a) Total marks obtained by each student.
    (b) The highest marks in each subject and the marks of the student who secured it.
    (c) The student who obtained the highest total marks.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

- Develop C programs for simple applications.
- Making use of basic constructs, arrays and strings.
- Develop C programs involving functions,
- Develop program using recursion, pointers, and structures.
- Design applications using sequential and random access file processing.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3		3										2			
CO 2					2					1					2	
CO 3				2					1							2
CO 4		2				2					2			2		
CO 5								3				1	2			

1901208 ENGINEERING PRACTICES LABORATORY **L T P C**

(Common to all branches of B.E. / B.Tech. Programmes) **0 0 4 2**

COURSE OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.
- To provide hands on training for fabrication of components using carpentry, sheet metal and welding equipment / tools
- To gain the skills for making fitting joints and assembling air conditioner
- To develop the skills for making simple electrical wiring connections using suitable tools
- To provide hands on experience for soldering and gain knowledge about the behavior of electronics components

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE **15**

Buildings:

a) Study of plumbing and carpentry components of residential and industrial buildings safety aspects.

Plumbing Works:

a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.

b) Study of pipe connections requirements for pumps and turbines.

c) Preparation of plumbing line sketches for water supply and sewage works.

d) Hands-on-exercise:
Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry works:

a) Study of the joints in roofs, doors, windows and furniture.

b) Hands-on-exercise:
Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 15

Welding:

a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.

b) Gas welding practice

Basic Machining:

a) Simple Turning and Taper turning

b) Drilling Practice

Sheet Metal Work:

a) Forming & Bending

b) Model making – Trays and funnels.

c) Different type of joints.

Fitting:

a) Preparation of square fitting

b) Preparation of V – fitting models.

Machine assembly practice:

a) Assembly of centrifugal pump

b) Assembly of air conditioner

Demonstration on:

a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.

b) Foundry operations like mould preparation for gear and step cone pulley.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE **15**

1. Residential house wiring using Switches, Fuse, Indicator, Lamp and Energy meter.
2. Fluorescent Lamp Wiring.
3. Staircase Wiring.
4. Measurement of Voltage, Current, Power and Power factor in electrical circuit.
5. Measurement of Energy using Analog & Digital Energy meter.
6. Measurement of Earth Resistance.
7. Study of Industrial house wiring.
8. Identification & Study of protective devices: Fuses & Fuse carriers, MCB, ELCB and Isolators with ratings and usage.

IV ELECTRONICS ENGINEERING PRACTICE **15**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components, Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Carry out various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering

- Fabricate carpentry components and pipe connections including plumbing works and use welding equipment's to join the structures.
- Carry out the basic machining operations, make the models using sheet metalworks. Illustrate on centrifugal pump, air conditioner, operations of smithy, foundry and fittings
- Carry out basic home electrical works and measure the electrical quantities
- Elaborate on the electronics components, gates and soldering practices

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets
2.	Carpentry vice (fitted to work bench)	15 Nos.
3.	Standard woodworking tools	15 Sets
4.	Models of industrial trusses, door joints, furniture joints	5 each

MECHANICAL

1.	Arc welding transformer with cables and holders	5 Nos.
2.	Welding booth with exhaust facility	5 Nos.
3.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets
4.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5.	Centre lathe	2 Nos.

6. Hearth furnace, anvil and smithy tools 2 Sets
7. Moulding table, foundry tools 2 Sets
8. Power Tool: Angle Grinder 2 Nos.
9. Study-purpose items: centrifugal pump, air-conditioner One each
10. Fitting tools, Hack saw frame, 12' file, hack saw blade 15 Nos.

ELECTRICAL

1. Assorted electrical components for house wiring 15 Sets
2. Fluorescent Lamp 15 Sets
3. Electrical measuring instruments 10 Sets
4. Analog & Digital energy meter 5 Sets
5. Megger 2

ELECTRONICS

1. Soldering guns 10 Nos.
2. Assorted electronic components for making circuits 50 Nos.
3. Small PCBs 10 Nos.
4. Multimeters 10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply

CO	PROGRAM OUTCOMES											
	1	2	3	4	5	6	7	8	9	10	11	12
CO 1	3					1						1
CO 2		1	2		3						1	
CO 3				3	2							1
CO 4		2	3	1	2							
CO 5		3	2	2					1			

1901209 APPLIED PHYSICS AND ENVIRONMENTAL CHEMISTRY LABORATORY

L	T	P	C
0	0	4	2

(Common to all branches of B.E. / B.Tech. Programmes)

(Laboratory classes on alternate weeks for Physics and Environmental Chemistry)

APPLIED PHYSICS LABORATORY

COURSE OBJECTIVES:

- To measure the band gap of given semi conductor.
- To study I-V characteristics of solar cell
- To measure electrical resistivity of metal and alloy
- To calculate the hkl planes
- To measure the paramagnetic susceptibility by Quinke's method

LIST OF EXPERIMENTS: (Any 5 Experiments)

1. Determination of band gap of a semiconductor.
2. Study of I-V characteristics of solar cell and determination of its efficiency.
3. Determination of electrical resistivity of metal and alloy –Carey foster Bridge.
4. Calculation of lattice cell parameter – X-ray diffraction method.
5. Measurement of susceptibility of paramagnetic solution by Quinke's method.
6. Study of magnetic Hysteresis-B-H curve.
7. Measurement of Temperature using LM35.

TOTAL: 30 PERIODS

DEMO:

1. Crystal growth- Low temperature solution growth.
2. Absorption and transmittance measurement of materials – UV visible spectrum.
3. Attenuation losses in optical Fiber.

COURSE OUTCOMES:

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

- Measure the band gap of semiconductors
- Measure the efficiency of solar cell
- Compare the resistivity of metals and alloys
- Calculate the lattice parameter and interplanar distance.
- Understand the susceptibility values for any paramagnetic substances

REFERENCE BOOKS:

1. Wilson J.D. and Hernaandez Hall C.A. – **"Physics Laboratory Experiments",** Houghton Mifflin Company, New York, 2005.
2. S. Srinivasan, **"A Text Book of Practical Physics",** S. Sultan Chand publications. 2005.
3. R. Sasikumar, **"Practical Physics",** PHI Learning Pvt. Ltd, New Delhi, 2011.

CO	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3	1	2	2	-	1	-	1	1	-	-	-	2	-	-	-
CO 2	3	2	2	2	-	1	-	1	1	-	-	-	2	-	-	-
CO 3	3	2	2	1	-	-	-	1	1	-	-	-	3	-	-	-
CO 4	3	1	2	2	-	1	-	1	1	-	-	-	1	-	-	-
CO 5	3	2	2	2	-	2	-	1	1	-	-	-	2	-	-	-

ENVIRONMENTAL CHEMISTRY LABORATORY

COURSE OBJECTIVES:

- To determine the dissolved oxygen and chloride content in water
- To determine calcium and magnesium present in domestic water
- To estimate iron, sodium and chlorine using various techniques
- To determine the chemical oxygen demand in industrial effluent
- To determine the available chlorine in bleaching powder.

LIST OF EXPERIMENTS: (Any 5 Experiments)

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of DO content of water sample by Winkler's method.
3. Determination of chloride content of water sample by argentometric method.
4. Estimation of iron content of the water sample using spectrophotometer
5. Determination of COD value of industrial effluents
6. Estimation of sodium by flame photometry

7. Estimation of available chlorine in bleaching powder

TOTAL: 30 PERIODS

DEMO:

1. Pollution abatement by adsorption techniques
2. Scintillation Process

COURSE OUTCOMES:

The student should be able to:

- Appreciate the basic requirements for potable water.
- Understand the need of dissolved oxygen in water.
- Explore the quantity of bleaching powder to be added in water.
- Analyze the ill effects caused by the industrial effluents.
- Explore new research areas in the treatment of waste water.

TEXTBOOKS:

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{th} Edition, 2014)

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3	3	3	3		3	3					1				
CO 2	3	3	2	3		3	3					1				
CO 3	3	3	3	3		2	3					1				
CO 4	2	3	3	2		3	3					2	2	3	2	1
CO 5	3	3	3	3		3	3					1				

SEMESTER III

1918301 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
3 1 0 4

OBJECTIVES:

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

UNIT-I: PARTIAL DIFFERENTIAL EQUATIONS 9L+3T

Formation of partial differential equations - Solutions Lagrange's linear equation — Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT-II: FOURIER SERIES 9L+3T

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis.

UNIT-III: APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS
9L+3T

Classification of PDE – Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction in infinite plates(excluding insulated edges).

UNIT-IV: FOURIER TRANSFORMS
9L+3T

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

UNIT-V: Z – TRANSFORMS AND DIFFERENCE EQUATIONS

9L+3T

Z- transforms – Elementary properties – Inverse Z – transform (using partial fraction and residues) – Convolution theorem – Solution of difference equations using Z – transform.

TOTAL:45L+15T PERIODS

OUTCOMES:

- Understand the fundamental concept of the concepts of Partial differential Equations.
- Understand the basic concepts of mathematical principles on Fourier & Z-transforms.
- Apply the concept of PDE and Solve Wave equation, and Heat flow equations.
- Understand the concept Fourier series and apply the concept in solving PDE.
- Understand the fundamental concept of the concepts of Solution of difference equations

TEXT BOOKS:

1. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill
   Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3. Narayanan.S.,ManicavachagomPillay.T.K and Ramanaiah.G "Advanced Mathematicsfor Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt. Ltd.1998.

REFERENCE BOOKS:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
2. Ramana.B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing
   Company Limited, NewDelhi, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson
   Education, 2007.

4.Erwin Kreyszig,“Advanced Engineering Mathematics”, 8th Edition, Wiley India, 2007.

5. Ray Wylie. C and Barrett.L.C, “Advanced Engineering Mathematics” Tata McGraw
Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.

6. P.Sivaramakrishna Das, C.Vijayakumari, Transforms and Partial Differential Equations, Pearson India Education Services Pvt. Ltd, 2019.

CO	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	3	-	-	1	-	-	-	-	-	-	1	-	-	-	-
CO2	3	3	-	-	1	-	-	-	-	-	-	1	-	-	-	-
CO3	3	3	-	-	1	-	-	-	-	-	-	1	-	-	-	-
CO4	3	3	-	-	1	-	-	-	-	-	-	1	-	-	-	-
CO5	3	3	-	-	1	-	-	-	-	-	-	1	-	-	-	-

1905302	DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge on the following Topics

- To introduce the fundamentals of combinational and sequential digital circuit
- To study various number systems and to simplify the mathematical expressions using Boolean functions word problems
- To study implementation of combinational circuits using Gates` and MSI Devices
- To study the design of various synchronous and asynchronous circuits
- To introduce digital simulation techniques for development of application oriented logic circuit

UNIT-I: NUMBER SYSTEMS, BOOLEAN ALGEBRA AND COMBINATIONAL CIRCUITS **9**

Number system, error detection, corrections & codes conversions, Boolean algebra:

De-Morgan's theorem, switching functions and minimisation using K-maps & Quine McCluskey method

UNIT-II: DESIGN OF COMBINATIONAL LOGIC CIRCUITS USING GATES AND MSI DEVICES 9

Design of adder, subtractor, comparators, code converters, encoders, decoders, multiplexers and demultiplexers, Realisation of Boolean Functions using MSI devices, memories and PLA

UNIT-III: ANALYSIS AND DESIGN OF SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Flip flops - SR, D, JK and T, shift registers, counters, state assignments analysis and design of synchronous sequential circuits, state diagram; state reduction

UNIT-IV: ANALYSIS AND DESIGN OF ASYNCHRONOUS SEQUENCTIAL CIRCUITS 9

Latches - SR - D ,Asynchronous sequential logic circuits-Transition table, flow table – race conditions – circuits with latches, analysis of asynchronous sequential logic circuits – introduction to design – implication table

UNIT-V: LOGIC FAMILIES AND VHDL 9

Logic families: RTL and DTL Circuits, TTL ECL NMOS and CMOS: Introduction to VHDL: Design – combinational logic – Types – Operators – Packages – Sequential circuit – Sub programs – Test benches. (Examples: adders, counters, flipflops, FSM, Multiplexers / Multiplexers).

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- To understand and examine the structure of various number systems and its application in digital design to solve real world problems.
- Analyze and design combinational logic circuits using gates and MSI devices.
- Analyze and Design synchronous sequential logic circuits using Flip flops and gates.
- Analyze and Design Asynchronous sequential logic circuits using Latches and gates.
- Selection of logic families and skill development for application specific

digital circuit design using VHDL.

TEXTBOOKS:

1. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, 2005.
2. Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill, 1st Edition, 2003.
3. Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11 th Edition, 2015.

REFERENCE BOOKS:

1. Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 2014.
2. Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	1	2		2								1			
2	1		1		3							2		3		
3		1	2	2		3									2	1
4			2	1				3			1	3			1	1
5		3			1			1					1	3		3

ELECTRICAL MACHINES - I

1905303	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

OBJECTIVES:

To impart knowledge on the following topics

- Magnetic-circuit analysis and introduce magnetic materials.
- Constructional details, the principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections.
- Working principles of electrical machines using the concepts of electromechanical energy conversion principles and derive expressions for generated voltage and torque developed in all Electrical Machines.
- Working principles of DC machines as Generator types, determination of their no- load/load characteristics, starting and methods of speed control of motors.
- Various losses taking place in D.C. Motor and to study the different testing methods to arrive at their performance.

UNIT-I: MAGNETIC CIRCUITS AND MAGNETIC MATERIALS 9

Magnetic circuits –Laws governing magnetic circuits - Flux linkage, Inductance and energy – Statically and Dynamically induced EMF - Torque – Properties of magnetic materials, Hysteresis and Eddy Current losses - AC excitation, introduction to permanent magnets- Transformer as a magnetically coupled circuit.

UNIT-II: TRANSFORMERS 9

Construction – principle of operation – equivalent circuit parameters – phasor diagrams, losses – testing – efficiency and voltage regulation-all day efficiency- Sumpner's test, per unit representation – inrush current - three phase transformers-connections – Scott Connection – Phasing of transformer– parallel operation of three phase transformers-auto transformer – tap changing transformers- tertiary winding.

UNIT-III: ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES **9**

Energy in magnetic system – Field energy and co energy-force and torque equations – singly and multiply excited magnetic field systems-mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines – rotating mmf waves – magnetic saturation and leakage fluxes.

UNIT-IV: DC GENERATORS **9**

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

UNIT-V: DC MOTORS **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 – Retardation test- Swinburne's test and Hopkinson's test – Permanent Magnet DC (PMDC) motors-applications of DC Motor.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to analyze the magnetic-circuits.
- Ability to acquire the knowledge in constructional details of transformers.
- Ability to understand the concepts of electromechanical energy conversion.
- Ability to acquire the knowledge in working principles of DC Generator.
- Ability to acquire the knowledge in working principles of DC Motor.

TEXTBOOKS:

1. Stephen J. Chapman, "Electric Machinery Fundamentals" 4th edition, McGraw Hill Education Pvt. Ltd, 2010.
2. P.C. Sen "Principles of Electric Machines and Power Electronics" John Wiley & Sons; 3rd Edition 2013.
3. Nagrath, I.J. and Kothari.D.P., "Electric Machines", McGraw-Hill Education, 2004.

REFERENCE BOOKS:

1. Theodore Wildi, “Electrical Machines, Drives, and Power Systems”, Pearson Education., (5th Edition), 2002.
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.
5. Surinder Pal Bali, “Electrical Technology Machines & Measurements”, Vol.II, Pearson, 2013.
6. Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, “Electric Machinery”, Sixth edition, McGraw Hill Books Company, 2003.

co	**PO**												**PSO**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	3	3										1	2	1		
2	3	3	2	2								1	3	3		
3	3	3	1	2								1	2	2		
4	3	3	1	2								1	2	2		
5	3	3	1	2								1	2	2		

1905304 **ANALOG ELECTRONICS**

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge on the following Topics

- To be familiar with the structure of basic electronic devices.
- To be exposed to the operation and application of electronic devices and their circuits.
- To analyze circuit characteristics with signal analysis using Op-amp ICs.
- To design and construct application circuits with ICs as Op-amp, 555, 566 etc.
- To study internal functional blocks and the applications of special ICs like Timers, PLL circuits regulator ICs and DAC/ADCs

UNIT-I: ELECTRONIC DEVICES AND THEIR CHARACTERISTICS 9

PN junction diodes – structure, operation and VI characteristics: drift and diffusion current, transient capacitance – BJT, JFET, MOSFET: structure, operation and characteristics; biasing; UJT based relaxation oscillator.

UNIT-II: AMPLIFIER CIRCUITS 9

BJT small signal model – Analysis of CE amplifier , Gain and Frequency response – Differential Amplifier - Multi-stage amplifier - Common mode and Differential mode analysis - Current mirror circuits - Introduction to internal circuit of typical OPAMP.

UNIT-III: OPAMP AND CHARACTERISTICS 9

Ideal OPAMP characteristics, DC characteristics, AC characteristics, Voltage -series feedback and voltage -shunt feedback - Frequency response of OPAMP - Basic applications: inverting, non-inverting and differential amplifier circuits, Adder-subtractor circuits - Differentiation and integrator circuits.

UNIT-IV: APPLICATION OF OPAMPS 9

Instrumentation amplifiers, First-order and Second order active filters, V to I and I to V converters, Comparators and multi-vibrators, Waveform generators, Clippers and Clampers, Peak detector, D/A converters (Weighted resistance type and R-2R ladder type), A/D converters (Flash type, Dual slope type and Successive Approximation types).

UNIT-V: SPECIAL ICS **9**

555 Timer circuit: Functional block diagram, characteristics & applications – Astable and monostable multivibrator -566 Voltage Controlled Oscillator circuits - PLL Phase Locked Loop applications - Function generator circuit – Linear Voltage regulators.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand the structure and underlying semiconductor physics concepts.
- Ability to design circuits employing electronic devices.
- Analyze, comprehend and design of analog electronic circuits involving OPAMP.
- Analyze, comprehend and design of analog electronic circuits involving timer 555.
- Analyze, comprehend and design of analog electronic circuits involving PLL, voltage regulator & other specializes.

TEXTBOOKS:

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

REFERENCE BOOKS:

1 Millman and Halkias, “Integrated Electronics", McGraw Hill Publications.
2 Muhammad H. Rashid, “Linear Integrated Circuits", Cengage Learning, 2014.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
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2	3	1	1		1				1		2		2		1	3
3	2	1	1		1				1		2		2		2	2
4	3	2	1		1				1		1		2		1	3
5	2	1	1						1		1		1		2	2

1905305 CIRCUIT THEORY L T P C

3 0 0 3

OBJECTIVES:

To impart knowledge on the following Topics

- 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 – Ohm's Law Resistors in series and parallel circuits – Kirchhoff's laws – Mesh current and node voltage - methods of analysis. Tree and Cotree

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 Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem.

UNIT-III: TRANSIENT RESPONSE ANALYSIS 9

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

UNIT-IV: THREE PHASE CIRCUITS 9

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

UNIT-V: RESONANCE AND COUPLED CIRCUITS 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to analyse electrical circuits.
- Ability to apply circuit theorems.
- Ability to analyse transients.
- Ability to analyse three phase circuits.
- Ability to analyse frequency response of resonance and coupled circuits.

TEXTBOOKS:

1 William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuits Analysis”, McGraw Hill publishers, edition, New Delhi, 2013.

2 Sudhakar A and Shyam Mohan SP, “Circuits and Network Analysis and Synthesis”, Tata McGraw Hill, 2015.

REFERENCE BOOKS:

1 Chakrabarti A, “Circuits Theory (Analysis and Synthesis), Dhanpat Rai & Sons, New Delhi, 2013.

2 Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, Second Edition, McGraw Hill, 2013.

co	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	1	1									3		1		2	
2	1		1	2								3	1			
3	1		1		2			3					1		2	3
4	1	1	1								3	1	1	1		
5	1	1			2								1			3

1905306	ANALOG ELECTRONICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

To impart knowledge on the following Topics

- To be familiar with the structure of basic electronic devices.
- To be exposed to the operation and application of electronic devices and their circuits.
- To analyze circuit characteristics with signal analysis using Op-amp ICs.
- To design and construct application circuits with ICs as Op-amp, 555 etc.
- To study internal functional blocks and the applications of special ICs like Timers, DAC/ADCs

I: EXPERIMENTS ON BASIC ELECTRONIC DEVICES

1. Introduction to circuit simulation package by:
   i) PN junction characteristics
   ii) Transistor (CE conf) characteristics
   iii) JFET characteristics.
2. Frequency response of transistor amplifier circuit.
3. Line and load regulation of Zener regulator.
4. UJT – relaxation oscillator circuit.
5. Wien bridge oscillator.
6. Transistorized Differential amplifier.

II: EXPERIMENTS USING LINEAR INTEGRATED CIRCUITS (ICS):

7. OPAMP based amplifier circuits :
   i) Inverting amplifier.
   ii) Non-inverting amplifier and voltage follower
   iii) Differential amplifier and Instrumentation amplifier.
8. Design of Adder-subtractor circuits.
9. Square wave oscillator/ tri-angular wave oscillator.
10. OPAMP based RC –phase shift oscillator.
11. 555 – timer IC based astable multi-vibrator.
12. OPAMP based precision rectifier circuit/ clipper circuits.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No	Name of the equipment's / Components	Quantity Required	Remarks
1	Semiconductor devices like Diode, Zener Diode, NPN Transistors, JFET, UJT, Photo diode, Photo Transistor	10	-
2	Resistors, Capacitors and inductors	10	-
3	Dual ,(0-30V) variability Power Supply	10	-
4	CRO	9	30MHz
5	Digital Multimeter	10	Digital
6	Function Generator	8	1 MHz
7	IC Tester (Analog)	2	
8	Bread board	10	
9	Computer (PSPICE installed)	1	

Consumability (sufficient quantity)

IC 741/ IC NE555/566/565, Digital IC types, LED, LM317, LM723, ICSG3524 / SG3525, Transistor – 2N3391, IN 4001,BY126, Zener diodes, Step-down transformer 230V/12-0-12V & Potentiometer

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- Ability to understand the structure and underlying semiconductor physics concepts.
- Ability to design circuits employing electronic devices.
- Analyze, comprehend and design of analog electronic circuits involving OPAMP.
- Analyze, comprehend and design of analog electronic circuits involving timer 555.
- Analyze, comprehend and design of analog electronic circuits involving ADC & DAC other specializes.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	2	2				1	1				2		1		2	
2	2	3	2		1				2		2		3		1	
3	3	2	1		1				2		2		2		1	
4	2	2	2		1				2		2		2		2	
5	2	2	1						2		2		1		2	

1905307 ELECTRICAL MACHINES LABORATORY-I

		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- To expose the students to the operation of D.C. machines.
- To expose the students to the operation of transformers.
- To expose the students to the operation of generators.
- To impart knowledge about open circuit and load characteristics.
- To impart knowledge about performance characteristics.

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 Measurement of Magnetic Inrush current of Transformers (Single Phase).

COURSE OUTCOMES:

- Ability to understand and analyze DC Generator.
- Ability to understand and analyze DC Motor.
- Ability to understand and analyze Transformers.
- Ability to understand the performance characteristics.
- Ability to understand the starters

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

1	DC Shunt Motor with Loading Arrangement	3
2	DC Shunt Motor Coupled with Three phase Alternator	1
3	Single Phase Transformer	4
4	DC Series Motor with Loading Arrangement	1
5	DC compound Motor with Loading Arrangement	1
6	Three Phase Induction Motor with Loading Arrangement	2
7	Single Phase Induction Motor with Loading Arrangement	1
8	DC Shunt Motor Coupled With DC Compound Generator	2
9	DC Shunt Motor Coupled With DC Shunt Motor	1
10	Tachometer-Digital/Analog	8
11	Single Phase Auto Transformer	2
12	Three Phase Auto Transformer	1
13	Single Phase, Three Phase Resistive Loading Bank	2 each

TOTAL : 60 PERIODS

co	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	3	3		1								1	2	2		
2	3	3		1								1	2	2		
3	3	3	2	2								2	3	3		
4	3	3										1	2	2		
5	3	3										1	2	2		

1905308	ELECTRIC CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To simulate various electric circuits using Pspice/ Matlab/e-Sim / Scilab.
- To gain practical experience on electric circuits and verification of theorems.
- To gain practical experience on frequency response of RC and RLC circuit.
- To simulate the frequency response of RC and RLC circuits.
- To simulate and gain practical experience on 3 phase balanced circuit.

LIST OF EXPERIMENTS

1	Simulation and experimental verification of electrical circuit problems using Kirchhoff's voltage and current laws.
2	Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
3	Simulation and experimental verification of electrical circuit problems using Norton's theorem.
4	Simulation and experimental verification of electrical circuit problems using Superposition theorem.
5	Simulation and experimental verification of Maximum Power transfer Theorem.
6	Study of Analog and digital oscilloscopes and measurement of sinusoidal voltage, frequency and power factor.
7	Simulation and Experimental validation of R-C electric circuit transients.
8	Simulation and Experimental validation of frequency response of RLC electric circuit.
9	Design and Simulation of series resonance circuit.
10	Design and Simulation of parallel resonant circuits.
11	Simulation of three phase balanced and unbalanced star, delta networks circuits.
12	Simulation and experimental verification of Millman's theorem.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- Understand and apply circuit theorems and concepts in engineering applications.
- Simulate electric circuits.

- Understand the concept of frequency response of the systems.
- Understand the concept of 3 phase balanced circuit.
- Understand the concept of 3 phase un-balanced circuit.

S.No	LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:	Quantity Required
1	Regulated Power Supply: 0 – 15 V D.C	10
2	Function Generator (1 MHz)	10
3	Single Phase Energy Meter	01
4	Oscilloscope (20 MHz)	10
5	Digital Storage Oscilloscope (20 MHz)	1
6	PC	10
7	Circuit Simulation Software (e-Sim/ Scilab/ Pspice / MATLAB / other Equivalent software Package)	Min.10 Users
8	Printer	1
9	AC/DC - Voltmeters	10
10	Ammeters	10
11	Multi-meters	10
12	Single Phase Wattmeter	3
13	Decade Resistance Box, Decade Inductance Box, Decade Capacitance Box	6 Nos. each
14	Circuit Connection Boards	10
15	Resistors, Inductors, Capacitors of various capacities (Quarter Watt to 10 Watt)	As Required

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1						2		3				1			
2	1	1			1						2			2	2	
3				1			3	2			2			2		3
4	1	1										3			2	
5			1		1			2	3					3		

1918401 **NUMERICAL METHODS**

L	T	P	C
3	1	0	4

OBJECTIVES:

- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals in real life.
- To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering
- To understand the knowledge of various techniques and methods of solving various types of ordinary differential equations.
- To give knowledge about numerical solving one dimensional wave and heat equations.

UNIT-I: SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

9L+3T

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method , Inverse of a matrix by Jordan Method –Iterative method of Gauss Seidel –Dominant Eigenvalue of a matrix by Power method.

UNIT-II: INTERPOLATION AND APPROXIMATION

9L+3T

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Difference operators and relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT-III: NUMERICAL DIFFERENTIATION AND INTEGRATION

9L+3T

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

UNIT-IV: INITIAL VALUE PROBLEMS FOR ORDINARYDIFFERENTIAL EQUATIONS

9L+3T

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

UNIT-V: BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

9L+3T

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: 45L+15T PERIODS

OUTCOMES:

- Understand the basic concepts and techniques of solving algebraic and transcendental equations and numerical techniques of interpolation and error approximations.
- Apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
- Understand the basic concepts of solving Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain

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. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6^{th} Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt.Ltd, 3rd Edition, New Delhi, 2007.

CO	PROGRAM OUTCOMES												Program Specific Outcomes			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
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	-	-	-	-

1905402	ELECTRICAL MACHINES-II	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge on the following topics

- Construction, principle of operation and performance of induction machines.
- Starting and speed control of three-phase induction motors.
- 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 single phase induction motors and special machines.

UNIT-I: 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 – Synchronous induction motor.

UNIT-II: STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR **9**

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

UNIT-III: SYNCHRONOUS GENERATOR **9**

Constructional details – Types of rotors – winding factors - emf equation – Synchronous reactance – Armature reaction – Phasor diagrams of non salient pole synchronous generator connected to infinite bus - Synchronizing and parallel operation – Synchronizing torque - Change of excitation and mechanical input - Voltage regulation – EMF, MMF, ZPF and A.S.A methods – steady state power-angle characteristics – Two reaction theory – slip test -short circuit transients - Capability Curves.

UNIT-IV: SYNCHRONOUS MOTOR **9**

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed - Hunting – natural frequency of oscillations – damper windings - synchronous condenser.

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 - Shaded pole induction motor - Linear induction motor – Repulsion motor - Hysteresis motor - AC series motor - Servo motors - Stepper motors - introduction to magnetic levitation systems - DC Linear Motor - Linear Synchronous Motor.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand the construction and working principle of Three phase Induction Motor.
- Ability to understand the construction and working principle of Synchronous Generator.
- Ability to understand MMF curves and armature windings.
- Ability to acquire knowledge on Synchronous motor.
- Ability to understand the construction and working principle of Special Machines.

TEXTBOOKS:

1 A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Mc Graw Hill publishing Company Ltd, 2003.

2 Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.

3 Stephen J. Chapman, 'Electric Machinery Fundamentals' 4th edition, Mc Graw Hill Education Pvt. Ltd, 2010.

REFERENCE BOOKS:

1. D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 2002.
2. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2003.
3. M.N. Bandyopadhyay, 'Electrical Machines Theory and Practice', PHI Learning PVT LTD., New Delhi, 2009.
4. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers, 3rd Edition, Reprint 2015.
5. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, 2002.
6. Alexander S. Langsdorf, 'Theory of Alternating-Current Machinery', McGraw Hill Publications, 2001.
7. Naser A and Boldea, 'Linear Electric Motors: Theory Design and Practical Applications' Prentice Hall Inc, New Jersey 1987.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	3	3	3	3	2	3	3	2					3	2	2	2
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3	3	3	3	3	2	3	3	2				2	3	2		
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5	3	3	3	3	2	3	3	2				3	3	2		

1905403 TRANSMISSION AND DISTRIBUTION

	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To study the structure of electric power system and to develop expressions for the computation of transmission line parameters.
- To obtain the equivalent circuits for the transmission lines based on distance and to determine voltage regulation and efficiency.
- To understand the mechanical design of transmission lines and to analyze the voltage distribution in insulator strings to improve theefficiency.
- To study the types, construction of cables and methods to improve the efficiency.
- To study about distribution systems, types of substations, methods of grounding, EHVAC, HVDC and FACTS.

UNIT-I: TRANSMISSION LINE PARAMETERS 9

Structure of Power System - Parameters of single and three phase transmission lines with single and double circuits - Resistance, inductance and capacitance of solid, stranded and bundled conductors, Symmetrical and unsymmetrical spacing and transposition - application of self and mutual GMD; skin and proximity effects - Typical configurations, conductor types and electrical parameters of EHV lines. Interference with Neighboring Communication circuits.

UNIT-II: MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Performance of Transmission lines - short line, medium line and long line - equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance - transmission efficiency and voltage regulation, real and reactive power flow in lines - Power Circle diagrams - Formation of Corona – Critical Voltages – Effect on Line Performance.

UNIT-III: MECHANICAL DESIGN OF LINES 9

Mechanical design of OH lines – Line Supports – Types of towers – Stress and Sag Calculation – Effects of Wind and Ice loading. Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators. Standards for testing of Insulators.

UNIT-IV: UNDER GROUND CABLE 9

Underground cable - Types of cable – Construction of single core and 3 core Cables - Insulation Resistance – Potential Gradient - Capacitance of Single-core and 3 core cables - Grading of cables - Power factor and heating of cables – DC cables.

UNIT-V: DISTRIBUTION SYSTEMS 9

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions - Techniques of Voltage Control and Power factor improvement – Distribution Loss – Types of Substations - Methods of Grounding – Trends in Transmission and Distribution: EHVAC, HVDC and FACTS (Qualitative treatment only).

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- To understand the importance and the functioning of transmission line parameters.
- To acquire knowledge on the performance of Transmission lines.
- To understand the concepts of Lines and Insulators.
- To acquire knowledge on Underground Cables.
- To understand the importance of distribution of the electric power in power system and to become familiar with the function of different components used in T&D systems.

TEXTBOOKS:

1. S.N. Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2011.
2. C.L.Wadhwa, "Electrical Power Systems", New Academic Science Ltd, 2009.

3. D.P.Kothari, I.J. Nagarath, “Power System Engineering”, Mc Graw-Hill Publishing Company limited, New Delhi, Second Edition, 2008.

REFERENCE BOOKS:

1. B.R.Gupta, “Power System Analysis and Design” S. Chand, New Delhi, Fifth Edition, 2008.
2. Luces M.Fualken berry, Walter Coffer, “Electrical Power Distribution and Transmission”, Pearson Education, 2007.
3. Arun Ingole, "power transmission and distribution" Pearson Education, 2017.
4. J.Brian, Hardy and Colin R.Bayliss “Transmission and Distribution in Electrical Engineering”, Newnes; Fourth Edition, 2012.
5. G.Ramamurthy, “Handbook of Electrical power Distribution,” Universities Press, 2013.
6. V.K.Mehta, Rohit Mehta, “Principles of power system”, S. Chand & Company Ltd, New Delhi, 2013.

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1905404	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following topics

- Basic functional elements of instrumentation.
- Fundamentals of electrical and electronic instruments.
- Comparison between various measurement techniques.
- Various storage and display devices.
- Various transducers and the data acquisition systems.

UNIT-I: INTRODUCTION 9

Functional elements of an instrument – Classification of Instruments - Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration - Principle and types of analog and digital voltmeters, ammeters.

UNIT-II: ELECTRICAL AND ELECTRONIC INSTRUMENTS 9

Principle and types of multi meters – Single and three phase watt meters and energy meters – Magnetic measurements – Determination of B-H curve and measurements of iron loss – Instrument transformers – Instruments for measurement of frequency and phase.

UNIT-III: COMPARATIVE METHODS OF MEASUREMENTS 9

D.C and AC potentiometers, D.C (Wheat stone, Kelvin and Kelvin Double bridge) & A.C bridges (Maxwell, Anderson and Schering bridges), transformer ratio bridges, self-balancing bridges. Interference & screening – Multiple earth and earth loops - Electrostatic and electromagnetic Interference – Grounding techniques.

UNIT-IV: STORAGE AND DISPLAY DEVICES 9

Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Data Loggers.

UNIT-V: TRANSDUCERS AND DATA ACQUISITION SYSTEMS 9

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive Transducers – Piezoelectric, Hall effect, Mechanical Transducers, optical and digital transducers – Elements of data acquisition system – Smart sensors - Thermal Imagers.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- To acquire knowledge on Basic functional elements of instrumentation.
- To understand the concepts of Fundamentals of electrical and electronic instruments.
- Ability to compare between various measurement techniques.
- To acquire knowledge on various storage and display devices.
- To understand the concepts Various transducers and the data acquisition systems.

TEXTBOOKS:

1. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2010.
2. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2013.
3. Doebelin E.O. and Manik D.N., 'Measurement Systems – Applications and Design', Special Indian Edition, McGraw Hill Education Pvt. Ltd., 2007.

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1. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, III Edition 2010.
2. D.V.S. Murthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2015.
3. David Bell, 'Electronic Instrumentation & Measurements', Oxford University Press, 2013.
4. Martin Reissland, 'Electrical Measurements', New Age International (P) Ltd., Delhi, 2001.
5. Alan. S. Morris, 'Principles of Measurements and Instrumentation', 2nd Edition, Prentice Hall of India, 2003.

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1905405	ELECTROMAGNETIC THEORY	L	T	P	C
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OBJECTIVES:

To impart knowledge on the concepts of

- Electrostatic fields, electrical potential, energy density and their applications
- Coordinate systems, basic theorems and applications in electric field
- Magneto static fields, magnetic flux density, vector potential and its applications
- Different methods of emf generation and Maxwell's equations
- Electromagnetic waves and characterizing parameters

UNIT-I: ELECTROSTATICS – I 9

Sources and effects of electromagnetic fields – Coordinate Systems – Vector fields – Gradient, Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and applications.

UNIT-II: ELECTROSTATICS – II 9

Electric potential – Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization – Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

UNIT-III: MAGNETOSTATICS 9

Lorentz force, magnetic field intensity (H) – Biot–Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media – Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.

UNIT-IV: ELECTRODYNAMIC FIELDS 9

Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current - Maxwell's equations (differential and integral form, Phasor form) – Relation between field theory and circuit theory – Applications.

UNIT-V: ELECTROMAGNETIC WAVES 9

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction. Transmission lines-Line equations-Input impedances-Standing wave application.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand the basic mathematical concepts related to electromagnetic vector fields
- Ability to understand the basic concepts about electrostatic fields, electrical potential, energy density and their applications
- Ability to acquire the knowledge in magneto static fields, magnetic flux density, vector potential and its applications
- Ability to understand the different methods of emf generation and Maxwell's equations
- Ability to understand the basic concepts electromagnetic waves and characterizing parameters

TEXTBOOKS:

1 Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.

2 William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.

3 Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.

REFERENCE BOOKS:

1 V.V.Sarwate, 'Electromagnetic fields and waves', First Edition, Newage Publishers, 1993.

2 J.P.Tewari, 'Engineering Electromagnetics- Theory, Problems and Applications', Second Edition, Khanna Publishers.

3 Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), McGraw Hill, 2010.

4 S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education(India) Private Limited, 2012.

5 K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Eighth Reprint: 2015.

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1915001 **PROFESSIONAL ETHICS** L T P C

3 0 0 3

OBJECTIVES:

- To introduce and educate the students on the concept of Human Values.
- To enable the students to have awareness on Engineering Ethics theories and models.
- To make students understand the code of ethics and fundamental principles in social experiments in engineering.
- To educate on safety and risk aspects in engineering and to appreciate the rights of others.
- To create awareness about international issues related to ethics.

UNIT – I: HUMAN VALUES 9

Moral values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Introduction to Yoga and Meditation for professional excellence and stress management - Simple Living and High Thinking, Science and Spirituality.

UNIT – II: ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of Professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT – III: ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters - Engineer's Responsibilities to Economically Deprived People and Environment, Corruption – Codes of Ethics- Fundamental Principles – A Balanced Outlook on Law – Challenger Case Study

UNIT – IV: SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk –Government Regulator's approach to risks - The Three Mile Island, Chernobyl & Bhopal Case Studies, Greenery Effects - Collegiality and Loyalty - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Unethical Behaviour at Work Place – Reporting Unethical Behaviour- Professional Rights – Employee Rights – Intellectual Property Rights (IPR).

UNIT – V: INTERNATIONAL ISSUES 9

Multinational corporations - Business ethics - Environmental ethics - Internet ethics - Role in Technological Development - Weapons development-engineers as managers - Consulting Engineers - Engineers as expert witnesses and advisors - Honesty - leadership - Sample code of conduct ethics - ASME, ASCE, IEEE, Institution of Engineers (India),Indian Institute of Materials Management Institution of electronics and telecommunication engineers (IETE), India – Corporate Social Responsibility, Indian and Western Culture – Cyber Crime.

TOTAL: 45 PERIODS

OUTCOMES:

- Students should be able to understand human values and apply ethics in societal issues.
- Students will be able to get understanding on nuances of engineering ethics.
- Student will have an understanding of engineer’s responsibility to society and code of ethics
- Students will understand risk and safety issues related to engineering.
- Students will be able to advocate on applying ethical principles in international context.

TEXT BOOKS:

1. World Community Service Centre, “Value Education", Vethathiri publications, Erode, 2011.
2. R. Subramanian, ‘Professional Ethics’ Oxford University Press, 2nd

Edition 2017

3. R. S. Nagarazan, ‘A Textbook on Professional Ethics and Human Values’ New Age International Publishers, 2015
4. Sekhar, R.C., Ethical Choices in Business Response Books, New Delhi, Sage Publications,1997

REFERENCES:

1. Langford, Duncan (EDT): Internet Ethics, London, Macmillan Press Ltd., 2000.
2. Erwann, M. David, Michele S. Shauf, Computers, Ethics and Society, Oxford University Press,2003
3. Alan Kitson and Robert Campbell:” The Ethical Organisation”, Red Globe Press, 2008.
4. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Professional Ethics and Human Values”, Prentice Hall of India, New Delhi, 2013.
5. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw Hill, New York, 3rd edition (2017).

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1905406 ELECTRICAL MACHINES LABORATORY-II

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OBJECTIVES:

- To expose the students to the operation of synchronous machines.
- To impart knowledge on voltage regulation of alternators.
- To expose the students to the operation of induction motors.
- To impart knowledge on equivalent circuit of the induction motors.
- To impart knowledge on necessity of starters.

LIST OF EXPERIMENTS

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

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should have the:

- Ability to understand the importance of Induction machines.
- Ability to acquire knowledge on separation of losses.
- Ability to understand and analyze EMF and MMF methods.
- Ability to understand the importance of Synchronousmachines.
- Ability to analyze the characteristics of V and Inverted Vcurves.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

1.	Synchronous Induction motor 3HP	1
2.	DC Shunt Motor Coupled With Three phase Alternator	4
3.	DC Shunt Motor Coupled With Three phase Slip ring Induction motor	1
4.	Three Phase Induction Motor with Loading Arrangement	2
5.	Single Phase Induction Motor with Loading Arrangement	2
6.	Tachometer-Digital/Analog	8
7.	Single Phase Auto Transformer	2
8.	Three Phase Auto Transformer	3
9.	Single Phase Resistive Loading Bank	2
10.	Three Phase Resistive Loading Bank	2
11.	Capacitor Bank	1

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1905407	TECHNICAL SEMINAR	L	T	P	C
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OBJECTIVES:

- To encourage the students to study advanced engineering developments.
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as power point presentation and demonstrative models.

METHOD OF EVALUATION:

During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for duration of about 8 to 10 minutes. In a session of three periods per week, 15 students are expected to present the seminar. Each student is expected to present at least twice during the semester and the student is evaluated based on that. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

TOTAL :30 PERIODS

COURSE OUTCOMES:

1. Ability to review, prepare and present technological developments.
2. Ability to face the placement interviews.

1919001 Communication Skills laboratory – Project based

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The Course will enable learners to:

- Equip students with the English language skills required for the successful undertaking of academic studies with primary emphasis on academic speaking and listening skills.
- Provide guidance and practice in basic general and classroom conversation and to engage in specific academic speaking activities and make effective presentations.
- Improve general and academic listening skills and technical writing skills.
- Strengthen the reading skills of students of engineering.
- Provide more opportunities to develop their project and proposal writing skills.

UNIT- I Informal Communication – An Introduction 6

Listening - Listening as a key skill- its importance- **Speaking** - give personal information - ask for personal information - express ability - enquire about ability – rephrase for clarification or emphasis - Improving pronunciation – Articulation of speaking –vowel sounds. **Reading** – Strategies for effective reading- Read and recognize different text types in a newspaper - **Writing**-Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence.

UNIT- II Mechanics of Basic Communication 6

Listening - Listen to a process information- **Speaking** - asking for details formal/informal – give views, opinions and justification of a news- consonant sounds –diphthongs -.- **Reading**-Read for vocabulary through scientific invention the same into a paragraph-. **Writing**- compare and contrast ideas using adjectives from multiple sources stating reasons and examples to support ideas. Write a paragraph with reasons and examples- Write a rejoint to a newspaper expressing opinions on particular news.

UNIT- III Nuances of LSRW **6**

Listening - Lexical chunking for accuracy and fluency- factors that influence fluency- listen for and follow the gist- listen for detail **Speaking** - deliver a five-minute informal talk - invite and offer - accept - decline - take leave - word stress – stress rules-ability to recognize RP sound.– **Reading**-skimming / Scanning a text to apply both the concepts – to search – to analyze. **Writing**–Use of dictionary and usage of

UNIT- IV Technical Communication-Basic presentation Skills **6**

Listening - Being an active listener: giving verbal and non-verbal feedback- listening to a podcast of a native speaker and reciprocating **Speaking** - participating in a group discussion - conversational speech listening to and participating in conversations - persuade.– Sentence stress – intonations types-features of connected speech –**Reading**-Genre and Organization of Ideas- note taking and summarizing **Writing–**Email writing- Job application- Blog writing.

UNIT- V Communication Skills for Formal Occasion **6**

Listening : Listening to documentaries and make notes (TED talks) **Speaking** - Power point presentation - strategies for presentations and interactive communication - group/pair presentations –use stress and intonation to convey meaning and nuances of meaning clearly- **Reading-**Technical passages for comprehension- understanding how the text positions the reader- **Writing**– Statement of Purpose - analyse the situation in a picture / photo and write a suitable description with a proper title

TOTAL : 30 PERIODS

The lab course is offered as an **Employability Enhancement Course.**

The Course will have an Internal End semester exam includes a **project work**. The Students need to have **75% attendance** for the completion of the course.

OUTCOMES:

At the end of the course Learners will be able to:

- Read and evaluate texts critically
- Make effective presentations
- Participate confidently and appropriately in conversations both formal and informal
- Write winning job applications.
- Display critical thinking in various professional contexts.

REFERENCE BOOKS:

1. Gramer F.Margot and Colin S.Ward 'Reading and Writing' (Level 3) Oxford University Press: Oxford, 2011.
2. Debra Daise, CharlNorloff, and Paul 'Reading and Writing' (Level 4) Oxford University Press: Oxford, 2011
3. Brooks, Margret. 'Skills for Success. Listening and Speaking.'(Level 4)Oxford University Press, Oxford: 2011.
4. Richards,C. Jack. & David Bholke. 'Speak Now'(Level 3.) Oxford University Press, Oxford: 2010
5. Davis,Jason and Rhonda LIss. 'Effective Academic Writing' (Level 3) Oxford University Press: Oxford, 2006
6. E.Suresh Kumar. 'Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012
7. Petelin, Roslyn and Marsh Durham. 'The Professional Writing Guide: Knowing Well and Knowing Why'. Business & Professional Publishing: Australia, 2004.
8. Bhatnagar, Nitin and Mamta Bhatnagar. 'Communicative English for Engineers and Professionals'. Pearson: New Delhi, 2010.
9. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.
10. Vargo, Mari. Speak Now (Level 4). Oxford University Press: Oxford, 2013.
11. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.
12. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014
13. IELTS, TOFEL testing series

14. Jack c. Richards. Tactics for Listening: Developing. Oxford University Press: Oxford,.2004
15. New Oxford Dictionary for writers and editors: The essential A-Z Guide to the Written Word 2005.

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CO3	3	3	-	2	-	-	-	-	-	3	-	1	1	1	1	1
CO4	3	3	-	-	-	-	3	-	-	2	-	1	1	1	1	1
CO5	3	2	2	-	-	-	-	-	-	3	-	1	2	1	1	2

1905501	POWER SYSTEM ANALYSIS	L	T	P	C
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OBJECTIVES:

- To model the power system components under steady state operating condition.
- To understand and apply iterative techniques for power flow analysis.
- To model and carry out symmetrical short circuit studies on power system.
- To model and carry out Un-symmetrical short circuit studies on power system.
- To model and analyze stability problems in power system.

UNIT-I: POWER SYSTEM OVERVIEW 9

Need for system planning and operational studies - Power scenario in India - Power system components – Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram - Network graph, Bus incidence matrix, Primitive parameters, Bus admittance matrix from primitive parameters - Representation of off- nominal transformer - Formation of bus admittance matrix of large power network.

UNIT-II: POWER FLOW ANALYSIS 9

Bus classification - Formulation of Power Flow problem in polar coordinates - Power flow solution using Gauss Seidel method - Handling of Voltage controlled buses - Power Flow Solution by Newton Raphson method.

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 OUTCOMES:

- Ability to model the power system components under steady state operating condition.
- Ability to understand and apply iterative techniques for power flow analysis.
- Ability to model and carry out symmetrical short circuit studies on power system.
- Ability to model and find the parameters needed for protection of power system.
- Ability to model and analyze stability problems in power system

TEXTBOOKS:

1. John J. Grainger, William D. Stevenson, Jr, “Power System Analysis”, Mc Graw Hill Education (India) Private Limited, New Delhi, 2017.
2. Kothari D.P. and Nagrath I.J., “Power System Engineering”, Tata McGraw-Hill Education, Third Edition, 2019.
3. Hadi Saadat, “Power System Analysis”, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.
4. Pai M A, Chatterjee “Computer Techniques in Power System Analysis”, Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Third Edition, 2017.

REFERENCE BOOKS:

1. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, “Power System Analysis & Design”, Cengage Learning, Fifth Edition, 2012.
2. Gupta B.R., “Power System - Analysis and Design”, S. Chand Publishing, 2005.
3. Kundur P., “Power System Stability and Control”, Tata McGraw Hill Education Pvt.Ltd., New Delhi, 10th reprint, 2010.

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1905502	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following Topics

- Architecture of µP8085 & µC 8051
- Architecture of µP8086
- Addressing modes & instruction set of 8085 & 8051.
- Need & use of Interrupt structure 8085 & 8051.
- Simple applications development with programming 8085 & 8051

UNIT-I: 8085 PROCESSOR 9

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts – 8086 Processor (Architecture only).

UNIT-II: PROGRAMMING OF 8085 PROCESSOR 9

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

UNIT-III: 8051 MICRO CONTROLLER 9

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts- Data Transfer, Manipulation, Control Algorithms& I/O instructions, Comparison to Programming concepts with 8085.

UNIT-IV: PERIPHERAL INTERFACING 9

Study on need, Architecture, configuration and interfacing, with ICs: 8255, 8259, 8254, 8279, - A/D and D/A converters &Interfacing with 8085& 8051.

UNIT-V: MICRO CONTROLLER PROGRAMMING & APPLICATIONS 9

Simple programming exercises- key board and display interface –Control of servo motor- stepper motor control- Application to automation systems. Arduino UNO

Board-Architecture-Arduino IoT - Communications -Sensing-Displays. Raspberry Pi Development Board- Architecture - Raspberry Pi IoT - Communication facilities on raspberry Pi (I2C, SPI, UART)-Interfacing of Sensors and Actuators.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to acquire knowledge in Addressing modes & instruction set of 8085 & 8051.
- Ability to need & use of Interrupt structure 8085 & 8051.
- Ability to understand the importance of Interfacing.
- Ability to explain the architecture of Microprocessor and Microcontroller and it's applications.
- Ability to write the assembly language programme.

TEXTBOOKS:

1. Sunil Mathur & Jeebananda Panda, "Microprocessor and Microcontrollers", PHI Learning Pvt. Ltd, 2016.
2. R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013.
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D. Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003.

REFERENCE BOOKS:

1. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2007.
2. B.RAM," Computer Fundamentals Architecture and Organization" New Age International Private Limited, Fifth edition, 2017.
3. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.
4. Ajay V.Deshmukh, 'Microcontroller Theory &Applications', McGraw Hill Edu,2016
5. Douglas V.Hall, 'Microprocessor and Interfacing', McGraw Hill Edu,2016.
6. Arduino for Beginners: Essential Skills Every Maker Needs, John Baichtal, Pearson Education, Inc.,1st edition
7. Raspberry Pi User Guide, Eben Upton and Gareth Halfacree, John Wiley & sons,2016

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1905503 **POWER ELECTRONICS**

L	T	P	C
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OBJECTIVES:

To impart knowledge on the following Topics

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

UNIT-I: POWER SEMI-CONDUCTOR DEVICES 9

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

UNIT-II: PHASE-CONTROLLED CONVERTERS 9

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

UNIT-III: DC TO DC CONVERTERS 9

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

UNIT-IV: INVERTERS 9

Single phase and three phase voltage source inverters (both120° 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. SMPS-HVDC and FACTS systems.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to acquire the knowledge o f different types of power semiconductor devices and their switching.
- Ability to acquire the knowledge o n operation, characteristics and performance parameters of controlled rectifiers.
- Ability to acquire the knowledge on operation, switching techniques and basics topologies of DC-DC switching regulators.
- Ability to acquire the knowledge on different modulation techniques of pulse width modulated inverters and harmonic reduction methods.
- Ability to acquire the knowledge on operation of AC voltage controller and various configurations.

TEXTBOOKS:

1. M.H. Rashid, ‘Power Electronics: Circuits, Devices and Applications’, Pearson Education, Third Edition, New Delhi, 2004.
2. P.S.Bimbra “Power Electronics” Khanna Publishers, fourth Edition, 2007.
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, 6th Reprint, 2013.
2. Philip T. Krein, “Elements of Power Electronics” Oxford University Press, 2004 Edition.
3. L. Umanand, “Power Electronics Essentials and Applications”, Wiley, 2010.

4. Ned Mohan Tore. M. Undel and, William. P. Robbins, 'Power Electronics Converters, Applications and Design', John Wiley and sons, third edition, 2003.
5. S.Rama Reddy, 'Fundamentals of Power Electronics', Narosa Publications, 2014
6. M.D. Singh and K.B. Khanchandani, "Power Electronics," Mc Graw Hill India, 2013.
7. Jai P Agarwal," Power Electronic Systems: Theory and Design" firstedition, Pearson Education, 2009.

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1905504	CONTROL SYSTEMS	L	T	P	C
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OBJECTIVES:

- Transfer function models for analysis physical systems and introduce the control system components
- Knowledge in the time response of systems and steady state error analysis.
- Basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- Stability analysis and design of compensators
- 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, Synchros, – 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, N i c ho l s C h a r t – 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- Lag ,lead, lag-lead network, Performance criteria – Effect of Lag, lead and lag-lead compensation on frequency response-Design of Lag, lead and lag- lead compensator using bode plots.

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 OUTCOMES:

- Ability to develop various representations of system based on the knowledge of Mathematics, Science and Engineering fundamentals.
- Ability to do time domain and frequency domain analysis of various models of linear system.
- Ability to interpret characteristics of the system to develop mathematical model.
- Ability to understand and design appropriate compensator for the given specifications.
- Ability to design State variable representation of physical systems

TEXTBOOKS:

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,Twelth Edition,2011.
3. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
4. Rames C.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.
6. NPTEL Video Lecture Notes on “Control Engineering “by Prof. S. D. Agashe, IIT Bombay.

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1905505	DIGITAL SIGNAL PROCESSING	L	T	P	C
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OBJECTIVES:

- To classify signals and systems & their mathematical representation
- To analyse the discrete time systems.
- To study various transformation techniques & their computation.
- To study about filters and their design for digital implementation.
- To study about a programmable digital signal processors.

UNIT-I: SIGNALS AND SYSTEMS 9

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; Sampling and reconstruction of signals - aliasing; Sampling theorem, Nyquist rate, quantization and quantization error.

UNIT-II: DISCRETE TIME SYSTEM ANALYSIS 9

Analysis of Discrete-Time Linear Time-invaraint System, Convolution Sum, z-Transform, Region of Convergence, Properties of z-transform, Inverse z-transforms, Analysis of Linear Shift Invariant systems using z-transform, Interpretation of stability in z-domain. Discrete Time Fourier transform, magnitude and phase representation

UNIT-III: DISCRETE FOURIER TRANSFORM & COMPUTATION 9

Discrete Fourier Transform- properties, magnitude and phase representation - Properties of DFT - periodicity, symmetry, circular convolution. Filtering long data sequences - overlap save and overlap add method. Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT – Butterfly structure.

UNIT-IV: DESIGN OF DIGITAL FILTERS 9

FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. Analog filter design – Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation

UNIT-V: DIGITAL SIGNAL PROCESSORS 9

DSP functionalities - Circular buffering – DSP architecture – Fixed and Floating point architecture principles – Addressing Formats – Functional modes - Introduction to Commercial DSP Processors.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to acquire knowledge on Signals and systems & their mathematical representation
- Ability to understand and analyze the discrete time systems.
- Ability to analyze the transformation techniques & their computation.
- Ability to understand the types of filters and their design for digital implementation.
- Ability to acquire knowledge on programmability digital signal processors

TEXTBOOKS:

1 J.G. Proakis and D.G. Manolakis, ‘Digital Signal Processing Principles, Algorithms and Applications’, Pearson Education, 2007.

2 S.K. Mitra, ‘Digital Signal Processing – A Computer Based Approach’, McGraw Hill Edu, 2013

3 Lonnie C.Ludeman ,”Fundamentals of Digital Signal Processing”,Wiley,2013

4 Bhaskar, M. and Venkataramani, B, “Digital signal processors: architecture, programming and applications”, Tata McGraw-Hill Pub, 2002

REFERENCE BOOKS:

1 Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using Matlab”, Cengage Learning,2014.

2 B.P.Lathi, ‘Principles of Signal Processing and Linear Systems’, Oxford University Press, 2010 3. Taan S. ElAli, ‘Discrete Systems and Digital Signal Processing with Mat Lab’, CRC Press, 2009.

3 Sen M.Kuo and Woon-Seng S.Gan, “Digital Signal Processors, Architecture, Implementations & Applications, Pearson,2013

4 Richard G. Lyons, Understanding Digital Signal Processing (3rd Edition), prantice hall,2011

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1905506	**CONTROL AND INSTRUMENTATION LABORATORY**	**L T P C** **0 0 4 2**

OBJECTIVES:

To provide knowledge on analysis and design of control system along with basics of instrumentation.

- To understand the design of controller and stability analysis technique
- To understand the design compensators techniques
- To understand the basic concepts of bridge networks.
- To understand the basics of signal conditioning circuits.
- To understand the simulation packages.

LIST OF EXPERIMENTS

CONTROLSYSTEMS:

1 Study of P, PI and PID controllers
2 Stability Analysis
3 Modeling of Systems – Machines, Sensors and Transducers
4 Design of Lag, Lead and Lag-Lead Compensators
5 Position Control Systems
6 Synchro-Transmitter- Receiver and Characteristics
7 Simulation of Control Systems by Mathematical development tools.

INSTRUMENTATION:

8 Bridge Networks –AC and DC Bridges.
9 Dynamics of Sensors/Transducers
(a) Temperature (b) pressure (c) Displacement (d) Optical (e) Strain (f) Flow
10 Power and Energy Measurement
11 Signal Conditioning Circuits
(a) Instrumentation Amplifier
(b) Analog – Digital and Digital –Analog converters (ADC and DACs)
12 Process Simulation
13 Simulation of Time domain and Frequency domain specifications.

TOTAL :60 PERIODS

COURSE OUTCOMES:

- Ability to understand control theory and apply them to electrical engineering problems and analyze various converters
- Ability to design compensators
- Ability to understand the basic concepts of bridge networks
- Ability to the basics of signal conditioning circuits
- Ability to study the simulation packages

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

CONTROL SYSTEMS:

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

INSTRUMENTATION:

9	R, L, C Bridge kit (with manual)	
10	a) Electric heater	1 No.
	Thermometer	1 No.
	Thermistor (silicon type) RTD nickel type	1 No.
	b) 30 psi Pressure chamber (complete set)	1 No.
	Current generator (0 – 20mA) Air foot pump (with necessary connecting tubes)	1 No.
	c) LVDT 20mm core length movability type	1 No.
	CRO 30MHz	1 No.
	d) Optical sensor and Light source	1 No.
	e) Strain Gauge Kit with Handy lever beam	1 No.
	100gm weights	10 No.
	f) Flow measurement Trainer kit (1/2 HP Motor, Water tank, Digital Milli ammeter, complete set)	1 No.
11	Single phase Power and Energy Measurement	1 No.
	Single phase Auto transformer	
	Watt-hour meter (energy meter)	1 No.
	Ammeter	1 No.
	Voltmeter	1 No.
	Rheostat	1 No.
	Stop watch	1 No.
	Connecting wires (3/20)	Few
12	IC Transistor kit	1 No.
13	Instrumentation Amplifier kit	1 No.
	Analog – Digital and Digital –Analog converters (ADC and	1 No.
14	DACs).	

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1905507	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	L	T	P	C
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OBJECTIVES:

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

Programming exercises / Experiments with µP8085:

1	Simple arithmetic operations: Multi precision addition / subtraction /multiplication / division.
2	Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
3	Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller.
4	Stepper motor controller interface.

Programming exercises / Experiments with µC8051:

5	Simple arithmetic operations with 8051: Multi precision addition / subtraction / multiplication / division.
6	Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
7	Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller.

8 Stepper motor controller interface.

Experiments with Digital ICs:

9 Study of Basic Digital IC's.
(Verification of truth table for AND, OR, EXOR, NOT, NOR, NAND, JK FF, RS, FF, D FF)

10 Implementation of Boolean Functions, Adder/ Subtractor circuits; Realizing given function with minimum number of gates by minimization methods.

11 Study of binary / BCD counters, modulo-n counters.

12 Design and implementation of Synchronous sequential counters.

13 Programming ARM architecture with software tools.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- Ability to design and implement combinational logic circuits and to analysis simple sequential logic circuits.
- Ability to write assembly language program for microprocessor and microcontroller.
- Ability to design and implement interfacing of peripheral with microprocessor and microcontroller.
- Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring.
- Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

1	8085 Microprocessor Trainer with Power Supply	15
2	8051 Micro Controller Trainer Kit with power supply	15
3	8255 Interface boards	5
4	8251 Interface boards	5
5	8259 Interface boards	5
6	8279 Keyboard / Display Interface boards	5
7	8254 timer/ counters	5
8	ADC and DAC cards	5
9	AC & DC motor with Controllers	5

10 Traffic Light Control Systems 5

11 Stepper motor Controllers 5

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1905601	SOLID STATE DRIVES	L	T	P	C
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OBJECTIVES:

- To understand steady state operation and transient dynamics of a motor load system
- To study and analyze the operation of the converter/chopper fed DC drive, both qualitatively and Quantitatively
- To study and understand the operation and performance of AC motor drives
- To analyze and design the current and speed controllers for a closed loop solid state DC motor drives
- To study and understand the operation and performance of synchronous motor drives

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, modes of operation.

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 and discontinuous conduction– Time ratio and current limit control – 4 quadrant operations of converter / chopper fed drive-Effect of ripples on the DC motor performance.

UNIT-III: INDUCTION MOTOR DRIVES 9

Stator voltage control–energy efficient drive–v/f control–constant air gap flux–field weakening mode– Voltage / current fed inverter – closed loop control-slip power recovery scheme- 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. Effects of Harmonics.

UNIT-V: DESIGN OF CONTROLLERS FOR DRIVES 9

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback–armature voltage control and field weakening mode –

Design of Controllers; current controller and speed controller- converter selection and characteristics

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand drive characteristics
- Ability to understand chopper fed drive
- Ability to understand induction motor drives
- Ability to understand synchronous motor drives
- Ability to understand design of controllers for drives

TEXTBOOKS:

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, Prentice Hall of India, 2001

REFERENCE BOOKS:

1. John Hindmarsh and Alasdain Renfrew, “Electrical Machines and Drives System,” Elsevier 2012

2 Shaahin Felizadeh, “Electric Machines and Drives”, CRC Press(Taylor and Francis Group),2013.

3 S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 1993

4 S. Sivanagaraju, M. Balasubba Reddy, A. Mallikarjuna Prasad “Power semiconductor drives” PHI, 5th printing, 2013

5 N.K.De., P.K.SEN”Electric drives” PHI, 2012

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1905602	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following topics

- 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 centers- 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. Introduction of Restructured power system.

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 – special aspects of short term and long term hydrothermal problems.

UNIT –V: COMPUTER CONTROL OFPOWER 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 problem – measurements and errors - weighted least square estimation - various operating states - state transition diagram.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand the significance of power system operation and control.
- Ability to acquire knowledge on real power-frequency interaction.
- Ability to understand the reactive power-voltage interaction.
- Ability to analyze the control actions to be implemented on the system to meet the minute-to-minute variation of system demand and Economic operation of power system.
- Ability to design SCADA and its application for real time operation.

TEXTBOOKS:

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.

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1905603	DESIGN OF ELECTRICAL APPARATUS	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following topics

- Magnetic circuit parameters and thermal rating of various types of electrical machines.
- Core, yoke, windings and cooling systems of transformers and the importance of computer aided design method.
- Armature and field systems for D.C. machines and computer aided design method.
- Design of stator and rotor of induction machines and computer aided design method.
- Design of stator and rotor of synchronous machines and the computer aided design method.

UNIT-I: DESIGN OF FIELD SYSTEM AND ARMATURE 9

Major considerations in Electrical Machine Design – Materials for Electrical apparatus – Space factor –Choice of Specific Electrical and Magnetic loadings - Design of Magnetic circuits – Magnetising current – Flux leakage – Leakage in Armature. Design of lap winding and wave winding.

UNIT-II: DESIGN OF TRANSFORMERS 9

Construction - KVA output for single and three phase transformers – Overall dimensions – design of yoke, core and winding for core and shell type transformers – Estimation of No load current – Temperature rise in Transformers – Design of Tank and cooling tubes of Transformers. Computer program: Complete Design of single phase core transformer.

UNIT-III: DESIGN OF DC MACHINES 9

Construction - Output Equations – Main Dimensions – Choice of specific loadings – Carter’s Coefficient - Net length of Iron –Real & Apparent flux densities - Selection of number of poles – Design of Armature – Design of commutator and brushes – design of field - Computer program: Design of Armature main dimensions.

UNIT-IV: DESIGN OF INDUCTION MOTORS 9

Construction - Output equation of Induction motor – Main dimensions – choice of specific loadings – Length of air gap - Design of squirrel cage rotor and wound rotor –Magnetic leakage calculations – Operating characteristics : Magnetizing current - Short circuit current – Circle diagram - Computer program: Design of slip-ring rotor.

UNIT-V: DESIGN OF SYNCHRONOUS MACHINES 9

Output equations – Main Dimensions - choice of specific loadings – Design of salient pole machines – Short circuit ratio – shape of pole face - Armature design – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field MMF – Design of field winding – Design of turbo alternators -Computer program: Design of Stator main dimensions-Brushless DC Machines.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand basics of design considerations for rotating and static electrical machines and design of field system for its application.
- Ability to design single and three phase transformer.
- Ability to design armature and field of DC machines.
- Ability to design stator and rotor of induction motor.
- Ability to design and analyze synchronous machines.

TEXTBOOKS:

1 Sawhney, A.K., ‘A Course in Electrical Machine Design’, Dhanpat Rai& Sons, New Delhi, Fifth Edition, 1984.

2 M V Deshpande ‘Design and Testing of Electrical Machines’ PHI learning Pvt Lt, 2011.

3 Sen, S.K., ‘Principles of Electrical Machine Designs with Computer Programmes’, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2009.

REFERENCE BOOKS:

1 V Rajini, V.S Nagarajan, 'Electrical Machine Design', Pearson, 2017.
2 K.M.Vishnumurthy 'Computer aided design of electrical machines' B S Publications, 2008.
3 A.Shanmugasundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint 2007.
4 'Electrical Machine Design', Balbir Singh, Vikas Publishing House Private Limited, 1981.

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4	3	3	2	2	2								2	1		
5	3	3	2	2	2								2	1		

1905610	POWER ELECTRONICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To provide exposure to the students with gate Pulse generation of Various Triggering.
- To provide exposure to the students Characteristics of SCR ,TRIAC MOSFET and IGBT.
- To provide exposure to the students Characteristics of Controlled Converter and Chopper single Phase and Three Phase PWM Inverter and AC Voltage Controller, SMPS.
- To provide exposure to the students Simulation of Various Power Electronics Circuits.
- To provide better understanding Characteristics of GTO, PMBLDC Motor and dynamics Characteristics of SCR and MOSFET.

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 converters, 1Φ & 3Φ full converters, DC-DC converters, AC voltage controllers
12. Characteristics of GTO
13. Characteristics of PMBLDC motor
14. Dynamic Characteristics of SCR and MOSFET.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- Ability to practice and understand students with gate Pulse generation of Various Triggering.
- Ability to experiment about Characteristics of SCR ,TRIAC, MOSFET and IGBT.
- Ability to experiment about Characteristics of Controlled Converter and Chopper single Phase and Three Phase PWM Inverter and AC Voltage Controller, SMPS.
- Ability to understanding about the Simulation of Various Power Electronics Circuits.
- Ability to understanding Characteristics of GTO, PMBLDC Motor and dynamics Characteristics of SCR and MOSFET.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

1	Device characteristics (for SCR, MOSFET, TRIAC,GTO, and IGBT kit with built-in / discrete power supply and meters)	2 each
2	Single phase SCR based half controlled converter and fully controlled converter along with built-in/separate/firingcircuit/module and meter	2 each
3	MOSFET based step up and step down choppers (Built in/ Discrete)	1 each
4	IGBT based single phase PWM inverter module/Discrete Component	2
5	IGBT based three phase PWM inverter module/Discrete Component	2
6	Switched mode power converter module/Discrete Component	1
7	SCR &TRIAC based 1 phase AC controller along with lamp or rheostat load	2
8	Cyclo converter kit with firing module	1
9	Dual regulated DC power supply with common ground	
10	Cathode ray Oscilloscope	10
11	Isolation Transformer	5
12	Single phase Auto transformer	3
13	Components (Inductance, Capacitance)	3

14	Multimeter	5
15	LCR meter	3
16	Rheostats of various ranges	2 sets of 10 value
17	Work tabilitys	10
18	DC and AC meters of required ranges	20
19	Component data sheets to be provided	

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	1	2	2	1	2				2				1			
2	1	2	2	1	2				2					2	3	
3	1	2	1	2	2				2					2	2	
4	1	2	2	1	2				2						3	
5	1	2	2	1	2				2							2

1905611 POWER SYSTEM SIMULATION LABORATORY

L	T	P	C
0	**0**	**4**	**2**

OBJECTIVES:

- To provide better understanding of power system analysis through digital simulation
- To present a problem oriented knowledge of power system analysis methods
- To address the underlying concepts & approaches behind analysis of power system network using software tools
- To identify & formulate solutions to problems relevant to power system using software tools
- To solve power flow problem for simple power systems

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 Dynamics of Single- Area and Two-Area Power Systems
9 State estimation: Weighted least square estimation
10 Electromagnetic Transients in Power Systems : Transmission Line Energization
11 Power flow analysis using Fast decoupled method.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

- Ability to understand power system planning and operational studies
- Ability to acquire knowledge on Formation of Bus Admittance and Impedance Matrices and Solution of Networks
- Ability to analyze the power flow using GS and NR method
- Ability to find Symmetric and Unsymmetrical fault

- Ability to understand the economic dispatch and analyze the electromagnetic transients

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

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

co	PO												PSO			
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2	2	3		2						2			1	2		
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4	1			2									3	1		
5	3		2		3					2		2	1	1		

1905612 **MINI PROJECT**

L	T	P	C
0	0	4	2

OBJECTIVES:

a. To develop their own innovative prototype of ideas

b. 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 prepare a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 60 PERIODS

OUTCOMES

- 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.

1919002 PROFESSIONAL COMMUNICATION L T P C

0 0 2 1

OBJECTIVES

The course aims to

- Enhance the Employability and Career Skills of students.
- Orient the students towards grooming as a professional.
- To learn how to speak in Group discussions
- Make them employable Graduates and help them attend interviews successfully.
- Develop their confidence and help them express views clearly.

UNIT- I: General English for competitive Exams 6

English for competitive exams —General awareness of Current Affairs – multiple choice – Cloze – Vocabulary Structure.

UNIT- II: Mechanics of Interpersonal Communication 6

Introduction to soft skills - Interpersonal communication - Introducing oneself to the audience –– answering questions – writing a message – memo –mail – asking for comments – giving information – agreeing to requests – apologizing – Complaining – Business proposal – short report – summarizing.

UNIT- III: Basics of Group Discussion 6

Introduction to Group Discussion— participating in group discussions-questioning and clarifying –GD strategies –monologues – dialogues – discussions.

UNIT- IV: Fundamentals of Interview Skills 6

Interview etiquette –Portfolio development- attending job interviews–FAQs related to job interviews- Interview types –expressing opinions – present circumstances - past experiences – future plans

UNIT- V: Specific skills for Career advancement 6

Recognizing differences between groups and teams - networking professionally- respecting social protocols- understanding career management- developing a long-term career plan- making career changes. – organizing a larger unit of discourse –

expressing and justifying opinions – negotiating – collaborating – disagreeing – speculating – decision taking.

TOTAL : 30 PERIODS

The lab course is offered as an **Employability Enhancement Course**

The course is offered as a **one credit** paper with an End Semester Examination.

OUTCOMES:

At the end of the course learners will be able to:

- Make effective presentations.
- Participate confidently in Group Discussions
- attend job interviews and interacting in different situations.
- write business reports, proposals and related correspondence.
- Develop adequate Soft Skills required for the workplace

REFERENCE BOOKS:

1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
2. Interact English Lab Manual for Undergraduate Students, Orient Blackswan: Hyderabad, 2016.
3. E.Suresh Kumar Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
4. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
5. S. Hariharan. Soft Skills. MJP Publishers: Chennai, 2010.
6. Successful Presentations: DVD and Student's Book. A video series teaching business communication skills for adult professionals by John Huges and Andrew Mallett- OUP 2012.
7. Goodheart-Willcox, "Professional Communication", First Edition , 2017. Online test book
8. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India, 6 edition, 2015

9. English for success in Competitive exams. Philip Sunil Solomon – OUP 2009.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	3	3	-	-	-	-	3	-	1	2	1	1	1
CO2	3	2	2	2	2	-	3	-	-	2	-	1	1	1	1	1
CO3	3	2	-	3	-	-	-	-	-	3	-	1	1	-	-	-
CO4	3	3	-	-	-	-	3	-	-	3	-	1	1	1	1	1
CO5	3	2	3	-	-	-	-	-	-	3	-	1	2	2	2	2

1905701	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge on the following Topics

- Various types of over voltages in power system and protection methods
- Generation of over voltages in laboratories
- Measurement of over voltages
- Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics
- Testing of Power apparatus

UNIT-I: OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages, Corona and its effects – 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 – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment's.

UNIT-III: GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9

Generation of High DC voltage: Rectifiers, voltage multipliers, vandegraff generator: generation of high impulse voltage: single and multistage Marx circuits – generation of high AC voltages: cascaded transformers, resonant transformer and tesla coil- generation of switching surges – 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 & 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, circuit breakers, bushing, isolators and transformers- Insulation Coordination & testing of cables.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand Transients in power system
- Ability to understand Generation and measurement of high voltage
- Ability to understand High voltage testing
- Ability to understand various types of over voltages in power system
- Ability to measure and test power apparatus

TEXTBOOKS:

1 S.Naidu and V. Kamaraju, ˆHigh Voltage Engineering,, Tata McGraw Hill, Fifth Edition, 2013

2 E. Kuffel and W.S. Zaengl, J.Kuffel, ˆHigh voltage Engineering fundamentals,, Newnes Second Edition Elsevier , New Delhi

3 C.L. Wadhwa, ˆHigh voltage Engineering,, New Age International Publishers, Third Edition, 2010.

REFERENCE BOOKS:

1 L.L. Alston, ˆHigh Voltage Technology,, Oxford University Press, First Indian Edition, 2011.

2 Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice, Second Edition Marcel Dekker, Inc., 2010.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	1	1					3			2			1			
2	1		2		2							2		2	3	
3		3		1		3								2		
4			2					2			3				3	
5		1			1			3								2

1905702	RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To impart knowledge on the following Topics

- Awareness about renewable Energy Sources and technologies.
- Adequate inputs on a variety of issues in harnessing renewable Energy.
- Recognize current and possible future role of renewable energy sources.
- To get adequate knowledge of PV systems and Wind Energy systems.
- To understand the biomass energy system and other energy sources.

UNIT- I: RENEWABLE ENERGY (RE) SOURCES 9

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

UNIT –II: WIND ENERGY 9

Power in the Wind – Types of Wind Power Plants(WPPs)–Components of WPPs Working of WPPs- Siting of WPPs-Grid integration issues of WPPs.

UNIT- III: SOLAR PV AND THERMAL SYSTEMS 9

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds.- Thermal Energy storage system with PCM- Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

UNIT- IV: BIOMASS ENERGY 9

Introduction-Bio mass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

UNIT- V: OTHER ENERGY SOURCES 9

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell : Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems, Need for Hybrid systems-Range and type of systems.

OUTCOMES: TOTAL : 45 PERIODS

- Ability to create awareness about renewable Energy Sources and technologies.
- Ability to get adequate inputs on a variety of issues in harnessing renewable Energy.
- Ability to recognize current and possible future role of renewable energy sources.
- Ability to explain the various renewable energy resources and technologies and their applications.
- Ability to understand basics about biomass energy.

TEXTBOOKS:

1. Joshua Earnest, Tore Wizeliu, ˆWind 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. A.K.Mukerjee and Nivedita Thakur,” Photovoltaic Systems: Analysis and Design”, PHI Learning Private Limited, New Delhi, 2011.
2. Richard A. Dunlap,” Sustainable Energy” Cengage Learning India Private Limited, Delhi, 2015.
3. Chetan Singh Solanki, “ Solar Photovoltaics : Fundamentals, Technologies and Applications”, PHI Learning Private Limited, New Delhi, 2011.
4. Bradley A. Striebig, Adebayo A.Ogundipe and Maria Papadakis,”

Engineering Applications in Sustainable Design and Development”, Cengage Learning India Private Limited, Delhi, 2016.

5. Godfrey Boyle, “Renewable energy”, Open University, Oxford University Press in association with the Open University, 2004.

6. Shobh Nath Singh, ˆNon-conventional Energy resources, Pearson Education ,2015.

Co	**PO**												**PSO**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	1	3		1			2			1			3			
2	2		3		2			3				2		3	1	
3	1	2		3		3			3					2		
4				2				2			2				1	
5	3	1			1			2				1				

1905703 PROTECTION AND SWITCHGEAR

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge on Causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- To impart knowledge on Characteristics and functions of relays and protection schemes.
- To impart knowledge on Apparatus protection using Current transformers and Potential transformers.
- To impart knowledge on the characteristics and functions of relays and protection schemes.
- To impart knowledge on Functioning of circuit breaker

UNIT-I: PROTECTION SCHEMES 9

Principles and need for protective schemes – nature and causes of faults – types of faults –Methods of Grounding - Zones of protection and essential qualities of protection – Protection scheme. - Protection against travelling waves.

UNIT-II: ELECTROMAGNETIC RELAYS 9

Operating principles of relays - the Universal relay – Torque equation – R-X diagram –Electromagnetic Relays – Over current, Directional, Distance, Differential, Negative sequence and Under frequency relays.

UNIT-III: APPARATUS PROTECTION 9

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

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 - DC and AC circuit breaking – restriking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching -current chopping - interruption of capacitive current - 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.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand and analyze Electromagnetic and Static Relays.
- Ability to find the causes of abnormal operating conditions of the apparatus and system.
- Ability to analyze the characteristics and functions of relays and protection schemes.
- Ability to study about the apparatus protection, static and numerical relays.
- Ability to acquire knowledge on functioning of circuit breaker.

TEXTBOOKS:

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 Arun Ingole, ‘Switch Gear and Protection’ Pearson Education, 2017.

REFERENCE BOOKS:

1 Badri Ram, 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 RavindraP.Singh, ‘Switchgear and Power System Protection’, PHI Learning Private Ltd., NewDelhi, 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.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	2						1	2					1			2
2		2				1				2				1		2
3				1	1				2			3		1	2	
4			1			1		1					1		2	
5					1	1					2	3		2		

1905708	RENEWABLE ENERGY SYSTEMS LABORATORY	L T P C
		0 0 4 2

OBJECTIVES:

- To train the students in Renewable Energy Sources and technologies.
- To provide adequate inputs on a variety of issues in harnessing Renewable Energy.
- To recognize current and possible future role of Renewable energy sources.
- To train the students in intelligent controllers for hybrid systems.
- To provide adequate knowledge of simulation study on Renewable Energy Sources.

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 Intelligent Controllers for Hybrid Systems.
12. Simulation study of converter using solar PV systems.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

- Ability to understand and analyze Renewable energy systems.
- Ability to train the students in Renewable Energy Sources and technologies.
- Ability to provide adequate inputs on a variety of issues in harnessing Renewable Energy.
- Ability to recognize current and possible future role of Renewable energy sources.
- Ability to simulate the various Renewable energy sources and to understand basics

of Intelligent Controllers.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

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

Co	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	2	3					3			1			1			
2		3	2		1							2		2	3	
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4		2						2			3				2	
5			1		3			1	1					3		3

1905709	PROJECT WORK- PHASE I	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.
- The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three 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 based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 60 PERIODS

OUTCOMES

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

1905811	PROJECT WORK - PHASE II	L	T	P	C
		0	0	12	6

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

- The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three 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 based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 180 PERIODS

OUTCOMES

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

1905604	ADVANCED CONTROL SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on design state feedback control and state observer.
- To provide knowledge in phase plane analysis.
- To give basic knowledge in describing function analysis.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter

UNIT-I: STATE VARIABLE ANALYSIS 9

Introduction- concepts of state variables and state model-State model for linear continuous time systems, Diagonalisation- solution of state equations- Concepts of controllability and observability

UNIT-II: STATE VARIABLE DESIGN 9

Introduction to state model: Effect of state feedback - Pole placement design: Necessary and sufficient condition for arbitrary pole placement, State regulator design Design of state observers- Separation principle- Design of servo systems: State feedback with integral control.

UNIT-III: SAMPLED DATA ANALYSIS 9

Introduction to sampling theorem spectrum analysis of sampling process signal reconstruction difference equations The Z transform function, the inverse Z transform function, response of Linear discrete system, the Z transform analysis of sampled data control systems, response between sampling instants, the Z and S domain relationship. Stability analysis-Jury's test, Bilinear transform and compensation techniques.

UNIT-IV: NON LINEAR SYSTEMS 9

Introduction, common physical non linearites, The phase plane method: concepts, singular points, stability of non linear systems, construction of phase trajectories system analysis by phase plane method. The describing function method, stability analysis by describing function method, Jump resonance, Limit cycle.

UNIT-V: OPTIMAL CONTROL 9

Introduction: Classical control and optimization, formulation of optimal control problem, Typical optimal control performance measures - Optimal state regulator design: Lyapunov equation, Matrix Riccati equation - LQR steady state optimal control – Application examples.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Able to design state feedback controller and state observer.
- Able to understand and analyse linear and nonlinear systems using phase plane method and describing function method.
- Able to understand and design optimal controller.
- Able to understand optimal estimator including Kalman Filter.
- Ability to apply advanced control strategies to practical engineering problems

TEXTBOOKS:

1. M.Gopal, “Digital Control and State Variable Methods”, 4th edition, Mc Graw Hill India, 2012.
2. K. Ogata, ‘Modern Control Engineering’, 5th Edition, Pearson, 2012.
3. K. P. Mohandas, “Modern Control Engineering”, Sanguine Technical Publishers, 2006.

REFERENCE BOOKS:

1. M.Gopal, Modern Control System Theory, 3rd edition, New Age International Publishers, 2014.
2. William S Levine, “Control System Fundamentals,” The Control Handbook, CRC Press, Tayler and Francies Group, 2011.
3. Ashish Tewari, ‘Modern Control Design with Matlab and Simulink’, John Wiley, New Delhi, 2002.
4. T. Glad and L. Ljung,, “Control Theory –Multivariable and Non-Linear Methods”, Taylor & Francis,2002.
5. D.S.Naidu, “Optimal Control Systems” First Indian Reprint, CRC Press, 2009.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
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2		1	3		1						1	2			2	
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4		2		2						2				1		
5	2		1		3						3				1	2

1905605 **POWER SYSTEMS STABILITY**

L	T	P	C
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OBJECTIVES:

- To understand the fundamental concepts of stability of power systems and its classification.
- To expose the students to dynamic behavior of the power system for small disturbances.
- To expose the students to dynamic behavior of the power system for large disturbances.
- To understand the fundamental concepts of voltage stability.
- To understand and enhance the stability of power systems.

UNIT –I: INTRODUCTION TO STABILITY 9

Fundamental concepts - Stability and energy of a system - Power System Stability: Definition, Causes, Nature and Effects of disturbances, Classification of stability, Modelling of electrical components - Basic assumptions made in stability studies Modelling of Synchronous machine for stability studies(classical model)- Rotor dynamics and the swing equation.

UNIT –II: SMALL-SIGNAL STABILITY 9

Basic concepts and definitions – State space representation, Physical Interpretation of small–signal stability, Eigen properties of the state matrix: Eigen values and eigen vectors,modal matrices, eigen value and stability, mode shape and participation factor. Small–signal stability analysis of a Single-Machine Infinite Bus (SMIB) Configuration with numerical example.

UNIT- III: TRANSIENT STABILITY 9

Review of numerical integration methods: modified Euler and Fourth Order Runge-Kutta methods, Numerical stability, Interfacing of Synchronous machine (classical machine) model to the transient stability algorithm(TSA) with partitioned – explicit approaches- Application of TSA to SMIB system.

9

UNIT-IV: VOLTAGE STABILITY

Factors affecting voltage stability- Classification of Voltage stability-Transmission system characteristics- Generator characteristics- Load characteristics- Characteristics of reactive power compensating Devices- Voltage collapse.

UNIT-V: ENHANCEMENT OF SMALL-SIGNAL STABILITY AND TRANSIENT STABILITY **9**

Power System Stabilizer –. Principle behind transient stability enhancement methods: high-speed fault clearing, regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit-breakers, single-pole switching, fast valving, high-speed excitation systems. Data-omega of p-s stabilizer

TOTAL : 45 PERIODS

OUTCOMES:

- Learners will attain knowledge about the stability of power system
- Learners will have knowledge on small-signal stability, transient stability
- Learners will have knowledge on voltage stability
- Learners will be able to understand the dynamic behavior of synchronous generator for different disturbances.
- Learners will be able to understand the various methods to enhance the stability of a power system.

TEXTBOOKS:

1. Kundur P., Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
2. R.Ramnujam," Power System Dynamics Analysis and Simulation", PHI Learning Private Limited, New Delhi, 2009
3. T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwer publishers,1998

REFERENCES:

1. Peter W., Saucer, Pai M.A., “Power System Dynamics and Stability, Pearson Education (Singapore, 9th Edition, 2007.
2. EW. Kimbark., “Power System Stability”, John Wiley & Sons Limited, New Jersey,2013.
3. SB. Crary., “Power System Stability”, John Wiley & Sons Limited, New Jersey, 1955.
4. K.N. Shubhanga,“Power System Analysis” Pearson, 2017.
5. Power systems dynamics: Stability and control / K.R. Padiyar, BS Publications, 2008
6. Power system control and Stability P.M. Anderson, A.A. Foud, Iowa State University Press, 1977.

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1905606	MODERN POWER CONVERTERS	L	T	P	C
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OBJECTIVES:

To impart knowledge about the following topics:

- To understand the fundamental concepts of Switched mode power supplies
- To study about the concepts of Matrix Converter.
- To study the concept of Soft switched converters
- To understand the fundamental concepts of AC-AC Converters With and Without DC Link
- To understand the fundamental concepts of Soft-Switching Power Converters

UNIT- I: SWITCHED MODE POWER SUPPLIES (SMPS) 9

DC Power supplies and Classification; Switched mode dc power supplies – with and without isolation, single and multiple outputs; Closed loop control and regulation; Design examples on converter and closed loop performance.

UNIT- II: AC-DC CONVERTERS 9

Switched mode AC-DC converters. Synchronous rectification - single and three phase topologies – switching techniques – high input power factor . reduced input current harmonic distortion. Improved efficiency. With and without input-output isolation. Performance indices design examples-PWM Rectifiers, Power factor improvement techniques.

UNIT – III: DC-AC CONVERTERS 9

Multi-level Inversion – concept, classification of multilevel inverters, Principle of operation, main features and analysis of Diode clamped, Flying capacitor and cascaded multilevel inverters; Modulation schemes.

UNIT- IV: AC-AC CONVERTERS WITH AND WITHOUT DC LINK 9

Matrix converters. Basic topology of matrix converter; Commutation – current path; Modulation techniques – scalar modulation, indirect modulation; Matrix converter as only AC-DC converter; AC-AC converter with DC link – topologies and operation – with and without resonance link – converter with dc link converter; Performance comparison with matrix converter with DC link converters.

UNIT – V: SOFT-SWITCHING POWER CONVERTERS 9

Soft switching techniques. ZVS, ZCS, quasi resonance operation; Performance comparison hard switched and soft switched converters.AC-DC converter, DC-DC converter, DC-AC converter; Resonant DC power supplies.

OUTCOMES:

- Ability to suggest converters for AC-DC conversion and SMPS.
- Ability to study about the concepts of AC – DC converters.
- Ability to study about the concepts of DC – AC converters.
- Ability to understand basics of AC-AC converters with and without DC link
- Learners will attain knowledge about soft switching power converter.

TEXTBOOKS:

1 Power Electronics Handbook, M.H.Rashid, Academic press, Newyork, 2000.

2 Advanced DC/DC Converters, Fang Lin Luo and Fang Lin Luo, CRC Press, NewYork, 2004.

3 Control in Power Electronics-Selected Problem, Marian P.Kazmierkowski, R.Krishnan and Frede Blaabjerg, Academic Press(Elsevier Science),2002.

REFERENCE BOOKS:

1 Power Electronic Circuits, Issa Batarseh, John Wiley and Sons, Inc.2004.

2 Power Electronics for Modern Wind Turbines, Frede Blaabjerg and Zhe Chen, Morgan & Claypool Publishers series, United States of America,2006.

3 Krein Philip T, Elements of Power Electronics,Oxford University press,2008

4 Agarwal, Power Electronics: Converters, Applications, and Design, 3rd edition, Jai P, Prentice Hall, 2000.

5 L. Umanand, Power Electronics: Essentials & Applications, John Wiley and Sons, 2009.

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1908605 **VISUAL LANGUAGES AND APPLICATIONS** **L T P C**

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OBJECTIVES:

- To study about the concepts of windows programming models, MFC applications, drawing with the GDI, getting inputs from Mouse and the Keyboard.
- To study the concepts of Menu basics, menu magic and classic controls of the windows programming using VC++.
- To study the concept of Document/View Architecture with single & multiple document interface, toolbars, status bars and File I/O Serialization.
- To study about the integrated development programming event driven programming variability's, constants, procedures and basic ActiveX controls in visual basic.
- To understand the database and the database management system, visual data manager, data bound controls and ADO controls in VB.

UNIT - I: FUNDAMENTALS OF WINDOWS AND MFC 9

Messages - Windows programming - SDK style - Hungarian notation and windows data types - SDK programming in perspective. The benefits of C++ and MFC - MFC design philosophy – Document / View architecture - MFC class hierarchy - AFX functions. Application object - Frame window object - Message map. Drawing the lines – Curves – Ellipse – Polygons and other shapes. GDI pens – Brushes - GDI fonts - Deleting GDI objects and deselecting GDI objects. Getting input from the mouse: Client & Non-client – Area mouse messages - Mouse wheel - Cursor. Getting input from the keyboard: Input focus - Keystroke messages - Virtual key codes - Character & dead key messages.

UNIT - II: RESOURCES AND CONTROLS 9

Creating a menu – Loading and displaying a menu – Responding to menu commands – Command ranges - Updating the items in menu, update ranges – Keyboard accelerators. Creating menus programmatically - Modifying menus programmatically - The system menu - Owner draw menus – Cascading menus - Context menus. The C button class – C list box class – C static class - The font view application – C edit class – C combo box class – C scrollbar class. Model dialog boxes – Modeless dialog boxes.

UNIT - III: DOCUMENT / VIEW ARCHITECTURE 9

The in existence function revisited – Document object – View object – Frame window object – Dynamic object creation. SDI document template - Command routing. Synchronizing multiple views of a document – Mid squares application – Supporting multiple document types – Alternatives to MDI. Splitter Windows: Dynamic splitter window – Static splitter windows. Creating & initializing a toolbar - Controlling the toolbar's visibility – Creating & initializing a status bar - Creating custom status bar panes – Status bar support in appwizard. Opening, closing and creating the files - Reading & Writing – C file derivatives – Serialization basics - Writing serializability classes.

UNIT - IV: FUNDAMENTALS OF VISUAL BASIC 9

Menu bar – Tool bar – Project explorer – Toolbox – Properties window – Form designer – Form layout – Intermediate window. Designing the user interface: Aligning the controls – Running the application – Visual development and event driven programming. Variabilitys: Declaration – Types – Converting variability types – User defined data types - Lifetime of a variability. Constants - Arrays – Types of arrays. Procedures: Subroutines – Functions – Calling procedures. Text box controls – List box & Combo box controls – Scroll bar and slider controls – File controls.

UNIT - V: DATABASE PROGRAMMING WITH VB 9

Record sets – Data control – Data control properties, methods. Visual data manager: Specifying indices with the visual data manager – Entering data with the visual data manager. Data bound list control – Data bound combo box – Data bound grid control. Mapping databases: Database object – Tability def object, Query def object. Programming the active database objects – ADO object model – Establishing a connection - ExecutingSQL statements – Cursor types and locking mechanism – Manipulating the record set object – Simple record editing and updating.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand and apply computing platform and software for engineering problems
- Apply the concepts of Menu basics, menu magic and classic controls.
- Implement the concept of Document/View Architecture with single & multiple document interface.
- Design and develop integrated development programming via event driven

programming.

- Understand the concepts of database and the database management system.

TEXT BOOKS:

1. Jeff Prosise, 'Programming Windows With MFC', Second Edition, WP Publishers & Distributors (P) Ltd, Reprinted, 2002.
2. Evangelos Petroutsos, 'Mastering Visual Basic 6.0', BPB Publications, 2002.

REFERENCE BOOKS:

1. Herbert Schildt, 'MFC Programming From the Ground Up', Second Edition, McGraw Hill, reprinted, 2002.
2. John Paul Muller, 'Visual C++ 6 From the Ground Up Second Edition', McGraw Hill, Reprinted, 2002.
3. Curtis Smith & Micheal Amundsen, 'Teach Yourself Database Programming with Visual Basic 6 in 21 days', Techmedia Pub, 1999.

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1904606 **INTELLECTUAL PROPERTY RIGHTS** **L T P C**

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OBJECTIVES:

- To give an idea about IPR, registration and its enforcement.
- To acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
- To compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
- To provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.
- To encourage and protect innovation in the form of intellectual property rights.

UNIT - I: INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property – Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT - II: REGISTRATION OF IPRs 9

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.

UNIT - III: AGREEMENTS AND REGISTRATION 9

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT – IV: DIGITAL PRODUCTS AND LAW 10

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT - V: ENFORCEMENT OF IPRs 8

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL: 45 PERIODS

OUTCOMES:

- Skill to understand the concept of intellectual property rights.
- Develops procedural knowledge to Legal System and solving the problem relating to intellectual property rights.
- Skill to pursue the professional programs in Company Secretaryship, Law. Business (MBA), International Affairs, Public Administration and Other fields.
- Employability as the Compliance Officer, Public Relation Officer and Liaison Officer.
- Establishment of Legal Consultancy and service provider.

TEXT BOOKS:

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012

2. S. V. Satakar, —Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.

REFERENCES:

1. Deborah E. Bouchoux, —Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning, Third Edition, 2012.

2. Prabuddha Ganguli,Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education, 2011.

3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

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1903612 **DISASTER MANAGEMENT** **L T P C**

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OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR).
- To enhance awareness of institutional processes in the country.
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

UNIT- I: INTRODUCTION TO DISASTERS **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don’ts during various types of Disasters.

UNIT- II: APPROACHES TO DISASTER RISK REDUCTION (DRR) **9**

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake- holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT- III: INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT **9**

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India -

Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT-IV: DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, and Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT- V: DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Differentiate the types of disasters, causes and their impact on environment and society.
- Assess factors of vulnerability and its impacts.
- Knowledge of various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India and Scenarious in the Indian context.
- Assess Disaster damage assessment and management

TEXT BOOKS:

1. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13:978-9380386423.
2. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13:978-1259007361.
3. Gupta Anil K, Sreeja S. Nair. "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011.
4. Kapur Anu Vulnerable India "A Geographical Study of Disasters, IIAS and Sage Publishers", New Delhi, 2010.

REFERENCE BOOKS:

1. Govt. of India, Disaster Management Act , Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.

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1907608 **PRINCIPLES OF ROBOTICS** **L T P C**

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COURSE OBJECTIVES:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

UNIT I BASIC CONCEPTS **9**

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and Control issues- Various manipulators – Sensors - work cell - Programming languages.

UNIT II DIRECT AND INVERSE KINEMATICS **9**

Mathematical representation of Robots - Position and orientation – Homogeneous transformation- Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

UNIT III MANIPULATOR DIFFERENTIAL MOTION AND STATICS **9**

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

UNIT IV PATH PLANNING **9**

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

UNIT V DYNAMICS AND CONTROL **9**

Lagrangian mechanics-2 DOF Manipulator-Lagrange Euler formulation-Dynamic model –Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Ability to understand basic concept of robotics.
- To analyze Instrumentation systems and their applications to various
- To know about the differential motion add statics in robotics
- To know about the various path planning techniques.
- To know about the dynamics and control in robotics industries.

TEXT BOOKS:

1. R.K.Mittal and I.J.Nagrath, "Robotics and Control", Tata McGraw Hill, New Delhi, 6th Reprint, 2007.
2. John J.Craig , "Introduction to Robotics Mechanics and Control", Third edition, Pearson Education, 2009.
3. M.P.Groover, M.Weiss, R.N. Nagel and N. G.Odrey, "Industrial Robotics", McGraw-Hill Singapore, 1996.

REFERENCES:

1. Ashitava Ghoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, "Robotics", I K International, 2007.
3. Edwin Wise, "Applied Robotics", Cengage Learning, 2003.
4. R.D.Klafter, T.A.Chimielewski and M.Negin, "Robotic Engineering–An Integrated Approach", Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, "Control in Robotics and Automation: Sensor Based Integration", Allied Publishers, Chennai, 1998.
6. S.Ghoshal, "Embedded Systems & Robotics – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

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1905608	EMBEDDED SYSTEMS	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following Topics

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

UNIT-I: INTRODUCTION TO EMBEDDED SYSTEMS 9

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

UNIT-II: EMBEDDED NETWORKING 9

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS422 – RS 485 - CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers. USB, Bluetooth, Zigbee.

UNIT-III: EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT 9

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

UNIT-IV: RTOS BASED EMBEDDED SYSTEM DESIGN 9

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

UNIT-V: EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT 9

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

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand and analyze embedded systems.
- Ability to operate various Embedded Development Strategies
- Ability to study about the bus Communication in processors.
- Ability to acquire knowledge on various processor scheduling algorithms.
- Ability to understand basics of Real time operating system.

TEXTBOOKS:

1 Peckol, “Embedded system Design”, John Wiley & Sons,2019.
2 Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2013
3 Shibu. K.V, “Introduction to Embedded Systems”, 2e, Mc graw Hill, 2017.

REFERENCE BOOKS:

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

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1905609	EHVAC TRANSMISSION	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following Topics

- To introduce the concept of EHVAC Transmission lines
- To understand the Electrostatic field of AC lines
- To understand the Corona HV lines
- To analyse the Power control
- To analyze the Transient limits

UNIT-I: INTRODUCTION 9

EHVAC transmission line trends and preliminary aspect - standard transmission voltages Estimation at line and ground parameters-Bundle conductors: Properties - Inductance and Capacitance of EHV lines – Positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

UNIT-II: ELECTROSTATIC FIELDS 9

Electrostatic field and voltage gradients – Calculations of electrostatic field of AC lines – Effect of high electrostatic field on biological organisms and human beings – Surface voltage gradients and Maximum gradients of actual transmission lines – Voltage gradients on sub conductor.

UNIT-III: POWER CONTROL 9

Electrostatic induction in un energized lines – Measurement of field and voltage gradients for three phase single and double circuit lines – Un energized lines. Power Frequency Voltage control and overvoltage in EHV lines: No load voltage – Charging currents at power frequency-Voltage control – Shunt and Series compensation – Static VAR compensation.

UNIT-IV: CORONA EFFECTS AND RADIO INTERFERENCE 9

Corona in EHV lines – Corona loss formulae-Charge voltage diagram- Attenuation of traveling waves due to Corona – Audio noise due to Corona, its generation, characteristic and limits. Measurements of audio noise radio interference due to

Corona - properties of radio noise – Frequency spectrum of RI fields – Measurements of RI and RIV. Reduction of corona.

UNIT-V: STEADY STATE AND TRANSIENT LIMITS 9

Design of EHV lines based on steady state and transient limits - EHV cabilitys and their characteristics-Introduction six phase transmission – UHV.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand the principles and types of EHVAC system
- Ability to analyze the electrostatic field of AC lines
- Ability to study about the compensation
- Ability to study about the corona in E.H.V. lines
- Ability to analyze the steady state and transient limits

TEXTBOOKS:

1. Rokosh Das Begamudre, "Extra High Voltage AC Transmission Engineering"– Wiley Eastern LTD., NEW DELHI 1990
2. S. Rao, "HVAC and HVDC Transmission, Engineering and Practice" Khanna Publisher, Delhi, 1990

REFERENCE BOOKS:

1. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India Private Limited, 2013.
2. RD Begamudre, "Extra High Voltage AC Transmission Engineering"– New Academic Science Ltd; 4 edition 2011

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1906004 **COMMUNICATION ENGINEERING** **L T P C**

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OBJECTIVES:

The student should be made:

- To understand analog communication techniques.
- To be made aware of Pulse modulation techniques.
- To study the various digital modulation techniques.
- To study the principles behind information theory and coding.
- To study the various digital communication techniques

UNIT - I: ANALOG COMMUNICATION **9**

Amplitude Modulation – AM, DSBSC, SSBSC, VSB – PSD, modulators and demodulators – Angle modulation – PM and FM – PSD, modulators and demodulators – Superheterodyne receivers.

UNIT - II: PULSE MODULATION **9**

Low pass sampling theorem – Quantization – PAM – Line coding – PCM, DPCM, DM, and ADPCM and ADM, Channel Vocoder - Time Division Multiplexing, Frequency Division Multiplexing.

UNIT - III: DIGITAL MODULATION AND TRANSMISSION **9**

Phase shift keying – BPSK, DPSK, QPSK – Principles of M-ary signaling M-ary PSK & QAM – Comparison, ISI – Pulse shaping – Duo binary encoding – Cosine filters – Eye pattern, equalizers.

UNIT - IV: INFORMATION THEORY AND CODING **9**

Measure of information – Entropy – Source coding theorem – Shannon–Fano coding, Huffman, Coding, LZ Coding – Channel capacity – Shannon-Hartley law – Shannon's limit – Error control codes – Cyclic codes, Syndrome calculation – Convolution Coding, Sequential and Viterbi decoding.

UNIT - V: SPREAD SPECTRUM AND MULTIPLE ACCESS **9**

PN sequences – properties – m-sequence – DSSS – Processing gain, Jamming – FHSS – Synchronisation and tracking – Multiple Access – FDMA, TDMA, CDMA.

TOTAL PERIODS: 45

OUTCOMES:

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

- Apply analog communication techniques.
- Apply digital communication techniques.
- Use data and pulse communication techniques.
- Analyze Source and Error control coding.
- Utilize spread spectrum and multiple access communication.

TEXT BOOKS:

1. H Taub, D L Schilling, G Saha, "Principles of Communication Systems" 3/e, TMH 2007.
2. S. Haykin "Digital Communications" John Wiley 2005.

REFERENCE BOOKS:

1. B.P.Lathi, "Modern Digital and Analog Communication Systems", 3rd edition, Oxford University Press, 2007.
2. H P Hsu, Schaum Outline Series – "Analog and Digital Communications" TMH 2006.
3. B.Sklar, Digital Communications Fundamentals and Applications" 2/e Pearson Education 2007.

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5	2	3	3	2	-	3	-	-	-	-	-	3	1	-	-	-

1920001 FUNDAMENTALS OF NANOSCIENCE

L T P C

3 0 0 3

OBJECTIVE:

- To learn about basis of nanomaterials and their properties.
- To learn the general preparation techniques of nanomaterials.
- To make the students learn the different synthesis techniques of nanomaterials.
- To explore various characterization techniques.
- To elucidate the different applications of nanomaterials.

UNIT-I: INTRODUCTION 9

Nano scale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nano structured materials- nano particles- quantum dots, nano wires-ultra-thinfilms- multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT- II: GENERAL METHODSOF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT- III: NANOMATERIALS 9

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO,TiO2,MgO, ZrO2, NiO, nano alumina, Ferrites, Quantum wires, Quantum dots-preparation, properties and applications.

UNIT- IV: CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA,SIMS-Nano indentation.

UNIT-V: APPLICATION 9

Nano InfoTech: Information storage- nano computer, molecular switch, super chip, nano crystal, Nano biotechnology: nano probes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bio imaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, nano crystalline silver for bacterial inhibition, Nano particles for sun barrier products - In Photostat, printing, solar cell, battery.

TOTAL : 45 PERIODS

OUTCOMES

- Will familiarize about the science of nanomaterials.
- Will demonstrate the preparation of nanomaterials.
- Will get knowledge on different materials and their synthesize technique.
- Will develop knowledge in characteristic nanomaterials.
- Will learn where and how to apply the various properties of nanomaterials.

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia,1996.
2. N John Dinardo, "Nanoscale Characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH,2000.

REFERENCE BOOKS:

1. G Timp, "Nanotechnology", AIP press/Springer,1999.
2. AkhleshLakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

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1915002 PRINCIPLES OF MANAGEMENT LT P C

3 0 0 3

OBJECTIVES:

- To study the principles of management, functions and its application an organization.
- To educate the students on the concept of planning and decision making.
- To understand the dynamics of human relations in organisations.
- To learn about motivation, communication and leadership aspects.
- To study the process controlling and the various techniques involved in controlling.

UNIT – I: INTRODUCTION TO MANAGEMENT AND ORGANIZATION 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers managerial roles and skills –Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment –Multinational Corporations - Current trends and issues in Management.

UNIT – II: PLANNING 9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management –types of strategies – Planning Tools and Techniques – Decision making steps and process.

UNIT – III: ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Talent Acquisition, Training and Development, Performance

Management, Career planning and management.

UNIT – IV: DIRECTING 9

Motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

UNIT – V: CONTROLLING 9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Quality control and Inventory Control - Productivity problems and management – control and performance – direct and preventive control – Maintenance control and purchase control– reporting.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to have a clear understanding of managerial functions.
- Students would have knowledge to apply planning techniques and decision making.
- Understand concept of Human Resource Management.
- Students would be able to understand motivation, leadership and communication principles.
- Students would be able to apply control techniques in the organization.

TEXTBOOKS:

1. Stephen P. Robbins & Mary Coulter, “Management”, 14th Edition, Pearson, 2017
2. JAF Stoner, Freeman R.E and Daniel R Gilbert “Management”, 6th Edition, Pearson, 2004.

REFERENCES:

1. Stephen A. Robbins & David A. Decenzo & Mary Coulter, “Fundamentals of Management” 10th Edition, Pearson Education, 2016.
2. Robert Kreitner & Mamata Mohapatra, “Management”, Biztantra, 2008.
3. Harold Koontz & Heinz Weihrich “Essentials of management” Tata Mc Graw Hill, 2006.
4. Tripathy PC & Reddy PN, “Principles of Management”, Tata McGraw Hill, 6th edition 2017.

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1915004 **HUMAN RIGHTS** **L T P C**

3 0 0 3

OBJECTIVE:

- To sensitize the Engineering students to various aspects of Human Rights.
- To educate on the evolution of human rights movement.
- To create awareness and understanding on the international deliberations towards human rights.
- To educate on constitutional rights and provisions related to human rights in India.
- Create awareness on support organisations in Human Rights in India.

UNIT – I: INTRODUCTION 9

Human Rights - Meaning, Origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil, Political Rights, Economic, Social and Cultural Rights, Educational Rights, Collective and Solidarity Rights - Societal problems and human rights

UNIT – II: EVOLUTION OF HUMAN RIGHTS MOVEMENT 9

Evolution of the concept of Human Rights Magana carta – Geneva Convention1864. Universal Declaration of Human Rights, 1948. Principles of Human Rights - Theories of Human Rights – Feminist Perspectives of Human Rights – Human Rights Problems - Violence against Women and Children, Communal Violence

UNIT – III: INTERNATIONAL PRESPECTIVES 9

Theories and Perspectives of United Nation Laws – United Nations Agencies to monitor and compliance – United National Commission of Human Rights (UNCHR) – United Nations Children Fund (UNICEF) – United Nations Commission for Refugee (UNHCR) – United Nations Education, scientific and cultural Organisation (UNESCO) – International Labour Organisation and Labour Rights

UNIT – IV: HUMAN RIGHTS IN INDIA 9

Human Rights in India – Constitutional Provisions / Guarantees. – Fundamental rights, Directive Principles of State, Policies, Fundamental

Duties - International Human Rights and the Indian Constitution – Human Rights violation in Private and Public Domain - Within the Family, by Dominant Castes and Religious Groups, Riots and Violence

UNIT – V: HUMAN RIGHTS SUPPORT ORGANISATION 9

Human Rights of Disadvantaged People, Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People - Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL: 45 PERIODS

OUTCOME:

- Engineering students will acquire the basic knowledge of human rights.
- Students will have an understanding on the evolution of human rights movement.
- Students will be able to show an understanding on UN laws and agencies related to human rights.
- Students will be able to advocate on constitutional provisions related to human rights in India.
- Students will have understanding on the various organisations involved in support of human rights in India.

REFERENCES:

1. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 7th edition 2014.
2. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, 'The Future of Human Rights', Oxford University Press, NewDelhi, 3rd edition 2012.

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1907704 FIBRE OPTICS AND LASER INSTRUMENTATION

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AIM:

To contribute to the knowledge of Fiber optics and Laser Instrumentation and its Industrial and Medical Application.

COURSE OBJECTIVES:

- To impart about the basic concepts of optical fibers and their properties.
- To provide adequate knowledge about the Industrial applications of optical fibers.
- To familiarize about Industrial application of lasers.
- To enhance the students knowledge in Laser fundamentals.
- To illustrate about holography and Medical applications of Lasers.

UNIT-I: OPTICAL FIBRES AND THEIR PROPERTIES 9

Construction of optical fiber cable: Guiding mechanism in optical fiber and Basic component of optical fiber communication, –Principles of light propagation through a fibre: Total internal reflection, Acceptance angle (θa), Numerical aperture and Skew mode, –Different types of fibres and their properties: Single and multimode fibers and Step index and graded index fibers,– fibre characteristics: Mechanical characteristics and Transmission characteristics, – Absorption losses – Scattering losses – Dispersion – Connectors and splicers –Fibre termination – Optical sources: Light Emitting Diode (LED), – Optical detectors: PIN Diode.

UNIT-II: INDUSTRIAL APPLICATION OF OPTICAL FIBRES 9

Fibre optic sensors: Types of fiber optics sensor, Intrinsic sensor- Temperature/ Pressure sensor, Extrinsic sensors, Phase Modulated Fibre Optic Sensor and Displacement sensor (Extrinsic Sensor) – Fibre optic instrumentation system: Measurement of attenuation (by cut back method), Optical domain reflect meters, Fiber Scattering loss Measurement, Fiber Absorption Measurement, Fiber dispersion measurements, End reflection method and Near field scanning techniques – Different types of modulators: Electro-optic modulator (EOM) – Interferometry method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.

UNIT-III: LASER FUNDAMENTALS 9

Fundamental characteristics of lasers – Level Lasers: Two-Level Laser, Three Level Laser, Quasi Three and four level lasers – Properties of laser: Monochromaticity, Coherence, Divergence and Directionality and Brightness – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers; – Gas lasers, solid lasers, liquid lasers and semiconductor lasers.

UNIT-IV: INDUSTRIAL APPLICATION OF LASERS 9

Laser for measurement of distance, Laser for measurement of length, Laser for measurement of velocity, Laser for measurement of acceleration, Laser for measurement of current, voltage and Laser for measurement of Atmospheric Effect: Types of LIDAR, Construction And Working, and LIDAR Applications – Material processing: Laser instrumentation for material processing, Powder Feeder, Laser Heating, Laser Welding, Laser Melting, Conduction Limited Melting and Key Hole Melting – Laser trimming of material: Process Of Laser Trimming, Types Of Trim, Construction And Working Advantages – Material Removal and vaporization: Process Of Material Removal.

UNIT-V: HOLOGRAM AND MEDICAL APPLICATIONS 9

Holography: Basic Principle, Holography vs. photography, Principle Of Hologram Recording, Condition For Recording A Hologram, Reconstructing and viewing the holographic image– Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser-Tissue Interactions Photochemical reactions, Thermalisation, collisional relaxation, Types of Interactions and Selecting an Interaction Mechanism – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

TOTAL: 45 PERIODS

COURSE OUTCOMES (COs):

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

- Understand the principle, transmission, dispersion and attenuation characteristics of optical fibers
- Apply the gained knowledge on optical fibers for its use as communication medium and as sensor as well which have important applications in production, manufacturing industrial and biomedical applications.
- Understand laser theory and laser generation system.
- Apply laser theory for the selection of lasers for a specific Industrial application.
- Illustrate about holography and medical application of lasers.

TEXT BOOKS:

1. J.M. Senior, 'Optical Fibre Communication – Principles and Practice', 3rd Edition, Pearson Education India, 2010.
2. J. Wilson and J.F.B. Hawkes, 'Introduction to Opto Electronics', Prentice Hall of India, 2001.
3. Eric Udd, William B., and Spillman, Jr., "Fiber Optic Sensors: An Introduction for Engineers and Scientists ", John Wiley & Sons, 2nd Edition,2011.

REFERENCES:

1. M. Arumugam, 'Optical Fibre Communication and Sensors', Anuradha Agencies, 2002.
2. John F. Ready, "Industrial Applications of Lasers", Academic Press, Digitized in 2008.
3. Monte Ross, 'Laser Applications', McGraw Hill, 1968.
4. John and Harry, "Industrial lasers and their application", McGraw-Hill, 2002.
5. Keiser, G., "Optical Fiber Communication", McGraw-Hill, 5th Edition, 2017.

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1905704 SPECIAL ELECTRICAL MACHINES

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OBJECTIVES:

- Construction, principle of operation and performance of synchronous reluctance motors.
- Construction, principle of operation, control and performance of stepping motors.
- Construction, principle of operation, control and performance of switched reluctance motors.
- Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
- Construction, principle of operation and performance of permanent magnet synchronous motors.

UNIT-I: SYNCHRONOUS RELUCTANCE MOTORS 9

Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance Motors – Voltage and Torque Equations - Phasor diagram - performance characteristics – Applications.

UNIT-II: STEPPER MOTORS 9

Constructional features – Principle of operation – Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits – Closed loop control – Concept of lead angle – Applications of Stepper motor in robotics, CNC, Computer peripherals, 3D printers.

UNIT-III: SWITCHED RELUCTANCE MOTORS (SRM) 9

Constructional features – Principle of operation - Torque prediction – Characteristics Steady state performance prediction – Analytical Method – Power controllers – Control of SRM drive - Sensor less operation of SRM – Applications.

UNIT-IV: PERMANENT MAGNET BRUSHLESS D.C. MOTORS 9

Fundamentals of Permanent Magnets – Types - Principle of operation - Magnetic circuit analysis - EMF and Torque equations - Power Converter Circuits and their controllers - Characteristics and control - Applications.

UNIT-V: PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM) 9

Constructional features - Principle of operation – EMF and Torque equations - Sine wave motor with practical windings - Phasor diagram - Power controllers – performance characteristics - Digital controllers – Applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to acquire the knowledge on construction, operation and control of synchronous reluctance motors.
- Ability to acquire the knowledge on construction, operation and control of stepper motors.
- Ability to acquire the knowledge on construction, operation and control of switched reluctance motors.
- Ability to acquire the knowledge on construction, operation and control of permanent magnet brushless D.C. motors.
- Ability to acquire the knowledge on construction and operation of permanent magnet synchronous motors.

TEXTBOOKS:

1. K. Venkataratnam, ‘Special Electrical Machines’, Universities Press (India) Private Limited, 2008.
2. T. Kenjo, ‘Stepping Motors and Their Microprocessor Controls’, Clarendon Press London, 1984.
3. E.G. Janardanan, ‘Special electrical machines’, PHI learning Private Limited, Delhi, 2014.

REFERENCE BOOKS:

1 R. Krishnan, ‘Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application’, CRC Press, New York, 2001.

2 T. Kenjo and S. Nagamori, ‘Permanent Magnet and Brushless DC Motors’, Clarendon Press, London, 1988.

3 T.J.E. Miller, ‘Brushless Permanent-Magnet and Reluctance Motor Drives’, Oxford University Press, 1989.

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1909003	OPERATIONS RESEARCH	L	T	P	C
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OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Selecting the constraints on the availability of resources and developing a model and render an optimal solution during the given circumstances.
- Appraising the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits.
- Planning the purchase/manufacturing policies, managing the spares/stock and meeting the customer demands.
- Analyzing the queue discipline and exploring the avenues for better customer service.
- Investigating the nature of the project/failure and offering methodical assistance towards decision making.

UNIT-I: LINEAR MODELS 15

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT-II: TRANSPORTATION MODELS AND NETWORK MODELS 8

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencingmodels.

UNIT-III: INVENTORY MODELS 6

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT-IV: QUEUEING MODELS 6

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT-V: DECISION MODELS 10

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life – Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

- Select the constraints on the availability of resources, develop a model and render an optimal solution during the given circumstances.
- Appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.
- Plan the purchase/ manufacturing policies, manage the spares/ stocks and meet the customer demands.
- Analyze the queue discipline and explore the avenues for better customer service.
- Investigate the nature of the project/ failure and offer methodical assistance towards decision making.

TEXTBOOKS:

1. Wayne.L.Winston, "Operations research applications and algorithms", 4thedition, Cengage learning, 2004.
2. HamdyATaha, "Operations research an introduction", 10th edition, PHI/Pearson education, 2017.

REFERENCE BOOKS:

1. Srinivasan G, "Operations research principles and applications", 3rd edition EEE PHI, 2017.
2. Pannerselvam R, "Operations research", 2nd edition, PHI, 2009.
3. Ravindran, Phillips and Solberg, "Operations research principles and practice", 2nd edition, Wiley India, 2007.
4. Sharma J K, "Operations research theory and applications",5th edition, Macmillan India, 2013.
5. Premkumar Gupta and D.S.Hira, "Problems in Operations research", S.Chand, 2009.

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CO 1	2	2	2										3			3
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1905705 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

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OBJECTIVES: To impart knowledge about the following topics:

- Obtain the concept of system identification and adaptive control
- Black-box approach based system identification
- Batch and recursive identification
- Computer Controlled Systems
- Design concept for adaptive control schemes

UNIT I NON-PARAMETRIC METHODS 9

Non-parametric methods - Transient analysis - frequency analysis - Correlation analysis - Spectral analysis - Input signal design for identification.

UNIT II PARAMETRIC METHODS 9

Least squares estimation – Analysis of the least squares estimate - Best linear unbiased estimate – Model parameterizations - Prediction error methods.

UNIT III RECURSIVE IDENTIFICATION METHODS 9

The recursive least square method - Model validation –Model structure determination - Introduction to closed loop system identification.

UNIT IV ADAPTIVE CONTROL SCHEMES 9

Introduction – Auto-tuning of PID controller using relay feedback approach – Types of adaptive control schemes, Gain scheduling, Model reference adaptive control, Self–tuning controller with suitable example– Design of gain scheduled adaptive controller – Applications of gain scheduling.

UNIT V MODEL-REFERENCE ADAPTIVE SYSTEM (MRAS) and SELF-TUNING REGULATOR (STR) 9

STR – Pole placement design – Indirect STR and direct STR – MRAC - MIT rule and determination of adaptive gain– Lyapunov theory – Relationship between MRAC and STR.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand various system identification techniques and features of adaptive control like STR and MRAC.
- Ability to understand the concept of system identification and adaptive control
- Ability to understand about Black-box approach based system identification
- Ability to get knowledge about batch and recursive identification
- Ability to study about computer controlled systems and also todesign adaptive control systems

TEXTBOOKS:

1. T. Soderstrom and PetreStoica, System Identification, Prentice Hall International (UK) Ltd. 1989.
2. Karl J. Astrom and Bjorn Witten mark, Adaptive Control, Pearson Education, Second edition, Fifth impression, 2009.

REFERENCE BOOKS:

1. L. Ljung, System Identification - Theory for the User, 2nd edition,PTR Prentice Hall, Upper Saddle River, N.J., 1999.
2. K. S. Narendra and A. M. Annaswamy, Stability Adaptive Systems, Prentice-Hall,1989.
3. H. K. Khalil, Nonlinear Systems, Prentice Hall, 3rd edition, 2002.
4. William S.Levine, "Control Systems Advanced Methods, theControl Handbook, CRC Press 2011.
5. S. Sastry and M. Bodson, Adaptive Control, Prentice-Hall, 1989.

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1908006 **COMPUTER ARCHITECTURE** **L T P C**

3 0 0 3

OBJECTIVES:

- To learn the basic structure and operations of a computer.
- To learn the arithmetic and logic unit and implementation of fixed-point and floating point arithmetic unit.
- To learn the basics of pipelined execution.
- To understand parallelism and multi-core processors.
- To understand the memory hierarchies, cache memories, virtual memories and different ways of communication with I/O devices.

UNIT - I: BASIC STRUCTURE OF A COMPUTER SYSTEM 9

Functional Units – Basic Operational Concepts – Performance – Instructions: Language of the Computer – Operations, Operands – Instruction representation – Logical operations – decision making – MIPS Addressing.

UNIT - II: ARITHMETIC FOR COMPUTERS 9

Addition and Subtraction – Multiplication – Division – Floating Point Representation – Floating Point Operations – Subword Parallelism

UNIT - III: PROCESSOR AND CONTROL UNIT 9

A Basic MIPS implementation – Building a Datapath – Control Implementation Scheme – Pipelining – Pipelined datapath and control – Handling Data Hazards & Control Hazards – Exceptions.

UNIT - IV: PARALLELISIM 9

Parallel processing challenges – Flynn's classification – SISD, MIMD, SIMD, SPMD, and Vector Architectures - Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors - Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message-Passing Multiprocessors.

UNIT - V: MEMORY & I/O SYSTEMS 9

Memory Hierarchy - memory technologies – cache memory – measuring and improving cache performance – virtual memory, TLB's – Accessing I/O Devices – Interrupts – Direct Memory Access – Bus structure – Bus operation – Arbitration – Interface circuits - USB.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Understand the basics structure of computers, operations and instructions.
- Design arithmetic and logic unit.
- Understand pipelined execution and design control unit.
- Understand parallel processing architectures.
- Understand the various memory systems and I/O communication.

TEXT BOOKS:

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Fifth Edition, Morgan Kaufmann / Elsevier, 2014.
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, Sixth Edition, Tata McGraw Hill, 2012.

REFERENCE BOOKS:

1. William Stallings, Computer Organization and Architecture – Designing for Performance, Eighth Edition, Pearson Education, 2010.
2. John P. Hayes, Computer Architecture and Organization, Third Edition, Tata McGraw Hill, 2012.
3. John L. Hennessey and David A. Patterson, Computer Architecture – A Quantitative Approach, Morgan Kaufmann / Elsevier Publishers, Fifth Edition, 2012.

CO	**PO**												**PSO**			
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CO 5	3	2	3										2			2

1905706	CONTROL OF ELECTRICAL DRIVES	L	T	P	C
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OBJECTIVES:

- To understand DC drive control.
- To study and analyze the Induction motor drive control.
- To study and understand the Synchronous motor drive control.
- To study and analyze the SRM and BLDC motor drive control.
- To analyze and design digital control for drives.

UNIT-I: CONTROL OF DC DRIVES 9

Losses in electrical drive system - Energy efficient operation of drives - Block diagram/transfer function of self, separately excited DC motors - Closed loop control - Speed control - Current control - Constant torque/power operation - P, PI and PID controllers – Response comparison.

UNIT-II: CONTROL OF INDUCTION MOTOR DRIVE 9

VSI and CSI fed induction motor drives - Principles of V/f control - Closed loop variable frequency PWM inverter with dynamic braking - Static Scherbius drives - Power factor considerations – Modified Kramer drives - Principle of vector control-implementation-block diagram, Design of closed loop operation of V/f control of Induction motor drive systems.

UNIT-III: CONTROL OF SYNCHRONOUS MOTOR DRIVES 9

Open loop VSI fed drive and its characteristics – Self control – Torque control – Torque angle control – Power factor control – Brushless excitation systems - Field oriented control – Design of closed loop operation of Self control of Synchronous motor drive systems.

UNIT-IV: CONTROL OF SRM AND BLDC MOTOR DRIVES 9

SRM construction - Principle of operation - SRM drive design factors - Torque controlled SRM - Block diagram of Instantaneous Torque control using current controllers and flux controllers. Construction and Principle of operation of BLDC Machine - Sensing and logic switching scheme - Sinusoidal and trapezoidal type of Brushless dc motors – Block diagram of current controlled Brushless dc motor drive.

UNIT-V: DIGITAL CONTROL OF DC DRIVE **9**

Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant torque and constant horse power operations - Speed detection and current sensing circuits and feedback elements.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand various control strategies and controllers for DC Motor Drive systems.
- Ability to understand various control strategies and controllers for Induction Motor Drive systems.
- Ability to understand various control strategies and controllers for Synchronous Motor Drive systems.
- Ability to understand various control strategies and controllers for SRM & BLDC Motor Drive systems.
- Ability to design digital control for drives.

TEXTBOOKS:

1 Dubey, G.K, "Power semiconductor controlled devices", Prentice Hall International, New Jersey, 1989.
2 R. Krishnan, "Electric Motor Drives - Modeling, Analysis and Control", Prentice- Hall of India Pvt. Ltd., New Delhi, 2008.
3 Murphy, J.M.D, Turnbull F.G, "Thyristor control of AC motors", Pergamon Press, Oxford, 1988.

REFERENCE BOOKS:

1 Bin Wu, "High-Power Converters and AC Drives", Wiley-IEEE Press, 2006.
2 Buxbaum, A.Schierau, and K.Staughen, "A design of control systems for DC drives", Springer-Verlag, Berlin, 1990.
3 Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
4 R. Krishnan, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications", CRC press, 2001.
5 Werner Leonhard, "Control of Electrical Drives", 3rd Edition, Springer, Sept., 2001.
6 R. Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor

Drives”, CRC press, 2001.

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1906005 **VLSI DESIGN** **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the fundamentals of CMOS circuits and its characteristics.
- To learn the design and realization of combinational digital circuits.
- To design and realize the sequential digital circuits.
- To Examine the Architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology.
- To Explore the different FPGA architectures and testability of VLSI circuits.

UNIT – I: INTRODUCTION TO MOS TRANSISTOR 9

MOS Transistor, CMOS logic, Inverter, Pass Transistor, Transmission gate, Layout Design Rules, Gate Layouts, Stick Diagrams, Long-Channel I-V Charters tics, C-V Charters tics, Non ideal I-V Effects, DC Transfer characteristics, RC Delay Model, Elmore Delay, Linear Delay Model, Logical effort, Parasitic Delay, Delay in Logic Gate, Scaling.

UNIT – II: COMBINATIONAL MOS LOGIC CIRCUITS 9

Circuit Families: Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Dual Rail Domino, CPL, DCVSPG, DPL, Circuit Pitfalls. Power: Dynamic Power, Static Power, Low Power Architecture.

UNIT – III: SEQUENTIAL CIRCUIT DESIGN 9

Static latches and Registers, Dynamic latches and Registers, Pulse Registers, Sense Amplifier Based Register, Pipelining, Schmitt Trigger, Monostable Sequential Circuits, Astable Sequential Circuits. Timing Issues: Timing Classification of Digital System, Synchronous Design.

UNIT – IV: DESIGN OF ARITHMETIC BUILDING BLOCKS AND SUBSYSTEM 9

Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, Power and speed tradeoffs, Case Study: Design as a tradeoff. Designing Memory and Array structures: Memory Architectures and Building Blocks, Memory Core, Memory Peripheral Circuitry.

UNIT – V: IMPLEMENTATION STRATEGIES AND TESTING 9

FPGA Building Block Architectures, FPGA Interconnect Routing Procedures. ASIC design flow, Need for Testing, Design for Testability: Ad Hoc Testing, Scan Design, BIST, IDDQ Testing, Design for Manufacturability, Boundary Scan.

TOTAL :45 PERIODS

OUTCOMES:

On completion of the course, the student should be able to,

- Realize the concepts of digital building blocks using MOS transistor.
- Design combinational MOS circuits and power strategies.
- Construct the Sequential Circuits and Timing systems.
- Develop arithmetic building blocks and memory subsystems.
- Apply and implement FPGA, ASIC design flow and testing.

TEXT BOOKS:

1. Neil H.E. Weste, David Money Harris “CMOS VLSI Design: A Circuits and Systems Perspective”, 4th Edition, Pearson, 2017 (UNIT I,II,V)
2. Jan M. Rabaey,Anantha Chandrakasan, Borivoje. Nikolic,”Digital Integrated Circuits:A Design perspective”, Second Edition , Pearson , 2016.(UNIT III,IV)

REFERENCE BOOKS:

1. M.J. Smith, “Application Specific Integrated Circuits”, Addisson Wesley, 1997.
2. Sung-Mo kang, Yusuf leblebici, Chulwoo Kim, “CMOS Digital Integrated Circuits:Analysis & Design”, 4th edition McGraw Hill Education,2013.
3. Wayne Wolf, “Modern VLSI Design: System On Chip”, Pearson Education, 2007.
4. R.Jacob Baker, Harry W.LI., David E.Boyee, “CMOS Circuit Design, Layout and Simulation”, Prentice Hall of India 2005.

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1905707	POWER SYSTEMS TRANSIENTS	L	T	P	C
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OBJECTIVES:

To impart knowledge about the following topics:

- To understand the importance of study of transients in power systems.
- Generation of switching transients and their control using circuit – theoretical concept.
- Mechanism of lighting strokes and the production of lighting surges.
- Propagation, reflection and refraction of travelling waves.
- Voltage transients caused by faults, circuit breaker action, load rejection on integrated power system

UNIT-I: INTRODUCTION AND SURVEY 9

Review and importance of the study of transients - Review of RLC transients with DC Excitation causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning

UNIT-II: SWITCHING TRANSIENTS 9

Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients - Ferro resonance.

UNIT-III: LIGHTNING TRANSIENTS 9

Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.

UNIT-IV: TRAVELING WAVES ON TRANSMISSION LINE AND COMPUTATION OF TRNNSIENTS 9

Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves

UNIT-V: TRANSIENTS IN INTEGRATED POWER SYSTEM 9

The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - over voltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to Understand and analyze the importance of transients in power systems.
- Ability to acquire knowledge on generation of switching transients and their control.
- Ability to analyze the mechanism of lighting strokes.
- Ability to understand the importance of propagation, reflection and refraction of travelling waves.
- Ability to find the voltage transients caused by faults, and to understand the concept of circuit breaker action, load rejection on integrated power system.

TEXTBOOKS:

1. Allan Greenwood, "Electrical Transients in Power Systems", Wiley Inter Science, New York, 2nd Edition, 2010.
2. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009.
3. C.S. Indulkar, D.P.Kothari, K. Ramalingam, "Power System Transients – A statistical approach", PHI Learning Private Limited, Second Edition, 2010.

REFERENCE BOOKS:

1. M.S.Naidu and V.Kamaraju, "High Voltage Engineering", McGraw Hill, Fifth Edition, 2013.
2. R.D. Begamudre, "Extra High Voltage AC Transmission Engineering", New Academic Science Ltd; 4th edition, 2011.
3. Y.Hase, Handbook of Power System Engineering," Wiley India, 2012.
4. J.L.Kirtley, "Electric Power Principles, Sources, Conversion, Distribution and use," Wiley, 2012.
5. Akihiro Ametani," Power System Transient theory and applications", CRC press, 2016

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1915003 TOTAL QUALITY MANAGEMENT L T P C

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OBJECTIVES:

- To understand the need and evolution of quality concepts, contribution of quality gurus.
- To understand the TQM Principles and Models.
- To learn and apply the traditional tools and techniques of TQM.
- To educate students to apply the modern tools and techniques in TQM.
- To understand and apply QMS and EMS in any organization.

UNIT – I: INTRODUCTION 9

Introduction - Definition of quality - Need for quality - Evolution of quality - Dimensions of product and service quality - Definition of TQM - Basic concepts of TQM – Principles of TQM - TQM Framework- Barriers to TQM – Benefits of TQM – Cost of Quality.

UNIT – II: TQM PRINCIPLES 9

Leadership--The Deming Philosophy, Quality council, Quality statements and Strategic planning- Hoshin Planning - Customer Satisfaction – Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward - Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Sourcing, Supplier selection, Supplier Rating and Relationship development

UNIT – III: TQM TOOLS &TECHNIQUES I 9

The seven traditional tools of quality – New management tools – Six-sigma Process Capability–Bench marking – Reasons to bench mark, Bench marking process, Criticisms of Bench Marking – FMEA –FMEA Documentation, Stages.

UNIT – IV: TQM TOOLS & TECHNIQUES II 9

Quality Circles – Quality Function Deployment (QFD) – House of Quality –

QFD Process, Benefits – Total Productive Maintenance – Concepts, Benefits – Business Process Reengineering – Concepts, Process and Applications – Business Process Improvement.

UNIT – V: QUALITY MANAGEMENT SYSTEM 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000--ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration--Environmental Management System: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001 -Requirements of ISO 14001—Benefits of EMS – National and International Awards.

TOTAL: 45 PERIODS

OUTCOMES:

- Students would understand the basic concepts, contribution of quality guru's and TQM framework.
- Students would become acquainted with TQM Principles.
- Student would be able to apply the tools and techniques of quality management.
- Students will be able to apply Quality philosophy in business processes with an understanding on customer requirements.
- Students can apply QMS and EMS in any organisation.

TEXT BOOK:

1. Dale Besterfield, Carol B. Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal.R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice

Hall (India) Pvt. Ltd.,7 th Print 2011.

4. Itay Abuhav, ISO 9001: 2015 - A Complete Guide to Quality Management Systems, CRC Press; 1st edition(2017)
5. ISO 9001-2015 standard

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1905801	FLEXIBLE AC TRANSMISSION SYSTEMS	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following Topics

- Concepts of the start-of-art of the power system.
- Performance of VAR Compensators and its Applications.
- Modelling of Thyristor Controlled Series Compensators and Power Flow analysis.
- Performance of Different FACTS Controller and Load flow analysis.
- Operation of various configurations of Advanced FACTS Controllers.

UNIT-I: INTRODUCTION 9

Real and reactive power control in electrical power transmission lines–loads & system compensation-Uncompensated transmission line–shunt and series compensation.

UNIT-II: STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9

Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator–TCR-FC-TCR-Modelling of SVC for power flow and fast transient stability– Applications: Enhancement of transient stability – Steady state power transfer –Enhancement of power system damping.

UNIT-III: THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Operation of the TCSC–Different modes of operation–Modelling of TCSC, Variability reactance model– Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit–Enhancement of system damping

UNIT-IV: VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS **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 and the control of power flow–modelling of SSSC in load flow and transient stability studies-Dynamic voltage restorer (DVR).

UNIT-V: ADVANCED FACTS CONTROLLERS **9**

Interline DVR(IDVR) - Unified Power flow controller (UPFC) - Interline power flow controller (IPFC) - Unified Power quality conditioner (UPQC).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Ability to acquire the knowledge o n Concepts of the start-of-art of the power system.
- Ability to acquire the knowledge o n Performance of VAR Compensators and its applications.
- Ability to acquire the knowledge on Modeling of Thyristor Controlled Series Compensators and Power Flow analysis.
- Ability to acquire the knowledge on Performance of Different FACTS Controller and Load flow analysis.
- Ability to acquire the knowledge on Operation of various configurations of Advanced FACTS Controllers.

TEXTBOOKS:

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.
3. T.J.E Miller, Power Electronics in power systems, John Wiley and sons.

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 Electricaland Electronic Engineers (IEEE), 1999.
3. V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Powe System, APRIL 2004, Kluwer Academic Publishers, 2004.

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1905802	SOFT COMPUTING TECHNIQUES	L	T	P	C
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OBJECTIVES:

- To understand the basics of artificial neural network
- Get exposed to the various neural modeling and control techniques
- Gain Knowledge on fuzzy set theory and fuzzy rules.
- Able to design and implement the fuzzy logic modeling and control
- Capable of designing hybrid control schemes, selected optimization algorithms with case study using simulation tool box.

UNIT-I: ARTIFICIAL NEURAL NETWORK 9

Review of fundamentals – Biological neuron, artificial neuron, activation function, single layer perceptron – Limitation – Multi layer perceptron – Back Propagation Algorithm (BPA) – Recurrent Neural Network (RNN) – Adaptive Resonance Theory (ART) based network – Radial basis function network – online learning algorithms, BP through time – RTRL algorithms – Reinforcement learning

UNIT-II: NEURAL NETWORKS FOR MODELING AND CONTROL 9

Modelling of non-linear systems using ANN – Generation of training data – Optimal architecture– Model validation – Control of non-linear systems using ANN – Direct and indirect neuro control schemes – Adaptive neuro controller – Familiarization with neural network toolbox

UNIT-III: FUZZY SET THEORY 9

Fuzzy set theory – Fuzzy sets – Operation on fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection, complement (Yager and Sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation – Fuzzy membership functions

UNIT-IV: FUZZY LOGIC FOR MODELING AND CONTROL 9

Modelling of non-linear systems using fuzzy models – TSK model – Fuzzy logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification – Adaptive fuzzy systems – Familiarization with fuzzy logic toolbox.

UNIT-V: HYBRID CONTROL SCHEMES 9

Genetic Algorithms and Genetic Programming- Fuzzification and rule base using ANN – Neuro fuzzy systems – ANFIS – Fuzzy neuron– GA – Optimization of membership function and rule base using Genetic Algorithm –Case study – Familiarization with ANFIS toolbox.

TOTAL : 45 Periods

COURSE OUTCOMES:

- Ability to understand the basics of artificial neural network and training algorithms
- Ability to get knowledge on modeling and control of Neuro controller systems
- Ability to understand the basics of Fuzzy sets
- Ability to get design fuzzy controller for non linear systems
- Ability to acquire knowledge on hybrid control schemes

TEXTBOOKS:

1. Laurene V. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms And Applications", Pearson Education, 2004
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India, 2016
3. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.

REFERENCE BOOKS:

1 Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.

2 J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy & Soft Computing - A Computational Approach to Learning and Machine Intelligence", Pearson, 2016

3 Zhang Huaguang and Liu Derong, "Fuzzy Modeling and Fuzzy Control Series: Control Engineering", 2006

4 Millon W.T., Sutton R.S. and Webrose P.J., "Neural Networks for Control", MIT press, 1992

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5	3	3	3	3	3									3	3	

1905803	POWER SYSTEMS DYNAMICS	L	T	P	C
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OBJECTIVES:

To impart knowledge about the following topics:

- Basics of dynamics and stability problems
- Modeling of synchronous machines
- Excitation system and speed-governing controllers.
- Small signal stability of a single-machine infinite bus system with excitation system and power system stabilizer.
- Transient stability simulation of multi machine power system.

UNIT-I: INTRODUCTION 9

Basics of system dynamics – numerical techniques – introduction to software packages to study the responses. Concept and importance of power system stability in the operation and design - distinction between transient and dynamic stability - complexity of stability problem in large system – necessity for reduced models - stability of interconnected systems.

UNIT II SYNCHRONOUS MACHINE MODELLING 9

Synchronous machine - flux linkage equations - Park's transformation - per unit conversion - normalizing the equations - equivalent circuit - current space model - flux linkage state space model. Sub-transient and transient inductances - time constants. Simplified models (one axis and constant flux linkage)- steady state equations and phasor diagrams

UNIT-III: MACHINE CONTROLLERS 9

Exciter and voltage regulators - function and types of excitation systems - typical excitation system configuration - block diagram and state space representation of IEEE type 1 excitation system - saturation function - stabilizing circuit. Function of speed governing systems - block diagram and state space representation of IEEE mechanical hydraulic governor and electrical hydraulic governors for hydro turbines and steam turbines.

UNIT-IV: TRANSIENT STABILITY 9

State equation for multi machine system with one axis model and simulation – modelling of multi machine power system with one axis machine model including excitation system and speed governing system and simulation using R-K method of fourth order (Gill's technique)for transient stability analysis - power system stabilizer. For all simulations, the algorithm and flow chart have to be discussed.

UNIT-V: DYNAMIC STABILITY 9

System response to small disturbances - linear model of the unregulated synchronous machine and its modes of oscillation - regulated synchronous machine - distribution of power impact - linearization of the load equation for the one machine problem – simplified linear model - effect of excitation on dynamic stability - approximate system representation- supplementary stabilizing signals - dynamic performance measure - small signal performance measures. Small signal stability improvement methods: delta-omega & delta p-omega stabilizers.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand and analyze power system operation, stability, control and protection.
- Ability to get knowledge on the basics of dynamics and stability problems and design and modelling of synchronous machines
- Ability to study about excitation system and speed-governing controllers.
- Ability to understand the concept of small signal stability of a single-machine infinite bus system with excitation system.
- Ability to analyze the transient stability simulation

TEXTBOOKS:

1. P.M. Anderson and A.A.Fouad, 'Power System Control and Stability', Galgotia Publications, New Delhi, 2003.
2. Kundur P., Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
3. R.Ramanujam, "Power System Dynamics – Analysis and Simulation", PHI, 2009.

REFERENCE BOOKS:

1. M.A.Pai and W.Sauer, ‘Power System Dynamics and Stability’, Pearson Education Asia, India, 2002.
2. James A.Momoh, Mohamed. E. El-Hawary. “ Electric Systems, Dynamics and Stability with Artificial Intelligence applications”, Marcel Dekker, USA First Edition,2000.
3. C.A.Gross, “Power System Analysis,” Wiley India, 2011.
4. B.M.Weedy, B.J.Lory, N.Jenkins, J.B.Ekanayake and G.Strbac,” Electric Power Systems”, Wiley India, 2013.
5. K.Umarao, “Computer Techniques and Models in Power System,” I.K. International,2007

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1905804 **SMPS AND UPS** **L T P C**

3 0 0 3

OBJECTIVES:

To impart knowledge on the following Topics

- Modern power electronic converters and its applications in electric power utility.
- Resonant converters and UPS.
- To learn the Switched Mode Power Converters.
- To learn the DC-DC converters & DC-AC converters.
- To learn the Power conditioners & Filters.

UNIT-I: DC-DC CONVERTERS 9

Principles of step down and step up converters – Analysis and state space modeling of Buck, Boost, Buck- Boost and Cuk converters-Different Class of Chopper.

UNIT-II: SWITCHED MODE POWER CONVERTERS 9

Analysis and state space modeling of fly back, Forward, Push pull, Luo, Half bridge and full bridge converters- control circuits and PWM techniques.

UNIT-III: RESONANT CONVERTERS 9

Introduction- classification- basic concepts- Resonant switch- Load Resonant converters- ZVS , Clamped voltage topologies- DC link inverters with Zero Voltage Switching- Series and parallel Resonant inverters- Voltage control.

UNIT-IV: DC-AC CONVERTERS 9

Single phase and three phase inverters, control using various (sine PWM, SVPWM and PSPWM) techniques, various harmonic elimination techniques- Multilevel inverters Concepts- Types: Diode clamped- Flying capacitor- Cascaded types- Applications.

UNIT-V: POWER CONDITIONERS, UPS & FILTERS 9

Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to analyze the state space model for DC – DC converters.
- Ability to acquire knowledge on switched mode power converters.
- Ability to understand the importance of Resonant Converters.
- Ability to analyze the PWM techniques for DC-AC converters.
- Ability to acquire knowledge on modern power electronic converters, power conditioners, ups & filters and its applications in electric power utility.

TEXTBOOKS:

1. Simon Ang, Alejandro Oliva,” Power-Switching Converters”, Third Edition, CRC Press, 2010.
2. KjeldThorborg, “Power Electronics – In theory and Practice”, Overseas Press, First Indian Edition 2005.
3. M.H. Rashid – Power Electronics handbook, Elsevier Publication, 2001.

REFERENCE BOOKS:

1 Philip T Krein, “ Elements of Power Electronics”, Oxford University Press.

2 Ned Mohan, Tore.M.Undeland, William.P.Robbins, Power Electronics converters, Applications and design- Third Edition- John Wiley and Sons- 2006.

3 M.H. Rashid – Power Electronics circuits, devices and applications- third edition Prentice Hall of India New Delhi, 2007.

4 Erickson, Robert W, “Fundamentals of Power Electronics”, Springer, second edition, 2010.

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1905805	ELECTRIC ENERGY GENERATION, UTILIZATION AND CONSERVATION	L	T	P	C
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OBJECTIVES:

- To study the generation, conservation of electrical power and energy efficient equipment
- To understand the principle, design of illumination systems and energy efficiency lamps.
- To study about the air conditioning and refrigeration system.
- To impart knowledge on industrial heating and welding.
- To understand the electric traction systems and their performance.

UNIT-I: ILLUMINATION 9

Importance of lighting – properties of good lighting scheme – laws of illumination – photometry - types of lamps – lighting calculations – basic design of illumination schemes for residential, commercial, street lighting, factory lighting and flood lighting – LED lighting and energy efficient lamps

UNIT-II: REFRIGERATION AND AIR CONDITIONING 9

Refrigeration-Domestic refrigerator and water coolers - Air-Conditioning-Various types of air-conditioning system and their applications, smart air conditioning units - Energy Efficient motors: Standard motor efficiency, need for efficient motors, Motor life cycle, Direct Savings and payback analysis, efficiency evaluation factor

UNIT-III: HEATING AND WELDING 9

Role of electric heating for industrial applications – resistance heating – induction heating – dielectric heating - electric arc furnaces. Brief introduction to electric welding – welding generator, welding transformer and the characteristics. Power supply for radiation welding.

UNIT-IV: TRACTION 9

Merits of electric traction – requirements of electric traction system – supply systems – mechanics of train movement – traction motors and control – braking – recent trends in electric traction. Systems of railway electrification. Traction motors and its characteristics.

UNIT-V: DOMESTIC UTILIZATION OF ELECTRICAL ENERGY 9

Domestic utilization of electrical energy – House wiring. Induction based appliances, Online and OFF-line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing – Domestic, Industrial and Substation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand the main aspects of generation, utilization and conservation.
- Ability to identify an appropriate method of heating for any particular industrial application
- Ability to handle domestic wiring connection and debug any faults occurred
- Ability to construct an electric connection for any domestic appliance like refrigerator as well as to design a battery charging circuit for a specific household application.
- Able to understand the concept of electric traction system.

TEXTBOOKS:

1 Wadhwa, C.L. “Generation, Distribution and Utilization of Electrical Energy”, New Age International Pvt. Ltd, 2003.
2 Dr. Uppal S.L. and Prof. S. Rao, ‘Electrical Power Systems’, Khanna Publishers, New Delhi, 15th Edition, 2014.
3 Energy Efficiency in Electric Utilities, BEE Guide Book, 2010

REFERENCE BOOKS:

1 Partab.H, “Art and Science of Utilisation of Electrical Energy”, Dhanpat Rai and Co, New Delhi, 2004.
2 Openshaw Taylor.E, “Utilization of Electrical Energy in SI Units”, Orient Longman Pvt. Ltd, 2003.
3 Gupta.J.B, “Utilization of Electric Power and Electric Traction”, S.K.Kataria and Sons, 2002.
4 Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council.

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1905806	POWER QUALITY	L	T	P	C
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OBJECTIVES:

To impart knowledge on the following Topics

- To study the various sources and effects of power quality issues
- To introduce different mitigation techniques of various power quality events
- To impart knowledge of various sources & mitigation of harmonics
- To learn the Various Active & Passive power filters
- To study the various power quality monitoring and custom power devices

UNIT-I: INTRODUCTION TO POWER QUALITY 9

Terms and definitions & Sources – Overloading, under voltage, over voltage - Linear and Non-linear load, Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Sags and swells - Voltage sag - Voltage swell - Voltage imbalance –Voltage fluctuations - Power frequency variations - International standards of power quality– Computer Business Equipment Manufacturers Associations (CBEMA) curve- Power Quality issues of Grid connected Renewable Energy Sources.

UNIT-II: VOLTAGE SAG AND SWELL 9

Estimating voltage sag performance - Thevenin's equivalent source - Analysis and calculation of various faulted condition - Estimation of the sag severity - Mitigation of voltage sag, Static transfer switches and fast transfer switches. - Capacitor switching – Lightning - Ferro resonance - Mitigation of voltage swell.

UNIT-III: HARMONICS 9

Harmonic sources from commercial and industrial loads - Locating harmonic sources – Power system response characteristics - Harmonics Vs transients. Effect of harmonics – Harmonic distortion - Voltage and current distortions - Harmonic indices - Inter harmonics – Resonance Harmonic distortion evaluation, IEEE and IEC standards.

UNIT-IV: PASSIVEPOWER COMPENSATORS **9**

Principle of Operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators Simulation and Performance of Passive Power Filters- Limitations of Passive Filters Parallel Resonance of Passive Filters with the Supply System and Its Mitigation. Fundamentals of load compensation – voltage regulation & power factor correction.

UNIT-V: POWER QUALITY MONITORING & CUSTOM POWER DEVICES **9**

Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters Disturbance analyzer - Applications of expert systems for power quality monitoring. Principle& Working of DSTATCOM – DSTATCOM in Voltage control mode, current control mode, DVR Structure – Rectifier supported DVR – DC Capacitor supported DVR -Unified power quality conditioner.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Ability to understand various sources and effects of power quality issues.
- Ability to analyze different mitigation techniques of various PQevents.
- Ability to study about different sources and mitigation ofharmonics.
- Ability to analyze and design various Active & Passive powerfilters.
- Ability to understand various PQ monitoring and custom power devices

TEXT BOOKS:

1. Roger. C. Dugan, Mark. F. Mc Granagham, Surya Santoso, H.WayneBeaty, “Electrical Power Systems Quality”, McGraw Hill, 2003
2. J. Arrillaga, N.R. Watson, S. Chen, “Power System Quality Assessment”, (New York : Wiley), 2000
3. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad,” Power Quality Problems & Mitigation Techniques” Wiley, 2015.

REFERENCE BOOKS:

1.G.T. Heydt, “Electric Power Quality”, 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994

2. M.H.J Bollen, “Understanding Power Quality Problems: Voltage Sags and

Interruptions”, (New York: IEEE Press), 2000.

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1905807 ENERGY MANAGEMENT AND AUDITING

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OBJECTIVES:

To impart knowledge about the following topics:

- To impact concepts of behind economic analysis and Load management.
- To impact concepts of Energy management on various electrical equipment and metering.
- To understand the Concept of lighting systems and cogeneration.
- To understand the concepts of Metering for Energy Management
- To understand the concepts of Economic Analysis and Models

UNIT- I: INTRODUCTION 9

Basics of Energy – Need for energy management – Energy accounting - Energy monitoring, targeting and reporting - Energy audit process.

UNIT- II: ENERGY MANAGEMENT FOR MOTORS AND COGENERATION 9

Energy management for electric motors – Transformer and reactors - Capacitors and synchronous machines, energy management by cogeneration – Forms of cogeneration – Feasibility of cogeneration – Electrical interconnection.

UNIT - III: LIGHTING SYSTEMS 9

Energy management in lighting systems – Task and the working space - Light sources – Ballasts – Lighting controls – Optimizing lighting energy – Power factor and effect of harmonics, lighting and energy standards.

UNIT- IV: METERING FOR ENERGY MANAGEMENT 9

Metering for energy management – Units of measure - Utility meters – Demand meters – Paralleling of current transformers – Instrument transformer burdens – Multi tasking solid state meters, metering location vs requirements, metering techniques and practical examples.

UNIT- V: ECONOMIC ANALYSIS AND MODELS 9

Economic analysis – Economic models - Time value of money - Utility rate structures – Cost of electricity – Loss evaluation, load management – Demand control techniques – Utility monitoring and control system – HVAC and energy management – Economic justification.

TOTAL :45 PERIODS

OUTCOMES:

- Ability to understand the basics of Energy audit process.
- Ability to understand the basics of energy management bycogeneration.
- Ability to acquire knowledge on Energy management in lightingsystems.
- Ability to impact concepts behind economic analysis and Load management.
- Ability to understand the importance of Energy management on various electrical equipment and metering and ability to acquire knowledge on HVAC.

TEXTBOOKS :

1 Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006.

2 Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN 0 582-03184 ,1990.

REFERENCE BOOKS :

1 Reay D.A, Industrial Energy Conservation, 1stedition, Pergamon Press, 1977.

2 IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 196.

3 Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.

4 Electricity in buildings good practice guide, McGraw-Hill Education, 2016.

5 National Productivity Council Guide Books.

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1905808	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C
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OBJECTIVES:

To impart knowledge about the following topics:

- Planning of DC power transmission and comparison with AC power transmission.
- HVDC converters.
- HVDC system control.
- Harmonics and design of filters.
- Power flow in HVDC system under steady state.

UNIT-I: INTRODUCTION 9

DC Power transmission technology–Comparison of AC and DC transmission–Application of DC transmission–Description of DC transmission system–Planning for HVDC transmission–Modern trends in HVDC technology–DC breakers–Operating problems–HVDC transmission based on VSC –Types and applications of MTDC systems.

UNIT-II: ANALYSIS OF HVDC CONVERTERS 9

Line commutated converter -Analysis of Graetz circuit with and without overlap –Pulse number– Choice of converter configuration – Converter bridge characteristics–Analysis of a 12 pulse converters– Analysis of VSC topologies and firing schemes.

UNIT-III: CONVERTER AND HVDC SYSTEM CONTROL 9

Principles of DC link control–Converter control characteristics–System control hierarchy– Firing angle control– Current and extinction angle control–Starting and stopping of DC link–Power control –Higher level controllers –Control of VSC based HVDC link.

UNIT-IV: REACTIVE POWER AND HARMONICS CONTROL 9

Reactive power requirements in steady state–Sources of reactive power–SVC and STATCOM– Generation of harmonics –Design of AC and DC filters– Active filters.

UNIT-V: POWER FLOW ANALYSIS IN AC/DC SYSTEMS 9

Per unit system for DC quantities–DC system model –Inclusion of constraints –Power flow analysis –case study-Nation initiative of projects.

TOTAL : 45 PERIODS

OUTCOMES:

- Ability to understand the principles, types and concepts of HVDC system.
- Ability to acquire knowledge on DC link control.
- Ability to understand the concepts of reactive power management, harmonics and power flow analysis.
- Ability to get knowledge about Planning of DC power transmission and comparison with AC power transmission.
- Ability to understand the importance of power flow in HVDC system under steady state.

TEXTBOOKS:

1. Padiyar,K.R., "HVDC power transmission system", New Age International (P)Ltd. New Delhi, Second Edition, 2010.
2. Arrillaga,J., "High Voltage Direct Current Transmission", Peter Pregrinus, London,1983.

REFERENCE BOOKS:

1. Kundur P., Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
2. Colin Adamson and Hingorani NG, "High Voltage Direct Current Power Transmission", Garraway Limited, London, 1960.
3. Edward Wilson Kimbark, "Direct Current Transmission", Vol.I, Wiley inter science,New York, London, Sydney,1971.

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1905809	MICROCONTROLLER BASED SYSTEM DESIGN	L	T	P	C
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OBJECTIVES:

- To impart knowledge on Architecture of PIC microcontroller
- To impart knowledge on Interrupts and timers
- To impart knowledge on Peripheral devices for data communication and transfer
- To impart knowledge on Functional blocks of ARM processor
- To impart knowledge on Architecture of ARM processors

UNIT-I: INTRODUCTION TO PIC MICROCONTROLLER 9

Introduction to PIC Microcontroller–PIC 16C6x and PIC16C7x Architecture–IC16cxx–- Pipelining - Program Memory considerations – Register File Structure - Instruction Set - Addressing modes – Simple Operations

UNIT-II: INTERRUPTS AND TIMER 9

PIC micro controller Interrupts- External Interrupts-Interrupt Programming–Loop time subroutine Timers-Timer Programming– Front panel I/O-Soft Keys– State machines and key switches– Display of Constant and Variabilitystrings.

UNIT-III: PERIPHERALS AND INTERFACING 9

I2C Bus for Peripherals Chip Access– Bus operation-Bus subroutines– Serial EEPROM— Analog to Digital Converter–UART-Baud rate selection–Data handling circuit–Initialization -LCD and keyboard Interfacing -ADC, DAC, and Sensor Interfacing.- Flash memories

UNIT-IV: INTRODUCTION TO ARM PROCESSOR 9

Architecture –ARM programmer’s model –ARM Development tools- Memory Hierarchy –ARM Assembly Language Programming–Simple Examples–Architectural Support for Operating systems.

UNIT-V: ARM ORGANIZATION 9

3-Stage Pipeline ARM Organization– 5-Stage Pipeline ARM Organization–ARM Instruction Execution- ARM Implementation– ARM Instruction Set– ARM coprocessor interface–Architectural support for High Level Languages – Embedded ARM Applications.

TOTAL:45PERIODS

COURSE OUTCOMES:

- Ability to understand the concepts of Architecture of PIC microcontroller
- Ability to acquire knowledge on Interrupts and timers.
- Ability to understand the importance of Peripheral devices for data communication
- Ability to understand the functional blocks of ARM Processor
- Ability to acquire knowledge in Architecture of ARM processors

TEXTBOOKS:

1. Peatman,J.B., “Design with PIC Micro Controllers”PearsonEducation,3 rd Edition, 2004.
2. Furber,S., “ARM System on Chip Architecture” Addison Wesley trade Computer Publication, 2000.

REFERENCE BOOKS:

1 Mazidi, M.A.,“PIC Microcontroller” Rollin Mckinlay, Danny causey ,Prentice Hall of India, 2007

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1905810	SMART GRID	L	T	P	C
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OBJECTIVES:

To impart knowledge about the following topics:

- Smart Grid technologies
- different smart meters
- advanced metering infrastructure
- The power quality management issues in Smart Grid.
- The high-performance computing for Smart Grid applications

UNIT-I: INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid. Power Distribution utility in India, IEEE communication surveys.

UNIT-II: SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution, Transformers, Phase Shifting Transformers, Plug-in Hybrid Electric Vehicles(PHEV).

UNIT-III: SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering in frastructure(AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED)& their application for monitoring & protection

UNIT-IV: POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based

Power Quality monitoring, Power Quality Audit.

UNIT-V: HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network(LAN),House Area Network(HAN), Wide Area Network(WAN), Broad band over Power line(BPL),IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- Learners will develop more understanding on the concepts of Smart Grid and its present developments.
- Learners will study about different Smart Grid technologies.
- Learners will acquire knowledge about different smart meters and advanced metering infrastructure.
- Learners will have knowledge on power quality management in Smart Grids
- Learners will develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

TEXTBOOKS:

1. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”,CRCPress2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama,“Smart Grid: Technology and Applications”, Wiley 2012.

REFERENCE BOOKS:

1. VehbiC. Güngör ,Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, “Smart Grid Technologies: CommunicationTechnologies and Standards” IEEE Transactions On Industrial Informatics, Vol.7,No.4,November2011.
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang“SmartGrid –The New and Improved Power Grid: A Survey” ,IEEE Transaction on Smart Grids,vol.14,2012.
3. James Momohe “Smart Grid: Fundamentals of Design and Analysis,”, Wiley-IEEE Press, 2012.

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1902512 **ENVIRONMENT AND AGRICULTURE** **L T P C**

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OBJECTIVES:

- To emphasize on the importance of environment and agriculture on changing global scenario and the emerging issues connected to it.
- To understand the ecological context of agriculture and its concerns.
- To study the context of climate change and emerging global issues.
- To gain knowledge on water balance.
- To understand the importance of virtual water.

UNIT-I: ENVIRONMENTAL CONCERNS **9**

Environmental basis for agriculture and food – Land use and landscape changes – Water quality issues – Changing social structure and economic focus – Globalization and its impacts – Agro ecosystems.

UNIT-II: ENVIRONMENTAL IMPACTS **9**

Irrigation development and watersheds – mechanized agriculture and soil cover impacts – Erosion and problems of deposition in irrigation systems – Agricultural drainage and downstream impacts – Agriculture versus urban impacts.

UNIT- III: CLIMATE CHANGE **9**

Global warming and changing environment – Ecosystem changes – Changing blue-green-grey water cycles – Water scarcity and water shortages – Desertification.

UNIT-IV: ECOLOGICAL DIVERSITY AND AGRICULTURE **9**

Ecological diversity, wild life and agriculture – GM crops and their impacts on the environment – Insets and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

UNIT-V: EMERGING ISSUES **9**

Global environmental governance – alternate culture systems – Mega farms and vertical farms – Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts – Sustainable agriculture.

TOTAL: 45 PERIODS

OUTCOMES:

- Students may be able to know how the environment and agriculture are related and the changes in the environmental due to agriculture.
- Students will be able to gather idea on about how the mechanization helps and impacts of soil erosion due to agricultural activities.
- Students will have a wide knowledge of changing environment due to global warming and climate change and its impact on water.
- Students are exposed to the ecological diversity in agriculture and different technologies used in farming activities.
- Students are able to understand the global governance system and agricultural policies involved in the sustainable agricultural systems.

TEXT BOOKS:

1. M.Lakshmi Narasaiah, Environment and Agriculture, Discovery Pub. House, 2006.
2. Arvind Kumar, Environment and Agriculture, ABH Publications, New Delhi, 2005

REFERENCE BOOKS:

1. T.C. Byerly, Environment and Agriculture, United States Dept. of Agriculture, Economic Research Service, 2006.
2. Robert D. Havener, Steven A. Breth, Environment and agriculture: rethinking development issues for the 21st century: proceedings of a symposium, Winrock International Institute for Agricultural Development, 1994.
3. Environment and agriculture: environmental problems affecting agriculture in the Asia and Pacific region; World Food Day Symposium, Bangkok, Thailand. 1989.

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1902513	PRODUCTION TECHNOLOGY OF AGRICULTURAL MACHINERY	L T P C 3 0 0 3

OBJECTIVES:

- To understand the mechanical properties of engineering materials and their classifications
- To understand the basic principles of lathe and the corresponding machines.
- To gain knowledge on various welding techniques available.
- To understand the importance of advanced manufacturing process.
- To emphasize on the importance of accuracy on machine operation.

UNIT- I: ENGINEERING MATERIALS 9

Engineering materials - their classification - Mechanical properties of materials, strength, elasticity, plasticity, stiffness, malleability, ductility, brittleness, toughness, hardness, resilience, machinability, formability, weldability. Steels and cast irons: Carbon steels, their classification based on percentage of carbon as low, mild, medium & high carbon steel, their properties & applications. Wrought iron, cast iron. Alloy steels: Stainless steel, tool steel.

UNIT- II: MACHINING 9

Basic principles of lathe - machine and operations performed on it. Basic description of machines and operations of Shaper-Planner, Drilling, Milling & Grinding.

UNIT- III: WELDING 9

Introduction, classification of welding processes. Gas welding, types of flames and their applications. Electric Arc welding. Resistance welding, Soldering & Brazing processes and their uses.

UNIT-IV: ADVANCED MANUFACTURING PROCESS 9

Abrasive flow machining - abrasive jet machining - water jet machining - Electro Discharge Machining (EDM) - Wire cut EDM - Electro Chemical Machining (ECM) - Ultrasonic Machining / Drilling (USM / USD) - Electron Beam Machining (EBM) - Laser Beam Machining (LBM).

UNIT- V: CNC MACHINE 9

Numerical control (NC) machine tools - CNC: types, constitutional details, special features - design considerations of CNC machines for improving machining accuracy - structural members - slide ways - linear bearings - ball screws - spindle drives and feed drives. Part programming fundamentals - manual programming.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course,

- Students can able to apply the different manufacturing process and use this in industry for component production.
- Students will be able to understand the working principle of lathe and various operations done on it.
- Students will be able to gather idea on welding and soldering process.
- Students will gain wide knowledge on various advance manufacturing process.
- Students will gain knowledge in CNC machine and improving the machining accuracy.

TEXTBOOKS:

1. "Manufacturing Engineering and Technology", Kalpakjian and Schmid, Pearson, 2010.
2. Hajra Choudry, "Elements of workshop technology - Vol II", Media promoters, 2002.

REFERENCE BOOKS:

1. Gupta. K.N., and Kaushik, J.P., 1998, Workshop Technology Vol I and II, New Heights, Daryaganj, New Delhi.
2. Arthur. D., et. al. 1998, General Engineering Workshop Practice, Asia Publishing House, Bombay.
3. Chapman W.A.J., Workshop Technology, 1992, Part I, II, III, E.L.B.S. and Edward Amold Publishers Ltd, London.

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1903514 AIR POLLUTION AND CONTROL ENGINEERING L T P C

3 0 0 3

OBJECTIVE:

- To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.
- To gain knowledge of characteristics of air pollution and noise pollution.
- To create awareness among the sources and effects of air pollution.
- To gain knowledge on air pollution control equipments.
- To develop a knowledge on air quality standards.

UNIT- I: INTRODUCTION 9

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards – Ambient and stack sampling and Analysis of Particulate and Gaseous Pollutants.

UNIT- II: METEOROLOGY 9

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

UNIT- III: CONTROL OF PARTICULATE CONTAMINANTS 9

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle, Design and performance equations of Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations.

UNIT- IV: CONTROL OF GASEOUS CONTAMINANTS 9

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations.

UNIT- V: INDOOR AIR QUALITY MANAGEMENT 9

Air quality standards - Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness - Town planning regulations of industries-Sources and Effects of Noise Pollution – Measurement – Standards – Control and Preventive measures.

TOTAL: 45 PERIODS

OUTCOMES:

The students completing the course will have

- An understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management.
- Ability to identify, formulate and solve air and noise pollution problems.
- Ability to design stacks and particulate air pollution control devices to meet applicable standards.
- Ability to select control equipments.
- Ability to control effects of noise pollution and indoor air pollution.

TEXTBOOKS:

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science , science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.

REFERENCE BOOKS:

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution", Tata Mcgraw Hill Publishing Company limited, 2007.

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1903515 PARTICIPATORY WATER RESOURCES MANAGEMENT L T P C

3 0 0 3

OBJECTIVE:

- To gain an insight on local and global perceptions and approaches on participatory water resource management
- To know the role of farmers in socio economic issues and challenges.
- To bring the knowledge of water conservation.
- To gain knowledge on issues of water management.
- To develop knowledge on global challenges and solutions.

UNIT- I: FUNDAMENTALS: SOCIOLOGY AND PARTICIPATORY APPROACH 9

Sociology – Basic concepts – Perspectives- Social Stratification – Irrigation as a Socio technical Process - Participatory concepts– Needs for participatory -Objectives of participatory approach.

UNIT- II: UNDERSTANDING FARMERS PARTICIPATION 9

Farmers participation - Need and Benefits - Comparisons of cost and benefit - Sustained system performance - Kinds of participation - Context of participation, factors in the environment - WUA - Constraints in organizing FA - Role of Community Organizer – socio economic - Case Studies.

UNIT- III: ISSUES IN WATER MANAGEMENT 9

Multiple use of water – Issues in Inter-sectoral Water Allocation - domestic, irrigation, industrial sectors - Modernization techniques and its challenges – Command Area Development - Water delivery systems – Advantages and disadvantages.

UNIT-IV: PARTICIPATORY WATER CONSERVATION 9

Global Challenges -Social – Economic – Environmental - Solutions –Political - Water Marketing –Water Rights -Consumer education – Success Stories Case Studies.

UNIT- V: PARTICIPATORY WATERSHED DEVELOPMENT 9

Concept and significance of watershed - Basic factors influencing watershed development –Principles of watershed management - Definition of watershed management – Identification of problems - Watershed approach in Government programmes – People’s participation – Entry point activities - Evaluation of watershed management measures.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Gain knowledge on various processes involved in participatory water resource management.
- Understand farmer's participation in water resources management.
- Aware of the issues related to water conservation and watershed Development.
- Get knowledge in participatory water conservation.
- Understand concept, principle and approach of watershed management.

TEXT BOOKS:

1. Sivasubramaniyan, K. “Water Management”, SIMRES Publication, Chennai, 2011.
2. Uphoff.N, “Improving International Irrigation management with Farmer Participation – Getting the process Right – Studies in water Policy and Management”, No.11, West view press, Boulder, CO, 1986.
3. Tideman E.M., “Watershed Management”, Omega Scientific Publishers, New Delhi, 1996.

REFERENCE BOOKS:

1. Chambers Robert, “Managing canal irrigation”, Cambridge University Press, 1989.
2. Murty,J.V.S., “Watershed Management in India”, Wiley Eastern Ltd.,Newyork,1995
3. Sharma V.K.(1989): “Water Resources &Water Management”, Himalaya Publishing Bombay

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1904504 **GEOGRAPHIC INFORMATION SYSTEM** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To introduce the fundamentals and components of Geographic Information System.
- To provide details of spatial data structures and input, management and output processes.
- To provide details about raster input data structures.
- To be familiar with network topologies.
- To Analyze data analytics and various applications of GIS.

UNIT - I: FUNDAMENTALS OF GIS 9

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - geographical data types - Spatial, Attribute data- types of attributes – scales/ levels of measurements.

UNIT – II: SPATIAL DATA MODELS 9

Database Structures – Relational, Object Oriented – ER diagram - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models TIN and GRID data models - OGC standards - Data Quality.

UNIT - III: DATA INPUT AND TOPOLOGY 9

Scanner - Raster Data Input – Raster Data File Formats – Vector Data Input –Digitiser – Topology - Adjacency, connectivity and containment – Topological Consistency rules – Attribute Data linking – ODBC – GPS - Concept GPS based mapping.

UNIT - IV: DATA ANALYSIS 9

Vector Data Analysis tools - Data Analysis tools - Network Analysis - Digital Education models - 3D data collection and utilisation.

UNIT - V: APPLICATIONS 9

GIS Applicant - Natural Resource Management - Engineering - Navigation - Vehicle tracking and fleet management - Marketing and Business applications - Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

This course equips the student to

- Have basic idea about the fundamentals of GIS.
- Understand the types of data models.
- Get knowledge about data input and topology.
- Gain knowledge on data quality and standards.
- Understand data management functions and data output.

TEXT BOOKS:

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.

2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition, 2007.

REFERENCES:

1. Lo.C.P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006.

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1904007 **DATA STRUCTURES** **L T P C**

3 0 0 3

OBJECTIVE

- To understand Linear Data structures programs
- To understand the Non linear data structures program
- To have an idea about implementing search techniques
- To have a better understanding in sorting techniques
- To understand the various Indexing algorithms

UNIT I LINEAR DATA STRUCTURES - LIST **9**

Introduction to structure-Abstract Data Types (ADTs) - List ADT - array-based implementation - linked list implementation - singly linked lists- circularly linked lists - applications of lists –Polynomial Manipulation.

UNIT II LINEAR DATA STRUCTURES - STACKS, QUEUES **9**

Stack ADT – Operations – Applications – Evaluating arithmetic expressions-Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – deQueue –applications of queues.

UNIT III NON LINEAR DATA STRUCTURES TREES- GRAPHS **9**

Binary Trees – Binary tree representation and traversals – Application of trees: – Graph and its representations – Graph Traversals – Connected components.

UNIT IV SORTING **9**

Selection sort-Insertion sort – Merge sort – Quick sort – Heap sort – Bubble sort-Shell sort – Radix sort.

UNIT V SEARCHING AND INDEXING **9**

Linear Search – Binary Search - Hash tables – Overflow handling – Hash Index – B-Tree Indexing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ellis Horowitz and Sartaj Sahni, Fundamentals of Data Structures, Galgotia Book Source, Gurgaon, 1976.
2. Gregory L. Heilman, Data Structures, Algorithms and Object Oriented Programming, Tata Mcgraw-Hill, New Delhi, 2002.

REFERENCES:

1. Jean-Paul Tremblay and Paul G. Sorenson, An Introduction to Data

Structures with Applications, Second Edition, Tata McGraw-Hill, New Delhi, 1991.
2. Alfred V. Aho, John E. Hopcroft and Jeffry D. Ullman, Data Structures and Algorithms, Pearson Education, New Delhi, 2006.

OUTCOME

- To learn about Linear Data structures
- Ability to describe stack queue and linked list operation
- Ability to analyze algorithms
- To understand about the tree concepts.
- Ability to summarize searching and sorting techniques.

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1904508 **DATABASE MANAGEMENT SYSTEM** **L T P C**

3 0 0 3

OBJECTIVES:

- To learn the fundamentals of data models and to represent a database system using ER diagrams.
- To study SQL and relational database design.
- To understand the fundamental concepts of transaction processing- concurrency control techniques recovery procedures
- To have an introductory knowledge about Query Processing.
- To analyze the different DB storage like XML,ODMG etc. in distributed environment

UNIT –I: INTRODUCTION TO DATABASE 9

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping.

UNIT - II: RELATIONAL DATABASE 9

Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL.

UNIT -III: DATABASE DESIGN 9

Functional Dependencies – Non-loss Decomposition -First, Second, Third Normal Forms, Dependency Preservation – Boyce Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

UNIT - IV: TRANSACTION PROCESSING AND CONCURRENCY CONTROL 9

Transaction Concepts – ACID Properties – Schedules – Serializability – Concurrency Control – Need for Concurrency – Locking Protocols – Two Phase Locking – Deadlock – Transaction Recovery - Save Points – Isolation Levels – SQL Facilities for Concurrency and Recovery.

UNIT -V: IMPLEMENTATION TECHNIQUES 9

RAID – File Organization – Organization of Records in Files – Indexing and Hashing – Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Query optimization using Heuristics and Cost Estimation.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Classify the modern and futuristic database applications based on size and complexity
- Map ER model to Relational model to perform database design effectively
- Write queries using normalization criteria and optimize queries.
- Compare and contrast various indexing strategies in different database systems
- Appraise how advanced databases differ from traditional databases.

TEXT BOOKS:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts, Sixth Edition, Tata McGraw Hill, 2011

2. Ramez Elmasri, Shamkant B. Navathe, ―Fundamentals of Database Systems, Sixth Edition, Pearson, 2011.

REFERENCES:

1. C. J. Date, A.Kannan, S. Swamynathan, ―An Introduction to Database Systems‖, Eighth Edition, Pearson Education, 2006.

2. Raghu Ramakrishnan, ―Database Management Systems‖, Fourth Edition, McGraw-Hill College Publications, 2015.

3. G.K.Gupta, "Database Management Systems‖, Tata McGraw Hill, 2011.

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1904509 **CLOUD COMPUTING** **L T P C**

3 0 0 3

OBJECTIVES:

- To understand the concept of cloud computing.
- To appreciate the evolution of cloud from the existing technologies.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

UNIT I **INTRODUCTION** **9**

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics.

UNIT II **CLOUD ENABLING TECHNOLOGIES** **9**

Service Oriented Architecture – REST and Systems of Systems – Web Services – Publish Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU –Memory – I/O Devices.

UNIT III **CLOUD ARCHITECTURE, SERVICES AND STORAGE** **9**

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - IaaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.

UNIT IV **RESOURCE MANAGEMENT AND SECURITY IN CLOUD** **9**

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM –Security Standards.

UNIT V **CLOUD TECHNOLOGIES AND ADVANCEMENTS** **9**

Hadoop – Map Reduce –Google App Engine – Programming Environment for Google App Engine –– Amazon Web services-Open Stack – Federation in the Cloud.

TOTAL: 45 PERIODS

OUTCOMES:

On Completion of the course, the students should be able to:

- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
- Explain the core issues of cloud computing such as resource management and security.
- Be able to install and use current cloud technologies.

TEXT BOOKS:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security, CRC Press, 2017.

REFERENCES:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, —Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach, Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009.

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1906507	ENTERTAINTRONICS	L T P C
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OBJECTIVES:

The student should be made:

- To understand the basics of display devices.
- To enhance the student knowledge in Audio broadcasting systems.
- To enable the student to learn about Television systems.
- To develop the student knowledge in Interactive Gaming Applications.
- To apply the knowledge of Consumer Electronic Applications.

UNIT - I: DISPLAY DEVICES 9

Introduction – Underlying technologies of displays -Types of Electronic displays – Segment displays – Two dimensional displays: Liquid Crystal display, Light emitting diode display – Three dimensional displays: Laser display, Holographic display – Applications.

UNIT - II: AUDIO BROADCASTING SYSTEMS 9

Loud Speakers: construction, working principles and applications of crystal, condenser and dynamic loudspeakers – Tweeters, Squawkers & Woofers - Public address system - Requirements of Public Addressing system -Microphones: construction, working principles and applications of Carbon, Moving coil and Crystal microphones. Headphones: Principle of operation of crystal and dynamic and Bluetooth based headphones.

UNIT - III: TELEVISION SYSTEMS 9

Basics of Television: Television standards, frequency bands, Scanning method, interlacing and synchronization, bandwidth, Advanced TV systems: LCD, LED, HDTV,3DTV, Smart TV. Color concepts, concepts of luminance, Hue and Saturation, Color TV (PAL Systems). Cable TV concepts, Closed Circuit Television.

UNIT - IV: INTERACTIVE GAMING APPLICATIONS 9

Fundamental of game design - Gaming scenarios – Interfaces- Multi player interactive gaming – Programming concepts – educational games – Privacy and security in games – Introduction to Android games and its development – Online games.

UNIT - V: CONSUMER ELECTRONIC APPLICATIONS 9

Principle of operation of digital clocks, electronic calculator, cellular phones- smart phonesmicrowave ovens, washing machines, air conditioners, ATMs and set-top-boxes – Compact Ultrafast Fiber lasers for Consumer electronics – Virtual reality applications, Alexa.

TOTAL: 45 PERIODS

OUTCOMES:

The student should be able to:

- Understand the basic applications of display devices.
- Analyze the operation of Audio devices and its applications.
- Know the basic TV Standards and the basics of Television.
- Design the Gaming scenarios and knowing programming concepts.
- Apply the knowledge on the applications of Consumer electronics.

TEXT BOOKS:

1. Shoichi Matsumoto, "Electronic display devices", Wiley, 1990.
2. Ajay Sharma, "Audio video and TV Engineering-Consumer Electronics", Dhanpat Rai and co, 2003.
3. R.G. Gupta, "Audio and Video systems", Tata Mc Graw Hill Publishing Co.Ltd, 2010.

REFERENCE BOOKS:

1. R. Gulati, "Monochrome and Color Television", New Age International (P) Ltd, New Delhi, 2014.
2. S P Bali, "Consumer Electronics", Pearson, 2007.

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1906505 **PHOTONIC NETWORKS** **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To enable the students to manifest the components used is the optical system, propagation of signals and their impairments in optical fiber.
- To enable the student to understand the importance of the backbone infrastructure for our present and future communication needs.
- To familiarize the students about the optical network architectures and the protocol stack in use.
- To enable the student to understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods and the network management and protection methods in vogue.
- To expose the student to the advances in networking and switching domains and the future trends.

UNIT - I: OPTICAL SYSTEM COMPONENTS 9

Light Propagation in optical fibers – Loss & bandwidth, System limitations, Nonlinear effects; Solitons; Optical Network Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.

UNIT - II: OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks; Wavelength Division Multiplexing, optical add/drop multiplexer, SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols, Wavelength Routing Architecture.

UNIT - III: WAVELENGTH ROUTING NETWORKS 9

The optical layer, Optical Network Nodes, Routing and wavelength assignment, Traffic Grooming in Optical Networks, Architectural variations- Linear Light wave networks, Logically Routed Networks.

UNIT - IV: PACKET SWITCHING AND ACCESS NETWORKS 9

Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch-based networks, Contention Resolution Access Networks – Network Architecture overview, Optical Access Network Architectures and OTDM networks, OTDR.

UNIT - V: NETWORK DESIGN AND MANAGEMENT 9

Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion, Wavelength stabilization, Overall design considerations, Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

TOTAL:45 PERIODS

OUTCOMES:

The student should be able to:

- Elucidate the components in an optical system.
- Use the backbone infrastructure for our present and future communication needs.
- Analyze the architectures and the protocol stack.
- Compare the differences in the design of data plane, control plane, routing, switching, resource allocation methods.
- Annotate the network management and protection methods in vogue.

TEXT BOOKS:

1 Rajiv Ramaswami and Kumar N. Sivarajan, “Optical Networks: A Practical Perspective”, Second Edition, Harcourt Asia Pte Ltd., 2004.

2 Siva Ram Moorthy and Mohan Gurusamy, “WDM Optical Networks: Concept, Design and Algorithms”, 1st Edition, Prentice Hall of India, 2002.

REFERENCE BOOKS:

1. John M. Senior ,“Optical Fiber Communication”,3rd edition, Prentice Hall,2009.
2. Uyless N. Black, “Optical Networks, Third Generation Transport Systems”,1st Edition, Prentice hall of India, 2002.
3. Biswanath Mukherjee, “Optical WDM Networks”, Springer Series, 2006.
4. Govind P. Agrawal, “Fiber Optic Communication Systems”, 3rd Edition, Wiley India (P) Ltd, 2002.
5. Gerd Keiser , “Optical Fiber Communication” , 5th Edition , McGraw Hill Education (India) Pvt. Ltd. , 2013.

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1906506 TELECOMMUNICATION NETWORK MANAGEMENT L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- To understand the concept of network management standards.
- To design the common management information service element model.
- To analyze the various concept of information modeling.
- To examine the concept of SNMPv1 and SNMPv2 protocol.
- To exhibit the examples of network management.

UNIT - I: BASIC FOUNDATIONS AND NETWORK MANAGEMENT APPLICATIONS 9

Network management standards–Network management model– Organization model– Information model - Abstract syntax notation One (ASN.1) – Encoding structure– Macros –Functional model. Network management applications functional requirements: Configuration management– Fault management–Performance management–Error correlation technology– Security management– Accounting management– Common management–report management– Policy based management – Service level management – Management service– Community definitions– capturing the requirements– simple and formal approaches–semi formal and formal notations.

UNIT - II: COMMON MANAGEMENT INFORMATION SERVICE ELEMENT 9

CMISE model–service definitions–errors–scooping and filtering features– synchronization–functional units– association services– common management information protocol specification.

UNIT - III: INFORMATION MODELING FOR TMN 9

Rationale for information modeling–management information model–object oriented modeling paradigm– structure of management information–managed object class definition–management information base.

UNIT - IV: SIMPLE NETWORK MANAGEMENT PROTOCOL 9

SNMPv1: Managed networks–SNMP models– organization model– Information model–SNMPv1 communication model–functional model. SNMPv2-major changes in SNMPv2–structure of management information, MIB–SNMPv2 protocol– compatibility with SNMPv1. SNMPv3– architecture–applications–MIB- security, SNMP Management: remote monitoring–SMI and MIB– RMON1 and RMON2.

UNIT - V: NETWORK MANAGEMENT EXAMPLES 9

ATM integrated local management interface–ATM MIB–M1– M2–M3–M4–interfaces–ATM digital exchange interface management–digita1 subscriber loop and asymmetric DSL technologies–ADSL configuration management–performance management Network management tools: Network statistics management–network management system–management platform case studies: OPENVIEW–ALMAP.

TOTAL :45 PERIODS

OUTCOMES:

On completion of the course, the student should be able to,

- Design and analyze of fault management.
- Analyze the common management information protocol specifications.
- Explain the functioning and design of management information model.
- Describe the simple network management protocol.
- Interpret the various types of network management tools with case studies.

TEXT BOOKS:

1. Mani Subramanian, “Network Management: Principles and Practice”, Pearson Education, Second edition, 2010.
2. Lakshmi G Raman, “Fundamentals of Telecommunications Network Management”, Wiley, 1999.

REFERENCE BOOKS:

1. Henry Haojin Wang, “Telecommunication Network Management”, Mc- Graw Hill, 1999.
2. Salah Aidarous & Thomas Plevyak, “Telecommunication Network Management: Technologies and Implementations”, Wiley, 1997.
3. Singh B, “Network Security and Management”, Eastern Economy Edition, 2012.

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2	3	3	3	1	-	-	2	2	-	-	-	2	1	2	-	-
3	3	3	3	2	-	-	-	-	-	-	-	2	1	1	-	-
4	3	3	2	3	-		2	2		-	-	2	3	2	-	-
5	2	2	1	1	-	2	2	2	2	-	-	2	2	2	-	-

1907503 **SENSORS AND TRANSDUCERS** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To understand the concepts of measurement technology.
- To learn the applications and working of motion and ranging sensors.
- To explore the latest sensor technologies like MEMS & nano sensors, smart sensors
- To learn the various sensors used to measure various physical parameters.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development.

UNIT I INTRODUCTION **9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS **9**

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer.,– GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS **9**

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS **9**

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING and DAQ SYSTEMS **9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL : 45 PERIODS

OUTCOMES:

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

- Explain various calibration techniques and signal types for sensors.
- Understand the basic principles of various sensors.
- Illustrate the basic principles of various smart sensors.
- Apply the various sensors in the Automotive and Mechatronics applications
- Implement the DAQ systems with different sensors for real time applications

TEXT BOOKS:

1. Ernest O Doebelin, Dhanesh N.Manik “Measurement Systems – Applications and Design”, seventh Edition McGraw-Hill, 2019.
2. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES:

1. Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2010.
2. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 1999.
3. Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

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CO 2		3	2											3		1
CO 3			3			3	2					1		3		
CO 4						2	2					1		3		2
CO 5	3	2	2	2	2							1	3		3	

1907504 INSTRUMENTATION IN BIOMEDICAL ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

- To study about the different bio potential and its propagation
- To understand the different types of electrodes and its placement for various recording
- To study the design of bio amplifier for various physiological recording
- To learn the different measurement techniques for non-physiological parameters.
- To familiarize the different biochemical measurements.

UNIT I BIO POTENTIAL GENERATION AND ELECTRODES TYPES 9

Origin of bio potential and its propagation. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes

UNIT II BIOSIGNAL CHARACTERISTICS AND ELECTRODECONFIGURATIONS 9

Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode.

UNIT III SIGNAL CONDITIONING CIRCUITS 9

Need for bio-amplifier - differential bio-amplifier, Impedance matching circuit, isolation amplifiers, Power line interference, Right leg driven ECG amplifier, Band pass filtering

UNIT IV MEASUREMENT OF NON-ELECTRICALPARAMETERS 9

Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method, ultrasound blood flow measurement.

UNIT V BIO-CHEMICAL MEASUREMENT 9

Blood gas analyzers and Non-Invasive monitoring, colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Understand the different bio potential and its propagation.
- Explain the different electrode placement for various physiological recording

- Design bio amplifier for various physiological recording
- Understand various technique of non electrical physiological measurements
- Understand the different biochemical measurements

TEXT BOOKS:

1. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2007.
2. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2004. (Units I, II & V)

REFERENCES:

1. Myer Kutz, “Standard Handbook of Biomedical Engineering and Design”, McGraw Hill Publisher, 2003.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2003.(Units II & IV)
3. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson Education, 2004.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
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CO 2				1		1							3	2		
CO 3	3	1	2	1	1	1										
CO 4			2	1	1	1								2		3
CO 5			2	1	1	1									1	3

1908001 **3D PRINTING AND DESIGN** **L T P C**

3 0 0 3

OBJECTIVES

- The course is designed to impart knowledge and skills related to 3D printing technologies.
- Selection of material and equipment and develop a product using this technique.
- To understand Industry 4.0 environment.
- To understand CAD and Additive manufacturing
- To understand Additive Equipment.

UNIT I 3D PRINTING AND ADDITIVE MANUFACTURING 9

Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing

processes, Applications.

UNIT II CAD AND ADDITIVE MANUFACTURING 9

CAD for Additive Manufacturing-CAD Data formats, Data translation, Data loss, STL format. Additive Manufacturing Techniques - Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.

UNIT III PROCESS 9

Process, Process parameter, Process Selection for various applications. Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

UNIT IV MATERIALS 9

Polymers, Metals, Non-Metals, Ceramics, Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials.

UNIT V ADDITIVE MANUFACTURING EQUIPMENT 9

Process Equipment- Design and process parameters-Governing Bonding Mechanism-Common faults and troubleshooting - Process Design- Post Processing: Requirement and Techniques- Product Quality.

TOTAL: 45 PERIODS

OUTCOMES

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

- Develop CAD models for 3D printing.
- Import and Export CAD data and generate .stl file.
- Select a specific material for the given application.
- Select a 3D printing process for an application.
- Produce a product using 3D Printing or Additive Manufacturing (AM).

TEXT BOOKS

1. Lan Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing”, Hanser Publisher, 2011.

REFERENCE BOOKS

1. Khanna Editorial,“3D Printing and Design”, Khanna Publishing House ,Delhi.CK Chua,Kah Fai Leong,“3D Printing and Rapid Prototyping- Principles and Applications,” World Scientific,2017.
2. J.D.Majumdar and I.Manna, “Laser-Assisted Fabrication of Materials”, Springer Series in Material Science, 2013.
3. L.Lu,J.Fuh and Y.S.wong,“Laser-Induced Materials and Processes for Rapid Prototyping”, Kulwar Academic Press,2001.
4. Zhiqiang Fan And Frank Liou, “Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy”, Intech, 2012.

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CO 2	2			3											2	
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CO 4		2	3												2	
CO 5					2				3						2	

1908002	SCRIPTING LANGUAGES	L T P C
		3 0 0 3

OBJECTIVES

- The principles of scripting languages.
- Difference between scripting languages and non- scripting languages.
- Types of scripting languages.
- Scripting languages such as PERL, TCL/TK, python and BASH.
- Creation of programs in the Linux environment and usage of scripting languages in IC design flow.

UNIT I LINUX BASICS 9

Introduction to Linux , File System of the Linux, General usage of Linux kernel & basic commands, Linux users and group, Permissions for file, directory and users, searching a file & directory, zipping and unzipping concepts

UNIT II LINUX NETWORKING 9

Introduction to Networking in Linux, Network basics & Tools, File Transfer Protocol in Linux, Network file system, Domain Naming Services, Dynamic hosting configuration Protocol & Network information Services.

UNIT III PERL SCRIPTING 9

Introduction to Perl Scripting, working with simple values, Lists and Hashes, Loops and Decisions, Regular Expressions, Files and Data in Perl Scripting, References & Subroutines, Running and Debugging Perl, Modules, Object – Oriented Perl.

UNIT IV TCL / TK SCRIPTING 9

Tcl Fundamentals, String and Pattern Matching, Tcl Data Structures, Control Flow Commands, Procedures and Scope, Evel, Working with Unix, Reflection and Debugging, Script Libraries, Tk Fundamentals, Tk by examples, The Pack Geometry Manager, Binding Commands to X Events, Buttons and Menus, Simple Tk Widgets, Entry and List box Widgets Focus, Grabs and Dialogs.

UNIT V PYTHON SCRIPTING 9

Introduction to Python, using the Python Interpreter, More Control Flow Tools, Data Structures, Modules, Input and Output, Errors and Exceptions, Classes, Brief Tour of the Standard Library.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Create and run scripts using PERL in IC design flow.
- Create and run scripts using TCl in IC design flow
- Create and run scripts using Python in IC design flow
- Use Linux environment and write programs for automation of scripts in VLSI tool design flow.
- Usage of scripting languages in IC design flow.

TEXT BOOKS

1. Python Tutorial by Guido Van Rossum, Fred L. Drake Jr. editor , Release 2.6.4
2. Practical Programming in Tcl and Tk by Brent Welch, Updated for Tcl 7.4 and Tk4.0.
3. Teach Yorself Perl in 21 days by David Till.
4. Red Hat Enterprise Linux 4 : System Administration Guide Copyright, 2005 Red Hat Inc.

REFERENCE BOOKS

1. Learning Python – 2nd Ed., Mark Lutz and David Ascher, 2003, O'Reilly.
2. Perl in 24 Hours – 3rd Ed., Clinton Pierce, 2005, Sams Publishing.
3. Learning Perl – 4th Ed. Randal Schwartz, Tom Phoenix and Brain d foy. 2005.
4. Jython Essentials – Samuele Pedroni and Noel Pappin.2002. O'Reilly.
5. Programming Perl – Larry Wall, Tom Christiansen and John Orwant, 3rd Edition, O'Reilly, 2000. (ISBN 0596000278)

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1909510	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Product design and development
- Apply the concept of prototyping in a real-life problem.
- Reduce the waste by using product architecture**.**
- Understand the concepts of industrial design.
- Understand the concepts of DFM

UNIT-I: INTRODUCTION 9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements.

UNIT-II: CONCEPT GENERATION AND SELECTION 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT-III: PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions

UNIT-IV: INDUSTRIAL DESIGN 9

Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT-V: DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis.

TOTAL : 45 PERIODS

COURSE OUTCOMES: Upon Completion of this course, the students will be able to:

- Product design and development
- Apply the concept of prototyping in a real life problem.
- Reduce the waste by using product architecture**.**
- Understand the concepts of industrial design.
- Understand the concepts of DFM

TEXTBOOKS:

1. Kari T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw-Hill International Edn.2017.

REFERENCE BOOKS:

1. Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.

2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	2	1	1	1				1		1		1			1	1
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4	1	1	1				1	1		1					1	1
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1909511 **VIBRATION AND NOISE CONTROL** **L T P C**

3 0 0 3

OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Apply the fundamental concepts of vibration.
- Apply the fundamentals of noise.
- Describe the various sources of noise for automotive applications.
- Determine the natural frequencies and mode shapes of the two degree freedom systems.
- Describe the different types of noise and its control measures

UNIT-I: BASICS OF VIBRATION 9

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies

UNIT-II: BASICS OF NOISE 9

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT-III: AUTOMOTIVE NOISE SOURCES 9

Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine necessary contributed noise, transmission noise, aerodynamic noise, tire noise, brake noise.

UNIT-IV: CONTROLTECHNIQUES 9

Vibration isolation, tuned absorbers, un-tuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

UNIT-V: SOURCE OF NOISE AND CONTROL **9**

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

TOTAL : 45 PERIODS

COURSE OUTCOMES: Upon Completion of this course, the students will be able to:

- Apply the fundamental concepts of vibration.
- Apply the fundamentals of noise.
- Describe the various sources of noise for automotive applications.
- Determine the natural frequencies and mode shapes of the two degree freedom systems.
- Describe the different types of noise and its control measures

TEXTBOOKS:

1. Singiresu S.Rao, "Mechanical Vibrations", 6th Edition, Pearson Education, 2016

REFERENCE BOOKS:

1. Balakumar Balachandran and Edward B. Magrab, "Fundamentals of Vibrations", 1st Editon, Cengage Learning, 2009
2. Benson H. Tongue, "Principles of Vibrations", 2nd Edition, Oxford University, 2007

CO	PO												PSO			
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1	3	2	2	2			1					1	2	2		
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3	3	2	2	2			1					1	2	2		
4	3	2	2	2			1					1	2	2		
5	3	2	2	2			1					1	2	2		

1909512 **INDUSTRIAL SAFETY ENGINEERING** **L T P C**

3 0 0 3

OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Identify unsafe conditions and recognize unsafe alerts.
- Interpret the rules and regulations for safety operations.
- Capable of solving problem of accidents.
- Capable of solving the present for criticizing the present for improved safety.
- Collaborate and modify processes / procedures for safety.

UNIT-I: INTRODUCTION 9

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

UNIT-II: CHEMICAL HAZARDS 9

Chemical exposure – Toxic materials – Radiation Ionizing and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

UNIT-III: ENVIRONMENTAL CONTROL 9

Industrial Health Hazards – Environmental Control – Industrial Noise- Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

UNIT-IV: HAZARD ANALYSIS 9

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment.

UNIT-V: SAFETY REGULATIONS 9

Explosions – Disaster management – catastrophe control, hazard control, Factories Act, Safety regulations Product safety – case studies.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon Completion of this course, the students will be able to:

- Identify and prevent chemical, environmental mechanical, fire hazard.

- Collect, analyze and interpret the accidents data based on various safety techniques.
- Apply proper safety techniques on safety engineering and management.
- Able to perform hazard analysis.
- Aid to design the system with environmental consciousness by implementing safety regulation.

TEXTBOOKS:

1. John V.Grimaldi, "Safety Management", AITB S Publishers, 2003.

REFERENCE BOOKS:

1. David L.Goetsch, "Occupational Safety and Health for Technologists", Engineers and Managers, Pearson Education Ltd. 5th Edition, 2005.
2. Deshmukh L M, "Industrial Safety Management", Tata McGraw-Hill Publishing Company Ltd.,2005
3. Safety Manual, "EDEL Engineering Consultancy", 2000.

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	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	2	1	2			2	1					1	1	1		
2	2	1	2			2	1					1	1	1		
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1910504 PRINCIPLES OF FOOD PRESERVATION L T P C

3 0 0 3

OBJECTIVES:

- To learn about the shelf life of food products.
- To gain knowledge on the storage of food products.
- To know about the thermal processing methods of food products.
- To design different types of Dryers.
- To understand the non thermal methods of food preservation.

UNIT – I: FOOD PRESERVATION AND ITS IMPORTANCE 9

Introduction to food preservation. Wastage of processed foods; Shelf life of food products; Types of food based on its perishability. Traditional methods of preservation.

UNIT – II: METHODS OF FOOD HANDLING AND STORAGE 9

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.retort pouch packing, Aseptic packaging.

UNIT – III: THERMAL METHODS 9

Newer methods of thermal processing; batch and continuous; In container sterilization- canning; application of infra-red microwaves; ohmic heating; control of water activity; preservation by concentration and dehydration; osmotic methods.

UNIT – IV: DRYING PROCESS FOR TYPICAL FOODS 9

Rate of drying for food products; design parameters of different type of dryers; properties of air-water mixtures. Psychrometric chart, freezing and cold storage.freeze concentration, dehydro-freezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

UNIT – V: NON-THERMAL METHODS 9

Super Critical Technology for Preservation - Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology,

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students are expected to

- Be aware of the different thermal processing methods of food products.
- Understand the concept of food storage.

- Be familiarize with shelf life of food products.
- Recognize the different types of dryers.
- Acquire knowledge on non thermal methods of food preservation.

TEXT BOOKS:

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice".Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

REFERENCE BOOKS:

1. Rahman, M. Shafiur. "Handbook of Food Preservation". Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh-Sarensen, Leif. "Food Preservation Techniques". CRC / Wood Head Publishing, 2003.
3. Ranganna, S. "Handbook of Canning and Aseptic Packaging". Tata McGraw-Hill, 2000.

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3	3	2	1	2	-	1	1	-	-	-	-	2	1	3	2	-
4	3	2	1	2	-	1	1	-	-	-	-	2	1	3	-	-
5	3	1	2	-	-	1	1	-	-	-	-	2	-	3	-	1

1920501	NANOTECHNOLOGY	L T P C 3 0 0 3

OBJECTIVES

- Make the students to understand the fundamentals of nanomaterials.
- To acquire the knowledge on different classifications in nano materials.
- To educate the different synthesis techniques.
- To provide information on different fabrication and characterization techniques.
- Make the students to understand and apply the techniques to different systems.

UNIT -I: BASICS OF NANOTECHNOLOGY 9

Introduction –Scientific revolutions –Time and length scale in structures –Definition of a nanosystem –Dimensionality and size dependent phenomena –Surface to volume ratio -Fraction of surface atoms-Properties at nanoscale (optical, mechanical, electronic and magnetic).

UNIT- II: DIFFERENT CLASSES OF NANOMATERIALS 9

Classification based on dimensionality-Quantum Dots, Wells and Wires-Carbon-based nano materials (buckyballs, nanotubes, graphene)–Metal based nano materials (nanogold, nanosilver and metal oxides) –Nanocomposites-Nanopolymers –Nanoglasses –Nano ceramics.

UNIT-III: SYNTHESIS OF NANOMATERIALS 9

Classification of synthesis: Top down and bottom up nanofabrication. Chemical Methods: Solvothermal Synthesis-Photochemical Synthesis –Sonochemical Routes-Chemical Vapor Deposition (CVD) –Metal Oxide -Chemical Vapor Deposition (MOCVD). Physical Methods: Ball Milling –Electrodeposition -Spray Pyrolysis -Flame Pyrolysis - DC/RF Magnetron Sputtering -Molecular Beam Epitaxy (MBE).

UNIT-IV: FABRICATION AND CHARACTERIZATION OF NANOSTRUCTURES 9

Nanofabrication: Photolithography and its limitation-Electron-beam lithography (EBL)-Nanoimprint –Softlithography patterning. Characterization: Environmental Scanning Electron Microscopy (ESEM) High Resolution Transmission Electron Microscope (HRTEM) –Scanning Tunneling Microscope (STM)-Surface enhanced Raman spectroscopy (SERS)-X-ray Photoelectron Spectroscopy (XPS) -Auger electron spectroscopy (AES).

UNIT-V: APPLICATIONS **9**

Solar energy conversion and catalysis -Molecular electronics and printed electronics –Nanoelectronics -Polymers with a special architecture -Liquid crystalline systems -optical properties, Applications in displays and other devices -Photonics, Plasmonics-Chemical and biosensors –Nanomedicine and Nanobiotechnology –Nanotoxicology challenges.

TOTAL: 45 PERIODS

OUTCOMES

- Able to understand the basics of nanoscience.
- Able to differentiate the materials based on their structures.
- Ability to understand the different synthesis techniques of nanomaterials.
- Ability to identify various fabrication techniques and characterization of nanostructures.
- Able to apply them for suitable applications.

TEXT BOOKS:

1. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd Edition, 2007.
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002.
3. Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.

REFERENCE BOOKS:

1. Charles P. Poole Jr., Frank J. Ownes, 'Introduction to Nanotechnology", Wiley Interscience, 2003.
2. Dupas C., Houdy P., Lahmani M., "Nanoscience: Nanotechnologies and Nanophysics",Springer-Verlag Berlin Heidelberg, 2007.
3. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, 2003.
4. Nabok A., "Organic and Inorganic Nanostructures", Artech House, 2005.

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CO1	3	-	3	3	3	1	-	-	-	-	-	1	2	-	-	-
CO2	2	-	3	3	3	-	-	-	-	-	-	1	2	-	-	-
CO3	2	-	3	3	3	-	-	-	-	-	-	1	2	-	-	-
CO4	2	-	3	3	3	1	1	-	-	-	-	1	2	-	-	-
CO5	3	-	3	3	3	1	1	-	-	-	-	1	2	-	-	-

1920502 **MICROSCOPY** **L T P C**

3 0 0 3

OBJECTIVES

- To introduce the basic principles of optical and electron microscopy.
- To elucidate the different microscopic techniques.
- To explore the knowledge on electron microscopy
- Make the students to learn the sample preparation techniques for the micro structural analysis.
- To investigate on different chemical analysis techniques.

UNIT- I: INTRODUCTION 9

History of Microscopy, Overview of current microscopy techniques. Light as particles and waves, Fundamental of optics: Diffraction and interference in image formation, real and virtual images, Resolution, Depth of field and focus, Magnification, Numerical aperture, Aberration of lenses. Components of Light Microscopy, Compound light microscopy and its variations**.**

UNIT- II: MICROSCOPY 9

Phase contrast microscopy: optical design, theory, image interpretation, Dark-field microscopy: optical design, theory, image interpretation, Polarization Microscopy: Polarized light, optical design, theory, image interpretation, Differential Interference Contrast (DIC): equipment and optics, image interpretation, Modulation contrast microscopy: contrast methods using oblique illumination.

UNIT- III: ELECTRON MICROSCOPY 9

Interaction of electrons with matter, elastic and inelastic scattering, secondary effects, Components of electron microscopy: Electron sources, pumps and holders, lenses, apertures, and resolution. Scanning Electron and Transmission Electron Microscopy: Principle, construction, applications and limitations.

UNIT- IV: SAMPLE PREPARATION FOR MICROSTRUCTURAL ANALYSIS 9

Optical Microscopy sample preparation: Grinding, polishing and etching, SEM sample preparation: size constrains, TEM sample preparation: Disk preparation, electro polishing, ion milling, lithography, storing specimens.

UNIT-V: CHEMICAL ANALYSIS 9

Surface chemical composition (Principle and applications) - Mass spectroscopy and X-ray emission spectroscopy - Energy Dispersive Spectroscopy- Wave Dispersive Spectroscopy. Electron spectroscopy for chemical analysis (ESCA), X ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES)- Applications.

TOTAL: 45 PERIODS

OUTCOMES

- Able to understand the physics behind the microscopy.
- Ability to describe the principle, construction and working of light microscopy.
- Ability to describe electron microscopy.
- Ability to understand about the important of sample preparation technique.
- Ability to identify the appropriate spectroscopy technique for chemical analysis.

TEXT BOOKS:

1. Douglas B. Murphy, Fundamentals of light microscopy and electronic imaging, 2001, Wiley- Liss, Inc. USA
2. David B. Williams and C. Barry Carter, Transmission Electron Microscopy-A Textbook for Materials Science, Springer US, 2nd edition, 2009.

REFERENCE BOOKS:

1. Brandon D. G, “Modern Techniques in Metallography”, Von Nostrand Inc. NJ, USA,1986.
2. Whan R E (Ed), ASM Handbook, Volume 10, Materials Characterization“, Ninth Edition, ASM international, USA, 1986.
3. Thomas G., “Transmission electron microscopy of metals”, John Wiley, 1996.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	2	2	1	1	1	1	-	-	-	1	1	1	-	-	-
CO2	2	2	2	1	2	-	1	-	-	-	-	1	-	-	-	-
CO3	3	3	3	-	3	2	-	-	-	-	-	1	2	-	-	2
CO4	3	3	3	1	3	3	-	-	-	-	-	1	-	1	-	1
CO5	3	3	2	2	3	3	-	-	-	-	1	1	1	1	1	1

1921501 ADVANCED ENGINEERING CHEMISTRY L T P C

3 0 0 3

COURSE OBJECTIVE

- To make the students conversant with basics of polymer chemistry.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
- To make the student acquire sound knowledge of second law of thermodynamics and second law based derivations of importance in engineering applications in all disciplines.
- To develop and understand the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.

UNIT-I: POLYMERS AND SPECIALITY POLYMER 9

Polymers – Types of polymerization – Degree of polymerization – Plastics and types – Mechanism of polymerization (free radical mechanism) properties of polymers - T_g and tacticity – Compounding of plastics – Fabrication of plastics – Blow and extrusion mouldings. Speciality polymers-Conducting polymers: Polyacetylene, polyaniline, synthesis, mechanism of conduction – Applications of conducting polymers. Bio-degradable polymers: Requirements, factors affecting degradation – PLA– preparation, properties –applications.

UNIT-II: ENERGY SOURCES AND STORAGE DEVICES 9

Solar energy conversion – Solar cells: Types – Wind energy. Batteries: Types of batteries – Primary battery (alkaline battery), secondary battery (lead acid battery, NICAD battery, lithium, lithium-ion & lithium-sulphur battery), fuel cells – H_2-O_2 fuel cell.

UNIT-III: PHOTO CHEMISTRY & ANALYTICAL TECHNIQUES 9

Photochemistry: Laws of photochemistry - Grothuss–Draper law, Stark–Einstein law and Beer-Lambert's Law. Quantum efficiency – determination - Photophysical processes (Jablonski diagram) - photosensitization - Chemiluminescence and bioluminescence. Analytical techniques: IR, UV – principle, Instrumentation and applications. Thermal analysis: TGA & DTA - principle, instrumentation and applications. Chromatography: Basic principles of column & TLC – principles and applications.

UNIT-IV: THERMODYNAMICS 9

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; Entropy of phase transitions; Clausius inequality. Free energy and work function- Helmholtz and Gibbs free energy functions (problems); Criteria of spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore.

UNIT-V: PHASE RULE AND ALLOYS 9

Phase rule: Introduction, definition of terms with examples, One component system -Water system – Reduced phase rule – Thermal analysis and cooling curves – Two component systems – Lead-silver system – Pattinson process, Zn-Mg System. Alloys: Introduction- Definition- properties of alloys- Significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel.

TOTAL :45 PERIODS

COURSE OUTCOME

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

- Gain knowledge on polymer chemistry and its developments.
- Understand the process of advanced energy storage devices.
- Analyze the materials using spectroscopic techniques.
- Explain the various state of thermodynamics.
- Outline the nature of alloys by drawing phase rule.

TEXT BOOKS:

1. Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, 2016.
2. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India PVT, LTD, New Delhi, 2015.
3. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd., 2012.

REFERENCE BOOKS:

1. P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2019.
2. S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015.
3. B. K. Sharma, “Engineering Chemistry”, Krishna Prakashan Media (P) Ltd, Meerut, 2012.

CO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	3	2	2	2	2	2	3					2
CO 2	3	3	2	2	3	3	2					3
CO 3	2	2	1	2	2	2	1					1
CO 4	1	1	1	1		1	2		1			2
CO 5	2	2	2	3	1	1	2					1

1921502 **INDUSTRIAL NANOTECHNOLOGY** **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To elucidate on advantages of nanotechnology based applications in each industry
- To provide instances of contemporary industrial applications of nanotechnology
- To provide an overview of future technological advancements and increasing role of nanotechnology in each industry
- To provide an awareness on the nanomaterial synthesis for electronic materials
- To make the student conversant with the latest characterization techniques

UNIT-I: NANO ELECTRONICS **9**

Micro and Nanoelectromechanical systems – Sensors, Actuators, Data memory – Lighting and Displays – Applications of piezoelectric and ferroelectric materials- Nano for energy systems - Fuel cells and Photo-voltaic cells – Electric double layer capacitors –Nanoparticle coatings for electrical products

UNIT-II: BIONANOTECHNOLOGY **9**

Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis – Nanorobotics in Surgery –Nanosensors in Diagnosis– Neuro-electronic Interfaces– Therapeutic applications

UNIT-III: NANOTECHNOLOGY IN CHEMICAL INDUSTRY **9**

Nanocatalyts – Smart materials – Heterogenous nanostructures and composites – Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes) – Molecular Encapsulation and its applications – Nanoporous zeolites – Self-assembled Nanoreactors

UNIT-IV: NANOTECHNOLOGY IN AGRICULTURE AND FOOD TECHNOLOGY **9**

Nanotechnology in Agriculture -Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry

UNIT-V: CHARACTERIZATION TECHNIQUES 9

X-ray Diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including High-resolution imaging, Surface Analysis techniques-AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

- Analyze the nanoparticle coatings for electrical products.
- Define various therapeutic applications of bionanotechnology.
- Explain the process of molecular encapsulation and nanoreactors.
- Ability to understand the uses of nanotechnology in food industry.
- Outline the nanofiber production and formulation of gels.

TEXTBOOKS:

1. V.A. Rai and J.A. Bai, Nanotechnology Applications in the Food Industry, CRC Press, 2018.
2. S. Thomas, Y. Grohens and Y.B. Pottathara, Industrial Applications of Nanomaterials, Elsevier Press, 2019.
3. N John Dinardo, Nanoscale Characterization of surfaces & Interfaces, 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCE BOOKS:

1. Neelina H. Malsch, Biomedical Nanotechnology, CRC Press, 2005.
2. Udo H. Brinker, Jean-Luc Mieusset, Molecular Encapsulation: Organic Reactions in Constrained Systems, Wiley Publishers, 2010.
3. Jennifer Kuzma and Peter VerHage, Nanotechnology in Agriculture and Food Production, Woodrow Wilson International Center, 2006.
4. P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, 2007.
5. Y-W. Mai, Polymer Nano composites, Woodhead Publishing Limited, 2006.
6. W.N. Chang, Nanofibres fabrication, performance and applications, Nova Science Publishers Inc, 2009.

CO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	2	2	2		2	1	1		1			3
CO 2	1	2	3		1	3	1		1			2
CO 3	2	1	2		1	1	1		1			2
CO 4	3	2	1		2	1	1		1			3
CO 5	2	2	1	2	1	1	1		1			2

1903706 **GREEN BUILDING DESIGN** **L T P C**

3 0 0 3

OBJECTIVE:

- To develop buildings which use the natural resources to the minimal at the time of construction as well as operation.
- To ensure minimum negative impact on the environment by the construction and operation of a building.
- To gain knowledge on natural lighting and temperature control.
- To develop a design to further reduce the carbon footprint as well as reduce cost of operation.
- To preserve the external environment to the building location.

UNIT- I: ENVIRONMENTAL IMPLICATIONS OF BUILDINGS **9**

Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings.

UNIT- II: IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS **9**

Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.

UNIT- III: COMFORTS IN BUILDING **9**

Thermal Comfort in Buildings – Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings – Implications of Geographical Locations.

UNIT- IV: UTILITY OF SOLAR ENERGY IN BUILDINGS **9**

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

UNIT- V: GREEN COMPOSITES FOR BUILDINGS **9**

Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

TOTAL: 45 PERIODS

OUTCOMES:

The students completing the course will have ability to

- Describe the concepts of sustainable design and green building techniques including energy efficiency and indoor environmental quality management.
- Create drawings and models of their own personal green building project.
- Reducing waste, pollution and environmental degradation.
- Efficiently using energy, water, and other resources.
- Protecting occupant health and improving employee productivity.

TEXT BOOKS:

1. K.S.Jagadish, B. U. Venkatarama Reddy and K. S. Nanjunda Rao. "Alternative Building Materials and Technologies". New Age International, 2007.
2. "Low Energy Cooling For Sustainable Buildings". John Wiley and Sons Ltd, 2009.
3. Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.

REFERENCE BOOKS:

1. Osman Attmann, Green Architecture Advanced Technologies and Materials, McGraw Hill, 2010.
2. Jerry Yudelson, Green building Through Integrated Design, McGraw Hill, 2009.
3. Fundamentals of Integrated Design for Sustainable Building by Marian keeler, Bill Burke.

CO	**PO**												**PSO**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	3						3						2			
2		2														
3			2	1	2			1	2	2					1	
4						3						2				3
5											2	3		3		

1903716 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT L T P C

3 0 0 3

COURSE OBJECTIVE:

- To impart the knowledge of screening of environmental and social assessment.
- To gain the knowledge of methods for impact assessment.
- To mitigate the environmental and social impacts of developmental projects.
- To develop knowledge on Assessment of Impact on land, water, air, noise and energy, flora and fauna.
- To study on report preparation of EIA.

UNIT- I: INTRODUCTION 9

Impacts of Development on Environment – Rio Principles of Sustainable Development Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework–Stakeholders and their Role in EIA– Selection & Registration Criteria for EIA Consultants.

UNIT-II: ENVIRONMENTAL ASSESSMENT 9

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction – Analysis of alternatives.

UNIT- III: ENVIRONMENTAL MANAGEMENT PLAN 9

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Review of EIA Reports – Addressing the issues related to the Project Affected People - Environmental Clearance Post Project Monitoring.

UNIT- IV: SOCIO ECONOMIC ASSESSMENT 9

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis.

UNIT- V: CASE STUDIES **9**

EIA case studies pertaining to Infrastructure Projects – Real Estate Development - Roads and Bridges – Multi-storey Buildings Mass Rapid Transport Systems - Ports and Harbor – Airports - Dams and Irrigation projects - Power plants – Water supply and drainage projects- Waste water treatment plants, STP – Mining Projects.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students completing the course will have ability to

- Carry out scoping and screening of developmental projects for environmental and social assessments.
- To explain different methodologies for environmental impact prediction and assessment.
- Plan environmental impact assessments and environmental management plans.
- Evaluate environmental impact assessment reports.
- Analyse case studies on various projects.

TEXTBOOKS:

1. Canter, R.L, "Environmental impact Assessment", 2nd Edition, McGraw Hill Inc, New Delhi, 1995.
2. Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, "Environmental Impact Assessment for Developing Countries in Asia", Volume 1 – Overview, Asian Development Bank,1997.
3. Peter Morris, Riki Therivel "Methods of Environmental Impact Assessment", Routledge Publishers, 2009.

REFERENCE BOOKS:

1. Becker H. A., Frank Vanclay ,"The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing, 2003.
2. Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme, 2002.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.

4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	1				1		2						2			
2		2					1								3	
3					2	3	2	1	2	1						2
4			2	2			1					2		2		
5							1				2	3				3

1904703 TAMIL COMPUTING L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the Tamil grammar and programming basics for Tamil computing.
- To understand the various types of Tamil Computing applications.
- To make the students understand the use of Tamil computing tools and Resources.
- To strengthen the students' ability to carry out the Computational Linguistics in Tamil computing.
- To understand the concepts of Tamil text processing using open – Tamil python library.

UNIT - I: TAMIL GRAMMAR 9

Alphabets: Classification & Properties - Words: classification and components - Sentences: Structures and word ordering.

UNIT - II: PROGRAMMING BASICS FOR TAMIL COMPUTING 9

History of Tamil Computing - Standards & Fonts - UNICODE - Object Oriented Tamil Computing -Tamil text processing using open-tamil python library.

UNIT - III: COMPUTATIONAL LINGUISTICS 9

Basic linguistics - Phonology – Phonology computing – Tholkappiar's Morphological pattern– lexicography – syntax – semantics – pragmatics, Languages for specific purpose & disconise computing

UNIT - IV: TAMIL COMPUTING TOOLS & RESOURCES 9

POS Tagger - Morphological Analyser - Morphological Generator - Sentence Parser - Named Entity Recognizer - Word Sense Disambiguator - Ontologies – Universal Networking Language & UNL Enconvertor.

UNIT - V: TAMIL COMPUTING APPLICATIONS 9

Machine Translation – Speech : Synthesis & Processing - Information : retrieval & Extraction – Question Answering – Text Summarization – Automatic Indexing – Text

Mining – Conceptual Search.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Explain classification of Tamil grammar and properties
- Adopt a suitable process for tamil computing tools.
- Analyze the different types of computational linguistics such as phonology, Morphology, lexicography.
- Perform and analyze the Tamil computing applications.
- Analyze and process the Tamil python library.

TEXT BOOKS:

1. The Oxford Handbook of Computational Linguistics, Edited by Ruslan Mitkov, Oxford University Press, 2014.

REFERENCES:

1. Translation - Theory and Application, Valarmathi, International Institute of Tamil Studies, First Edition, 2001.

2. Tholkaappiyam - Thodariyal, Shanmugam, International Institute of Tamil Studies, First Edition, 2004.

3. Tholkaappiyam: Phonology & Morphology, Albert, International Institute of Tamil Studies, First Edition, 1985.

4. Natural language processing and computational linguistics, Bhargav Srinivasa-Desikan Packt Publishing, first edition 2018.

5. The Phonology and morphology of tamil chrisdas Prathima, 2016.

6. Pos Tasser R Morphological Analzser Shodhganga inflibnet.ac.in

7. A tamil Programming language ayxiv.org, muthiah Annamalai.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3					3				2						2
CO 2					3	3				3				3		
CO 3		3	2			3			2	2					3	
CO 4	3	2				3				2				2		
CO 5	2				3	3				2					3	2

1904010 OBJECT ORIENTED PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To understand Object Oriented Programming concepts and basic characteristics of Java
- To know the principles of packages, inheritance and interfaces
- To define exceptions and use I/O streams
- To develop a java application with threads and generics classes
- To design and build simple Graphical User Interfaces

UNIT I INTRODUCTION TO OOP AND JAVA FUNDAMENTALS 9

Object Oriented Programming - Abstraction – objects and classes - Encapsulation- Inheritance - Polymorphism- OOP in Java – Characteristics of Java – The Java Environment - Java Source File - Structure – Compilation. Fundamental Programming Structures in Java – Defining classes in Java – constructors, methods -access specifiers - static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays , Packages - JavaDoc comments.

UNIT II 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 - Strings.

UNIT III EXCEPTION HANDLING AND I/O 9

Exceptions - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files.

UNIT IV MULTITHREADING 9

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups.

UNIT V EVENT DRIVEN PROGRAMMING 9

Graphics programming - Frame – Components - working with 2D shapes - Using color, fonts, and images - Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Develop Java programs using OOP principles
- Develop Java programs with the concepts inheritance and interfaces
- Build Java applications using exceptions and I/O streams
- Develop Java applications with threads and generics classes
- Develop interactive Java programs using swings.

TEXT BOOKS:

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

REFERENCES:

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

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1	3						2	1			1	2		2		
CO 2		3	3	2		1							3			
CO 3	2					2			2						2	
CO 4			2	1					2	2				2		
CO 5	1		3	1	3	2			3	3			2			

1904712 **SOFTWARE ENGINEERING** **L T P C**

3 0 0 3

OBJECTIVES:

- To understand the phases in a software development project
- To understand the concepts of requirements analysis and modeling.
- To understand software design methodologies
- To learn various testing methodologies
- To be familiar with issues related to software maintenance

UNIT I SOFTWARE PROCESS **9**

Introduction to Software Engineering, scope – software crisis – principles of software engineering- Software process – Life cycle models – Traditional and Agile Models - Team organization.

UNIT II PLANNING AND ESTIMATION **9**

Planning and the software process – cost estimation: LOC, FP Based Estimation, COCOMO I & II Models – Duration estimation and tracking – Gantt chart - Software Project Management – plan – risk analysis and management.

UNIT III REQUIREMENTS ANALYSIS AND SPECIFICATION **9**

Software Requirements: Functional and Non-Functional, Software Requirements specification– Structured system Analysis – modeling: UML based tools, DFD - Requirement Engineering Process.

UNIT IV SOFTWARE DESIGN AND IMPLEMENTATION **9**

Design process – Design principles and guidelines – design techniques – coupling and cohesion - metrics – tools. Implementation: choice of programming language, programming practices – coding standards – code walkthroughs and inspections.

UNIT V TESTING AND MAINTENANCE **9**

Software testing fundamentals- Testing techniques: white box, black box, glass box testing - unit testing – integration testing –system testing – acceptance testing –

debugging. Post-delivery maintenance: Types – objectives - metrics - Reverse Engineering.

TOTAL: 45 PERIODS

OUTCOMES:

- At the end of this course, the students will be able to understand different software life cycle models.
- Perform software requirements analysis
- Apply systematic methodologies for software design and deployment.
- Understand various testing approaches and maintenance related issues.
- Plan project schedule, and estimate project cost and effort required.

TEXT BOOKS:

1. Roger S. Pressman, “Software Engineering – A Practitioner" s Approach”, Seventh Edition, Mc Graw-Hill International Edition, 2010.
2. Ian Sommerville, “Software Engineering”, 9th Edition, Pearson Education Asia, 2011.

REFERENCES:

1. Rajib Mall, “Fundamentals of Software Engineering”, Third Edition, PHI Learning PrivateLimited, 2009.
2. Pankaj Jalote, “Software Engineering, A Precise Approach”, Wiley India, 2010.
3. Kelkar S.A., “Software Engineering”, Prentice Hall of India Pvt Ltd, 2007.
4. Stephen R.Schach, “Software Engineering”, Tata McGraw-Hill Publishing CompanyLimited,2007.
5. http://nptel.ac.in/.

CO	**PO**												**PSO**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO 1	2		3	3								2	2			
CO 2	2		3	3		2								2		
CO 3			3	3							3				2	
CO 4		2								2				2		
CO 5		2				3					3				1	

1906705 **ACOUSTICS** **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To learn the origin of sound.
- To understand the knowledge in sound propagation.
- To enhance the concepts in Sound analysis.
- To acquire basic knowledge in Physiological acoustics.
- To enable the student to understand the analysis of acoustics.

UNIT - I: INTRODUCTION 9

Origin of sound. Objective and subjective sound. Sound vibrations, Amplitude, form, and period. Sound waves and their wavelength and speed. Sound pressure level. Energy parameters of sound. Dynamical range. Sound envelope, Sound frequency, Relation between frequency and period.

UNIT - II: PROPAGATION OF SOUND 9

Sound propagation. Spherical and plane waves. Change of intensity of a propagating sound wave. Sound reflections, echo, absorption, diffraction, refraction. Relation between pitch and frequency. Pitch standard. Sound spectrum. Types of Public Addressing system. Hi.fi speakers. Microphones: types and its applications.

UNIT - III: SOUND ANALYSIS 9

Natural scales. Origin of musical scale. Tonal material and modal scale. Pythagorean tuning, Temperaments. Non-equal temperaments. Equal temperaments. Relation of musical scale and kind of music. Sound Pre-Processing and analysis, Audio analysis tools.

UNIT - IV: PHYSIOLOGICAL ACOUSTICS 9

Physiological and psychological acoustics. Loudness. Loudness level. Fletcher-Munson diagram. Range of hearing. Masking. Compression of sound information, Pitch, timbre, subjective duration. Absolute pitch. Acoustics instruments. Peripheral auditory system.

UNIT - V: ACOUSTICAL ANALYSIS 9

Sound phenomena in rooms. Direct sound. Early reflections. Reverberation and its formation, Criteria for good acoustics of a room and methods of their realization, Reverberation time. Dependence of reverberation time on room volume and surfaces (area and absorption), Evaluation of reverberation time. Optimal reverberation times for various types of music and room sizes.

TOTAL PERIODS: 45

OUTCOMES:

The student should be able to:

- Analyze the basic parameters of sound.
- Understand the effects of propagation.
- Know the basic functions of sound analysis.
- Derive the output using Physiological acoustics.
- Acquire the knowledge on the Applications of acoustics.

TEXT BOOKS:

1. Rossing T. D., Moore R. F., Wheeler P. A.," The Science of Sound", 3rd edition San Francisco: Addison Wesley, 2002.
2. Hall D. E.," Musical Acoustics", 3rd edition Pacific Grove, CA: Brooks/Cole, 2001.
3. Howard D. M., Angus J. A. S.," Acoustics and psychoacoustics", 5th edition New York, London: Routledge, 2017.

REFERENCE BOOKS:

1. Everest F. A., Pohlmann K. C.," Master Handbook of Acoustics", 5th edition New York: McGraw-Hill, 2001.
2. Rossing T. D., ed.," Springer Handbook of Acoustics", 2nd edition Berlin, Heidelberg: SpringerVerlag 2014.
3. Chakrabarti, Pradip Kumar and Chowdhury, Satyabrata, "A Textbook on Waves and Acoustics", New Central book agency, 2010.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
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2	2	2	-	2	-	2	3	-	-	-	-	-	2	-	-	-
3	2	2	2	-	-	2	3	-	-	-	-	-	2	-	-	-
4	2	3	2	2	-	2	2	-	-	-	-	-	3	3	-	-
5	2	2	1	2	-	2	-	2	-	-	-	-	2	-	-	-

1906706 VISUAL COMMUNICATION L T P C

3 0 0 3

OBJECTIVES:

The student should be made:

- To know about the basics of communication.
- To learn and acquire the art of visual communication.
- To understand and relate the importance of visual communication
- To gain knowledge about the basic of Visual Communication.
- To acquire idea and concepts of various forms of Media.

UNIT - I: INTRODUCTION 9

Need for and the Importance of Human and Visual Communication. Communication a expression, skill and process, Understanding Communication: SMRC-Model.

UNIT - II: PROCESS IN COMMUNICATION 9

Communication as a process. Message, Meaning, Connotation, Denotation Culture/Codes etc Levels of communication: Technical, Semantic, and Pragmatic. The semiotic landscape: language and visual communication, narrative representation.

UNIT - III: METHODOLOGY 9

Fundamentals of Design: Definition. Approaches to Design, Centrality of Design, EIements/Elements of Design: Line, Shape, Space, Color, Texture. Form Etc. Principles of Design: Symmetry. Rhythm, Contrast, Balance Mass/Scale etc. Design and Designers (Need, role, process, methodologies etc.).

UNIT - IV: DESIGN PROCESS 9

Principles of Visual and other Sensory Perceptions. Color psychology and theory (some aspects) Definition, Optical / Visual Illusions Etc., Various stages of design process- problem identification, search for solution refinement, analysis, decision making, Implementation.

UNIT - V: GRAPHIC DESIGN 9

Basics of Graphic Design. Definition, Elements of GD, Design process-research, a source of concept, the process of developing ideas-verbal, visual, combination &

thematic, visual thinking, associative techniques, materials, tools (precision instruments etc.) design execution, and presentation.

TOTAL : 45 PERIODS

OUTCOMES:

The student should be able to:

- Learn about the history & evolution of Communication.
- Understand the Nature & functions of Visual Communication.
- Acquire knowledge on different types of perception & illusion.
- Get knowledge on semiotics.
- Remember the world of ideation creating.

TEXT BOOKS:

1. Lester, E, “Visual Communications: Images with Messages”, Thomson Learning, 2013.
2. Jonathan Baldwin, “Visual Communication: From Theory to Practice”, AVA publishing, 2006.

REFERENCE BOOKS:

1. Schildgen, T., “Pocket Guide to color with digital applications”, Thomsom Learning, 2000.
2. Palmer, Frederic, “Visual Elements of Art and Design”, Longman, 1990.
3. Carter, “Typographic Design : Form and Communication”, 6/e, John Wiley, 2014.

COURSE OUTCOMES - PROGRAM OUTCOMES MATRIX

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3	2	1	1	1	-	-	-	-	-	-	1	3	-	-	-
2	3	2	3	2	3	-	-	-	-	-	-	1	3	-	2	-
3	3	2	1	2	-	-	-	-	-	-	-	-	3	2	2	-
4	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3	-
5	3	-	2	2	3	-	-	-	-	-	-	2	2	2	3	-

1906707 **MEMS AND NEMS** **L T P C**

3 0 0 3

OBJECTIVES:

The student should be made:

- To introduce the concepts of micro and nano electromechanical devices.
- To know the fabrication process of microsystems.
- To know the design concepts of micro sensors.
- To understand the design of various micro actuators.
- To introduce the concepts of quantum mechanics and nano systems.

UNIT – I: INTRODUCTION TO MEMS AND NEMS 9

Introduction to Design of MEMS and NEMS, Overview of Nano and Microelectromechanical Systems, Applications of Micro and Nanoelectromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.

UNIT – II: MEMS FABRICATION TECHNOLOGIES 9

Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA, Micromolding.

UNIT – III: MICRO SENSORS 9

MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester.

UNIT – IV: MICRO ACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study: RF Switch.

UNIT – V: NANO DEVICES 9

Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.

TOTAL:45 PERIODS

OUTCOMES:

After studying this course, the student should be able to,

- Interpret the basics of micro/nano electromechanical systems including their applications and advantages.
- Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA.
- Analyze the key performance aspects of electromechanical sensors.
- Illustrate the design of micro actuators using various actuations.
- Comprehend the theoretical foundations of quantum mechanics and Nano systems.

TEXT BOOKS:

1. Marc Madou, "Fundamentals of Microfabrication", CRC press 1997.
2. Stephen D. Senturia, "Micro system Design", Kluwer Academic Publishers, 2001.

REFERENCES BOOKS:

1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill, 2002.
2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006.
3. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", CRC Press, 2002.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3	3	3	3	-	-	-	-	-	3	-	-	3	3	-	-
2	3	-	3	3	-	2	1	-	-	2	-	-	3	3	-	-
3	3	-	3	3	-	-	1	-	-	2	-	-	3	3	-	-
4	3	2	3	3	-	-	-	1	-	2	-	-	3	3	-	-
5	3	2	3	3	-	-	-	1	-	2	-	-	3	3	-	-

1907001 **TRANSDUCERS ENGINEERING** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- To make the students to know the methods of measurement, classification of transducers and to analyze error.
- To make the students to understand the behavior of transducers under static and dynamic conditions and hence to model the transducer.
- To expose the students to different types of resistive transducers and their application areas.
- To make the students to acquire knowledge on capacitive and inductive transducers.
- To impart knowledge on variety of transducers and get introduced to MEMS and Smart transducers.

UNIT I SCIENCE OF MEASUREMENTS AND CLASSIFICATION OF TRANSDUCERS 9

Units and standards – Static calibration – Classification of errors–Error analysis – Statistical methods – Odds and uncertainty – Classification of transducers – Selection of transducers.

UNIT II CHARACTERISTICS OF TRANSDUCERS 9

Static characteristics: - Accuracy, precision, resolution, sensitivity, linearity. Dynamic characteristics: Mathematical model of transducer, Zero, I and II order transducers, Response to impulse, step, ramp and sinusoidal inputs.

UNIT III VARIABLE RESISTANCE TRANSDUCERS 9

Principle of operation, construction details, characteristics and applications of potentiometer, strain gauge, resistance thermometer, Thermistor, hot-wire anemometer, piezo-resistive sensor and humidity sensor.

UNIT IV VARIABLE INDUCTANCE AND VARIABLE CAPACITANCE TRANSDUCERS 9

Inductive transducers: – Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer – Variable reluctance transducers – EI pickup-– Principle of operation, construction details, characteristics of capacitive transducers - Capacitor microphone, Proximity sensor.

UNIT V OTHER TRANSDUCERS 9

Piezoelectric transducer – Hall Effect transducer – Magneto elastic sensor – Digital transducers – Smart transducers - Fiber optic sensors – Thick & Thin Film sensors (Bio sensor & Chemical Sensor) – Nano sensors

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Apply the mathematical knowledge and science & engineering fundamentals gained to solve problems pertaining to measurement applications.
- Analyze the problems related to sensors & transducers.
- Select the right sensor/transducer for a given application.
- Determine the static and dynamic characteristics of transducers
- Understand fiber optic sensor, smart transducers and their applications.

TEXT BOOKS

1. Doebelin E.O. and Manik D.N., "Measurement Systems", 7th Edition, McGraw-Hill Education Pvt. Ltd., 2019.
2. A.K. Sawhney, A Course in Electrical & Electronic Measurements & Instrumentation, Dhanpat Rai and Co, New Delhi, 2015.

REFERENCES

1. Bela G.Liptak, Instrument Engineers' Handbook, Process Measurement and Analysis, 4th Edition, Vol. 1, ISA/CRC Press, 2003.
2. D. Patranabis, Sensors and Transducers, 2nd edition, Prentice Hall of India, 2010.

3. E.A. John P. Bentley, Principles of Measurement Systems, 4^{th} Edition, Pearson Education,2004.
4. W.Bolton, Engineering Science, Elsevier Newnes, Fifth edition, 2006.
5. Murthy, D.V.S., Transducers and Instrumentation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
6. S.Ranganathan,"Transducer Engineering", Allied Publishers Pvt. Ltd. 2003.

CO	PO											
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CO 1	3											
CO 2		3										
CO 3			1		2	3						1
CO 4					2	2						
CO 5				1	1	1						1

1907003 PROCESS MODELING AND SIMULATION

L T P C
3 0 0 3

COURSE OBJECTIVES:

- To give an overview of various methods of process modeling, different computational techniques for simulation.
- To analyze the simulation for steady state lumped system.
- To analyze the simulation for unsteady state lumped system.
- To analyze the simulation for steady state distributed system.
- To analyze the simulation for unsteady state distributed system.

UNIT I INTRODUCTION 9

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis, single and network of process units, systems yielding linear and nonlinear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 9

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES 9

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor. Empirical modeling, parameter estimation, population balance and stochastic modeling.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

- Develop the process models based on Conservation principles and Process data.
- Understand the characteristics of state lumped systems.
- Understand the characteristics of state distributed lumped systems.
- Carry out the analysis and design empirical modeling of systems.
- Apply computational techniques to solve the process models.

TEXT BOOKS:

1. Ramirez, W.; " Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ",2nd Edn, McGraw-Hill Book Co.,1990

REFERENCES:

1. Felder, R. M. and Rousseau, R. W., " Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., " Mathematical Modelling in Chemical Engineering ", John Wiley, 1967.
3. Amiya K. Jana,"Process Simulation and Control Using ASPEN", 2nd Edn,PHI Learning Ltd (2012).
4. Amiya K. Jana,"ChemicalProcess Modelling and Computer Simulation" 2nd Edn,PHI Learning Ltd,(2012).

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CO 1	3	3	2	3	2							1
CO 2	3	3	2	3	2							1
CO 3	3	3	2	3	3							1
CO 4	3	3	2	3	3							1
CO 5	3	3	2	3	3							1

1907708 STATE VARIABLE ANALYSIS AND DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge on design in state variable form.
- To study the design of state variable.
- To study the design of state estimator.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter.

UNIT I STATE FORMULATION 9

Formulation of state variable model, non-uniqueness, controllability, observability, stability.

UNIT II STATE VARIABLE DESIGN 9

Modes, controllability of modes -effect of state and output Feedback- pole placement Design

UNIT III STATE ESTIMATION 9

Need for state estimation - design of state Observers - full and reduced order - disturbance estimation - separation principle

UNIT IV OPTIMAL CONTROL 9

Introduction - Time varying optimal control - LQR steady state optimal control - Solution of Ricatti's equation - Application examples.

UNIT V OPTIMAL ESTIMATION 9

Optimal estimation - Kalman Bucy Filter-Solution by duality principle - Discrete systems - Kalman Filter - Application examples.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

- Apply advanced control theory to practical engineering problems.
- Understand and analyse state variable design.
- Understand and analyse state estimation.
- Understand and analyse optimal controller.
- Understand and analyse optimal estimator.

TEXT BOOKS:

1. K. P. Mohandas, "Modern Control Engineering", 2nd Edition, Sanguine Technical Publishers, 2016.

2. G. J. Thaler, “Automatic Control Systems”, Jaico Publishing House 1993.
3. M.Gopal, “Modern Control System Theory”, 3rd Edition, New Age International Publishers, 2014.

REFERENCES:

1. William S Levine, “Control System Fundamentals,” The Control Handbook, CRC Press, Tayler and Francies Group, 2011.
2. Ashish Tewari, “Modern Control Design with Matlab and Simulink”, John Wiley, New Delhi, 2002.
3. K. Ogata, “Modern Control Engineering”, 5th Edition, PHI, New Delhi, 2002.
4. T. Glad and L. Ljung,, “Control Theory –Multivariable and Non-Linear Methods”, Taylor & Francis, 2002.
5. D.S.Naidu, “Optimal Control Systems” First Indian Reprint, CRC Press, 2009.

CO	PO											
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CO 1	3	2										
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CO 3		2		2								
CO 4		2		2								
CO 5		2		2								

1908003 SOFTWARE QUALITY MANAGEMENT L T P C

3 0 0 3

OBJECTIVES

- To have an introduction to software quality
- To understand software quality assurance.
- To understand about quality control and reliability.
- To understand quality management system.
- To understand about Quality Standards.

UNIT I INTRODUCTION TO SOFTWARE QUALITY 9

Software Quality – Hierarchical models of Boehm and McCall – Quality measurement – Metrics measurement and analysis – Gilb's approach – GQM Model

UNIT II SOFTWARE QUALITY ASSURANCE 9

Quality tasks – SQA plan – Teams – Characteristics – Implementation – Documentation – Reviews and Audits

UNIT III QUALITY CONTROL AND RELIABILITY 9

Tools for Quality – Ishikawa's basic tools – CASE tools – Defect prevention and removal– Reliability models – Rayleigh model – Reliability growth models for quality Assessment

UNIT IV QUALITY MANAGEMENT SYSTEM 9

Elements of QMS – Rayleigh model framework – Reliability Growth models for QMS – Complexity metrics and models – Customer satisfaction analysis

UNIT V QUALITY STANDARDS 9

Need for standards – ISO 9000 Series – ISO 9000-3 for software development – CMM and CMMI – Six Sigma concepts.

TOTAL: 45 PERIODS

OUTCOMES

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

- To understand introduction about quality measurement.
- To understand SQA plan.
- To understand about Quality assessment.
- To understand about Customer satisfaction analysis.
- To understand Six Sigma Concepts.

TEXT BOOKS

1. Allan C. Gillies, "Software Quality: Theory and Management", Thomson Learning, 2003. (UI : Ch 1-4 ; UV : Ch 7-8)
2. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Pearson Education (Singapore) Pte Ltd., 2002. (UI : Ch 3-4; UIII : Ch 5-8 ; UIV : Ch9-11)

REFERENCES

1. Norman E. Fenton and Shari Lawrence Pfleeger, "Software Metrics" Thomson, 2003
2. Mordechai Ben – Menachem and Garry S.Marliss, "Software Quality", Thomson Asia Pte Ltd, 2003.
3. Mary Beth Chrissis, Mike Konrad and Sandy Shrum, "CMMI", Pearson Education (Singapore) Pte Ltd, 2003.
4. ISO 9000-3 "Notes for the application of the ISO 9001 Standard to software development".

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO 1			3													
CO 2		2												2		
CO 3	3		3												3	
CO 4				2										2		
CO 5	3	2	3	2											3	

1908004	C# and .NET Programming	L T P C
		3 0 0 3

OBJECTIVES

- To learn basic programming in C# and the object oriented programming concepts.
- To update and enhance skills in writing Windows applications, ADO.NET and ASP .NET.
- To study the advanced concepts in data connectivity, WPF, WCF and WWF with C# and .NET 4.5.
- To implement mobile applications using .Net compact framework
- To understand the working of base class libraries, their operations and manipulation of data using XML.

UNIT I C# LANGUAGE BASICS 9

.Net Architecture – Core C# – Variables – Data Types – Flow control – Objects and Types- Classes and Struts – Inheritance- Generics – Arrays and Tuples – Operators and Casts – Indexers

UNIT II C# ADVANCED FEATURES 9

Delegates – Lambdas – Lambda Expressions – Events – Event Publisher – Event Listener – Strings and Regular Expressions – Generics – Collections – Memory Management and Pointers – Errors and Exceptions – Reflection.

UNIT III BASE CLASS LIBRARIES AND DATA MANIPULATION 9

Diagnostics -Tasks, Threads and Synchronization – .Net Security – Localization – Manipulating XML- SAX and DOM – Manipulating files and the Registry- Transactions – ADO.NET- Peer-to-Peer Networking – PNRP – Building P2P Applications – Windows Presentation Foundation (WPF).

UNIT IV WINDOW BASED APPLICATIONS, WCF AND WWF 9

Window based applications – Core ASP.NET- ASP.NET Web forms -Windows Communication Foundation (WCF)- Introduction to Web Services – .Net Remoting – Windows Service – Windows Workflow Foundation (WWF) – Activities – Workflows

UNIT V .NET FRAMEWORK AND COMPACT FRAMEWORK 9

Assemblies – Shared assemblies – Custom Hosting with CLR Objects – App domains – Core XAML – Bubbling and Tunneling Events- Reading and Writing XAML – .Net Compact Framework – Compact Edition Data Stores – Errors, Testing and Debugging – Optimizing performance – Packaging and Deployment – Networking and Mobile Devices

TOTAL: 45 PERIODS

OUTCOMES

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

- Write various applications using C# Language in the .NET Framework.
- Develop programs using advanced C# concepts on .NET
- Analyse the base class libraries, operations and manipulation of data using XML.
- Develop distributed applications using .NET Framework.
- Create mobile applications using .NET compact Framework.

TEXT BOOKS

1. Christian Nagel, Bill Evjen, Jay Glynn, Karli Watson, Morgan Skinner . —Professional C# 2012 and .NET 4.5, Wiley, 2012
2. Harsh Bhasin, —Programming in C#, Oxford University Press, 2014.

REFERENCES

1. Ian Gariffiths, Mathew Adams, Jesse Liberty, —Programming C# 4.0, OReilly, Fourth Edition, 2010.
2. Andrew Troelsen, Pro C# 5.0 and the .NET 4.5 Framework, Apress publication, 2012.
3. Andy Wigley, Daniel Moth, Peter Foot, —Mobile Development Handbook, Microsoft Press, 2011.

CO	PO												PSO			
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CO 1	2	3	3													
CO 2		3		2									3			
CO 3	2		3										3		2	
CO 4			3													
CO 5	2	3	3	2									3	2		

1908005 **VIRTUAL REALITY** **L T P C**

3 0 0 3

OBJECTIVES

- To study about basic concepts of Virtual reality
- To understand Virtual environment
- To understand geometric modeling
- To study about Virtual Hardware and Software
- To develop Virtual Reality applications

UNIT I INTRODUCTION TO VIRTUAL REALITY 9

Virtual Reality & Virtual Environment : Introduction – Computer graphics – Real time computer graphics–Flight Simulation –Virtual environments–requirement – benefits of virtual reality- Historical development of VR : Introduction – Scientific Landmark -3D Computer Graphics :Introduction – The Virtual world space – positioning the virtual observer – the perspective projection – human vision – stereo perspective projection – 3D clipping – Colour theory – Simple 3D modeling- illumination models – Reflection models – Shading algorithms- Radiosity – Hidden Surface Removal – Realism-Stereographic image.

UNIT II GEOMETRIC MODELLING 9

Geometric Modeling: Introduction – From 2D to 3D – 3D space curves – 3D boundary representation - Geometrical Transformations: Introduction – Frames of reference – Modeling transformations – Instances –Picking – Flying – Scaling the VE – Collision detection - A Generic VR system: Introduction – The virtual environment – the Computer environment – VR Technology – Model of interaction-VR Systems.

UNIT III VIRTUAL ENVIRONMENT 9

Animating the Virtual Environment: Introduction – The dynamics of numbers – Linear and Non-linear interpolation - The animation of objects – linear and non- linear translation - shape & object in between ing – free from deformation – particle system- Physical Simulation : Introduction – Objects falling in a gravitational field-Rotating wheels – Elastic collisions – projectiles – simple pendulum – springs – Flight dynamics of an aircraft.

UNIT IV VR HARDWARES & SOFTWARES 9

Human factors: Introduction – the eye-the ear-the somatic senses-VR Hardware : Introduction – sensor hardware – Head-coupled displays –Acoustic hardware – Integrated VR systems-VR Software: Introduction –Modeling virtual world –Physical simulation- VR toolkits – Introduction to VRML.

UNIT V VR APPLICATION 9

Virtual Reality Applications: Introduction – Engineering – Entertainment – Science Training – The Future: Introduction – Virtual environments – modes of interaction.

TOTAL: 45 PERIODS

OUTCOMES

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

- Understood the basic concept of virtual reality
- Understood 3D computer Graphics System
- Design object objects using geometric modeling
- Develop Virtual environment.
- Apply study about Virtual Hardwares and Softwares
  Develop Virtual Reality applications and Develop Virtual Reality applications

TEXT BOOK

1. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.

REFERENCES BOOKS

1. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000.
2. Grigore C. Burdea, Philippe Coiffet, “Virtual Reality Technology”, Wiley Interscience, 2nd Edition, 2006.
3. William R. Sherman, Alan B. Craig, “Understanding Virtual Reality: Interface, Application, and Design”, Morgan Kaufmann, 2008.
4. www.vresources.org.

5. www.vrac.iastate.edu.
6. www.w3.org/MarkUp/VRML.

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CO 2	2													2		
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CO 4		2	2		2									3		
CO 5					2									3		

1909718 **ROBOTICS** **L T P C**

3 0 0 3

OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understand the functions of robots and review the need and application of robots in different engineering fields.
- Exemplify the different types of robot drive systems as well as robot end effectors.
- Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
- Develop robotic programs for different tasks and analyze the kinematics motions of robot.
- Implement robots in various industrial sectors and interpolate the economic analysis of robots.

UNIT-I: FUNDAMENTALS OF ROBOT 9

Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT-II: ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations

UNIT-III: SENSORS AND MACHINE VISION 9

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data-Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications-Inspection, Identification, Visual Serving and Navigation.

UNIT-IV: ROBOT KINEMATICS AND ROBOT PROGRAMMING 9

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

UNIT-V: IMPLEMENTATION AND ROBOT ECONOMICS 9

RGV, AGV; Implementation of Robots in Industries -Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TOTAL : 45 PERIODS

COURSE OUTCOMES: Upon Completion of this course, the students will be able to:

- Understand the functions of robots and review the need and application of robots in different engineering fields.
- Exemplify the different types of robot drive systems as well as robot end effectors.
- Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
- Develop robotic programs for different tasks and analyze the kinematics motions of robot.
- Implement robots in various industrial sectors and interpolate the economic analysis of robots.

TEXTBOOKS:

1. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.
2. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.

REFERENCE BOOKS:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.
3. Koren Y., “Robotics for Engineers", McGraw Hill Book Co., 1992.
4. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”,McGraw Hill Book Co., 1987.
5. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3		1	2									2	2		
2	3		2	2								1	2	2		
3	3	3	2	2								1	2	2		
4	3		2	3								1	2	2		
5	3		3	3								1	1	2		

1909719 TESTING OF MATERIALS L T P C

3 0 0 3

OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Apply the concept of testing to various materials and result analysis.
- Apply various mechanical testing procedures to different materials.
- Apply different nondestructive testing procedures to different materials.
- Apply material characterization testing for analysis.
- Apply advanced testing techniques for thermal and chemical fields.

UNIT-I: INTRODUCTION TO MATERIALS TESTING 9

Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing

UNIT-II: MECHANICAL TESTING 9

Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT-III: NON DESTRUCTIVE TESTING 9

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.

UNIT-IV: MATERIAL CHARACTERIZATION TESTING 9

Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.

UNIT-V: OTHER TESTING **9**

Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo- mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.

TOTAL : 45 PERIODS

COURSE OUTCOMES: Upon Completion of this course, the students will be able to:

- Apply the concept of testing to various materials and result analysis.
- Apply various mechanical testing procedures to different materials.
- Apply different nondestructive testing procedures to different materials.
- Apply material characterization testing for analysis.
- Apply advanced testing techniques for thermal and chemical fields.

TEXTBOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Cullity, B. D., "Elements of X-ray diffraction", 3rd Edition, Addison-Wesley Company Inc., New York, 2000.

REFERENCE BOOKS:

1. P. Field Foster, "The Mechanical Testing of Metals and Alloys" 7th Edition, Cousens Press, 2007.
2. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA.
4. Brandon D.G., "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 1986.

co	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	2	2	1	1								1	1	1		
2	3	2	1	1								1	1	1		
3	2	2	1	1								1	1	1		
4	3	2	1	1								1	1	1		
5	3	2	1	1								1	1	1		

1909720	DESIGN OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Understand about electric vehicle technology.
- Understand the load distribution and stability of vehicles.
- Analyze the handling characteristics of road vehicles.
- Analyze the steering, suspension and designing of breaks.
- Understand hybrid vehicles, power electronics and fuel cell vehicles.

UNIT-I: INTRODUCTION TO ELECTRIC VEHICLES 9

Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.

UNIT-II: STABILITY OF VEHICLES 9

Load distribution for three wheeler and four wheeler-Stability of vehicle running on slope, banked road and during turn-calculation of Tractive effort, maximum acceleration and reaction forces for different drives.

UNIT-III: HANDLING CHARACTERISTICS OF ROAD VEHICLES 9

Steering geometry-Steady state handling characteristics- Steady state response to steering input-Testing of handling characteristics-Transient response characteristics- Directional stability.

UNIT-IV: STEERING, SUSPENSION AND BRAKE 9

Steering System - Ackerman Principle of Steering - Front End Geometry - Steering Gearbox- Types-Recirculating Ball - Rack and Pinion - Power Steering. Suspension - Front and Rear Forks - Springs for Suspension - Telescopic Suspension - Monoshock Suspension - Hydraulic Shock Absorber - Dampers. Design Consideration – Brake - Drum Brakes - Disc Brakes - ABS

UNIT-V: POWER ELECTRONICS AND CONTROL FOR HYBRID AND FUEL CELL VEHICLES 9

Series Hybrid Vehicle Propulsion System, Parallel Hybrid Vehicle Propulsion System, Fuel Cell Vehicles, Power Electronics Requirements, Propulsion Motor Control Strategies, APU Control System in Series Hybrid Vehicles, Fuel Cell for APU Applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES: Upon Completion of this course, the students will be able to:

- Understand about electric vehicle technology.
- Understand the load distribution and stability of vehicles.
- Analyze the handling characteristics of road vehicles.
- Analyze the steering, suspension and designing of breaks.
- Understand hybrid vehicles, power electronics and fuel cell vehicles.

TEXTBOOKS:

1. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
2. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005.

REFERENCE BOOKS:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc, 1992.
2. Dr.Kirpal Singh, ‘Automobile Engineering’- Vol. I and II, Standard Publishers, New Delhi, 2011.
3. V. Ganesan, ‘Internal Combustion Engines’, Tata McGraw Hill Book Co, Eighth Reprint, 2010.
4. Ali Emadi, “Handbook of Automotive Power Electronics and Drives”, Taylor & Francis Group, First Edition, USA, 2005.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1		2	1	1		1		1			1	2	2	1	2	
2	2			1	2				1							
3	1		1			1					1			1	1	
4		2	2	1			2									
5	2	2		1							2		2	1	1	

1910703 **CLINICAL TRIALS** **L T P C**

3 0 0 3

OBJECTIVES:

- To highlight the epidemiologic methods, study design, protocol preparation.
- To learn about the crossover and factorial trial designs.
- To gain knowledge in the basic bio-statistical techniques involved in clinical research.
- To describe the principles involved in ethical, legal and regulatory issues in clinical trials.
- To gain knowledge on the reporting of trials.

UNIT – I: ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT 9

Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinical research, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

UNIT – II: FUNDAMENTALS OF TRIAL DESIGN 9

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

UNIT – III: ALTERNATE TRIAL DESIGNS 9

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

UNIT – IV: BASICS OF STATISTICAL ANALYSIS 9

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, missing data.

UNIT – V: REPORTING OF TRIALS 9

Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

TOTAL: 45 PERIODS

OUTCOMES:

The student will be able to

- Explain key concepts in the design of clinical trials.
- Describe study designs used in data management for clinical trials.
- Identify key issues and determine alternate trial designs.
- Recognize the roles of regulatory affairs in clinical trials.
- Provide the overview of reporting trialsto the students.

TEXT BOOKS:

1. Fundamentals of Clinical Trials, Lawrence M. Friedman, Springer Science & Business Media, 2010
2. Textbook of Clinical Trials, David Machin, Simon Day, Sylvan Green, John Wiley & Sons, 2007
3. Clinical Trials: A Practical Approach, Stuart J. Pocock, John Wiley & Sons, 17-Jul-2013.

REFERENCEBOOKS:

1. Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang and AmeetBakhai. Remedica. 2006.
2. Introduction to statistics in pharmaceutical clinical trials. T.A. Durham and J Rick Turner. Pharmaceutical Press.
3. Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines, Tom Brody, Academic Press, 2016.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	3	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-
2	3	2	2	-	-	-	-	2	-	-	-	2	2	3	-	-
3	3	3	2	2	-	-	-	2	-	-	-	2	2	3	-	-
4	3	3	-	-	-	-	2	3	-	-	-	2	2	2	-	-
5	3	-	-	-	-	-	-	3	-	-	-	2	2	2	-	-

1910704	REGULATORY REQUIREMENTS IN PHARAMACEUTICAL INDUSTRIES	L T P C 3 0 0 3

OBJECTIVES:

- To acquire the knowledge of pharmaceutical industry regulations.
- To learn about the packaging and labeling of drugs.
- To learn about the patent filling process.
- To gain knowledge about the quality guidelines in drug products.
- To gain knowledge on documentation.

UNIT-I: REGULATORY CONCEPTS 9

Quality assurance – Quality control – Practice of cGMP – Schedule M – USFDA.

UNIT – II: REGULATORY ASPECTS 9

Pharmaceuticals: Bulk drug manufacture; Personnel, Buildings and Facilities, Process Equipment, Documentation and Records, Materials Management, Production and In-Process Controls, Packaging and Identification Labelling of API's and Intermediates, Storage and distribution, – Biotechnology derived products; Principles, Personnel, Premises and equipments, Animal quarters and care, production, labelling, Lot processing records and distribution records, quality assurance and quality control..

UNIT – III: INTELLECTUAL PROPERTY RIGHTS 9

Patent system – Different types of patents – Filing process of application for patent – Infringement of patents – The patent rules 2003 as amended by the patents (amendment) rules 2016.

UNIT – IV: ICH GUIDELINES 9

Quality guidelines – Impurities in new drug substances (Q3A(R2)) – Impurities in newdrug products(Q3B(R2)) – Validation of analytical procedures text and methodology (Q2 (R1)).

UNIT – V: QUALITY AUDIT AND SELF INSPECTIONS 9

SOPs – Documentation – Loan license auditing – Common technical documentation (CTD) – Drug master file (DMF).

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able

- To be familiarise with the pharmaceutical industry manufacturing practices and regulatory aspects of pharmacy products.
- To know the process of patenting activities.
- To acquire knowledge on filling process.
- To know the quality guidelines followed for pharmaceutical products.
- To understand the aspects involved in document preparation for pharmaceutical product registration.

TEXT BOOKS:

1. C.V.S Subbrahmanyam & J.Thimmasetty, Pharmaceutical regulatory affairs, 1stEdn., vallabhPrakashan, New Delhi, 2012.
2. Willig, H., Tuckeman, M.M. and Hitchings, W.S., “Good Manufacturing Practices for Pharmaceuticals”, 5th Edition, Marcel Dekker Drugs and the Pharmaceutical Sciences, by CRC Press, New York, 2000.
3. N Udupa, Krishnamurthy Bhat, A Concise Textbook of Drug Regulatory Affairs, Manipal University Press (MUP); First Edition, 2015.

REFERENCEBOOKS:

1. Ira R. Berry,The Pharmaceutical Regulatory Process, marcel dekker Series: Drugs and the Pharmaceutical Sciences, by CRC Press, Newyork, 2004.
2. Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference, Pharmalogika Inc., USA, 2009.
3. Sharma, P.P., “How to Practice GMPs”, 3rd Edition, Vandana Publications, 2006.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	2	-	-	-	-	-	3	3	-	-	-	3	2	-	-	-
2	2	3	-	-	-	2	3	3	-	-	-	2	2	-	-	-
3	2	2	3	2	-	2	3	3	-	-	-	2	2	-	-	-
4	2	-	-	-	-	2	3	3	-	-	-	2	2	-	-	-
5	2	-	-	-	-	2	3	3	-	-	-	2	2	-	-	-

1910705 **MICROBIOLOGY** **L T P C**

3 0 0 3

OBJECTIVES:

- To introduce students to the principles of Microbiology.
- To emphasize the structure and biochemical aspects of various microbes.
- To learn about the Nutritional classification of microorganisms.
- To gain knowledge on the Physical and chemical control of microorganisms.
- To learn about the preservation of food.

UNIT – I: INTRODUCTION TO MICROBIOLOGY 9

classification and nomenclature of microorganisms, microscopic examination of microorganisms: light, fluorescent, dark field, phase contrast, and electron microscopy.

UNIT – II: MICROBES- STRUCTURE AND REPRODUCTION 9

Structural organization and multiplication of bacteria, viruses (TMV, Hepatitis B), algae (cyanophyta, rhodophyta) and fungi (Neurospora), life history of actinomycetes (Streptomyces), yeast (Sacharomyces), mycoplasma (M. pneumoniae) and bacteriophages (T4 phage, ʎ phage)

UNIT – III: MICROBIAL NUTRITION, GROWTH AND METABOLISM 9

Nutritional classification of microorganisms based on carbon, energy and electron sources Definition of growth, balanced and unbalanced growth, growth curve and different methods to quantify bacterial growth:(counting chamber, viable count method, counting without equipment, different media used for bacterial culture (defined, complex, selective, differential, enriched) themathematics of growth-generation time, specific growth rate.

UNIT – IV: CONTROL OF MICROORGANISMS 9

Physical and chemical control of microorganisms Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration.Disinfection sanitization, antiseptics sterilants and fumigation.mode of action and resistance to antibiotics; clinically important microorganisms

UNIT – V: INDUSTRIAL MICROBIOLOGY 9

Microbes involved in preservation (Lactobacillus,bacteriocins), spoilage of food and food borne pathogens (E.coli, S.aureus, Bacillus, Clostridium). Industrial use of microbes (production of penicillin, alcohol, vitamin B-12); biogas; bioremediation(oil spillage leaching of ores by microorganisms ,pollution control); biofertilizers, biopesticides. Biosensors.

TOTAL: 45 PERIODS

OUTCOMES:

- To provide to the students the fundamentals of Microbiology.
- To Describe the scope of microbiology
- To solve the problems in microbial infection and their control**.**
- To understand the concept of food preservation.
- To be familiarize with the industrial use of microbes.

TEXT BOOKS:

1. Pelczar, M.J. “Microbiology”, 5th Edition, Tata McGraw-Hill, 1993.
2. Prescot. Harley, Klein. “ Microbiology “: McGraw-Hill Higher Education, 2008.
3. Ananthanarayanan, R. and C.K. Jayaram Paniker, “Textbook of Microbiology”,4th Edition, Orient Longman, 1990.

REFERENCE BOOKS:

1. Pelczar, M.J. “Microbiology”, Fifth Edition, Tata McGraw-Hill, 1993.
2. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
3. Schlegel, H.G. “General Microbiology”, Seventh Edition, Cambridge University Press, 1993.

CO	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
2	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-	-
3	3	2	2	2	-	2	1	2	-	-	-	2	2	2	2	-
4	3	-	-	2	-	1	2	2	-	-	-	2	2	2	-	-
5	3	-	-	-	-	3	2	-	-	-	-	2	2	-	-	-

1920701 ANALYTICAL METHODS AND INSTRUMENTATION L T P C

3 0 0 3

OBJECTIVES

- Make the students understand the basics of spectrometry
- To explore the knowledge on molecular spectroscopy.
- To introduce the NMR and MASS spectrometry.
- To elucidate the various separation methods in chromatography.
- To gain knowledge on potentiometry and surface microscope.

UNIT- I: SPECTROMETRY 9

Properties of electromagnetic radiation- wave properties – components of optical instruments– Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Applications.

UNIT –II: MOLECULAR SPECTROSCOPY 9

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence –Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications.

UNIT- III: NMR AND MASS SPECTROMETRY 9

Theory of NMR – chemical shift- NMR-spectrometers – applications of 1H and 13C NMR- Molecular mass spectra – ion sources.Massspectrometer.Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation.

UNIT- IV: SEPARATION METHODS 9

General description of chromatography – Band broadening and optimization of column performance-Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

UNIT-V: ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9

Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ionselective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probemicroscopes – AFM and STM.

TOTAL: 45 PERIODS

OUTCOMES

- Ability to understand the concept of spectrometry
- Ability to know the operations of various instruments.
- Able to apply molecular spectroscopy concepts in NMR and MASS spectrometry.
- Ability to understand surface microscopy and its applications.
- Ability to acquire knowledge on surface microscopic techniques and voltametric applications.

TEXT BOOKS:

1. Skoog, D.A. F. James Holler, and Stanky, R.Crouch "Instrumental Methods of Analysis".CengageLearning , 2007.
2. Willard, Hobart, etal., "Instrumental Methods of Analysis". VIIth Edition, CBS, 1986.

3. Braun, Robert D. “Introduction to Instrumental Analysis”. Pharma Book Syndicate, 1987.
4. Ewing,G.W. “Instrumental Methods of Chemical Analysis”, Vth Edition, McGraw-Hill, 1985

REFERENCE BOOKS:

1. Sharma, B.K. “Instrumental Methods of Chemical Analysis : Analytical Chemistry” GoelPublishing House, 1972.
2. Haven, Mary C., etal., “Laboratory Instrumentation “. IVth Edition, John Wiley, 1995.

Course Outcomes	**PROGRAM OUTCOMES**												**Program Specific Outcomes**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	-	3	2	2	-	-	3	-	3	2	1	2	-	-	-
CO2	2	2	3	2	2	-	-	2	2	3	2	1	2	-	-	-
CO3	2	2	3	3	3	-	2	2	2	3	3	1	2	-	-	-
CO4	3	2	3	3	3	-	-	3	2	3	3	1	2	-	-	-
CO5	3	-	3	2	2	-	-	3	-	3	2	1	2	-	-	-

1920702 MEDICAL PHYSICS L T PC

3 0 0 3

COURSE OBJECTIVES

- To study the complete non-ionizing radiations including light and its effect in human body.
- To understand the principles of ultrasound radiation and its applications in medicine.
- To learn about radioactive nuclides.
- To know the interactions of radiation with matters and how isotopes are produced.
- To study the harmful effects of radiation and radiation protection regulations.

UNIT-I: NON-IONIZING RADIATION AND ITSMEDICALAPPLICATION 9

Introduction to EM waves - Tissue as a leaky dielectric - Relaxation processes: Debye model, Cole–Cole model- Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light-Measurement of light and its unit- limits of vision and color vision an overview - Applications of ultraviolet in medicine, Thermography.

UNIT-II: ULTRASOUND IN MEDICINE 9

Ultrasound fundamentals – Generation of ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with matter: Cavitation, Reflection, Transmission- Scanning systems – Artefacts- Ultrasound- Doppler-Double Doppler shift-Clinical Applications- Ultrasonography.

UNIT-III: PRINCIPLES OF RADIOACTIVE NUCLIDESANDDECAY 9

Introduction to Radioisotopes - Radioactive decay : Spontaneous Fission, Isomeric Transition, Alpha Decay, Beta Decay, Positron Decay, Electron Capture- Radioactive decay equations – Half life- Mean Life- Effective half-life - Natural and Artificial radioactivity, - Production of radionuclide –

Cyclotron produced Radionuclide - Reactor produced Radionuclide: fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclide - Radionuclide Generator-Technetium generator.

UNIT-IV: INTERACTION OF RADIATION WITH MATTER 9

Interaction of charged particles with matter –Specific ionization, Linear energy transfer, range, Bremsstrahlung, Annihilation - Interaction of X and Gamma radiation with matter: Photoelectric effect, Compton Scattering, Pair production- Attenuation of Gamma Radiation - Interaction of neutron with matter and their clinical significance- Radionuclide used in Medicine and Technology.

UNIT-V: RADIATION EFFECTS AND REGULATIONS 9

Classification of Radiation Damage, Stochastic and Deterministic Effects, Acute Effects of Total Body Irradiation, Long-Term Effects of Radiation, Risk Versus Benefit in Diagnostic Radiology and Nuclear Medicine, Risk of Pregnant Women, Nuclear Regulatory Commission, ALARA Program, Medical Uses of Radioactive Materials, Survey for Contamination and Exposure Rate, Dose Calibrators and Survey Meters, Bioassay, Radioactive Waste Disposal.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- Analyze the low frequency and high frequency effects of non-ionizing radiation and physics of light.
- Define various clinical applications based on ultrasound wave.
- Explain the process of radioactive nuclide production using different techniques
- Analyze radiation mechanics involved with various physiological systems
- Outline the detrimental effects of radiation and regulations for radiation safety.

TEXT BOOKS:

1. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, Medical Physics and Biomedical Engineering, 2nd Edition, IOP

Publishers.2001. (Unit I &II)

2. Gopal B. Saha, Physics and Radiobiology of Nuclear Medicine, 4th Edition, Springer, 2013. (Unit III &IV)
3. R.Hendee and Russell Ritenour “Medical Imaging Physics”, Fourth Edition William, Wiley-Liss, 2002. (Unit V).

REFERENCE BOOKS:

1. S.Webb “ The Physics of Medical Imaging”, Taylor and Francis,1988
2. HyltonB.Meire and Pat Farrant “Basic Ultrasound” John Wiley & Sons,1995

John R Cameran , James G Skofronick “Medical Physics” John-Wiley & Sons.1978.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	1	1	-	-	2	1	-	-	-	-	3	2	-	-	-
CO2	3	1	2	2	1	-	1	-	-	-	-	3	2	-	-	-
CO3	3	1	2	-	-	2	2	-	-	-	-	2	1	-	-	-
CO4	2	1	1	-	1	1	1	-	-	-	-	1	2	-	-	-
CO5	3	2	3	-	2	1	3	-	-	-	-	3	2	-	-	-

1920703 **ELECTRONIC MATERIALS** **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To Understand the various materials and its properties towards electrical and electronics field.
- To cover the properties of conducting materials.
- Make the students to understand various semiconducting and magnetic materials and their properties.
- To give an idea on dielectric and insulating materials.
- To explore the knowledge on optoelectronic and nano materials.

UNIT- I: INTRODUCTION 7

Structure: atomic structures and bonding, types of bonding, band formation. Defects and imperfections in solids:Point, Line and Planar defects; Interfacial defects and volume defects. Classification of materials based on bonding: conductors, semiconductors and insulators.

UNIT- II: CONDUCTING MATERIALS 9

Introduction, factors affecting the conductivity of materials, classification based on conductivity of materials, temperature dependence of resistivity, Low resistivity materials (graphite, Al, Cu and steel) and its applications, high resistivity materials (manganin, constantan, nichrome, tungsten) and their applications. Superconductors: Meissner effect, classification and applications.

UNIT- III: SEMICONDUCTING AND MAGNETIC MATERIALS 10

Semiconductors: Introduction, types of semiconductors, temperature dependence of semiconductors, compound semiconductors, basic ideas of amorphous and organic semiconductors. Magnetic Materials: classification of magnetic materials, ferromagnetism-B-H curve (Qualitative), hard and soft magnetic materials, magneto materials applications.

UNIT- IV: DIELECTRIC AND INSULATING MATERIALS 9

Dielectric Materials: Introduction, classification, temperature dependence on polarization, properties, dielectric loss, factors influencing dielectric strength and capacitor materials, applications. Insulators: Introduction, thermal and mechanical properties required for insulators, Inorganic materials, organic materials, liquid insulators, gaseous insulators and ageing of insulators, applications.

UNIT –V: OPTOELECTRONIC ANDNANO ELECTRONIC MATERIALS 10

Optoelectronic materials. Introduction, properties, factor affecting optical properties, role of optoelectronic materials in LEDs, LASERs, photo detectors, solar cells. Nano electronic Materials: Introduction, advantage of nanoelectronic devices, materials, fabrication, challenges in Nano electronic materials.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to understand the fundamentals of conducting materials
- Able to define various applications of semiconducting and magnetic materials
- Able to explain the concepts of dielectrics and insulating materials
- Ability to explain various optoelectronic devices and nano electronic materials
- With the basis, students will be able to have clear concepts on electronic behaviors of materials.

TEXT BOOKS:

1. S.O. Kasap "Principles of Electronic Materials and Devices", 3rd edition, McGraw-Hill Education (India) Pvt. Ltd., 2007.
2. W D Callister, "Materials Science & Engineering – An Introduction", Jr., John Willey &Sons,Inc, New York, 7th edition, 2007.

REFERENCE BOOKS:

1. B.G. Streetman and S. Banerjee, Solid State Electronic Devices, 6th edition, PHI Learning, 2009.
2. Eugene A. Irene, Electronic Materials Science, Wiley, 2005
3. Wei Gao, Zhengwei Li, Nigel Sammes, An Introduction to Electronic Materials for Engineers, 2nd Edition, World Scientific Publishing Co. Pvt. Ltd., 2011.

CO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	1	2	1	1	1	1	-	-	-	-	-	1	-	-	-
CO2	2	2	2	1	2	-	-	-	-	-	-	-	3	-	-	-
CO3	3	3	3	-	3	2	-	-	-	-	-	-	3	-	-	-
CO4	2	3	3	1	3	3	-	-	-	-	-	-	3	-	-	-
CO5	2	3	2	1	3	3	-	-	-	-	-	-	3	-	-	-

1921701 **WASTE WATER TREATMENT** **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To make the student conversant with the water treatment methods including adsorption and oxidation process.
- To provide basic under standings about the requirements of water and its preliminary treatment.
- To study the dynamic processes and understand the features of corrosion and its effects
- To develop and understand the waste water treatment process
- To provide a broad view about the water quality and its standards

UNIT-I: WATER QUALITY AND PRELIMINARY TREATMENT 9

Water Quality-physical-chemical and biological parameters of water-Water quality requirement - potable water standards-Wastewater effluent standards-water quality indices. Water purification systems in natural systems- physical processes-chemical processes and biological processes-Primary, secondary and tertiary treatment-Unit operations-unit processes. Mixing, clarification-sedimentation; Types-aeration and gas transfer-coagulation and flocculation, coagulation processes.

UNIT-II: INDUSTRIAL WATER TREATMENT 9

Filtration-size and shape characteristics of filtering media-sand filters hydraulics of filtration-design considerations-radial, upflow, highrate and multimedia filters, pressure filter. Water softening-lime soda, zeolite and demineralization processes – Boiler troubles-scale, sludge, priming, foaming, caustic embrittlement and boiler corrosion.

UNIT-III: CONVENTIONAL TREATMENT METHODS 9

Taste and odour control-Adsorption-activated carbon treatment-removal of color-iron and manganese removal-aeration, oxidation, ion exchange and other methods-effects of fluorides-fluoridation and defluoridation-desalination-Corrosion prevention and control-factors influencing corrosion-Langelier index-Corrosion control measures.

UNIT-IV: WASTEWATER TREATMENT 9

Wastewater treatment-pre and primary treatment-equalization neutralization-screening and grid removal-sedimentation-oil separation gas stripping of volatile organics-biological oxidation-lagoons and stabilization basins-aerated lagoons-activated sludge process-trickling filtration-anaerobic decomposition-Break point chlorination.

UNIT-V: ADSORPTION AND OXIDATION PROCESSES 9

Chemical process-Adsorption-theory of adsorption-Ion exchange process-chemical oxidation- advanced oxidation process-sludge handling and disposal-Miscellaneous treatment processes.

TOTAL : 45 PERIODS

COURSE OUTCOMES

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

- Gain idea about various methods available for water treatment.
- Appreciate the necessity of water and acquire knowledge of preliminary treatment.
- Interpret the nature of corrosion and its harmful effects.
- Value the various waste water treatment methods.
- Understand about adsorption and oxidation process.

TEXTBOOKS:

1. Metcalf and Eddy, “Wastewater Engineering”, 4th ed., McGraw Hill Higher Edu., 2002.
2. G.L.Karia and R.A. Christian, Waste Water Treatment, Concepts and Design Approach, Prentice Hall, 2013.
3. Joanne E. Drinon and Frank Spellman, Water and Waste Water Treatment, CRC Press, 2012.

REFERENCE BOOKS:

1. S.P. Mahajan, “Pollution control in process industries”, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.

2. M. Lancaster, “Green Chemistry: An Introductory Text”, 2nd edition, RSC publishing, 2010.
3. C.S. Rao, “Environmental Pollution Control Engineering”, New Age International, 2007.
4. M.J. Hammer and M.J. Hammer (Jr.), Water and Waste Water Technology, Pearson, 2011.

CO	**PO**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO 1	2	1	2				1		2			1
CO 2	1	2	2	2			3		1			1
CO 3	3	1		1	3	1	3					1
CO 4	2		2	2	1		3					1
CO 5	3	2			1							1