DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
ANNA UNIVERSITY, CHENNAI – 25

VISION:

The vision of the department is to produce analytically proficient and technologically competent Electrical and Electronics Engineers who can serve and take forward the academic, industry and research organizations to newer heights and be effective for building the nation.

MISSION:

- To impart high quality technical education with the state of the art laboratory practice.
- To provide conducive academic ambience to enable best teaching and learning processes.
- To generate resources through research and consultancy projects for pursuing research and developmental activities in emerging areas.
- To associate with academic and industrial organizations for research activities to develop and provide vital and viable solutions for social needs indigenously.
- To develop leadership skills in students with high degree of ethics, morals and values and instill confidence to lead the organization.

1. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I.	Employability in Core Electrical and Electronics Engineering and other allied emerging areas
II.	Motivated to take up technical lead position and lead the organization competitively.
III.	Pursue higher studies and research
IV.	Act as a consultant and provide solutions to the practical problems of core organization.
V.	Take up entrepreneurship as career and be part of electrical and electronics product and service industries.

2. PROGRAM OUTCOMES (POs)

PO#	Graduate Attribute
1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6	**The engineer and society**: Apply reasoning informed by the contextual knowledge toassess 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 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)

After completion of B.E – EEE, the students would have,

1.	The ability to understand, model, analyse, electrical circuits, equipment, Power system under steady state and transient conditions.
2.	The ability to formulate and design electrical systems for sustainable energy technologies.
3.	Ability for lifelong learning in electrical applications to societal problems.
4.	Ability to use knowledge in various domains to identify research gaps and hence to provide solution leading to new ideas and innovations.

SEMESTER	COURSE CODE	PROGRAM OUTCOMES												PROGRAM SPECIFIC OUTCOMES			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO4
I	**THEORY**																
	Matrices And Calculus	3	2	-	1	1	2	-	-	-	-	-	3	-	-	-	-
	Engineering Physics	2	2	1	2	1	-	-	-	-	-	-	-	-	-	-	-
	Engineering Chemistry	2	1	1	1	2	-	-	-	-	-	-	-	-	-	-	-
	Programming in C	3	3	3	3	2	1	-	-	3	2	3	3	-	-	-	-
	PRACTICALS																
II	**THEORY**																
	Ordinary Differential Equations And Transform Techniques	3	2	-	1	3	2	-	-	-	-	-	3	-	-	-	-
	Physics for Electrical Sciences	2	2	1	1	1	-	-	-	-	-	-	-	-	-	-	-
	Environmental Science and Sustainability	-	2	3	-	-	-	3	3	-	-	-	-	-	-	-	
	Electrical Circuit Analysis	2.8	2.8	2.2	2.8	2.2	-	-	-	3	-	3	2	2.6	-	2.6	2.6
	PRACTICALS																
	Electrical Circuit Laboratory	2.8	2.8	2.2	2.8	2.2	-	-	-	3	-	3	2	2.6	-	2.6	2.6
III	**THEORY**																
	Probability and Statistics	3	3	2	3	2	-	-	-	-	-	-	3	-	-	-	-
	Electromagnetic Theory	3	2	1	1	-	-	1	1	-	-	-	1	2	-	1	-
	Digital Electronics	3	3	3	1.5	3	-	-	-	-	-	-	1	3	-	1	1.5
	Analog Electronics	2	2.3	2.67	2.3	2	-	-	-	-	-	-	1	3	-	1	1.3
	PRACTICALS																
	Analog and Digital Electronics Laboratory	-	3	2.8	3	3	-	-	-	-	-	3	-	2	-	1	2
IV	**THEORY**																
	Electrical	3	3	1	3	3	-	-	2	-	-	2	2	3	1	3	3

	Machines - I																
	Control Systems	3	2	2	-	1	-	-	-	-	-	-	-	2.2	2.2	3	1
	Microprocessorsa nd Microcontrollers	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
	Transmission and Distribution	2.4	2.25	-	-	-	2	1.75	-	-	-	-	-	2	3	1	-
	PRACTICALS																
	Microprocessors and Microcontrollers Lab	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
	THEORY																
V	Electrical Machines - II	2.8	-	3	2.8	1	2.6	-	2	-	-	-	-	-	3	1.5	3
	Power Electronics	3	2	2	-	1	-	-	2	-	-	-	-	2	3	2	1
	Power System Analysis	3	2.6	2.4	1.8	1.4	-	-	-	1	-	-	1	1	1	1.4	1
	PRACTICALS																
	Electrical Machines Lab	3	3	1	1	2	1		1.5	1			2.8	3	3	1.6	-
	Power Electronics Lab	2	2	2	3	3	-	-	-	3	1	-	-	2	3	2	2
	THEORY																
	Protection and Switchgear	2.4	2.6	2	1.33	1.7	-	1.5	-	-	-	1	-	3	2.8	2	1.8
	Power System Operation and Control	3	2.6	1.8	1.6	2	1	1	-	-	-	3	-	3	3	2.2	2.86
VI	Measurement and Instrumentation	3	2	3	2	3	2	-	2	-	3	-	3	3	3	3	3
	PRACTICALS																
	Control and Instrumentation Lab	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3	3
	THEORY																
VII	High Voltage Engineering	3	2.2	2.4	2.4	2.2	2	2.4	2.6	1.6	1.4	2	2	2.4	2.4	2	2
	Electrical Machine Design	2	2	2.33	1	1	2	-	1	1	-	2	3	3	2	2	-
	PRACTICALS																
	Power System Lab	3	3	3	2	1	1.6	-	-	1	1	-	1.6	3	1	1	2

VIII	**THEORY**																
	Human Values and Ethics																
	PRACTICALS																
	Project Work																

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS 2023
B. E. ELECTRICAL AND ELECTRONICS ENGINEERING (PART TIME)
CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI I TO VIII SEMESTERS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTMA3151	Matrices and Calculus	BSC	3	1	0	4	4
2.	PTPH3151	Engineering Physics	BSC	3	0	0	3	3
3.	PTCY3151	Engineering Chemistry	BSC	3	0	0	3	3
4.	PTGE3153	Programming in C	ESC	2	0	4	6	4
			TOTAL	**11**	**1**	**4**	**16**	**14**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTMA3251	Ordinary Differential Equations and Transform Techniques	BSC	3	1	0	4	4
2.	PTPH3251	Physics for Electrical Sciences	BSC	3	0	0	3	3
3.	PTCY3251	Environmental Science and Sustainability	BSC	2	0	0	2	2
4.	PTEE3201	Electrical Circuit Analysis	PCC	3	0	0	3	3
PRACTICALS								
5.	PTEE3211	Electrical Circuit Laboratory	PCC	0	0	4	4	2
			TOTAL	**11**	**1**	**4**	**16**	**14**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTMA3352	Probability and Statistics	BSC	3	1	0	4	4
2.	PTEE3301	Electromagnetic Theory	PCC	3	0	0	3	3
3.	PTEE3302	Digital Electronics	PCC	3	0	0	3	3
4.	PTEE3303	Analog Electronics	PCC	3	0	0	3	3
PRACTICALS								
5.	PTEE3311	Analog and Digital Electronics Laboratory	PCC	0	0	4	4	2
			TOTAL	**12**	**1**	**4**	**17**	**15**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTEE3401	Electrical Machines - I	PCC	3	0	0	3	3
2.	PTEE3402	Control Systems	PCC	3	0	0	3	3
3.	PTEE3403	Microprocessors and Microcontrollers	PCC	3	0	0	3	3
4.	PTEE3404	Transmission and Distribution	PCC	3	0	0	3	3
PRACTICALS								
5.	PTEE3411	Microprocessors and Microcontrollers Laboratory	PCC	0	0	4	4	2
			TOTAL	**12**	**0**	**4**	**16**	**14**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTEE3501	Electrical Machines - II	PCC	3	0	0	3	3
2.	PTEE3502	Power Electronics	PCC	3	0	0	3	3
3.	PTEE3503	Power System Analysis	PCC	3	0	0	3	3
PRACTICALS								
4.	PTEE3511	Electrical Machines Laboratory	PCC	0	0	4	4	2
5.	PTEE3512	Power Electronics Laboratory	PCC	0	0	4	4	2
			TOTAL	**9**	**0**	**8**	**17**	**13**

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTEE3601	Protection and Switchgear	PCC	3	0	0	3	3
2.	PTEE3602	Power System Operation and Control	PCC	3	0	0	3	3
3.	PTEE3603	Measurement and Instrumentation	PCC	3	0	0	3	3
4.		Professional Elective - I	PEC	3	0	0	3	3
PRACTICALS								
5.	PTEE3611	Control and Instrumentation Laboratory	PCC	0	0	4	4	2
			TOTAL	**12**	**0**	**4**	**16**	**14**

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTEE3701	High Voltage Engineering	PCC	3	0	0	3	3
2.	PTEE3702	Electrical Machine Design	PCC	3	0	0	3	3
3.		Professional Elective - II	PEC	3	0	0	3	3
4.		Professional Elective - III	PEC	3	0	0	3	3
PRACTICALS								
5.	PTEE3711	Power System Laboratory	PCC	0	0	4	4	2
			TOTAL	**12**	**0**	**4**	**16**	**14**

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PTGE3851	Human Values and Ethics	HSMC	2	0	0	2	2
2.		Professional Elective - IV	PEC	3	0	0	3	3
3.		Professional Elective - V	PEC	3	0	0	3	3
4.		Professional Elective - VI	PEC	3	0	0	3	3
PRACTICALS								
5.	PTEE3811	Project Work	EEC	0	0	6	6	3
			TOTAL	**11**	**0**	**6**	**17**	**14**

TOTAL CREDITS : 112

POWER ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PTEE3001	Under Ground Cable Engineering	PEC	3	0	0	3	3
2.	PTEE3002	Substation Engineering and Automation	PEC	3	0	0	3	3
3.	PTEE3003	HVDC and FACTS	PEC	3	0	0	3	3
4.	PTEE3004	Energy Management and Auditing	PEC	3	0	0	3	3
5.	PTEE3005	Power System Transients	PEC	3	0	0	3	3
6.	PTEE3006	Smart Grid	PEC	3	0	0	3	3
7.	PTEE3007	Restructured Power Market	PEC	3	0	0	3	3
8.	PTEE3008	Design and Modelling of Renewable Energy Systems	PEC	3	0	0	3	3
9.	PTEE3009	Grid Integrating Techniques and Challenges	PEC	2	0	2	4	3
10.	PTEE3010	Sustainable and Environmental Friendly HV Insulation System	PEC	3	0	0	3	3

CONVERTERS AND DRIVES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PTEE3011	Electrical Machines-III	PEC	2	0	2	4	3
2.	PTEE3012	Analysis of Electrical Machines	PEC	2	0	2	4	3
3.	PTEE3013	Multilevel Power Converters	PEC	2	0	2	4	3
4.	PTEE3014	Electrical Drives	PEC	2	0	2	4	3
5.	PTEE3015	SMPS and UPS	PEC	2	0	2	4	3
6.	PTEE3016	Power Electronics for Renewable Energy Systems	PEC	2	0	2	4	3
7.	PTEE3017	Control of Power Electronics Circuits	PEC	2	0	2	4	3
8.	PTEE3018	Power Quality	PEC	3	0	0	3	3

EMBEDDED SYSTEMS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PTEE3019	Embedded System Design	PEC	2	0	2	4	3
2.	PTEE3020	Embedded C-Programming	PEC	2	0	2	4	3
3.	PTEE3021	Embedded Processors	PEC	2	0	2	4	3
4.	PTEE3022	Embedded Control for Electric Drives	PEC	2	0	2	4	3
5.	PTEE3023	Smart System Automation	PEC	2	0	2	4	3
6.	PTEE3024	Embedded System for Automotive Applications	PEC	2	0	2	4	3
7.	PTEE3025	VLSI Design	PEC	2	0	2	4	3
8.	PTEE3026	MEMS and NEMS	PEC	2	0	2	4	3
9.	PTEE3027	Digital Signal Processing	PEC	2	0	2	4	3
10.	PTEE3028	PLC Programming	PEC	3	0	0	3	3
11.	PTEE3029	Big Data Analytics	PEC	2	0	2	4	3

ELECTRIC VEHICLE TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PTEE3030	Electric Vehicle Architecture	PEC	3	0	0	3	3
2.	PTEE3031	Design of Motor and Power Converters for Electric Vehicles	PEC	2	0	2	4	3
3.	PTEE3032	Electric Vehicle Design, Mechanics and Control	PEC	2	0	2	4	3
4.	PTEE3033	Design of Electric Vehicle Charging System	PEC	2	0	2	4	3
5.	PTEE3034	Testing of Electric Vehicles	PEC	2	0	2	4	3
6.	PTEE3035	Grid Integration of Electric Vehicles	PEC	3	0	0	3	3
7.	PTEE3036	Intelligent control of Electric Vehicles	PEC	2	0	2	4	3
8.	PTEE3037	Energy Storage Systems	PEC	3	0	0	3	3
9.	PTEE3038	Hybrid Energy Technology	PEC	3	0	0	3	3

MODERN CONTROL AND INDUSTRIAL AUTOMATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PTEE3039	Industrial Automation Systems	PEC	3	0	0	3	3
2.	PTEE3040	Robotics And Automation	PEC	3	0	0	3	3
3.	PTEE3041	Model Based Control	PEC	3	0	0	3	3
4.	PTEE3042	Non Linear Control	PEC	3	0	0	3	3
5.	PTEE3043	System Identification	PEC	3	0	0	3	3
6.	PTEE3044	Adaptive Control	PEC	3	0	0	3	3
7.	PTEE3045	Process Modeling and Simulation	PEC	3	0	0	3	3
8.	PTEE3046	Computer Control of Processes	PEC	3	0	0	3	3
9.	PTEE3047	Flight Instrumentation	PEC	3	0	0	3	3

SUMMARY

SL. NO.	SUBJECT AREA	CREDITS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1.	HSMC								2	2
2.	BSC	10	9	4						23
3.	ESC	4								4
4.	PCC		5	11	14	13	11	8		62
5.	PEC						3	6	9	18
6.	OEC									
7.	EEC								3	3
	Total	14	14	15	14	13	14	14	14	112

HUMANITIES AND SOCIAL SCIENCE INCLUDED MANAGEMENT COURSES (HSMC)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PTGE3851	Human Values and Ethics	HSMC	2	0	0	2	2
							Total	**2**

BASIC SCIENCE COURSES (BSC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PTMA3151	Matrices and Calculus	BSC	3	1	0	4	4
2	PTPH3151	Engineering Physics	BSC	3	0	0	3	3
3	PTCY3151	Engineering Chemistry	BSC	3	0	0	3	3
4	PTMA3251	Ordinary Differential Equations And Transform Techniques	BSC	3	1	0	4	4
5	PTPH3251	Physics for Electrical Sciences	BSC	3	0	0	3	3
6	PTCY3251	Environmental Science and Sustainability	BSC	2	0	0	2	2
7	PTMA3352	Probability and Statistics	BSC	3	1	0	4	4
							Total	**23**

ENGINEERING SCIENCE COURSES (ESC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PTGE3153	Programming in C	ESC	2	0	4	6	4
							Total	**4**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PTEE3811	Project Work	EEC	0	0	6	6	3
							Total	**3**

PROFESSIONAL CORE COURSES (PCC)

S.No.	Course Code	Course Title	Periods per week			Credits	Semester
			L	T	P		
1.	PTEE3201	Electrical Circuit Analysis	3	0	0	3	II
2.	PTEE3211	Electrical Circuit Laboratory	0	0	4	2	II
3.	PTEE3301	Electromagnetic Theory	3	0	0	3	III
4.	PTEE3302	Digital Electronics	3	0	0	3	III
5.	PTEE3303	Analog Electronics	3	0	0	3	III
6.	PTEE3311	Analog and Digital Electronics Laboratory	0	0	4	2	III
7.	PTEE3401	Electrical Machines - I	3	0	0	3	IV
8.	PTEE3402	Control Systems	3	0	0	3	IV
9.	PTEE3403	Microprocessors and Microcontrollers	3	0	0	3	IV
10.	PTEE3404	Transmission and Distribution	3	0	0	3	IV
11.	PTEE3411	Microprocessors and Microcontrollers Laboratory	0	0	4	2	IV
12.	PTEE3501	Electrical Machines - II	3	0	0	3	V
13.	PTEE3502	Power Electronics	3	0	0	3	V
14.	PTEE3503	Power System Analysis	3	0	0	3	V
15.	PTEE3511	Electrical Machines Laboratory	0	0	4	2	V
16.	PTEE3512	Power Electronics Laboratory	0	0	4	2	V
17.	PTEE3601	Protection and Switchgear	3	0	0	3	VI
18.	PTEE3602	Power System Operation and Control	3	0	0	3	VI
19.	PTEE3603	Measurements and Instrumentation	3	0	0	3	VI
20.	PTEE3611	Control and Instrumentation Laboratory	0	0	4	2	VI
21.	PTEE3701	High Voltage Engineering	3	0	0	3	VII
22.	PTEE3702	Electrical Machine Design	3	0	0	3	VII
23.	PTEE3711	Power System Laboratory	0	0	4	2	VII
					Total	**62**	

PTMA3151 **MATRICES AND CALCULUS** **L T P C**
3 1 0 4

UNIT I MATRICES (9+3)

Eigen values and Eigen vectors of a real matrix – Properties of Eigen values - Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

UNIT II FUNCTIONS OF SEVERAL VARIABLES (9+3)

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions - Taylor‘s formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS (9+3)

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of integrals by using Beta and Gamma functions – Error functions.

UNIT IV MULTIPLE INTEGRALS (9+3)

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

UNIT V VECTOR CALCULUS (9+3)

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green‘s theorem, Stoke's and Gauss divergence theorems – Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Use the matrix algebra methods for solving practical problems.
CO2: Use differential calculus ideas on several variable functions.
CO3: Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO4: Apply multiple integral ideas in solving areas and volumes problems.
CO5: Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.
3. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2013.

REFERENCES:

1. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

MAPPING OF COs WITH POs AND PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	1	2	-	-	-	-	-	3
CO2	3	2	-	1	1	2	-	-	-	-	-	3
CO3	3	2	-	1	1	2	-	-	-	-	-	3
CO4	3	2	-	1	1	2	-	-	-	-	-	3
CO5	3	2	-	1	1	2	-	-	-	-	-	3
Avg.	**3**	**2**	**-**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**3**

- 1' = Low; '2' = Medium; '3' = High

.

PTPH3151 ENGINEERING PHYSICS **L T P C**
3 0 0 3

UNIT I MECHANICS OF MATERIALS 9

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

UNIT II OSCILLATIONS, SOUND AND THERMAL PHYSICS 9

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

UNIT III OPTICS AND LASERS 9

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

UNIT IV QUANTUM MECHANICS 9

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

UNIT V CRYSTAL PHYSICS 9

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students shall be

CO1: Understand the important mechanical properties of materials

CO2: Express the knowledge of oscillations, sound and applications of Thermal Physics

CO3: Know the basics of optics and lasers and its applications

CO4: Understand the basics and importance of quantum physics.

CO5: Understand the significance of crystal physics.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.
3. K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications. Springer, 2012

MAPPING OF COs WITH POs AND PSOs

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	1	1	2	1	-	-	-	-	-	-	-
CO2	2	2	1	2	1	-	-	-	-	-	-	-
CO3	2	2	2	2	1	-	-	-	-	-	-	-
CO4	2	1	1	1	1	-	-	-	-	-	-	-
CO5	2	2	2	2	1	-	-	-	-	-	-	-
Avg.	**2**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

- 1’ = Low; ‘2’ = Medium; ‘3’ = High

PTCY3151 ENGINEERING CHEMISTRY L T P C
3 0 0 3

UNIT I POLYMER CHEMISTRY 9

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension.
Engineering Plastics: Polyamides, Polycarbonates and Polyurethanes. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring

UNIT II NANOCHEMISTRY 9

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials - medicine, agriculture, electronics and catalysis.

UNIT III CORROSION SCIENCE 9

Electrochemical cell, redox reaction, electrode potential - oxidation and reduction potential. Measurement and its application Introduction to corrosion - chemical and electrochemical corrosions-mechanism of electrochemical and galvanic corrosions-concentration cell corrosion-passivity-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Corrosion control-material selection and design-electrochemical protection- sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

UNIT IV ENERGY SOURCES 9

Batteries - Characteristics - types of batteries – primary battery (dry cell), secondary battery (lead acid, lithium-ion-battery)- emerging batteries – nickel-metal hydride battery, aluminum air battery, batteries for automobiles and satellites - Fuel cells (Types) – H_2-O_2 fuel cell - Supercapacitors-Types and Applications, Renewable Energy: Solar- solar cells, DSSC

UNIT V WATER TECHNOLOGY 9

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, calgon and carbonate treatment. External conditioning - demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration and disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.
CO2: To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
CO3: To recognize and apply basic knowledge on suitable corrosion protection technique for practical problems.
CO4: To recognize different storage devices and apply them for suitable applications in energy sectors.
CO5**:** To demonstrate the knowledge of water and their quality in using at different industries.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Text book of Engineering Chemistry”, Chand Publications, 2004.

REFERENCE BOOKS:
1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.

MAPPING OF Cos WITH POs AND PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	-	-	-	-	-	-	-	-	-
CO2	2	1		2	2	-	-	-	-	-	-	-
CO3	2	2	1	1	2	-	-	-	-	-	-	-
CO4	2	-	2	-	2	-	-	-	-	-	-	-
CO5	3	2	2	1	1	-	-	-	-	-	-	-
Avg.	**2**	**1**	**1**	**1**	**2**	-	-	-	-	-	-	-

- 1’ = Low; ‘2’ = Medium; ‘3’ = High

PTGE3153 **PROGRAMMING IN C** **LT P C**
2 0 4 4

UNIT I BASICS OF C PROGRAMMING 6+12

Introduction to programming paradigms –- Structure of C program - C programming: Data Types - Constants - Keywords - Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements - Decision making statements - Switch statement.

PRACTICALS:
- Designing programs with algorithms/flowchart
- Programs for i/o operations with different data types
- Programs using various operators
- Programs using decision making and branching statements

UNIT II LOOP CONTROL STATEMENTS AND ARRAYS 6+12

Iteration statements: For, while, Do-while statements, nested loops, break & continue statements - Introduction to Arrays: Declaration, Initialization - One dimensional array -Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions - array of strings

PRACTICALS:
- Programs using for, while, do-while loops and nested loops.
- Programs using arrays and operations on arrays.
- Programs implementing searching and sorting using arrays
- Programs implementing string operations on arrays

UNIT III FUNCTIONS AND POINTERS 6+12

Modular programming - Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions - Pointers - Pointer increment, Pointer arithmetic - Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation with *malloc/calloc*

PRACTICALS:
- Programs using functions
- Programs using recursion
- Programs using pointers & strings with pointers
- Programs using Dynamic Memory Allocation

UNIT IV STRUCTURES AND UNION 6+12

Storage class, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef , bit fields , enumerated data types, Union.

PRACTICALS:

- Programs using Structures
- Programs using Unions
- Programs using pointers to structures and self-referential structures

UNIT V MACROS AND FILE PROCESSING 6+12

Preprocessor directives – Simple and Conditional macros with and without parameters - Files - Types of file processing: Sequential and Random access – File operations – read, write & seek.

PRACTICALS:

- Programs using pre-processor directives & macros
- Programs to handle file operations
- Programs to handle file with structure

COURSE OUTCOMES:

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

CO1: Write simple C programs using basic constructs.
CO2: Design searching and sorting algorithms using arrays and strings.
CO3: Implement modular applications using Functions and pointers.
CO4: Develop and execute applications using structures and Unions.
CO5: Solve real world problem using files.

TOTAL PERIODDS: 90 (30+60)

TEXT BOOKS:

1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCE BOOKS:

1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
2. Ashok N Kamthane, Programming in C, Pearson, Third Edition, 2020
3. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
4. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C"' McGraw-Hill Education, 1996.
6. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

MAPPING OF Cos WITH POs AND PSOs

CO	PO1	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	2	1	-	-	-	2	-	3
CO2	3		3	3	1	1	-	-	-	-	-	-
CO3	3	3	3	3	2	-	-	-	3	-	-	-
CO4	3	3	3	3	2	-	-	-	3	-	3	3
CO5	3	3	3	3	3	2	-	-	-	-	3	3
Avg.	**3**	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**3**	**2**	**3**	**3**

- 1' = Low; '2' = Medium; '3' = High

PTMA3251 ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES **L T P C 3 1 0 4**

UNIT I ORDINARY DIFFERENTIAL EQUATIONS (9+3)

Homogeneous linear ordinary differential equations of second order, linearity principle, general solution-Particular integral – Operator method – Solution by variation of parameters – Method of undetermined coefficients – Homogenous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS (9+3)

Existence theorem – Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties – Shifting theorems – Transforms of derivatives and integrals – Transform of periodic functions – Initial and Final value theorem - Inverse Laplace – Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES (9+3)

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT IV FOURIER TRANSFORMS (9+3)

Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transform of elementary functions – Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS (9+3)

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and final value theorems – Formation of difference equation – Solution of difference equation using Z – transform.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Solve higher order ordinary differential equations which arise in engineering applications.
CO2: Apply Laplace transform techniques in solving linear differential equations.
CO3: Apply Fourier series techniques in engineering applications.
CO4: Understand the Fourier transforms techniques in solving engineering problems.
CO5: Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

MAPPING OF Cos WITH POs AND PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	3	3	-	-	-	-	-	3
CO2	3	2	-	2	3	3	-	-	-	-	-	3
CO3	3	2	-	2	3	2	-	-	-	-	-	3
CO4	3	2	-	1	3	3	-	-	-	-	-	3
CO5	3	2	-	1	3	2	-	-	-	-	-	3
Avg.	**3**	**2**	**-**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**3**

1-low, 2-medium, 3-high

PTPH3251 PHYSICS FOR ELECTRICAL SCIENCES L T P C
3 0 0 3

UNIT I ELECTRICAL PROPERTIES OF MATERIALS 9

Classical free electron theory – Expression for electrical conductivity–Thermal conductivity, expression Wiedemann – Franz law – Quantum free electron theory – Degenerate energy states– Density of States – Fermi-Dirac statistics – Conduction electron density – Electron in a periodic potential – Energy bands in solids – Conductors – Semiconductors – Insulators – tight-binding approximation- Electron effective mass– the concept of hole.
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UNIT II SEMICONDUCTORS AND TRANSPORT PHYSICS 9

Intrinsic Semiconductors – Energy band diagram – direct and indirect bandgap semiconductors– Carrier concentration in intrinsic semiconductors – Determination of band gap – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility, diffusion and carrier lifetime – Hall effect –devices and sensors – Ohmic contacts – Peltier coolers – Schottky diode – solar cell

.UNIT III DIELECTRIC AND MAGNETIC PROPERTIES OF MATERIALS 9

Electric Dipole moment and polarization vector, Polarization mechanisms: electronic, ionic, orientational, interfacial and total polarization – dielectric constant and dielectric loss – dielectric strength and insulation – Applications of dielectric materials. Origin of Magnetism – atomic magnetic moments – Bohr magneton- magnetic materials: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism – Ferromagnetism – origin and exchange interaction – Domain theory –saturation magnetization and curie temperature-domain walls and motion – Hysteresis –- soft and hard magnetic materials – GMR effect - GMR materials – Applications – Magnetic data storage.
.

UNITI V OPTICAL PROPERTIES OF MATERIALS 9

Light waves in a homogeneous medium – refractive index – dispersion: refractive index-wavelength behavior – group velocity and group index – Fresnel's equations: reflection and transmission coefficients, Absorption, emission and scattering of light – Luminescence – Phosphors LED's : Principle and working – white LED, Laser diode – optical Amplifiers - Organic LED and Plasma light emitting devices, LCD - Homojunction and Hetero junction laser diodes. Optical data storage techniques(CD, DVD and Blue-ray disc,

UNIT V NANODEVICES 9

Electron density in a conductor – Significance between Fermi energy and volume of the material –Quantum confinement – Quantum structures – Density of states for quantum wells, wires and dots –Band gap of nanomaterials –Tunneling – Single electron phenomena – Single electron Transistor. The conductivity of metallic nanowires – Ballistic transport – Quantum resistance and conductance –Carbon nanotubes: Properties and applications Transporters – Spintronic devices and application.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completing the above subject, students will have

CO1: Knowledge of the electrical properties of materials

CO2: Acquire an adequate understanding of semiconductor physics and the functioning of semiconductor devices

CO3: Come to have firm knowledge of the dielectric and magnetic properties of materials and their applications

CO4: Understand the optical properties of materials and working principles of various optical devices

CO5: Appreciate the importance of nanotechnology, the physics of nanodevices, low-dimensional structures and their applications

REFERENCES

1. W.D.Callitser and D.G. Rethwish. Materials Science and Engineering. John Wiley & Sons, 2014.
2. S.O.Kasap Principles of Electronic Materials and Devices. McGraw Hill Education, 2017.
3. R.F.Pierret Semiconductor Device Fundamentals. Pearson, 2006.
4. N.Garcia, A. Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.
5. G.W. Hanson, Fundamentals of Nanoelectronics. Pearson Education, 2009.
6. J. Wilson and J.F.B. Hawkes. Optoelectronics. Pearson Education, 2018.
7. N. Gershenfeld. The Physics of Information Technology. Cambridge University Press, 2011.

MAPPING OF Cos WITH POs AND PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	1	-	-	-	-	-	-	-
CO2	2	2	1	1	1	-	-	-	-	-	-	-
CO3	2	2	1	2	1	-	-	-	-	-	-	-
CO4	2	2	2	1	1	-	-	-	-	-	-	-
CO5	2	1	2	2	1	-	-	-	-	-	-	-
Avg.	**2**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

- 1-low, 2-medium, 3-high

PTCY3251 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY LT P C
2 0 0 2

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, 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.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

UNIT III RENEWABLE SOURCES OF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocolsSustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cyclescarbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socioeconomical and technological change.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1 To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

CO2 To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.

CO3 To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

CO4 To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

CO5 To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXTBOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers , 2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Pearson; 1st edition, 2011.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering; International edition, 2015.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES :

1. Daniel J. Sherman, David R. Montgomery, " Environmental Science and Sustainability", W. W. Norton, Incorporated, 2nd edition, 2023.
2. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', B.S Publications, 2010.
3. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publications, Mumbai, 2001.
4. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
5. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 3rd edition, 2015.
6. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

MAPPING OF Cos WITH POs AND PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							3					
CO2		2	3									
CO3			2				3					
CO4							3	3				
CO5			3				2	2				
Avg	**-**	**2**	**3**	**-**	-	-	**3**	**3**	-	**-**	**-**	-

- 1-low, 2-medium, 3-high

PTEE3201	ELECTRICAL CIRCUIT ANALYSIS	LT P C
		3 0 0 3

UNIT I INTRODUCTION TO DC AND AC CIRCUITS 9

Types of sources, Independent and Dependent; Ohm's law, Kirchhoff's laws. Mesh, Node, super mesh and Super node analysis.

AC Circuits: Basic definitions; phasors and complex representation; RMS, Average value, form factor, peak factor- AC signals ;solution of RLC networks; power, energy relations and power factor calculations. Mesh and Nodal Analysis.

UNIT II NETWORK REDUCTION TECHNIQUES AND NETWORK THEOREMS 9

Series parallel circuits; star and delta transformation; Superposition, Rreciprocity, Compensation, Thevenin's, Norton's and Maximum Power Transfer Theorems; Analysis with dependent and independent sources-Application to DC and AC networks.

UNIT III SOLUTION OF FIRST AND SECOND ORDER NETWORKS 9

Solution of first and second order differential equations for Series and Parallel R-L, R-C, R-L-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response. Application of Laplace transforms and inverse Laplace transforms for electrical circuits.

UNIT IV RESONANCE AND TWO PORT NETWORKS 9

Resonant circuits-series, parallel, series-parallel circuits-effect of variation of Q on resonance. Relations between circuit parameters- Q, resonant frequency and bandwidth.

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.

UNIT V THREE PHASE CIRCUITS 9

Three phase balanced / unbalanced circuits, phase sequence — analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced loads – phasor diagram of voltages and currents – power and power factor measurements in three phase circuits.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 the concepts of electrical circuits, fundamental laws and theorems.
CO2 the natural response and the forced response to excitations of the first and second order networks.
CO3 the concepts of complex frequency and its use in relating the forced response and natural response.
CO4 magnetic coupling and two port networks.
CO5 the concepts of poly phase circuits.

TEXT BOOKS:

1. M Nahvi I J A Edminster "Electric Circuits"; Schaum's outline series , Tata McGraw Hill, 4th Edition, 2009
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Fifth Edition,McGraw Hill, 2013.
3. David A Bell ," Electric circuits ", Oxford University Press, 2011.

REFERENCES:

1. Mehdi Rahmani-Andebili, DC Electrical Circuit Analysis , Practice Problems, Methods, and Solution, Springer,2020.
2. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, Engineering Circuit Analysis", Tata McGraw Hill publishers, New Delhi, 2013.
3. Sudhakar. A, Shyammohan. S.P Circuits and Networks-Analysis and Synthesis. Tata McGraw Hill publishers, 5th Edition, 2015.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	-	-	-	-	-	-	3	3	-	3	2
CO2	3	3	3	3	2	-	-	-	-	-	-	2	2	-	2	3
CO3	2	3	2	3	3	-	-	-	-	-	-	1	3	-	3	2
CO4	3	2	2	3	2	-	-	-	-	-	-	3	2	-	2	3
CO5	3	3	2	2	2	-	-	-	-	-	-	1	3	-	3	3
Avg	2.8	2.8	2.2	2.8	2.2	-	-	-	-	-	-	2	2.6	-	2.6	2.6

- 1-low, 2-medium, 3-high

PTEE3211 **ELECTRICAL CIRCUIT LABORATORY** **L T P C**
0 0 4 2

LIST OF EXPERIMENT

1. Experimental verification of Kirchhoff's voltage and current laws.
2. Experimental verification of network theorems (Theveninm's, Norton's, Superposition and maximum power transfer Theorem, reciprocity theorem).
4. Experimental determination of time constant of series RL, RC circuits.
5. Experimental determination of frequency response of RLC circuits.
6. Design and Simulation of series resonant circuits.
7. Design and Simulation of parallel resonant circuits.
8. Simulation of three phase balanced and unbalanced star & delta connected networks.
9. Experimental determination of power in a three phase circuits by two-watt meter method.
10. Measurement of power and power factor using two watt meter method.
11. Steady state analysis of series RL, RC and RLC circuits

TOTAL : 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to understand and verify

CO1 the concepts of electrical circuits, fundamental laws and theorems.
CO2 the natural response and the forced response to excitations of the first and second order networks.
CO3 the concepts of complex frequency and its use in relating the forced response and natural response.
CO4 the concepts of resonant.
CO5 the concepts of poly phase circuits and power measurement.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	2	-	-	-	3	-	3	3	3	-	3	2
CO2	3	3	3	3	2	-	-	-	3	-	3	2	2	-	2	3
CO3	2	3	2	3	3	-	-	-	3	-	3	1	3	-	3	2
CO4	3	2	2	3	2	-	-	-	3	-	3	3	2	-	2	3
CO5	3	3	2	2	2	-	-	-	3	-	3	1	3	-	3	3
Avg	2.8	2.8	2.2	2.8	2.2	-	-	-	3	-	3	2	2.6	-	2.6	2.6

- 1-low, 2-medium, 3-high

PTMA3352 PROBABILITY AND STATISTICS LT P C
3 1 0 4

UNIT I ONE-DIMENSIONAL RANDOM VARIABLES (9+3)
Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a random variable.

UNIT II TWO-DIMENSIONAL RANDOM VARIABLES (9+3)
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III ESTIMATION THEORY (9+3)
Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

UNIT IV TESTS OF SIGNIFICANCE (9+3)
Type I and Type II errors – Tests for single mean, proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances –χ^2 test for goodness of fit – Independence of attributes.

UNIT V DESIGN OF EXPERIMENTS (9+3)
Completely Randomized Design – Randomized Block Design – Latin Square Design – 2^2 factorial design.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
On completion of the course, the students will be able to:
CO1: To analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
CO2: To be familiar with some of the commonly encountered two dimensional random variables and be equipped for a possible extension to multivariate analysis.
CO3: To apply the basic principles of the estimation theory to practical situations.
CO4: To demonstrate the knowledge of large / small sample theory in statistical inference.
CO5: To obtain a better understanding of the importance of the methods in modern industrial processes.

TEXT BOOKS:

1. Irwin Miller and Marylees Miller "John E. Freund's Mathematical Statistics with applications", Pearson India Education, Asia, 8th Edition, 2014.
2. Devore, J.L. "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 8th Edition, 2011.

REFERENCES:

1. Milton, J.S. and Arnold, J.C. "Introduction to Probability and Statistics", Tata McGraw Hill, New Delhi, 4th Edition, 3rd Reprint, 2008.
2. Ross, S.M. "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, New Delhi, 5th Edition, 2014.
3. Spiegel, M.R., Schiller, J., Srinivasan, R.A. and Goswami, D. "Schaum's Outline of Theory and Problems for Probability and Statistics", McGraw Hill Education, 3rd Edition, Reprint, 2017.
4. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K. "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2011.

MAPPING OF Cos WITH POs AND PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	-	-	-	-	-	-	3
CO2	3	3	2	3	2	-	-	-	-	-	-	3
CO3	3	3	2	3	2	-	-	-	-	-	-	3
CO4	3	3	2	3	2	-	-	-	-	-	-	3
CO5	3	3	2	3	2	-	-	-	-	-	-	3
Avg.	3	3	2	3	2	-	-	-	-	-	-	3

- 1-low, 2-medium, 3-high

PTEE3301 ELECTROMAGNETIC THEORY LT P C
3 0 0 3

UNIT I ELECTROSTATICS I 9
Sources, effects and exposure limits of electromagnetic fields, Coordinate systems, Vector calculus- Gradient, Divergence and Curl, theorems and applications, Coulomb's Law – Electric field intensity – Electric Field due to discrete and continuous charges – Gauss's law and applications.

UNIT II ELECTROSTATICS II 9
Electric potential – Electric fields and equipotential plots, Uniform and Non-Uniform fields, Utilization factor – Electric field in free space, conductors, dielectric -Dielectric polarization – Dielectric strength , Electric fields in multiple dielectrics – Boundary conditions, capacitance, Energy density, Poisson's and Laplace's equations – solutions by Direct Integration method, Applications.

UNIT III MAGNETOSTATICS 9
Lorentz force, magnetic field intensity (H) — Biot– Savart's Law - Ampere's Circuit Law and practical applications— 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 and mutual 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) – Time varying potential – Relation between field theory and circuit theory, Practical Applications.

UNIT V ELECTROMAGNETIC WAVES 9
Electromagnetic Wave Generation and Wave equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossless and lossy dielectrics, conductors-skin depth, Poynting vector, Plane wave reflection and refraction – Standing Wave, Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 apply the basic mathematical concepts related to electromagnetic fields and identify the electromagnetic sources and their effects.
CO2 compute and analyze electrostatic fields with practical applications.
CO3 compute and analyze magneto static fields with practical applications.
CO4 explain different methods of emf generation and Maxwell's equations.
CO5 explain the concept of electromagnetic waves and characterizing parameters.

TEXT BOOKS:

1.Mathew N. O. Sadiku, S.V.Kulkarni,'Principles of Electromagnetics', 6th Edition, Oxford University Press, 2015, Asian Edition.
2. Bhag Singh Guru and Hüseyin R. Hiziroglu "Electromagnetic field theory fundamentals",Cambridge University Press; Second Revised Edition, 2009.
3.Ashutosh Pramanik, 'Electromagnetism – Theory and Applications', PHI Learning Private Limited, New Delhi, Second Edition-2008.

REFERENCES:

1. Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Third Edition (Schaum's Outline Series), Tata McGraw Hill, 2010
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', Tata McGraw Hill, 8th Revised edition, 2012
3. Kraus and Fleisch, 'Electromagnetics with Applications', McGraw Hill International Editions,Fifth Edition, 2017.
4. Karl E .Lonngren, Sava V. Savov, Randy J. Jost, ' Fundamentals of Electromagnetics with MATLAB", 2nd Edition, PHI Learning Pvt. Ltd., 2009.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	-	-	1	1	-	-	-	1	2	-	1	-
CO2	3	2	1	2	-	-	1	-	-	-	-	1	2	-	1	-
CO3	3	2	1	2	-	-	1	-	-	-	-	1	2	-	1	-
CO4	3	2	1	2	-	-	1	-	-	-	-	1	2	-	1	-
CO5	3	2	1	2	-	-	1	-	-	-	-	1	2	-	1	-
Avg	3	2	1	2	-	-	1	1	-	-	-	1	2	-	1	-

PTEE3302 **DIGITAL ELECTRONICS** **LT P C**
3 0 0 3

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 ARITHMETIC CIRCUITS 9

Logic families : RTL ad DTL circuits ,TTL ECL NMOS and CMOS :Design – Binary adder-4-bit adder IC, Adder/subractor circuit using adder ICs, concept of carry look ahead, hardware multiplier circuit, Design with Multiplexers / Demultiplexers Introduction to VHDL.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 To understand and examine the structure of various number systems and its application in digital design to solve real world problems.

CO2 Analyze and design combinational logic circuits using gates.

CO3 Analyze and design combinational logic circuits using MSI devices.

CO4 Analyze and Design synchronous sequential logic circuits using Flip flops and gates.

CO5 Analyze and Design Asynchronous sequential logic circuits using Latches and gates.

CO6 Design of arithmetic circuits.

TEXT BOOKS:

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

REFERENCES:

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

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	3	-	-	-	-	-	-	1	3	-	1	1
CO2	3	3	3	2	3	-	-	-	-	-	-	1	3	-	1	2
CO3	3	3	3	2	3	-	-	-	-	-	-	1	3	-	1	2
CO4	3	3	3	2	3	-	-	-	-	-	-	1	3	-	1	2
CO5	3	3	3	1	3	-	-	-	-	-	-	1	3	-	1	1
CO6	3	3	3	1	3	-	-	-	-	-	-	1	3	-	1	1
Avg	3	3	3	1.5	3	-	-	-	-	-	-	1	3	-	1	1.5

- 1-low, 2-medium, 3-high

PTEE3303 ANALOG ELECTRONICS LT P C

3 0 0 3

UNIT I ELECTRONIC DEVICES AND THEIR CHARACTERISTICS 9

PN junction diodes – structure, operation and VI characteristics: drift and diffusion current, transient capacitance – BJT: structure, operation and characteristics; biasing; Introduction to JFET, MOSFET and UJT Applications.

UNIT II AMPLIFIER CIRCUITS 9

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

UNIT III OPAMP AND CHARACTERISTICS 9

Ideal OPAMP characteristics, DC characteristics, AC characteristics, Voltage-series feedback: non- inverting amplifier and voltage -shunt feedback : inverting amplifier-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:

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

CO1 understand the structure and underlying semiconductor physics concepts.
CO2 design circuits employing electronic devices.
CO3 understand the characteristics of OPAMP and its internal components.
CO4 analyze, design and implement analog electronic circuits involving OP-AMP.
CO5 analyze, design and implement analog electronic circuits involving timer 555.
CO6 analyze, comprehend and design of analog electronic circuits involving PLL, voltage regulator & other special ICs.

TEXT BOOKS:

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.
4. Donald A Neamen, “Electronic Circuits”, McGraw Hill, edition, 2007.

REFERENCES:

1. Millman and Halkias, " Integrated Electronics", McGraw Hill Publications, 2010.
2. Muhammad H. Rashid, " Linear Integrated Circuits", Cengage Learning, 2014

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	-	-	-	-	-	-	1	3	-	1	1
CO2	2	2	3	2	2	-	-	-	-	-	-	1	3	-	1	1
CO3	2	2	3	2	2	-	-	-	-	-	-	1	3	-	1	1
CO4	2	3	3	3	2	-	-	-	-	-	-	1	3	-	1	2
CO5	2	3	3	3	2	-	-	-	-	-	-	1	3	-	1	2
CO6	2	2	2	2	2	-	-	-	-	-	-	1	3	-	1	1
Avg	2	2.3	2.67	2.3	2	-	-	-	-	-	-	1	3	-	1	1.3

- 1-low, 2-medium, 3-high

PTEE3311 ANALOG AND DIGITAL ELECTRONICS LABORATORY L T P C
0 0 4 2

I Experiments On Basic Electronic Devices:

1. Transistor based RC phase shift oscillator.
2. Transistorized Differential amplifier.

II Experiments using Linear Integrated Circuits (ICs):

3. OPAMP based amplifier circuits.
   i) Inverting amplifier.
   ii) Non-inverting amplifier and voltage follower.
   iii) Differential amplifier and Instrumentation amplifier.
4. Design of Adder-subtractor circuits using Op-Amp
5. Square wave oscillator/ tri-angular wave oscillator.
6. Op-Amp based Wien bridge oscillator.
7. 555 – timer IC based astable multi-vibrator.

III Experiments using Digital Circuits:

8. Design of Adder-subtractor circuits using digital IC.
9. Study of basic digital ICs.
10. Design of combinational logic circuits .
11. Design of synchronous sequential logic circuits.
12. Study of counter ICs.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be

CO1 Ability to design circuits employing electronic devices.
CO2 Analyze, comprehend and design of analog electronic circuits involving OP-AMP.
CO3 Analyze, comprehend and design of analog electronic circuits involving 555 timer.
CO4 Ability to design various oscillators circuits.
CO5 Ability to understand the operation of basic gates and counter ICs Ability
CO6 to design combinational and sequential logic circuits

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	3	3	-	-	-	-	-	-	3	-	2	-	1	2
CO2	-	3	2	3	3	-	-	-	-	-	3	-	2	-	1	2
CO3	-	3	3	3	3	-	-	-	-	-	3	-	2	-	1	2
CO4	-	3	3	3	3	-	-	-	-	-	3	-	2	-	1	2
CO5	-	3	3	3	3	-	-	-	-	-	3	-	2	-	1	2
CO6	-	3	3	3	3	-	-	-	-	-	3	-	2	-	1	2
Avg	-	3	2.8	3	3	-	-	-	-	-	3	-	2	-	1	2

- 1-low, 2-medium, 3-high

PTEE3401 **ELECTRICAL MACHINES - I** **LT P C**
3 0 0 3

UNIT I MAGNETIC FIELDS AND MAGNETIC CIRCUITS 6
Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines.

UNIT II ELECTROMAGNETIC FORCE AND TORQUE 9
B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency.

UNIT III DC MACHINES 8
Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation — Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation - Derivation of back EMF equation,armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

UNIT IV DC MACHINE - MOTORING AND GENERATION 7
Armature circuit equation for motoring and generation, Types of field excitations — separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage and field current. Losses, load testing and back-to-back testing of DC machines.

UNIT V TRANSFORMERS 15
Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency. Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses. Three-phase transformer- construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers — construction principle, applications and comparison with two winding transformer, Magnetizing current effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers, Cooling of transformers.

TOTAL: 45 PERIODS

NOTE : The question paper for this course can be set with weightage of marks distribution as per the distribution of contact periods

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 Understand the concepts of magnetic circuits.
CO2 Understand the principles of induced emf's and torque in stationary and rotating machines.
CO3 Understand the operation of DC machines.
CO4 Analyse the differences in operation of different DC machine configurations.
CO5 Analyse the single phase and three phase transformers circuits.

TEXT / REFERENCES:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hil Education, 2013.
2. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons,Third Edition (Adapted Indian Edition).
3. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers,2004.
4. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
5. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
6. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3	2	-	-	2	-	-	2	2	3	-	3	3
CO2	3	3	1	3	3	-	-	2	-	-	2	2	3	-	3	3
CO3	3	3	1	3	3	-	-	2	-	-	2	2	3	1	3	3
CO4	3	3	1	3	3	-	-	2	-	-	2	2	3	-	3	3
CO5	3	3	1	3	3	-	-	2	-	-	2	2	3	1	3	3
Avg	3	3	1	3	3	-	-	2	-	-	2	2	3	1	3	3

- 1-low, 2-medium, 3-high

PTEE3402 CONTROL SYSYTEMS L T P C
3 0 0 3

UNIT I MODELING OF LINEAR TIME INVARIANT (LTIV) SYSTEMS 9

Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

UNIT II TIME DOMAIN ANALYSIS 9

Standard test inputs – Time responses – Time domain specifications – Stability analysis:Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation. Effect of adding poles and zeros.

UNIT III FREQUENCY DOMAIN ANALYSIS 9

Bode plot, Polar plot and Nyquist plot – Frequency domain specifications Introduction to closed loop Frequency Response - Effect of adding lag and lead compensators.

UNIT IV STATE VARIABLE ANALYSIS 9

State variable formulation – Non uniqueness of state space model – State transition matrix –Eigen values – Eigen vectors-Free and forced responses for Time Invariant and Time Varying Systems – Controllability – Observability.

UNIT V DESIGN OF FEED BACK CONTROL SYSTEM 9

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques –PID controller-Design using reaction curve and Ziegler-Nichols technique- PID control in State Feedback form.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Represent simple systems in transfer function and state variable forms.
CO2 Analyse simple systems in time domain.
CO3 Analyse simple systems in frequency domain.
CO4 Infer the stability of systems in time and frequency domain.
CO5 Interpret characteristics of the system and find out solution for simple control problems.

TEXT / REFERENCES:

1. Nagrath.I.J & Gopal.M, “Control Systems Engineering”, New Age International Pvt. Ltd., Seventh Edition, 2021.
2. Richard C.Dorf and Bishop, R.H., “Modern Control Systems”, Education Pearson, 13th Edition, 2017.
3. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, “Linear Control SystemAnalysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
4. Katsuhiko Ogata, “Modern Control Engineering”, Pearson, 5thEdition, 2015.

5. Farid Golnaraghi & Benjamin C. Kuo, “Automatic Control System”, Wiley, 9th Edition, 2010.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	1	-	-	-	-	-	-	-	3	2	3	1
CO2	3	2	2	-	1	-	-	-	-	-	-	-	2	2	3	1
CO3	3	2	2	-	1	-	-	-	-	-	-	-	2	2	3	1
CO4	3	2	2	-	1	-	-	-	-	-	-	-	2	2	3	1
CO5	3	2	2	-	1	-	-	-	-	-	-	-	2	3	3	1
Avg	3	2	2	-	1	-	-	-	-	-	-	-	2.2	2.2	3	1

- 1-low, 2-medium, 3-high

PTEE3403 MICROPROCESSORS AND MICROCONTROLLERS **LT P C**
3 0 0 3

UNIT I INTRODUCTION TO 8085 ARCHITECTURE 9

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

UNIT II 8085 INSTRUCTION SET AND PROGRAMMING 9

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

UNIT III INTERFACING BASICS AND ICS 9

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

UNIT IV INTRODUCTION TO 8051 MICROCONTROLLER 9

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

UNIT V INTRODUCTION TO ADVANCED ARCHITECTURE 9

ARM Cortex-M0 – overview - Programmer’s Model - Memory System Overview - System Control B lock - Microcontroller Start sequence – Ports: interfacing and programming.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be

CO1 Ability to write assembly language program for microprocessor and microcontroller.
CO2 Ability to comprehend, design and simulate microprocessor based systems used for control and monitoring.
CO3 Ability to analyze, design and implement interfacing of peripheral with microprocessor.
CO4 Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.
CO5 Ability to understand and appreciate advanced architecture evolving microprocessor architecture.

TEXT BOOKS:

1. Ramesh S. Gaonkar, ‘Microprocessor Architecture Programming and Application’, Penram International (P) ltd., Mumbai, 5 th edition, 2008.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, ‘The 8051 Micro Controller and Embedded Systems’, Pearson Education, 2007.
3. Joseph Yiu , ‘The Definitive Guide to the ARM Cortex-M0’ Newnes – Elsevier, 2011.
4. Kenneth Ayala, “The 8051 Microcontroller”, Cengage Learning India, 2007, 3rd Edition.

REFERENCES:

1. Douglas V. Hall, “Micro-processors & Interfacing”. Tata McGraw Hill 2nd edition, 2009.
2. Krishna Kant, “Micro-processors & Micro-controllers”, Prentice Hall of India, 2007.
3. Embedded Systems: Architecture, Programming & Design, Raj Kamal, 2008, Tata McGraw Hill
4. Raj Kamal, “Embedded Systems: Architecture, Programming & Design”, McGraw Hill Education, 2008
5. Mike Predko, “ 8051 Micro-controller”, McGraw Hill, 2009
6. Kenneth Ayala, ‘The 8051Microcontroller’, Thomson, 2005.
7. Muhammad Tahir and Kashif Javed, ‘ARM Microprocessor Systems - Cortex-M Architecture, Programming, and Interfacing’, CRC Press, 2011.
8. Muhammad Ali Mazidi, “ARM Assembly Language Programming & Architecture”, Microdigitaled, 2nd edition, 2016.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO2	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO3	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO4	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO5	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
Avg	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3

- 1-low, 2-medium, 3-high

PTEE3404 TRANSMISSION AND DISTRIBUTION **L T P C**
3 0 0 3

UNIT I STRUCTURE OF POWER SYSTEM 9

Structure of electric power system: generation, transmission and distribution; Choice of transmission voltage, overhead and underground systems, Types of AC and DC distributors–distributed and concentrated loads–voltage tolerances, interconnection-advantages and limitations–EHVAC and HVDC transmission-Introduction to FACTS devices.

UNIT II TRANSMISSION LINE PARAMETERS 9

Parameters of single and three phase transmission lines with single and double circuits-Resistance, inductance and capacitance of solid, stranded and bundled conductors, conductor types-Symmetrical and unsymmetrical spacing and transposition-application of self and mutual GMD; skin and proximity effects-Effects of earth on capacitance of transmission line - interference with neighboring communication circuits, corona discharge, factors affecting corona-advantages and disadvantages.

UNIT III MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Classification of lines–short line, medium line and long line-Evaluation of A,B,C,D constants- equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance and surge impedance loading; transmission efficiency and voltage regulation, real and reactive power flow in lines, Power-circle diagrams, methods of voltage control ;Ferranti effect, Charging current and losses in an open circuited line.

UNIT IV INSULATORS AND CABLES 9

Main components of overhead lines-Insulators-Types, voltage distribution in insulator string, improvement of string efficiency, Underground cables-Types of cables, insulation materials, Parameters of cable, Grading of cables, Capacitance of 3-core cable, heating, thermal resistance of cables,D.C cables.

UNIT V MECHANICAL DESIGN OFLINES AND GROUNDING 9

Mechanical design of transmission line, sag and tension calculations for different weather conditions, Tower spotting, Types of towers, Sub-station Layout (AIS, GIS), Methods of grounding – Substation and Building.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 understand structure of power system with different voltage levels.
CO2 compute line parameters for different configurations.
CO3 model transmission line and to determine the performance of line.
CO4 choose various insulators and cables for transmission and distribution.
CO5 carry out mechanical design of transmission line and grounding.

TEXT BOOKS:

1. S.N.Singh, 'Electric Power Generation ,Transmission and Distribution', Prentice Hall of India Pvt.Ltd, New Delhi, 2008.
2. B.R.Gupta,' Power System Analysis and Design', S.Chand, New Delhi, Fifth Edition 2005 -08.
3. R.K.Rajput, 'Power System Engineering' Laxmi Publications (P) Ltd, New Delhi, 2006

REFERENCES:

1. D.P.Kothari, I.J.Nagarath, 'Power System Engineering' Tata Mc Graw -Hill Publishing Company limited, New Delhi, 2007.
2. C.L.Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, 2009
3. Luces M.Fualkenberry ,Walter Coffer, 'Electrical Power Distribution and Transmission',Pearson Education, 2007.
4. HadiSaadat, 'Power System Analysis, 'PSA Publishing; Third Edition, 2010.
5. J.Brian, Hardy and Colin R.Bayliss' Transmission and Distribution in Electrical Engineering',Newnes;FourthEdition,2012.
6. Gorti Ramamurthy ,"Transmission and Distribution", Hand book of Electrical PowerDistribution, 2009, Universities Press.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	2	1	-	-	-	-	-	2	-	1	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-	2	3	1	-
CO3	3	3	-	-	-	-	2	-	-	-	-	-	2	3	1	-
CO4	2	2	-	-	-	-	2	-	-	-	-	-	2	-	1	-
CO5	2	2	-	-	-	-	2	-	-	-	-	-	2	-	1	-
Avg	2.4	2.25	-	-	-	2	1.75	-	-	-	-	-	2	3	1	-

PTEE3411 MICROPROCESSORS AND MICROCONTROLLERS LABORATORY L T P C
0 0 4 2

Programming exercises / Experiments with µP 8085:

1. Simple arithmetic operations with 8085: 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. A/D Interfacing
   b. D/A Interfacing
4. Interface Experiment: Traffic light controller.
5. Interface Experiment: Stepper motor controller interface.

Programming exercises / Experiments with μC 8051:

6. Simple arithmetic operations with 8051: Multi precision addition / subtraction /multiplication / division.
7. Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum /
   Minimum of numbers, rotate instructions, Hex / ASCII / BCD code conversions.
8. Interface Experiments:
   a. A/D Interfacing
   b. D/A Interfacing
9. Interface Experiment: Traffic light controller.
10. Interface Experiment: Stepper motor controller interface.

Experiments with Digital ICs :

11. Study of ARM board
12. ARM I/O interfacing with LCD / 7 segment LED

TOTAL : 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 design and implement combinational logic circuits and to analysis simple sequentiallogic circuits.

CO2 write assembly language program for microprocessor and microcontroller.

CO3 design and implement interfacing of peripheral with microprocessor and microcontroller.

CO4 analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring

CO5 analyze, comprehend, design and simulate microcontroller based systems used forcontrol and monitoring.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO2	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO3	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO4	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO5	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
Avg	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3

- 1-low, 2-medium, 3-high

PTEE3501 ELECTRICAL MACHINES – II LT P C
3 0 0 3

UNIT I FUNDAMENTALS OF AC MACHINE WINDINGS 8

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn Coil — active portion and overhang; full-pitch coils, concentrated winding, distributed winding, Winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed Current through winding - concentrated and distributed, Sinusoidally distributed winding, Winding distribution factor.

UNIT II PULSATING AND REVOLVING MAGNETIC FIELDS 6

Constant magnetic field, pulsating magnetic field — alternating current in windings with Spatial displacement, Magnetic field produced by a single winding — fixed current and Alternating current Pulsating fields produced by spatially displaced windings, Windings Spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three- phase balanced currents), revolving magnetic field.

UNIT III INDUCTION MACHINES 15

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit, Circle Diagram - Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self- excitation. Doubly-Fed Induction Machines.

UNIT IV SINGLE-PHASE INDUCTION MOTORS 6

Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications.

UNIT V SYNCHRONOUS MACHINES 10

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuitand phasor diagram, armature reaction, synchronous impedance, voltage regulation and pre-determination methods. Operating characteristics of synchronous machines, V-curves. Salient pole machine — two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

TOTAL: 45 PERIODS

NOTE: The question paper for this course can be set with weightage of marks distribution asper the distribution of contact periods.

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 Understand the concepts of windings, MMFs and rotating magnetic fields.
CO2 Understand the operation of AC machines.
CO3 Analyse the performance characteristics of AC machines.
CO4 Analyse the starting and speed control of AC machines.
CO5 Understand the field applications of AC machines.

REFERENCES:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, Third Edition, Adapted..
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
5. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
6. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	3	2	1	1	-	2	-	-	-	-	-	3	-	3
CO2	3	-	3	3	1	3	-	-	-	-	-	-	-	3	1	3
CO3	3	-	3	3	1	3	-	-	-	-	-	-	-	3	2	3
CO4	3	-	3	3	1	3	-	-	-	-	-	-	-	3	-	3
CO5	3	-	3	3	1	3	-	-	-	-	-	-	-	3	-	3
Avg	2.8	-	3	2.8	1	2.6	-	2	-	-	-	-	-	3	1.5	3

- 1-low, 2-medium, 3-high

PTEE3502 POWER ELECTRONICS L T P C
3 0 0 3

UNIT I SWITCHING POWER SUPPLIES 9

MOSFET dynamic behaviour - driver and snubber circuits--low power high switching frequency switching Power supplies, buck, boost, buck-boost converters – Isolated topologies – resonant converters switching loss calculations and thermal design.

UNIT II INVERTERS 9

IGBT : Static dynamic behaviour single phase half bridge and full bridge inverters - VSI :(1phase and three phase inverters square wave operation) - Voltage control of inverters single, multi pulse, sinusoidal, space vector modulation techniques– various harmonic elimination techniques-CSI .

UNIT III SINGLE PHASE RECTIFIERS 9

Power Diode – half wave rectifier – mid-point secondary transformer based full wave rectifier – bridge rectifier - distortion factor - LC filters – SCR-Two transistor analogy based turn- ON, Controlled converters (1 pulse, 2 pulse) displacement factor – ripple and harmonic factor effect of source inductance, inverter angle limit.

UNIT IV THREE PHASE RECTIFIERS 9

Three phase diode rectifiers– Concern for power quality, Controlled converters (3 pulse, 6 pulse) Computation of performance parameters.

UNIT V AC PHASE CONTROLLERS 9

TRIAC triggering concept with positive and negative gate pulse triggering, TRIAC based phase controllers various configurations for SCR based single and three phase controllers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 To understand operation of semiconductor devices, its dynamic characteristics and to design & analyze low power SMPS.
CO2 Analyze the various uncontrolled rectifiers and design suitable filter circuits.
CO3 Analyze the operation of the n-pulse converters and evaluate the performance parameters.
CO4 Understand various PWM techniques and apply voltage control and harmonic elimination methods to inverter circuits
CO5 Understand operation ofAC voltage controllers and its applications

TEXT BOOKS:

1. Ned Mohan, T.M.Undeland, W.P.Robbins, ”Power Electronics: Converters, applications and design”, John Wiley and Sons, 3rd Edition (reprint), 2009
2. Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall India, 3 rdEdition, New Delhi, 2004.

REFERENCES:

1. Cyril.W.Lander, Power Electronics, McGraw Hill International, Third Edition, 1993.
2. P.S.Bimbhra, Power Electronics, Khanna Publishers, Third Edition 2003
3. PhilipT.Krein, Elements of Power Electronics, Oxford University Press, 2013.
4. P.C.Sen, Power Electronics, Tata McGraw-Hill, 30th reprint, 2008.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	1	-	-	2	-	-	-	-	2	3	2	1
CO2	3	2	2	-	1	-	-	2	-	-	-	-	2	3	2	1
CO3	3	2	2	-	1	-	-	2	-	-	-	-	2	3	2	1
CO4	3	2	2	-	1	-	-	2	-	-	-	-	2	3	2	1
CO5	3	2	2	-	1	-	-	2	-	-	-	-	2	3	2	1
Avg	3	2	2	-	1	-	-	2	-	-	-	-	2	3	2	1

- 1-low, 2-medium, 3-high

PTEE3503 POWER SYSTEM ANALYSIS L T P C
3 0 0 3

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 network-, 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

Significance of Power Flow Analysis in planning and operation- Formulation of Power Flow problem in polar coordinates - Bus classification - 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

Importance of short circuit studies - Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix by 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 circuits of synchronous machine, transformer and transmission line-Sequence networks--Analysis of unsymmetrical faults: single-line- to-ground, line-to-line and double-line-to-ground using Thevenin's theorem and Z-Bus- computation of post fault currents in symmetrical component and phasor domains.

UNIT V STABILITY ANALYSIS 9

Importance of stability studies-Classification of power system stability: rotor angle stability and voltage stability –Single Machine Infinite Bus (SMIB) system: Development of swing equation - solution of the swing equation - Equal area criterion - Critical clearing angle and time – modified Euler method and Runge-Kutta fourth order method.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Model the various power system components for steady-state analysis.
CO2 Carry out the power flow analysis by Gauss-Seidel and Newton-Raphson methods.
CO3 Conduct the fault analysis of power system for balanced faults.
CO4 Carry out the short circuit analysis of the power system for unbalanced faults using symmetrical component theory.
CO5 Compute the stability of the system with the help of equal area criteria and Modified-Euler and Runge-Kutta fourth order methods.

TEXT BOOKS:

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

REFERENCES

1. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill PublishingCompany Ltd., New Delhi, Second Edition, 2007.
2. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012.

3. Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, 2001.
4. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	-	-	-	1	-	-	-	1	-	2
CO2	3	3	3	2	1	-	-	-	1	-	-	-	1	1	1
CO3	3	3	3	2	1	-	-	-	1	-	-	1	1	1	1
CO4	3	2	2	2	2	-	-	-	1	-	-	1	1	1	2
CO5	3	3	2	2	2	-	-	-	1	-	-	1	1	1	1
Avg	3	2.6	2.4	1.8	1.4	-	-	-	1	-	-	1	1	1	1.4

- 1-low, 2-medium, 3-high

PTEE3511 ELECTRICAL MACHINES LABORATORY **LT P C**
0 0 4 2

LIST OF EXPERIMENTS:

1. Open circuit and load characteristics of DC shunt / separately exited DC generator and critical speed.
2. Load test on DC series DC shunt and DC Compound motor.
3. Swinburne's test and speed control of DC shunt motor.
4. Hopkinson's Test
5. Load test on single-phase transformer and Sumpner's test.
6. Open circuit and short circuit tests on single phase transformer.
7. Regulation of three phase alternator by EMF,MMF and ZPF methods.
8. V and Inverted V curves of Three Phase Synchronous Motor.
9. Load test on three-phase induction motor.
10. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
11. Load test on single-phase induction motor.
12. No load and blocked rotor test on single-phase induction motor.
13. Study of Induction Motor Starters and DC Motor starter.
14. Slip test.
15. Simulation of PMDC machines.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Ability to understand and analyse predetermination methods of calculating regulation for synchronous generations.

CO2: Acquire hands on experience of conducting various tests on transformers, three phase induction motor and single phase induction motor.

CO3: Ability to acquire knowledge on separation of losses for static and induction motors.

CO4: Ability to understand the concepts related with encitating current, armature current and power factor for a synchronous motor.

CO5: Ability to understand the performance characterizes of AC and DC machines.

CO6: Capability to understand the parameters that control the speed of DC motor.

MAPPING OF CO'S WITH PO'S AND PSO'S

CO	PO1	PO2	PO3	PO4	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	3	2	1		1				2	3	3	2
CO2	3	3	3	3	2	1		1				2	3	3	2
CO3	3	3	3	3	2	1		1				2	3	3	2
CO4	3	3	3	3	2	1		1				2	3	3	2
CO5	3	2	2	3	2	1		1				2	3	3	2
CO6	2	1	1	-	-	1		1				2	3	3	1
Avg.	**3**	**3**	**1**	**1**	**2**	**1**		**1.5**	**1**			**2.8**	**3**	**3**	**1.6**

- 1-low, 2-medium, 3-high

PTEE3512 POWER ELECTRONICS LABORATORY L T P C
0 0 4 2

LIST OF EXPERIMENTS:

1. Characteristics of SCR and TRIAC
2. Characteristics of MOSFET and IGBT
3. AC to DC half controlled converter
4. AC to DC fully controlled Converter
5. Step down and step up MOSFET based choppers
6. IGBT based single phase PWM inverter
7. IGBT based three phase PWM inverter
8. AC Voltage controller
9. Switched mode power converter.
10. Simulation of PE circuits (1Φ & 3Φ semi converter, 1Φ & 3Φ full converter, dc-dc converters ac voltage controllers).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 Determine the characteristics of SCR, IGBT, TRIAC, MOSFET and IGBT.

CO2 Understand the performance of AC voltage controllers by simulation and experimentation and to find the transfer characteristics of full converter, semi converter, step up and step down choppers by simulation and experimentation.

CO3 Analyze the voltage waveforms for PWM inverter using various modulation techniques.

CO4 Design and experimentally verify the performance of basic DC/DC converter topologies used for SMPS

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	3	3	-	-	-	3	1	-	-	2	3	2	2
CO2	2	2	2	3	3	-	-	-	3	1	-	-	2	3	2	2
CO3	2	2	2	3	3	-	-	-	3	1	-	-	2	3	2	2
CO4	2	2	2	3	3	-	-	-	3	1	-	-	2	3	2	2
Avg	2	2	2	3	3	-	-	-	3	1	-	-	2	3	2	2

- 1-low, 2-medium, 3-high

PTEE3601 **PROTECTION AND SWITCHGEAR** **LT P C**
3 0 0 3

UNIT I FAULTS AND PROTECTIVE SCHEMES **9**
Nature, causes and consequence of faults – fault statistics, types of faults (symmetrical and unsymmetrical) – fault current calculation, Reactors–– need for protective schemes-zones of protection and essential qualities of protection.

UNIT II ELECTROMAGNETIC RELAYS **9**
Basic requirements of protective relaying – Classification and Operating principles of relays-Electromagnetic Relays – Over current, Directional, Distance, Differential and Negative sequence relays, R-X diagram – Universal Torque equation.

UNIT III APPARATUS PROTECTION **9**
Application of instrument transformers in protection schemes – Protection of transformer, generator,motor, bus bars, feeders 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 – re-striking voltage and recovery voltage - RRRV - current chopping - interruption of capacitive and inductive currents, resistance switching- Types of circuit breakers – air, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of Circuit breakers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
- **CO1** analyse different types of faults and their effects on power system and understand the practical significance of protection zones.
- **CO2** understand the basic principles, construction and characteristics of different Electromagnetic relays.
- **CO3** protect different power equipments like transformer, generator etc., against various electrical faults.
- **CO4** understand different aspects of static relays and numerical protection schemes.
- **CO5** understand the principles, construction, selection and problems associated with Different types of circuit breaker.

TEXT BOOKS:

1. Sunil S.Rao, Switchgear and Protection, Khanna publishers, New Delhi, 2008. SwitchgearProtection and Power Systems (Theory, Practice & Solved Problems)
2. Y.G.Paithankar and S.R.Bhide, Fundamentals of power system protection, Second Edition,Prentice Hall of India Pvt. Ltd., New Delhi – 2010

REFERENCES:

1. BadriRam ,B.H.Vishwakarma, Power System Protection and Switchgear, New AgeInternational Pvt Ltd Publishers, Second Edition 2011.
2. B.Rabindranath and N.Chander, Power System Protection and Switchgear, New AgeInternational (P) Ltd., First Edition 2011.
3. M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, A Text Book on Power SystemEngineering, Dhanpat Rai & Co., 1998.
4. C.L.Wadhwa, Electrical Power Systems, 6th Edition, New Age International (P) Ltd.,2010.
5. RavindraP.Singh, “ Switchgear and Power System Protection “ PHI Learning PrivateLtd., New Delhi 2009

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	2	-	-	-	-	-	-	-	3	3	3	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	3	2	2
CO3	2	3	2	1	2	-	2	-	-	-	-	-	3	3	2	1
CO4	2	3	2	2	1	-	1	-	-	-	1	-	3	2	1	2
CO5	2	3	2	1	-	-	-	-	-	-	1	-	3	3	2	2
Avg	2.4	2.6	2	1.33	1.7	-	1.5	-	-	-	1	-	3	2.8	2	1.8

- 1-low, 2-medium, 3-high

PTEE3602 POWER SYSTEM OPERATION AND CONTROL **L T P C**
3 0 0 3

UNIT I INTRODUCTION 9

Power scenario in Indian grid — National and Regional load dispatching centers — requirements of good power system - necessity of voltage and frequency regulation. System load variation, load curves - load forecast. Fundamentals of electricity markets: Privatization and deregulation, Types of electricity markets, Electricity market developments in India. IT application in electricity markets.

UNIT II REAL POWER - FREQUENCY CONTROL 9

Basics of speed governing mechanisms and modeling-speed regulation of two generators in parallel -Load Frequency Control (LFC) of single area system - static and dynamic analysis 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 variable 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 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) - lambda-iteration method - 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 scheduling problems.

UNIT V COMPUTER CONTROL OF POWER SYSTEM 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 Analyze the day-to-day operation of electric power system.
CO2 Analyze the control actions that are implemented to meet the minute-to-minute variation of system real power demand.
CO3 Analyze the compensators for reactive power control.
CO4 Prepare day ahead and real time economic generation scheduling.
CO5 Understand computer control of power system and the role of IT for efficient Energy Management system.

TEXT BOOKS:

1. Olle.I.Elgerd, ‘Electric Energy Systems theory - An introduction’, McGraw Hill Education Pvt.Ltd.,

New Delhi, 34th reprint, 2010.
2. Allen. J. Wood and Bruce F. Wollen Berg, ‘Power Generation, Operation and Control’, JohnWiley & Sons, Inc., 2016.
3. Robert Miller and James Malinowski, ‘Power system Opeartion’, McGraw Hill Education Pvt. Ltd., New Delhi, 2009.

REFERENCES:

1. Kothari D.P. and Nagrath I.J., ‘Power System Engineering’, Tata mcgraw-Hill Education,Second Edition, 2008.
2. Hadi Saadat, ‘Power System Analysis’, McGraw Hill Education Pvt. Ltd., New Delhi, 21streprint, 2010.
3. Kundur P., ‘Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.
4. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, “Restructured Electrical power systems: operation, trading and volatility” Pub., 2001.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	2	-	-	-	-	-	-	-	-	2	2	1	-
CO2	1	2	2	2	1	-	-	-	-	-	-	-	2	2	2	2
CO3	1	2	2	2	1	-	-	-	-	-	-	-	2	2	2	2
CO4	1	2	1	2	-	-	-	-	-	-	3	-	2	2	1	2
CO5	1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	2
Avg	1	1.6	1.4	1.8	1	1	-	-	-	-	3	-	2	2	1.4	2

- 1-low, 2-medium, 3-high

PTEE3603 MEASUREMENT AND INSTRUMENTATION LT P C
3 0 0 3

UNIT I MEASUREMENT CONCEPTS AND ANALOG INSTRUMENTS 9

Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data. Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type meters – Energy meter – Megger – Instrument transformers (CT & PT).

UNIT II SENSORS AND TRANSDUCERS 9

Principles: Resistive – Inductive – Capacitive - Magnetic sensing - Piezoelectric effects – Light - Temperature based sensing, Elements: Mechanical, Thermal, Electrical elements Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Smart Sensors.

UNIT III AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS 9

Wheatstone bridge, Kelvin double bridge Maxwell, Hay, Wien and Schering – Errors and compensation in A.C. bridges Instrumentation Amplifiers.

UNIT IV DIGITAL INSTRUMENTATION 9

A/D converters: types and characteristics – Sampling, Errors- Measurement of voltage, Current, frequency and phase - D/A converters: types and characteristics- DSO- Data Loggers –Instrument standards.

UNIT V PLC AND VIRTUAL INSTRUMENTATION 9

Evolution of PLC – Sequential and Programmable controllers – Architecture – Programming of PLC – Functional blocks – Communication Networks for PLC. Introduction to Virtual Instrumentation (VI) –

Architecture – Programming – Front Panel and Block diagram – Data flow programming – G programming concepts – Control structures – Error handling – String controls – File I/O VIs and functions.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 understand the concepts of measurement and the structural elements of various analog instruments.
CO2 understand the principles of various transducers.
CO3 understand the importance of signal conditioning circuits.
CO4 understand the concepts of digital instrumentation.
CO5 understand the PLC and virtual instrumentation.

TEXT BOOKS:

1. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2015.
2. H.S. Kalsi, 'Electronic Instrumentation and Measurements', Tata McGraw-Hill, New Delhi, 2019
3. Albert D. Helfrick & William D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall India Learning Private Limited, 1992
4. Dag H. Hanssen, Programmable Logic Controllers, A Practical Approach to IEC 61131-3 using CODESYS, John Wiley & Sons Ltd., 2015
5. Labview based Advanced Instrumentation systems, S. Sumathi & P. Surekha, Springer Publications, 2018 Edition.

REFERENCE BOOKS:

1. M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009 J.J.
2. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011
3. W.Bolton, Programmable Logic Controllers, 5th Ed, Elseiver, 2010.
4. R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 2008
5. E. O. Doebelin and D. N. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill, New Delhi, 2007
6. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", Chand Pub, 2016.
7. J.B. Gupta, "Electrical Measurements & Measuring Instruments", S.K. Kataria & Sons, 2020

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	3	2	-	2	-	-	-	3	3	3	3	3
CO2	3	3	3	2	-	2	-	-	-	3	-	3	3	3	3	3
CO3	3	3	3	-	3	2	-	-	-	-	-	3	3	3	3	3
CO4	3	3	3	-	-	-	-	2	-	3	-	3	3	3	3	3
CO5	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3	3
Avg	3	3	3	2	3	2	-	2	-	3	-	3	3	3	3	3

- 1-low, 2-medium, 3-high

PTEE3611 CONTROL AND INSTRUMENTATION LABORATORY LT P C
0 0 4 2

LIST OF EXPERIMENTS

Control systems:

1. Analog (op amp based) simulation of linear and nonlinear differential equations
2. Mathematical modeling and simulation of physical systems in at least two fields Mechanical¬ Electrical¬ Chemical process.

3. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform
4. Root Locus based analysis in simulation platform
5. Determination of transfer function of a physical system using frequency response and Bode's asymptotes
6. Design of Lag, lead compensators and evaluation of closed loop performance
7. Design of PID controllers and evaluation of closed loop performance
8. Test of controllability and observability in continuous and discrete domain in simulation platform

Instrumentation:

1. Static and Dynamic characteristics of Electrical and Non electrical sensors.
2. Signal conditioning circuits for Instrumentation – Design of Bridges, Filters, Instrumentation amplifier.
3. Design of A/D and D/A converters.
4. Calibration of analog and digital instruments.
5. PLC programming for Process Control Applications.
6. Development of GUI application for Process control.

Mini Project :

Demonstration of PC based data acquisition with complete closed loop control including sensor and actuator dynamics.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 model and analyze simple physical systems and simulate the performance in analog and digital platform.
CO2 design and implement compensators and simple controllers in standard forms.
CO3 design signal conditioning circuits for various transducers.
CO4 program PLC and develop GUI application for a physical system.
CO5 design PC based data acquisition with complete closed control loop and evaluate its performance for simple physical systems.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3	3
CO2	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3	3
CO3	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3	3
CO4	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3	3
Avg	3	3	3	3	3	-	-	1.5	-	-	-	2	3	3	3	3

- 1-low, 2-medium, 3-high

SEMESTER VII

PTEE3701 HIGH VOLTAGE ENGINEERING LT P C
3 0 0 3

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 – Reflection and Refractionof Travelling waves- protection against over voltages-Insulation Coordination.

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,–

Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment.

UNIT III GENERATION AND MEASUREMENTS OF HIGH VOLTAGESAND HIGH CURRENTS 9

Generation of High DC, AC, impulse voltages and impulse currents - Analysisof DC/AC and Impulse generator circuits - Tripping and control of impulse generators, Measurement of High voltages - High Resistance with series ammeter — Dividers - Resistance, Capacitance and Mixed dividers - PeakVoltmeter, Generating Voltmeters, Electrostatic Voltmeters – Sphere Gaps, Digital techniques in high voltage measurement, High current measurements – High current shunts, Rogowski coils and magnetic links.

UNIT IV HIGH VOLTAGE TESTING 9

High voltage testing of electrical power apparatus- International and Indian standards — Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers.

UNIT V HIGH VOLTAGE APPLICATIONS IN INDUSTRY 9

Introduction – electrostatic applications- electrostatic precipitation, separation, painting / coating, spraying, imaging, printing, Transport of materials – manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 analyze various over voltages and its effects on power systems.
CO2 understand the breakdown phenomena in different dielectric medium under uniform and non-uniform fields.
CO3 explain the methods of generating and measuring High DC, AC, Impulse voltage and currents.
CO4 suggest and Conduct suitable HV testing of Electrical power apparatus as per Standards.
CO5 explain the Industrial Applications of High Voltage Engineering.

TEXT BOOKS

1. M.S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, Sixth Edition,2020.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals',NewnessSecond Edition, Elsevier , New Delhi, 2005.
3. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, FourthEdition,2020.

REFERENCES

1. L.L.Alston, High Voltage Technology, Oxford University Press, First Indian Edition2006.
2. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, RoshdayRadwan, High VoltageEngineering – Theory &Practice,Second Edition, Taylor & FrancisGourp, 2019
3. Subir Ray." An Introduction to High Voltage Engineering "PHI Learning Private Limited,New Delhi,Second Edition-2011

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	2	2	-	1	2	2	3	2	2	1
CO2	3	2	2	2	2	1	2	3	1	1	1	2	2	2	2	2
CO3	3	3	2	3	2	1	2	2	2	1	1	1	3	2	1	2
CO4	3	2	2	3	2	2	3	3	3	2	3	2	2	3	2	2
CO5	3	2	3	2	3	3	3	3	2	2	3	3	2	3	3	3
Avg	3	2.2	2.4	2.4	2.2	2	2.4	2.6	1.6	1.4	2	2	2.4	2.4	2	2

- 1-low, 2-medium, 3-high

PTEE3702 **ELECTRICAL MACHINE DESIGN** **LT P C**
3 0 0 3

UNIT I DESIGN OF FIELD SYSTEM AND ARMATURE 9

Major considerations in Electrical Machine Design – Materials for Electrical apparatus – Design of Magnetic circuits – Magnetising current – Calculation of MMF Leakage in Armature. Design of lap winding and wave winding- Introduction to Computer aided design.

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 Equation – Main Dimensions – Choice of specific loadings – 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 – Design of squirrel cage rotor and wound rotor – Operating characteristics- Magnetizing current - Short circuit current – Circle diagram Computer program:Design of slip-ring rotor.

UNIT V DESIGN OF SYNCHRONOUS MACHINES 9

Output equation – choice of specific loadings – Design of salient pole machines – Short circuit ratio – Armature design – Estimation of air gap length – Design of rotor – 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:

After completion the above subject, students will be able to

CO1 understand basics of design considerations for rotating and static electrical machines.
CO2 design of single and three phase transformer.
CO3 design of armature and field of DC machines.
CO4 design of stator and rotor of induction motor.
CO5 design and analyze synchronous machines.

TEXT BOOKS

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.

REFERENCES:

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

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	-	1	-	-	-	-	-	-	-	3	2	-	-
CO2	3	2	-	1	1	-	-	-	-	-	-	-	3		-	-
CO3	2	2	3	1	1	-	-	-	-	-	2	3	3	2	-	-
CO4	1	2	3	1	1	-	-	1	1	-		3	3	2	-	-
CO5	2	2	1	-	1	2	-	-	-	-	2	-	3		2	-
Avg	2	2	2.33	1	1	2	-	1	1	-	2	3	3	2	2	-

- 1-low, 2-medium, 3-high

PTEE3711 POWER SYSTEM LABORATORY LT P C
0 0 4 2

LIST OF EXPERIMENTS:

1. Computation of Transmission line constants.
2. Power Flow Analysis using Gauss-Seidel Method.
3. Power Flow Analysis using Newton Raphson Method.
4. Symmetric and unsymmetrical fault analysis using any power system simulation tool.
5. Transient stability analysis of SMIB System.
6. Load – Frequency Dynamics of Single-Area and Two-Area Power Systems.
7. Stability analysis of AVR.
8. Relay Coordination using any power system simulation tool.
9. Familiarization of Relay Test Kit with testing of Numerical Over current Relay Simulation.
10. Co-ordination of over-current and distance relays for radial line protection.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject,

CO1 Learners will be able to analyze the power flow using Newton-Raphson method and Fast decoupled method.

CO2 Learners will be able to perform contingency analysis & economic dispatch.

CO3 Learners will be able to Set Digital Over Current Relay and Coordinate Relay.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1	1	-	-	1	1	-	1	3	-	1	2
CO2	3	3	3	3	1	2	-	-	1	1	-	2	3	1	1	2
CO3	3	3	3	2	1	2	-	-	1	1	-	2	3	-	1	2
Avg	3	3	3	2	1	1.6	-	-	1	1	-	1.6	3	1	1	2

- 1-low, 2-medium, 3-high

PTGE3851 **HUMAN VALUES AND ETHICS** **LT P C**
2 0 0 2

UNIT I DEMOCRATIC VALUES 6

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.

Reading Text: Excerpts from John Stuart Mills' *On Liberty*

UNIT II SECULAR VALUES 6

Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.

Reading Text: Excerpt from *Secularism in India: Concept and Practice* by Ram Puniyani

UNIT III SCIENTIFIC VALUES 6

Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.

Reading Text: Excerpt from *The Scientific Temper* by Antony Michaelis R

UNIT IV SOCIAL ETHICS 6

Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.

Reading Text: Excerpt from *21 Lessons for the 21st Century* by Yuval Noah Harari

UNIT V SCIENTIFIC ETHICS 6

Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.

Reading Text: Excerpt from *American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer* by Kai Bird and Martin J. Sherwin.

TOTAL: 30 PERIODS

REFERENCES:

1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

COURSE OUTCOMES

Students will be able to

CO1 : Identify the importance of democratic, secular and scientific values in harmonious functioning of social life

CO2 : Practice democratic and scientific values in both their personal and professional life.

CO3 : Find rational solutions to social problems.

CO4 : Behave in an ethical manner in society

CO5 : Practice critical thinking and the pursuit of truth.

POWER ENGINEERING

PTEE3001 **UNDERGROUND CABLE ENGINEERING** **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO ELECTRICAL POWER CABLES **7**

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

UNIT II CABLE ARCHITECHTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS **7**

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

UNIT III SUPPLY DISTRIBUTION SYSTEMS AND CABLES **7**

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

UNIT IV TRANSMISSION SYSTEMS AND CABLES **7**

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

UNIT V CABLE INSTALLATION, TESTING, MAINTENANCE **7**

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

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) **10**

Demonstration of cable architecture with cable samples of all types.

1. Understanding the cable manufacturing process through factory visit.
2. Familiarization of the cable laying procedure through field visits.
3. Familiarization of cable jointing / end termination techniques.
4. Understanding and familiarization of cable fault locating techniquesthrough field visit to local distribution company or inhouse laboratory.
5. Understanding testing procedures and condition monitoring tests

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 understand the fundamental of underground cable system.
CO2 gain knowledge on the architecture of UG cable and physical and electricalcharacteristics of the UG cable.
CO3 understand different types of cable used in distribution system.
CO4 acquire knowledge on Underground cables used in transmission system
CO5 understand the cable installations procedures and practices.
CO6 understand the theory / methodology of cable fault detection and rectification, testing and maintenance.

TEXT BOOKS:

1. William Thue, ‘Electrical Power Cable Engineering’, CRC Press Taylor & FrancisGroup., 6000 Broken Sound Parkway NW, Suite 300Boca Raton, FL 33487-2742, 3rd Edition 2017.

2. G. F. Moore, 'Electric Cables Handbook' -Third edition, Blackwell Science Ltd,9600 Garsington Road, Oxford OX4 2DQ, UK., January 2017.

REFERENCES:

1. Leonard L. Grigsby, 'Electrical Power Cable Engineering' - CRC Press, Marcel Dekker, 3rdEdition 2012.
2. Christian Flytkjaer Jensen, Online Location of Faults on AC Cables in UndergroundTransmission Systems (Springer Theses), 2014, March.
3. https://kafactor.com/content/technical-resources/kerite-underground-cable-engineering- handbook.pdf
4. Handbook on Cable Fault Localization (April 2020) https://rdso.indianrailways.gov.in/works/uploads/File/Handbook%20on%20Cable%20Fault%20Localization(2).pdf
5. K. H. Ali et al.: Industry Practice Guide for Underground Cable Fault-Finding in the LVDN: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279, June 2022.
6. R. W. Deltenre, J. J. Schwarz, and H. J. Wagnon, ''Underground cable fault location: A handbook to TD-153,'' BDM Corp., Albuquerque, NM, USA, Final Rep. EPRI EL-363, 1977. https://www.osti.gov/servlets/purl/7233049, doi: 10.2172/7233049, January 1997.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO2	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO3	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO4	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
CO5	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3
Avg	2	1	2	3	-	-	-	-	-	-	-	-	3	-	1	3

PTEE3002 SUBSTATION ENGINEERING AND AUTOMATION LT P C
3 0 0 3

UNIT I SUBSTATION DESIGN DEVELOPMENT 7

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

UNIT II SUBSTATION EQUIPMENT 7

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

UNIT III PROTECTION AND SUBSTATION AUTOMATION 7

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

UNIT IV SUBSTATION DESIGN & LAYOUT ENGINEERING 7

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

UNIT V INTERFACE ENGINEERING 7

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

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Battery sizing for a substation with a load cycle based on IEEE 1115 Ni-cd - A case studyOR
2. DG and auxiliary transformer sizing for a substation auxiliary power supply- A case study
3. Overcurrent Relay coordination in a substation- A case study
4. Earthmat sizing calculation for an outdoor substation based on IEEE80- A case studyOR
5. Direct stroke lightning protection calculation for outdoor switchyard based on IEC 62305- Acase study

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

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

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

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

CO4 Understand about Interdisciplinary aspects involved in substation design

CO5 Understand different protection and control scheme involved in substation design

CO6 Know about substation automation system and different communication protocol involved for efficient operation of a substation

REFERENCES:

1. McDonald John D, “Electric Power Substations Engineering”, CRC Press, 3rd Edition, 2012
2. Partap Singh Satnam, P.V. Gupta, “Sub-station Design and Equipment”, Dhanpat RaiPublications, 1st Edition, 2013
3. Sunil S. Rao, “Switchgear Protection and Power Systems (Theory, Practice & SolvedProblems)”, Khanna Publications, 14th Edition, 2019 .
4. Electrical substation and engineering & practice by S.Rao, 3rd Edition, Khanna Publishers2015
5. Manual on Substation by Central Board of irrigation and Power (CBIP) Publication No 342.,2006.
6. Substation automation system Design and implementation by Evelio Padilla by WileyPublications, 1st Edition, 2015 November.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	-	-	-	-	-	-	-	-	3	-	2	3
CO2	3	2	2	3	-	-	-	-	-	-	-	-	3	-	2	3
CO3	3	2	2	3	-	-	-	-	-	-	-	-	3	-	2	3
CO4	3	2	2	3	-	-	-	-	-	-	-	-	3	-	2	3
CO5	3	2	2	3	-	-	-	-	-	-	-	-	3	-	2	3
Avg	3	2	2	3	-	-	-	-	-	-	-	-	3	-	2	3

PTEE3003 **HVDC AND FACTS** **LT P C**
3 0 0 3

UNIT I INTRODUCTION **7**

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

UNIT II STATIC VAR COMPENSATOR (SVC) AND THYRISTOR CONTROLLED SERIES COMPENSATOR (TCSC) **7**

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

UNIT III VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS **7**

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

UNIT IV LINE COMMUTATED HVDC TRASMISSION **7**

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

UNIT V VSC BASED HVDC TRANSMISSION **7**

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

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) **10**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

- **CO1** To Identify and understand the problems in AC transmission systems and understand theneed for Flexible AC transmission systems and HVDC Transmission
- **CO2** To understand the operation and control of SVC and TCSC and its applications to enhancethe stability and damping.
- **CO3** To Analyze basic operation and control of voltage source converter based FACTScontrollers
- **CO4** To demonstrate basic operation and control of Line Commutated HVDC Transmission
- **CO5** To explain the d-q control based operation of VSC based HVDC Transmission

TEXT BOOKS:

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

REFERENCES:

1. K.R.Padiyar,”FACTS Controllersin Power Transmission and Distribution”,New Age International (P) Limited, Publishers, New Delhi, 2008.

2. A.T.John,“FlexibleA.C.TransmissionSystems”,InstitutionofElectricalandElectronic Engineers(IEEE), 1999.
3. V. K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004,KluwerAcademic Publishers,2004.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1	1	-	-	1	3	-	3	3	3	3	2
CO2	3	3	3	3	2	1	-	-	2	3	-	3	3	3	3	2
CO3	3	3	3	3	1	1	-	-	2	3	-	3	3	3	3	2
CO4	3	3	3	3	1	1	-	-	2	3	-	3	3	3	3	2
CO5	3	3	3	3	1	1	-	-	1	3	-	3	3	3	3	2
Avg	3	3	3	3	1.2	1	-	-	1.6	3	-	3	3	3	3	2

PTEE3004 ENERGY MANAGEMENT AND AUDITING LT P C
3 0 0 3

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGYAUDIT 7
Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector - Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, and its features - electricity tariff - Thermal Basics - need and types of energy audit - Energy management/audit approach- understanding energy costs - maximizing system efficiencies -optimizing the input energy requirements - energy audit instruments.

UNIT II MATERIAL AND ENERGY BALANCE 7
Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager — employees training and planning- Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 7
Introduction to fuels - properties of fuel oil, coal and gas - principles of combustion - combustion of oil, coal and gas - Boilers: Types, combustion in boilers, performances evaluation, analysis of losses - energy conservation opportunities - FBC boilers - Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings - Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery — Refractory : types, selection and application of refractories, heat loss - Cogeneration: classification and saving potentials - Case Study.

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM 7
Compressed Air System: Types of air compressors - efficient compressor operation - Compressed air system components - leakage test - savings opportunities - Refrigeration System: Vapour compression refrigeration cycle — refrigerants - coefficient of performance - factors affecting Refrigeration and Air conditioning system - savings opportunities - Vapour absorption refrigeration system: working principle - types and comparison with vapour compression system - saving potential - Cooling Tower: Types and performance evaluation, efficient system operation - flow control strategies and energy saving - Diesel Generating system: Factors affecting selection - energy performance assessment of diesel conservation avenues - Case Study.

UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES 7
Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient

motors - soft starters with energy saver - variable speed drives — Fans and blowers: Types - efficient system operation - flow control strategies -Pumps and Pumping System: Types - system operation - flow control methods - Lighting System: Light source, choice of lighting, luminance requirements — ballast - occupancy sensors - energy efficient lighting controls - energy conservation avenues - Case Study.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Study of Energy Conservation and Energy Audit Using Energy Audit Instruments.
2. Performance Analysis of Electric Motor and Energy Efficient Motor (EEM)
3. Performance Analysis of fan characteristic curves at different operating points
4. Case study of illumination system
5. Performance Analysis of Compressors

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject,

CO1 Students able to acquire knowledge in the field of energy management and auditing.
CO2 Learned the about basic concepts of economic analysis, material and energy balance.
CO3 Able to design the effective thermal utility system.
CO4 Able to improve the efficiency in compressed air system.
CO5 Acquired the design concepts in the field of lighting systems, light sources and variousforms of cogeneration.

TEXTBOOKS:

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

REFERENCES:

1. Moncef Krati, ‘Energy Audit of Building Systems: An Engineering Approach’, Third Edition,CRC Press, Dec.2020.
2. Sonal Desai, ‘Handbook of Energy Audit’, McGraw Hill Education (India) Private Limited,2015.
3. Michael P.Deru, Jim Kelsey, ‘Procedures for Commercial Building Energy Audits’,American Society of Heating, Refrigerating and Air conditioning Engineers, 2011.
4. Thomas D.Eastop, ‘Energy Efficiency: For Engineers and Technologists’, LongmanScientific & Technical, 1990, 1st Edition.
5. Daniel Martinez, Ben W. Ebenhack, Travis Wagner, “Energy Efficiency Concepts and Calculations”, First Edition, Elsevier Science, 2019
6. “Energy Efficiency in Electrical Utilities”, Third Edition, Bureau of Energy Efficiency (BEE), India, 2010
7. Al Thumann, William J.Younger, Terry Niehus, “Handbook of Energy Audits”, 8th Edition,The Fairmont Press, Inc., 2010

List of Open Source Software/ Learning website:

1. https://facilio.com/blog/commercial-energy-audit
2. https://www.sciencedirect.com/science/article/pii/S2212827114004491
3. https://mppolytechnic.ac.in/mpstaff/notes_u pload_photo/
CS595EnergyEfficiencyinElectricalUtilities-5391.pdf
4. http://knowledgeplatform.in/wp-content/uploads/2017/03/1.3-Energy-management-Audit.pdf

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
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CO1	3	1	1	2	-	2	1	3	2	2	-	2	-	3	2	1
CO2	3	2	1	2	-	-	-	1	2	-	3	2	-	1	2	-
CO3	2	1	3	1	2	-	1	1	2	2	-	2	-	3	2	1
CO4	1	2	2	1	2	1	1	-	1	2	-	1	-	2	2	1
CO5	2	2	3	2	2	1	1	-	1	1	2	1	-	3	1	1
Avg	2.2	1.6	2	1.6	2	1.33	1	1.6	1.6	1.75	2.5	1.6	-	2.4	1.8	1

PTEE3005 POWER SYSTEM TRANSIENTS LT P C
3 0 0 3

UNIT I INTRODUCTION AND SURVEY 7
Sources of different types of transients - RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients - study of transients in system planning - Importance of grounding.

UNIT II SWITCHING TRANSIENTS 7
Basic concept of switching transients - resistance switching and equivalent circuit for interruptingthe resistor current - load switching and equivalent circuit - waveforms for transient voltage acrossthe load and the switch - normal and abnormal switching transients. Current suppression - currentchopping - effective equivalent circuit - capacitance switching with a restrike, with multiple restrikes - ferro resonance.

UNIT III LIGHTNING TRANSIENTS 7
Theories of cloud formation - 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 COMPUTATION OF TRANSIENTS 7
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.Computation of overvoltages using EMTP.

UNIT V TRANSIENTS IN INTEGRATED POWER SYSTEM 7
The short line and kilometric fault - distribution of voltages in a power system - Line dropping andload rejection - voltage transients on closing and reclosing lines - overvoltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Simulation of circuit transients
2. Computation of over voltages for switching surges
3. Computation of over voltages for lightning surges
4. Computation of transients

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 Explain the principles of transients and its concepts.
CO2 Know the different types of switching transients and the way to draw the necessary equivalent circuit.
CO3 Explain the concepts behind lighting and the way to protect the same.
CO4 Compute the transient behavior in transmission line.
CO5 Explain the behavior of the Circuit during switching and to learn the simulation tool.

TEXT BOOKS:

1. Allan Greenwood, ‘Electrical Transients in Power Systems’, Wiley Inter Science, New York, 2nd Edition, 1991.
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.

REFERENCES:

1. M.S.Naidu and V.Kamaraju, ‘High Voltage Engineering’, Tata McGraw Hill, Fifth Edition, 2013.
2. R.D. Begamudre, ‘Extra High Voltage AC Transmission Engineering’, Wiley Eastern Limited,1986.
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.

MAPPING OF COs WITH POs AND PSOs

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CO3	3	3	2	3	2	1	2	2	2	1	1	1	3	2	1
CO4	3	2	2	3	2	2	3	3	3	2	3	2	2	3	2
CO5	3	2	3	2	3	3	3	3	2	2	3	3	2	3	3
Avg	3	2.2	2.4	2.4	2.2	2	2.4	2.6	1.6	1.4	2	2	2.4	2.4	2

PTEE3006 **SMART GRID** **LT P C**
3 0 0 3

UNIT I INTRODUCTION 7
Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional & Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Micro grid, National and International Initiatives in Smart Grid.

UNIT II SMART METERING 7
Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor MeasurementUnit (PMU).

UNIT III SMART GRID TECHNOLOGIES (Transmission) 7
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, Wide area Monitoring, Protection and control.

UNIT IV SMART GRID TECHNOLOGIES (Distribution) 7
DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High- Efficiency Distribution Transformers, Phase Shifting Transformers, Electric Vehicles.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 7
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 understand the importance and objectives of Power System Grid.
CO2 know and understand the concept of a smart grid.
CO3 identify and discuss smart metering devices and associated technologies.
CO4 get an overview of Microgrid and Electric Vehicle Technology.

CO5 have an up to date knowledge on the various computing technologies; to understand the role of Big Data and IoT for effective and efficient operation of Smart Grid.

TEXT BOOKS:

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited byStuart Borlase,CRC, 2018.
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley,2012
3. James Momoh ,Smart Grid Fundamentals of Design and Analysis, IEEE press 2012.

REFERENCES:

1. Ahmed F. Zobaa, Trevor J. Bihl, Big data analytics in future power systems, 1st Edition, CRC press 2018.
2. C. Gungor et al., "Smart Grid Technologies: Communication Technologies and Standards," in IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529-539, Nov. 2011.doi: 10.1109/TII.2011.2166794.
3. X. Fang, S. Misra, G. Xue and D. Yang, "Smart Grid — The New and Improved Power Grid: A Survey," in IEEE Communications Surveys & Tutorials, vol. 14, no. 4, pp. 944- 980, Fourth Quarter 2012. doi: 10.1109/SURV.2011.101911.00087.
4. Stuart Borlase “Smart Grid : Infrastructure, Technology and Solutions”, CRC Press 2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	1	1	-	-	-	-	-	-	-	2	-	1	1
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CO3	2	1	2	1	2	-	-	-	-	-	-	-	2	-	1	2
CO4	2	1	2	1	1	-	-	-	-	-	-	-	2	-	1	1
CO5	1	1	1	1	1	-	-	-	-	-	-	-	2	-	1	1
Avg	1.6	1	1.8	1	1.41	-	-	-	-	-	-	-	2	-	1	1.4

PTEE3007 RESTRUCTURED POWER MARKET LT P C
3 0 0 3

UNIT I INTRODUCTION 9

Deregulation of power industry, unbundling of electric utilities, Issues involved in deregulation – Fundamentals of Economics: Consumer and suppliers behavior, Total utility and marginal utility, Law of diminishing marginal utility, Elasticity of demand and supply curve, Market equilibrium, Consumer and supplier surplus, Global welfare, Deadweight loss - The Philosophy of Market Models.

UNIT II PRICING OF TRANSMISSION NETWORK AND CONGESTION MANAGEMENT 9

Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management.

UNIT III LOCATIONAL MARGINAL PRICES(LMP)AND FINANCIAL TRANSMISSION RIGHTS 9

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

UNIT IV ANCILLARY SERVICE MANAGEMENT 9

Types of ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services.

UNIT V MARKET EVOLUTION **9**

US market: California energy market - Reforms in Indian power sector: Framework of Indian power sector, Reform initiatives, Availability Based Tariff (ABT), The Electricity Act 2012, Open Access issues, Power exchange, role of RLDC and NLDC.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 Understand the process of restructuring of power industry and analyze the philosophy of market models

CO2 analyze various methods for calculating wheeling charges and congestion management in deregulated power system

CO3 analyze the locational marginal pricing and financial transmission rights

CO4 analyze the ancillary service management

CO5 explain the evolution of Indian and US power markets

TEXT BOOKS:

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

REFERENCES:

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

List of Open Source Software/ Learning website:

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

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-	-
CO3	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-	-
CO4	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-	-
CO5	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-	-
Avg	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-	-

PTEE3008 DESIGN AND MODELLING OF RENEWABLE ENERGY SYSTEMS **LT P C**
3 0 0 3

UNIT I RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES **7**

Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends.

UNIT II SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS **7**

Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single- Phase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters, Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer less Double-Stage PV Systems.

UNIT III THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES **7**

Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization,Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking.

UNIT IV SMALL WIND ENERGY SYSTEMS 7

Introduction-Generator Selection for Small-Scale Wind Energy Systems- Turbine Selection for Wind Energy-Self-Excited Induction Generators for Small Wind Energy Applications- Permanent Magnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small Wind Turbine Systems-Magnus Turbine–Based Wind Energy System.

UNIT V DOUBLY-FED INDUCTION GENERATOR-BASED WECS 7

Introduction – modelling of induction machine in machine variable form and arbitrary referenceframe, modelling of Doubly-fed Induction Generator.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Simulation of inverter for PV systems
2. Simulation of WECS with DFIG

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 Review the perspectives of renewable energy systems
CO2 Integrate photovoltaic systems with grid
CO3 Study inverter for PV systems
CO4 Elaborate the working of small wind power systems
CO5 Study the features of induction machine and doubly fed induction machine

TEXT BOOKS:

1. Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021
2. Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition,2021
3. Nabil Derbel, Quanmin ZhuModeling, "Identification and Control Methods in Renewable Energy Systems" , Springer, First Edition, 2019.

REFERENCES:

1. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1stEdition.
2. Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression.
3. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014,IET, 2nd Edition.
4. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, FredeBlaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.

List of Open Source Software/ Learning website:

1. https://www.mdpi.com/journal/applsci/topical_collections/Susta_Energy
2. https://www.mathworks.com/help/sps/ug/single-phase-grid-connected-in-pv-system.html
3. https://www.sciencedirect.com/topics/engineering/three-phase-inverter
4. https:// www.academia.edu/32704493/Wind_Power_Lecture_Notes
5. https://www.syscop.de/files/2018ss/WES/handouts/script.pdf
6. https://www.sciencedirect.com/topics/engineering/wound-rotor-induction-generator

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	-	-	-	-	-	-	-	-	2	2	3	3
CO2	3	3	3	3	3	2	3	-	3	3	-	3	2	2	3	3
CO3	3	3	3	3	3	2	3	-	3	3	-	3	2	2	3	3
CO4	3	3	3	3	3	2	3	-	3	3	-	3	2	2	3	3
CO5	3	3	3	3	3	2	3	-	3	3	-	3	2	2	3	3
Avg	3	3	3	2.6	3	2	3	-	3	3	-	3	2	2	3	3

PTEE3009 GRID INTEGRATING TECHNIQUES AND CHALLENGES **L T P C**
2 0 2 3

UNIT I PRESENT POWER SCENARIO IN INDIA 6
Introduction - Thermal Power Plant , Components of Thermal Power Plant , Major Thermal Power Plants in India- Gas-Based Power Generation - Nuclear Power Plants -Hydropower Generation - Pumped Storage Plants - Solar Power - Wind Energy — Power plants India.

UNIT II POWER GRIDS 6
Introduction -Electric Power ,Background , The Construction of a Power Grid System , BasicConcepts of Power Grids -Load Models - Transformers in Electric Power Grids - Modelling a MicrogridSystem.

UNIT III MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS 6
Introduction - Single-Phase DC/AC Inverters with Two Switches, Three-Phase DC/AC Inverters, PulseWidth Modulation Methods, The Triangular, The Identity Method, Analysis of DC/AC Three-Phase Inverters. Micro grid of Renewable Energy Systems- DC/DC Converters in Green Energy -Pulse WidthModulation -Sizing of an Inverter for Microgrid Operation, Sizing of a Rectifier for Microgrid Operation,The Sizing of DC/DC Converters for Micro grid.

UNIT IV WIND ENERGY SYSTEM GRID INTEGRATION 6
Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues in Grid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power Devices- Power Quality Point of View.

UNIT V GRID INTER CONNECTION 6
Grid Code requirements-Grid integration of WECS-Grid Integration of PV systems.

LAB COMPONENT: 30

1. Develop a model for the control of DC micro grid for non linear loads
2. Simulation study of three phase inverters with fixed and sine PWM techniques, Simulation and Design ofbuck/boost converters.
3. Simulate a Grid Connected Wind Energy System with STATCOM and investigate the improvement inpower quality.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 Review the power sector scenario in India.
CO2 Model a micro grid system.
CO3 Model a converter for power grid distributed system.
CO4 Integrate wind energy system.
CO5 Simulate three phase inverter with fixed and sine PWM.

TEXT BOOKS:

1. Brian D'Andrade "The Power Grid", Academic Press, 1st Edition, 2017.
2. Yang Han, "Modeling and Control of Power Electronic Converters for Microgrid Applications",Springer, 1st Edition 2022.
3. Siegfried Heier, "Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems",John Wiley & Sons, Ltd, 2014, 3rd Edition.

REFERENCES:

1. Integration of Renewable Energy Sources with Smart Grid, M. Kathiresh, A. Mahaboob Subahani,and G.R. Kanaga chidambaresan, Scrivener & Wiley, 2021, 1st Edition.
2. Control and Operation of Grid-Connected Wind Energy Systems, Ali M. Eltamaly, Almoataz Y. Abdelaziz, Ahmed G. Abo-Khalil, Springer 2021, 1st Edition.
3. Design of smart power grid renewable energy systems, Third Edition, Ali Keyhani, Wiley 2019.
4. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, Wiley 2017, 1st Edition.

5. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, Laxmi publications, 2013, 2nd Edition.
6. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.
7. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.
8. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.

List of Open Source Software/ Learning website:

1. https://www.academia.edu/14628492/Current_Power_Scenario_In_India
2. https://www.academia.edu/32120081/Power_Converters_Modeling_in_Matlab_Simulink_for_Microgrid_Simulations_Power_Converters_Modeling_in_Matlab_Simulink_for_Microgrid_Simulations
3. https://energyeducation.ca/encyclopedia/Electrical_grid
4. https://dnv.com/services/wind-farm-control-and-grid-integration
5. https://www.wind-energy-the-facts.org/images/chapter2.pdf

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	-	-	2	-	-	-	-	2	3	2	1	2
CO2	3	3	3	3	-	-	2	-	-	-	-	2	3	2	1	2
CO3	3	3	3	3	-	-	2	-	-	-	-	2	3	2	1	2
CO4	3	3	3	3	-	-	2	-	-	-	-	2	3	2	1	2
CO5	3	3	3	3	-	-	2	-	-	-	-	2	3	2	1	2
Avg	3	3	3	3	-	-	2	-	-	-	-	2	3	2	1	2

PTEE3010 SUSTAINABLE AND ENVIRONMENTAL FRIENDLY HV INSULATION SYSTEM — L T P C 3 0 0 3

UNIT I SUSTAINABLE AND ENVIRONMENTAL ENERGY AND PRODUCTS 9
Carbon print, global warming potential, environment requirement for any product and system.

UNIT II ALTERNATE GREEN GASEOUS INSULATORS 9
SF6 gas and its hazardous environmental effects, alternate gases, gaseous mixtures and other sources and it's properties.

UNIT III ALTERNATE GREEN LIQUID INSULATORS 9
hazardous effects of existing liquid dielectric materials (such as organic oil), alternate sources of environmental friendly liquid such as ester oil, vegetable oils dielectric and it's properties.

UNIT IV ALTERNATE GREEN SOLID INSULATORS 9
hazardous effects of existing solid dielectric materials, alternate sources of environmental friendlysolid dielectric and its properties.

UNIT V EVOLVING STANDARDS FOR GREEN INSULATION SYSTEMS 9
Requirements, evolving standards of management, testing, usage and disposal of alternate insulation systems, Major applications and standards.

TOTAL: 45 PERIODS

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

CO1 Know about sustainable and environmental energy and products.
CO2 Describe the alternate green gaseous insulators.
CO3 Describe the alternate green liquid insulators.
CO4 Describe the alternate green solid insulators.
CO5 Elaborate the standards for Green insulation systems.

REFERENCES:

1. https://www.iso.org/standard/79064.html
2. https://www.ictfootprint.eu/en/iec-tr-627252013-factsheet
3. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1275,25
4. https://www.iec.ch/ords/f?p=103:41:628762356646470::: :FSP_ORG_ID,FSP_LANG_ID:3237, 25
5. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1299,25
6. https://www.iec.ch/sdgs/sdg13
7. ht https://highperformanceinsulation.eu/wp-content/uploads/ 2016/08/ sustainability_a_guide.pdf

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	-	-	-	-	-	-	-	-	3	-	2	3
CO2	2	2	3	3	-	-	-	-	-	-	-	-	3	-	2	3
CO3	2	2	3	3	-	-	-	-	-	-	-	-	3	-	2	3
CO4	2	2	3	3	-	-	-	-	-	-	-	-	3	-	2	3
CO5	2	2	3	3	-	-	-	-	-	-	-	-	3	-	2	3
Avg	2	2	3	3	-	-	-	-	-	-	-	-	3	-	2	3

CONVERTERS AND DRIVES

PTEE3011 **ELECTRICAL MACHINES – III** **LT P C**
2 0 2 3

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS 6

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMFand Torque equations- Characteristics and control.

UNIT II PERMANENT MAGNET SYNCHROUNOUS MOTORS 6

Principle of operation – EMF and torque equations - Phasor diagram - Power controllers–performance characteristics – Digital controllers – Constructional features, operating principle and characteristics of synchronous reluctance motor.

UNIT III SWITCHED RELUCTANCE MOTORS 6

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

UNIT IV STEPPER MOTORS 6

Constructional features –Principle of operation –Types – Different modes of excitation – Torque equation – Characteristics – Drive circuits – Closed loop control – Applications.

UNIT V STUDY OF OTHER SPECIAL ELECTRICAL MACHINES 6

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

LAB COMPONENT: 30

Using electromagnetic software

1. Simulation of BLDC motor
2. Simulation of SRM motor

3. Simulation of stepper motor
4. Simulation of PMSM motor
5. Simulation of any other special machines

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 model and analyze power electronic systems and equipment usingcomputational software.

CO2 optimally design magnetics required in special machines based drive systems using FEM based software tools.

CO3 analyse the dynamic performance of special electrical machines

CO4 understand the operation and characteristics of other special electrical machines.

CO5 design and conduct experiments towards research.

REFERENCES:

1. T.J.E. Miller, ‘Brushless magnet and Reluctance motor drives’, Clarendon press, London, 1989
2. T.Kenjo, ‘ Stepping motors and their microprocessor controls’, Oxford University press, New Delhi, 2000 Dekker 2009
3. R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017.
4. Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.
5. Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press,Marcel Applications -CRC Press 2009

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	3	1	-	-	-	-	-	1	3	3	2	2
CO2	2	3	3	2	3	1	-	-	-	-	-	1	3	3	2	2
CO3	2	3	3	2	3	1	-	-	-	-	-	1	3	3	2	2
CO4	1	1	1	2	2	1	-	-	-	-	-	1	2	2	2	2
CO5	1	2	2	3	1	1	-	-	-	-	-	1	2	2	1	3
Avg	1.6	2.4	2.2	2.2	3	1	-	-	-	-	-	1	2.6	2.6	1.8	2.2

PTEE3012 ANALYSIS OF ELECTRICAL MACHINES LT P C
2 0 2 3

UNIT I MODELING OF BRUSHED-DC ELECTRIC MACHINERY 6

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

UNIT II REFERENCE FRAME THEORY 6

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

UNIT III INDUCTION MACHINES 6

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

UNIT IV SYNCHRONOUS MACHINES 6

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

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

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

LAB COMPONENT: 30

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

TOTAL : 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

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

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

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

CO4 Find the need and advantages of multiphase machines.

CO5 Demonstrate the working of multiphase induction and synchronous machine.

CO6 Compute the model of three phase and multiphase induction and synchronous machine.

REFERENCES:

1. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition,2020.
2. Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011, 1st Edition.
3. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
4. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015, 1st Edition.
5. R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k.International Publishing House Pvt.Ltd,2018.
6. Chee Mun Ong, Dynamic Simulation of Electric Machinery using MATLAB, Prentice Hall, 1997, 1st Edition.
7. Atif Iqbal,Shaikh Moinoddin, Bhimireddy Prathap Reddy, Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Wiley,2021,1st Edition

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	2	-	-	-	-	-	-	1	3	2	1	1
CO2	3	3	1	1	1	-	-	-	-	-	-	1	3	3	1	1
CO3	2	2	1	1	3	-	-	-	-	-	-	1	3	3	1	1
CO4	2	2	2	1	2	-	-	-	-	-	-	1	3	3	1	2
CO5	2	2	1	1	3	-	-	-	-	-	-	1	3	3	1	2
Avg	2.2	3	1.4	1.2	2.2	-	-	-	-	-	-	1	3	2.8	1	1.4

PTEE3013 MULTILEVEL POWER CONVERTERS **L T P C**
2 0 2 3

UNIT I MULTILEVEL TOPOLOGIES 6

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

UNIT II CASCADED H-BRIDGE MULTILEVEL INVERTERS 6

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation.Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages — PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level- Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes- staircase Modulation.

UNIT III DIODE CLAMPED MULTILEVEL CONVERTER (DCMC) 6

Introduction – Converter structure and Functional Description – Modulation scheme for diode clamped Multilevel converters– Voltage balance Control –Boundary of voltage balancing in DCMC converters –Performance results.

UNIT IV FLYING CAPACITOR MULTILEVEL CONVERTER (FCMC) 6

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltagebalance of FCMC.

UNIT V CASCADED ASYMMETRIC MULTILEVEL CONVERTER 6

Modulation Strategy- Multilevel inverter with reduced switch count-structures, working principles and pulse generationmethods.

LAB COMPONENT: 30

1. Simulation of Fixed PWM, Sinusoidal PWM for an inverter,
2. Simulation of H bridge inverter with R load .
3. Simulation of three level diode clamped MLI with R load.
4. Simulation of three level capacitor clamped MLI with R load
5. Simulation of MLI with reduced switch configuration.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 understand the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.
CO2 analyze the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation.
CO3 comprehend the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count.
CO4 analyze the voltage balancing performance in Diode clamped MLI.
CO5 simulate three level, capacitor clamed and diode clamped MLI with R and RL load.

TEXT BOOKS:

1. Rashid M.H,"Power Electronics Circuits, Devices and Applications", Prentice Hall India,Third Edition, New Delhi, 2014 Pearson 4th edition.
2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla,"Multilevel Converters for Industrial Applications", CRC Press, 22-Jul-2013, 20171st Edition.
3. BinWu, Mehdi Narimani,High Power Converters and AC drives by IEEE press 2017, 2ndEdition.

REFERENCES:

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice,D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1st Edition.
2. Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy,CRC Press, 22-Jan-2013, 2017, 1st Edition.
3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1stEdition.
4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic PressInc,2021, 1st Edition.
5. Iftekhar Maswood, Dehghani Tafti,Advanced Multilevel Converters and Applications in Grid

Integration, Wiley, 2018, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	2	1	-	-	-	-	-	1	3	2	1	2
CO2	2	2	2	1	2	1	-	-	-	-	-	1	3	2	1	2
CO3	2	3	2	1	2	1	-	-	-	-	-	1	3	2	2	3
CO4	2	2	2	1	2	1	-	-	-	-	-	1	3	2	2	2
CO5	2	2	2	1	2	1	-	-	-	-	-	1	3	2	2	2
Avg	2	2.2	2	1	2	1	-	-	-	-	-	1	3	2	1.6	2.2

PTEE3014 ELECTRICAL DRIVES LT P C
2 0 2 3

UNIT I DRIVE CHARACTERISTICS 6
Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 6
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 operationof converter / chopper fed drive.

UNIT III INDUCTION MOTOR DRIVES 6
Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakeningmode – voltage / current fed inverter – closed loop control.

UNIT IV SYNCHRONOUS MOTOR DRIVES 6
V/f control and self-control of synchronous motor: Margin angle control and power factor control — permanent magnet synchronous motor.

UNIT V DESIGN OF CONTROLLERS FOR DRIVES 6
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.

LAB COMPONENT: 30
1. Simulation of converter and chopper fed DC drive
2. Simulation of closed loop operation of stator voltage control of induction motordrive
3. Simulation of closed loop operation of v/f control of induction motor drive
4. Simulation of synchronous motor drive

TOTAL: 60 PERIODS

COURSE OUTCOMES:
After completion the above subject, students will be able to
CO1 understand the basic requirements of motor selection for different load profiles.
CO2 Analyse the steady state behavior and stability aspects of drive systems.
CO3 Analyse the dynamic performance of the DC drive using converter and chopper control.
CO4 Simulate the AC drive.
CO5 Design the controller for electrical drives.

TEXTBOOKS:
1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2nd EditionJanuary 2010.
2. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002 1st Edition.

REFERENCES:

1. S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 3rd Edition 2012.
2. Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988, 1st Edition.
3. Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey,1989, 1st Edition.
4. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India,2001, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	1	-	-	-	-	-	1	3	3	1	2
CO2	2	2	2	2	2	1	-	-	-	-	-	1	3	3	1	2
CO3	2	3	3	2	2	1	-	-	-	-	-	1	3	3	1	2
CO4	2	2	1	2	3	1	-	-	-	-	-	1	3	3	1	2
CO5	1	3	3	2	2	1	-	-	-	-	-	1	3	3	1	2
Avg	1.8	2.4	2.2	2	2.2	1	-	-	-	-	-	1	3	3	1	2

PTEE3015 SMPS AND UPS LT P C
2 0 2 3

UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 6

Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady- state relationships – Introduction to discontinuous conduction mode.

UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS 6

Introduction - classification- forward- flyback- pushpull – half bridge – full bridge topologies- C'ukconverter as cascade combination of boost followed by buck – isolated version of C'uk converter - design of SMPS — Introduction to design of magnetic components for SMPS, using relevant software- Simulation of bidirectional DC DC converter (both non-isolated and isolated) consideringEV as an example application.

UNIT III CONVERTER DYNAMICS 6

AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

UNIT IV CONTROLLER DESIGN 6

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost and buck-boost converters.

UNIT V POWER CONDITIONERS AND UPS 6

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger.

LAB COMPONENT: 30

1. Simulation of Basic topologies.
2. Simulation of bidirectional DC DC converter (both non-isolated and isolated)considering EV as an example application.
3. Simulation of basic topologies using state space model derived – Comparison withthe circuit model based simulation already carried out.
4. Simulation study of controller design for basic topologies.
5. Simulation of battery charger for EV applications.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

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

CO2 build buck/boost converters using suitable design method.

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

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

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

CO6 compare the different topologies of UPS and also simulate them.

TEXT BOOKS:

1. Robert W. Erickson & Dragon Maksimovic, " Fundamentals of Power Electronics", ThirdEdition, 2020
2. Ned Mohan," Power Electronics: A First Course", Johnwiley, 2013.
3. Marian K. Kazimierczuk and Agasthya Ayachit,"Laboratory Manual for Pulse-Width ModulatedDC–DC Power Converters", Wiley 2016.

REFERENCES:

1. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002.
2. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition2017.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	1	-	-	-	-	-	1	3	3	1	3
CO2	2	2	3	3	3	1	-	-	-	-	-	1	3	3	1	3
CO3	2	2	2	3	2	2	-	-	-	-	-	1	3	3	2	3
CO4	1	2	3	3	3	1	-	-	-	-	-	1	3	3	2	3
CO5	2	2	2	3	2	1	-	-	-	-	-	1	3	3	1	2
CO6	1	2	2	2	2	2	-	-	-	-	-	1	3	3	1	2
Avg	1.6	2	2.5	2.6	2.3	1.3	-	-	-	-	-	1	3	3	1.3	2.6

PTEE3016 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS **LT P C**
2 0 2 3

UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 6

Classification of Energy Sources — Importance of Non-conventional energy sources — Advantages and disadvantages of conventional energy sources - Environmental aspects of energy - Impacts ofrenewable energy generation on the environment - Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 6

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 6

Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT IV POWER CONVERTERS FOR WIND SYSTEMS 6

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 6

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind- PV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

LAB COMPONENT: 30

1. Simulation on modelling of Solar PV System- V I Characteristics
2. Simulation on Modelling of fuel cell- V I Characteristics
3. Simulation of self- excited Induction Generator.
4. Simulation of DFIG/ PMSG based Wind turbine.
5. Simulation on Grid integration of RES.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 critically evaluate the available renewable energy sources.
CO2 comprehend the working principles of electrical machines and power converters used for wind energy conversion system.
CO3 comprehend the principles of power converters used for solar PV systems.
CO4 Examine the available hybrid renewable energy systems.
CO5 Simulate AC-DC converters, buck/boost converters, AC-AC converters and PWMinverters.

REFERENCES:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press,2009, 7th impression.
2. Rashid .M. H “Power electronics Hand book”, Academic press,2nd Edition, 2006 4th Edition,2017
3. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017.
4. Rai. G.D,” Solar energy utilization”, Khanna publishers, 5th Edition, 2008.
5. Gray, L. Johnson, “Wind energy system”, prentice hall of india, 2nd Edition, 2006.
6. H.Khan "Non-conventional Energy sources ",Tata McGraw-hill Publishing Company, NewDelhi, 2017, 3rd Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	2	3	-	-	-	-	1	3	3	2	3
CO2	2	2	2	2	2	1	3	-	-	-	-	1	3	3	2	3
CO3	1	2	2	2	2	2	3	-	-	-	-	1	3	3	2	3
CO4	1	2	1	2	2	2	3	-	-	-	-	1	3	3	2	3
CO5	2	2	3	2	3	1	3	-	-	-	-	1	3	3	2	3
Avg	1.4	2	1.8	2	2.2	1.6	3	-	-	-	-	1	3	3	2	3

PTEE3017 CONTROL OF POWER ELECTRONICS CIRCUITS **L T P C**
2 0 2 3

UNIT I SIMULATION BASICS IN CONTROL SYSTEMS **6**

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT II SYMBOLIC CALCULATIONS **6**

Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions-Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices - Other Symbolic Matrix Operations.

UNIT III SLIDING MODE CONTROL BASICS **6**

Introduction- Introduction to Sliding-Mode Control- Basics of Sliding-Mode Theory- Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter.

UNIT IV POWER FACTOR CORRECTION CIRCUITS **6**

Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

UNIT V CONTROLLER DESIGN FOR PFC CIRCUITS **6**

Power factor correction circuit using other SMPS topologies: Cuk and SEPIC converter - PFC circuits employing bridgeless topologies.

LAB COMPONENT: **30**

1. Simulation exercises on zero, first and second order basic blocks.
2. Simulation exercises based on symbolic calculations.
3. Simulation of Sliding mode control based buck converter.
4. Simulation of Single-Phase PFC circuit employing boost converter.
5. Simulation of Single-Phase PFC circuit employing Cuk converters

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 calculate transfer function for constant, differential, integral, First order and Second orderfactors.
CO2 illustrate the effect of poles and zero's in the 's' plane.
CO3 select Symbolic equations for solving problems related with Matrices, Polynomial andvectors.
CO4 compute the control expression for DC – DC buck converter using sliding mode controltheory.
CO5 determine the controller expression for power factor correction circuits.
CO6 simulate sliding mode control of buck converter and power factor correction circuit.

TEXT BOOKS:

1. Feedback Control problems using MATLAB and the Control system tool box By DeanFrederick and Joe Chow, 2000, 1st Edition, Cengage Learning.
2. Ned Mohan,"Power Electronics: A First Course", Johnwiley, 2013, 1st Edition.
3. Marian K. Kazimierczuk and AgasthyaAyachit,"Laboratory Manual for Pulse-WidthModulated DC-DC Power Converters", Wiley 2016, 1st Edition.
4. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002,1st Edition.

REFERENCES:

1. Sliding mode control for Switching Power Converters:, Techniques and Implementation,Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1st Edition, CRC Press.
2. Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.
3. MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	-	-	-	-	-	1	3	3	1	3
CO2	2	2	1	2	2	1	-	-	-	-	-	1	3	3	1	2
CO3	2	2	2	2	2	1	-	-	-	-	-	1	3	3	2	2
CO4	3	2	2	3	2	1	-	-	-	-	-	1	3	3	2	2
CO5	2	2	2	3	3	2	-	-	-	-	-	1	3	3	2	2
CO6	2	2	2	2	3	2	-	-	-	-	-	1	3	2	2	2
Avg	2.2	2	1.8	2.3	2.3	1.5	-	-	-	-	-	1	3	2.8	1.6	2.2

PTEE3018 **POWER QUALITY** **LT P C**
3 0 0 3

UNIT I INTRODUCTION TO POWER QUALITY 7

Terms and definitions – Overloading, under voltage, over voltage - Concepts of transients - Short duration variations such as interruption - Long duration variation such as sustained interruption - Voltage sag - Voltage swell - Voltage imbalance – Voltage fluctuation - Power frequency variations - International standards of power quality – Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNIT II VOLTAGE SAGS AND INTERRUPTIONS 7

Sources of sags and interruptions - Estimating voltage sag performance - Thevenin's equivalent source - Analysis and calculation of various faulted condition - Voltage sag due to induction motor starting - Estimation of the sag severity - Mitigation of voltage sags, active series compensators - Static transfer switches and fast transfer switches.

UNIT III OVERVOLTAGES & HARMONICS 7

Sources of over voltages - Capacitor switching – Lightning - Ferro resonance - Mitigation of voltage swells - Surge arresters - Low pass filters - Power conditioners - Lightning protection – Shielding - Line arresters - Protection of transformers and cables - Harmonics Vs transients. Effect of harmonics – Harmonic distortion - Voltage and current distortion - Harmonic indices - Devices for controlling harmonic distortion - Passive and active filters.

UNIT IV POWER QUALITY MONITORING 7

Monitoring considerations - Monitoring and diagnostic techniques for various power quality problems - Modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - Power line disturbance analyzer – Quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters - Disturbance analyzer.

UNIT V POWER QUALITY MITIGATION 7

Conventional load Compensation methods: Harmonic reduction & Voltage Sag reduction – Analysis of Unbalance – Load compensation using DSTATCOM: Ideal 3-phase Shunt Compensation structure, Reference current generation, realization and control of DSTATCOM – Introduction to series compensation using DVR.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion the above subject, students will be able to

CO1 Comprehend the Basics of Power Quality issues and their Standards.

CO2 Understand the concepts of Sag and Swell problems.

CO3 Appreciate the harmonic problems and understand the enhancement methods.

CO4 Analyze the Power Quality problems and understand the monitoring Instruments.

CO5 Understand the mitigation methods including conventional compensation and modern techniques like usage of DSTATCOM and DVR.

TEXTBOOKS:

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, “Electrical Power Systems Quality”, McGraw Hill,2003.
2. J. Arrillaga, N.R. Watson, S. Chen, “Power System Quality Assessment”, (New York: Wiley, 1999).

REFERENCES:

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, 1999).
3. Arindhan Ghosh, “Power Quality Enhancement using custom Power Devices, Kluwer Academic Publishers,2002

List of Open Source Software/ Learning website:

http://nptel.iitm.ac.in/courses.php

https://old.amu.ac.in/emp/studym/2442.pdf

https://electricalacademia.com/electric-power

https://www.intechopen.com/books/6214

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

https://www.academia.edu/43237017/

Use_Series_Compensation_in_Distribution_Networks_33_KV

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	1	1	1	-	1	-	-	-	-	2	2	1	1
CO2	1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1
CO3	1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1
CO4	1	2	2	3	3	3	-	-	-	-	-	-	2	2	3	1
CO5	1	3	3	3	1	3	1	1	-	-	-	-	2	2	3	3
Avg	1	1.6	1.6	1.8	1.4	1	1	1	-	-	-	-	2	2	1.8	1.4

EMBEDDED SYSTEMS

PTEE3019 **EMBEDDED SYSTEM DESIGN** **LT P C**
2 0 2 3

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 6
Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA –– Memory management methods- Timer and Counting devices, Real Time Clock, In-circuit emulator, Target Hardware Debugging.

UNIT II EMBEDDED NETWORKING 6
Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS485 – CAN Bus- Serial Peripheral Interface (SPI) – Inter- Integrated Circuits (I^2C).

UNIT III INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER 6
Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept-interrupt sources – multiple interrupts – context and periods for context switching, interrupt latency and deadline — Introduction to Device Drivers.

UNIT IV RTOS-BASED EMBEDDED SYSTEM DESIGN 6
Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication-shared memory, message passing- Interprocess Communication- Introduction to process synchronization using semaphores.

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 6
Embedded Product Development Life Cycle - Case Study: Precision Agriculture- Autonomous car.

LAB COMPONENT: 30

1.Laboratory exercise:Use any Embedded processor/IDE/open source platform to give hands-on training on basic concepts of embedded system design:
   a. Introduction to IDE and Programming Environment.
   b. Configure timer block for signal generation (with given frequency).
   c. Interrupts programming example using GPIO.
   d. I^2C communication with peripherals
   e. Master-slave communication between processors using SPI.
   f. Networking of processor using Wi-Fi.
   g. Basic RTOS concept and programming

2.Assignment: Introduction to VxWorks, чC/OS-II, RT Linux

3.Embedded systems-based Mini project

TOTAL:60 PERIODS

COURSE OUTCOMES:
CO1 The hardware functionals and software strategies required to develop various Embedded systems.
CO2 The basic differences between various Bus communication standards.
CO3 The incorporation of the interface as Interrupt services.
CO4 The various scheduling algorithms through a Real-time operating system.
CO5 The various embedded concepts for developing automation applications.

TEXTBOOKS:

1. Rajkamal, ‘Embedded system-Architecture, Programming, Design, McGraw-Hill Edu, 3rd edition 2017
2. Peckol, “Embedded system Design”, John Wiley & Sons,2010.

REFERENCES:

1. Shibu. K.V, "Introduction to Embedded Systems", TataMcgraw Hill, 2nd edition 2017.
2. Lya B.Das," Embedded Systems" ,Pearson Education, 1st edition 2012.
3. Parag H.Dave,Himanshu B.Dave," Embedded Systems-Concepts ,Design and Programming, Pearson Education,2015, 1st edition.
4. Elicia White, "Making Embedded systems", O'Reilly Series ,SPD,2011, 1st edition.
5. Jonathan W. Valvano, 'Embedded Microcomputer Systems Real-time Interfacing', Cengage Learning , 3rd edition 2010.
6. Tammy Noergaard, "Embedded Systems Architecture", Newnes, 2nd edition, 2013.

List of Open Source Software/ Learning websites:

https://nptel.ac.in/courses/108102045

https://ece.uwaterloo.ca/~dwharder/icsrts/Lecture materials/A_practical_introduction_to_re al-time_systems_for_undergraduate_engineering.pdf

https://www.circuitbasics.com/basics-of-the-i2c-communication-protocol/

https://www.tutorialspoint.com/embedded_systems/es_interrupts.htm

https://www.theengineeringprojects.com/2016/11/examples-of-embedded-systems.html#:~:text=Embedded%20 Product%3A%20Automatic%20Washing%20Machine, done%20by%20your%20machine%20itself.

MAPPING OF COs WITH POs AND PSOs

:

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	1	1	1	1	-	2	2	3	3	2	1
CO2	2	2	3	2	2	1	1	1	1	-	2	2	2	3	2	2
CO3	2	3	1	2	1	1	1	1	1	-	2	1	1	1	1	2
CO4	3	2	1	1	2	1	1	1	1	-	2	1	1	2	1	1
CO5	2	1	2	3	3	1	1	1	1	-	2	1	2	2	1	3
Avg	2.4	2.2	1.8	2	2.2	1	1	1	1	-	2	1.3	1.8	2.2	1.4	1.8

PTEE3020 EMBEDDED C- PROGRAMMING LT P C
2 0 2 3

UNIT I BASIC C PROGRAMMING 6

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT II EMBEDDED C 6

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

UNIT III 8051 Programming in C 6

Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051 Accessing code ROM space in 8051, Data serialization using 8051.

UNIT IV 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C 6

Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051interrupts and programming, Programming for timer configuration.

UNIT V 8051 INTERFACING 6

8051:ADC interfacing , DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motorinterfacing.

LAB COMPONENT: 30

1. Laboratory exercise: Use 8051 microcontroller/Embedded processor/IDE/open sourceplatform to give hands-on training on Embedded C- programming.
   a. Introduction to IDE (like code blocks, vscode ,etc)and Programming Environment (likeKeililu vision, Proteus)
   b. Configuring an I/O port using bitwise programming.
   c. Configuring timer for generating hardware delay.
   d. Flashing an LED using an interrupt
   e. Serial communication using UART port of 8051
   f. Interfacing an ADC with 8051
   g. Interfacing an analog sensor with 8051
   h. Interfacing 16x2 LCD with 8051
   i. configuring timer for generating PWM signal
   j. Interfacing a stepper motor with 8051
2. Assignment: Introduction to Arduino IDE, Raspberry Pi
3. Embedded C-Programming -based Mini project.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Deliver insight into embedded C programming and its salient features for embeddedsystems.

CO2 Illustrate the software and hardware architecture for distributed computing in embedded systems.

CO3 Develop a solution for problems by using the concept learned in programming using the embedded controllers.

CO4 Develop simple applications with 8051 by using its various features and interfacing with various external hardware.

CO5 Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.

TEXTBOOKS:

1. Paul Deitel and Harvey Deitel, “C How to Program”, 9th Edition, Pearson EducationLimited, 2022, 1st edition.
2. Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.
3. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006.
4. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor &Francis Group, 2019

REFERENCES:

1. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015, 1st edition.
2. Steve Oualline, "Practical C programming", O'Reilly Media, 1997, 3rd edition.
3. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051Microcontroller and Embedded Systems’ Prentice Hall, 2nd Edition 2007.
4. Myke Predko, “Programming and customizing the 8051 microcontrollers”,McGrawwHill 2000, 1st edition.

List of Open Source Software/ Learning websites:

https://www.hackerrank.com/
https://www.cprogramming.com/
https://www.allaboutcircuits.com/technical-articles/introduction-to-the-c-programming-language-for-embedded-applications/
https://onlinecourses.nptel.ac.in/noc19_cs42/preview
https://microcontrollerslab.com/8051-microcontroller-tutorials-c/
https://www.circuitstoday.com/getting-started-with-keil-uvision

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
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CO2	2	2	2	3	2	-	-	-	1	-	1	1	1	2	2	2
CO3	3	1	2	1	1	-	-	-	1	-	1	2	1	1	1	2
CO4	2	3	3	1	1	-	-	-	1	-	1	2	1	2	1	3
CO5	2	2	2	3	2	-	-	-	1	-	1	1	1	2	1	3
Avg	2.4	2.2	2.2	2	1.8	-	-	-	1	-	1	1.6	1	1.8	1.2	2.6

PTEE3021 EMBEDDED PROCESSORS LT P C
2 0 2 3

UNIT I ARM ARCHITECTURE 6
Architecture – Memory Organization – addressing modes -Registers – Pipeline - Interrupts – Coprocessors — Interrupt Structure.

UNIT II ARM MICROCONTROLLER PROGRAMMING 6
ARM general Instruction set — Thumb instruction set –Introduction to DSP on ARM- basic programming.

UNIT III PERIPHERALS OF ARM 6
ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication withPC – ADC/DAC Interfacing-stepper motor interfacing.

UNIT IV ARM COMMUNICATION 6
ARM With CAN, I^2C, and SPI protocols.

UNIT V INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR 6
Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands -Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi.

LAB COMPONENTS: 30

1. Laboratory exercise:
   a) Programming with IDE - ARM microcontroller
   b) Advanced Timer Features, PWM Generator.
   c) RTC interfacing with ARM using Serial communication programming, Stepper motorcontrol.
   d) ARM-Based Wireless Environmental Parameter Monitoring System displayed throughMobile device.
2. Seminar:
   a) ARM and GSM/GPS interfacing
   b) Introduction to ARM Cortex Processor
3. Raspberry Pi based Mini project.

TOTAL:60 PERIODS

COURSE OUTCOMES:

CO1 Interpret the basics and functionality of processor functional blocks.
CO2 Observe the specialty of RISC processor Architecture.
CO3 Incorporate the I/O hardware interface of processor with peripherals.
CO4 Emphasis the communication features of the processor.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors.

TEXT BOOKS:

1. Steve Furber, 'ARM system on chip architecture',Addisonn Wesley,2nd Edition,2015.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield's ARM System Developer'sGuide Designing and Optimizing System Software', Elsevier 2004, 1st Edition.

REFERENCES:

1. William Hohl, ' ARMAssebly Language' Fundamentals and Techniques, CRC Press, 2nd Edition 2014.
2. Rajkamal," Microcontrollers Architecture, Programming, Interfacing, & System Design, Pearson,2012, 2nd Edition.
3. ARM Architecture Reference Manual, LPC214x User Manual www.Nuvoton .com/websites on Advanced ARM Cortex Processors
4. ARM System Developer's Guide: Designing and Optimizing System Software 1st Edition (Designing and Optimizing System Software) Publisher: Morgan Kaufmann Publishers, 2011.

List of Open Source Software/ Learning websites:

https://nptel.ac.in/courses/117106111
https://onlinecourses.nptel.ac.in/noc20_cs15/preview
https://www.csie.ntu.edu.tw/ ~cyy/courses/assembly/12fall/lectures/handouts/lec08_ARMarch.pdf
https://maxembedded.com/2013/07/introduction-to-single-board-computing/
https://www.youtube.com/watch?v=J4fhE4Pp55E&list=PLGs0VKk2DiYypuwUUM2wxzcl9B JHK4Bfh

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	-	-	-	1	-	1	2	3	3	2	1
CO2	2	2	3	2	2	-	-	-	1	-	1	2	2	3	2	2
CO3	2	3	1	2	1	-	-	-	1	-	1	1	1	1	1	2
CO4	3	2	1	1	2	-	-	-	1	-	1	1	1	2	1	1
CO5	2	1	2	3	3	-	-	-	1	-	1	1	2	2	1	3
Avg	2.4	2.2	1.8	2	2.2	-	-	-	1	-	1	1.3	1.8	2.2	1.4	1.8

PTEE3022 EMBEDDED CONTROL FOR ELECTRIC DRIVES **L T P C**
2 0 2 3

UNIT I INTRODUCTION TO ELECTRIC DRIVES **6**

Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives.

UNIT II EMBEDDED SYSTEM FOR MOTOR CONTROL **6**

Embedded Processors choice for motor control- Sensors and interface modules for Electric drives-IoT for Electrical drives applications.

UNIT III INDUCTION MOTOR CONTROL **6**

Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Basedspeed control for three-phase induction motor- Embedded processor based three phase inductionmotor speed control.

UNIT IV BLDC MOTOR CONTROL **6**

Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BDLC motor speed control.

UNIT V SRM MOTOR CONTROL **6**

Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor basedSRM motor speed control.

LAB COMPONENTS:

30

1. Laboratory exercise: Use any System level simulator/MATLAB/open source platform togive hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phase inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package
3. Seminar: IoT-based Control and Monitoring for DC Motor/ any Electric drives.
4. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Interpret the significance of embedded control of electrical drives.
CO2 Deliver insight into various control strategies for electrical drives.
CO3 Developing knowledge of Machine learning and optimization techniques for motor control.
CO4 Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

TEXT BOOKS:

1. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”,Prentice-Hall of India Pvt. Ltd., New Delhi,2010, 1st Edition.
2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1st Edition.

REFERENCES:

1. VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2nd Edition.
2. K. Venkataratnam ,Special Electrical Machines, Universities Press, 2014, 1st Edition.
3. Steve Furber, ‘ARM system on chip architecture’, Addision Wesley, 2nd Edition 2015.
4. Ron Sass and AnderewG.Schmidt, “ Embedded System design with platform FPGAs:Principles and Practices”, Elsevier, 2010, 1st Edition.
5. Tim Wescott , Applied Control Theory for Embedded Systems **,** Elsevier, 2006, 1st Edition.

List of Open Source Software/ Learning website:

1. https://archive.nptel.ac.in/courses/108/104/108104140/
2. https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/
3. https://www.e3sconferences.org/articles/e3sconf/pdf/2019/13/e3sconf SeFet2019_01004.pdf
4. https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html
5. http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	2	-	1	-	1	-	1	1	3	2	1	1
CO2	3	3	1	1	1	-	1	-	1	-	1	1	3	3	1	1
CO3	2	2	1	1	3	-	1	-	1	-	1	1	3	3	1	1
CO4	2	2	2	1	2	-	1	-	1	-	1	1	3	3	1	2
CO5	2	2	1	1	3	-	1	-	1	-	1	1	3	3	1	2
Avg	2.2	2.4	1.4	1.2	2.2	-	1	-	1	-	1	1	3	2.8	1	1.4

PTEE3023 SMART SYSTEM AUTOMATION LT P C
2 0 2 3

UNIT I INTRODUCTION 6
Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.

UNIT II HOME AUTOMATION 6
Home Automation – System Architecture - Essential Components- Design Considerations: ControlUnit, Sensing Requirements, Communication, Data Security.

UNIT III SMART APPLIANCES AND ENERGY MANAGEMENT 6
Significance of smart appliances for energy management -Smart Meters: Significance, Architecture& Energy Measurement Technique — Security Considerations.

UNIT IV SMART WEARABLE DEVICES 6
Body Area Networks - Sensors– communication protocol for Wearable devices- Application ofSmart Wearable in Healthcare & Activity Monitoring.

UNIT V EMBEDDED SYSTEMS AND ROBOTICS 6
Fundamental concepts in Robotics- Robots and Controllers components - Embedded processorbased: pick and place robot- Mobile Robot Design- UAV.

LAB COMPONENTS: 30

1. Laboratory exercise: Use Arduino/ R pi/ any other Embedded processors to givehands on training to understand concepts related to smart automation.
   a. Hands on experiments based on Ubidots & Thing speak / Open-source AnalyticsPlatform
   b. Design and implementation of a smart home system .
   c. Bluetooth Based Home Automation Project using Android Phone
   d. GSM Based Home Devices Control
   e. Pick and place robots using Arduino/ any suitable Embedded processor
2. Assignment: Revolution of Smart Automation system across the world and itscurrent scope available in India
3. Mini project: Design of a Smart Automation system (for any application ofstudents choice)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Understand the concepts of smart system design and its present developments.
CO2 Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.
CO3 Acquire knowledge on different platforms and Infrastructure for Smart system design.
CO4 Infer about smart appliances and energy management concepts.
CO5 Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

TEXTBOOKS:

1. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems forSmart Appliances and Energy Management, Springer 2013, 1st Edition.
2. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology,Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition.
3. NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-SourceTools, CRC press, 2016, 1st Edition.

REFERENCES:

1. Thomas Bräunl, Embedded Robotics, Springer, 2003.
2. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill,2008
3. Karim Yaghmour, Embedded Android, O'Reilly, 2013.

4. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress , 2013
5. C.K. Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.
6. Anna Ha´c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003.
7. J. J. Craig, “Introduction to Robotics Mechanics and Control”, Pearson Education.
8. Y. Koren, “Robotics for Engineers”, McGraw-Hill.
9. Robert Faludi, Wireless Sensor Networks, O’Reilly, 2011.

List of Open Source Software/ Learning website:
https://microcontrollerslab.com/home-automation-projects-ideas/
https://www.learnrobotics.org/blog/simple-robot/
https://robolabor.ee/homelab/en/iot
https://electrovolt.ir/wp-content/uploads/2018/03/ExploringRaspberryPiMolloyDerekElectroVolt.ir.pdf
http://www.robot.bmstu.ru/files/books/(Ebook%20-%20English)%20Mcgraw-Hil,%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	1	1	-	1	-	1	2	3	3	2	1
CO2	2	2	3	2	2	1	1	-	1	-	1	2	2	3	2	2
CO3	2	3	1	2	1	1	1	-	1	-	1	1	1	1	1	2
CO4	3	2	1	1	2	1	1	-	1	-	1	1	1	2	1	1
CO5	2	1	2	3	3	1	1	-	1	-	1	1	2	2	1	3
Avg	2.4	2.2	1.8	2	2.2	1	1	-	1	-	1	1.3	1.8	2.2	1.4	1.8

PTEE3024 EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS LT P C
2 0 2 3

UNIT I INTRODUCTION TO AUTOMOTIVE SYSTEMS 6
Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicleperformance; Electronic control Unit– open-source ECU.

UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES 6
Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.

UNIT III VEHICLE MANAGEMENT SYSTEMS 6
Energy Management system -Adaptive cruise control - anti-locking braking system - Safety andCollision Avoidance.

UNIT IV ONBOARD DIAGONSTICS AND COMMUNICATION 6
OBD , Vehicle communication protocols- Bluetooth, CAN, LIN, FLEXRAY and MOST.

UNIT V RECENT TRENDS 6
Navigation- Autonomous car- Role of IoT in Automotive systems.

LAB COMPONENTS: 30
1. Laboratory exercise:Use MATLAB SIMULINK /equivalent simulation /open source tools
    a. Simulation study of automotive sensors and actuators components.
    b. Adaptive cruise control, Anti-Lock Braking System.
    c. CAN Connectivity in an Automotive Application using vehicle network toolbox.
    d. Interfacing a sensor used in car with microcontroller.

e. Establishing connection between Bluetooth module and microcontroller.

2. Assignment: AUTOSAR
3. Mini project : Battery Management system for EV batteries

TOTAL:60 PERIODS

COURSE OUTCOMES:

CO1 Insight into the significance of the role of embedded system for automotive applications.
CO2 Illustrate the need, selection of sensors and actuators and interfacing with ECU.
CO3 Develop the Embedded concepts for vehicle management and control systems.
CO4 Demonstrate the need of Electrical vehicle and able to apply the embedded systemtechnology for various aspects of EVs.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation onrecent trends in embedded systems design and its application in automotive systems.

TEXTBOOKS:

1. William B. Ribbens ,"Understanding Automotive Electronics", Elseiver,8th Edition, 2017.
2. Jurgen, R., Automotive Electronics Hand Book, McGraw Hill, 2nd Edition, 1999.
3. L.Vlacic,M.Parent,F.Harahima,"Intelligent Vehicle Technologies",SAE International, 2001, 1stEdition, 2017.

REFERENCES:

1. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Airand Space Vehicles" Marcel Decker, 2004, 1st Edition.
2. Jack Erjavec,JeffArias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel CellVehicles",Cengage ,2012, 2nd Edition.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection –Ford 2nd Edition, 2004.
4. Automotive Electricals / Electronics System and Components, Tom Denton, 5th Edition, 2017.
5. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, andVehicle", Springer; 1st Edition, 2005.
6. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5th Edition 2014.
7. Automotive Hand Book, Robert Bosch, Bently Publishers, 10th Edition, 2018.

List of Open Source Software/ Learning website:

1. https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2. https://microcontrollerslab.com/can-communication-protocol/
3. https://ackodrive.com/car-guide/different-types-of-car-sensors/
4. https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/
5. https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/
6. https://www.synopsys.com/automotive/what-is-autonomous-car.html

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	-	1	-	1	1	1	2	3	3	2	1
CO2	2	2	3	2	2	-	1	-	1	1	1	2	2	3	2	2
CO3	2	3	1	2	1	-	1	-	1	1	1	1	1	1	1	2
CO4	3	2	1	1	2	-	1	-	1	1	1	1	1	2	1	1
CO5	2	1	2	3	3	-	1	-	1	1	1	1	2	2	1	3
Avg	2.4	2.2	1.8	2	2.2	-	1	-	1	1	1	1.3	1.8	2.2	1.4	1.8

PTEE3025 **VLSI DESIGN** **LT P C**
2 0 2 3

UNIT I CMOS BASICS **6**

MOSFET Scaling - CMOS logic design- Dynamic CMOS –Transmission Gates- BiCMOS.

UNIT II IC FABRICATION **6**

CMOS IC Fabrications: n well, p well, twin tub, SoI - Design Rules and Layout.

UNIT III PROGRAMABLE LOGIC DEVICES **6**

PAL, PLA, CPLD architecture and application.

UNIT IV RECONFIGURABLE PROCESSOR **6**

FPGA- Architecture, FPGA based application development- Introduction to FPAA.

UNIT V HDL PROGRAMMING **6**

Verilog HDL- Overview - structural and behavioural modeling concepts-Design examples- CarryLook ahead adders, ALU, Shift Registers.

LAB COMPONENTS: **30**

1. Laboratory exercise : Use any FPGA Board /IDE/open source package/ platform to givehands on training on CMOS design/ reconfigurable processor based applications,
   a. CMOS logic circuit simulation using any open source software package
   b. Experiments : structural and behavioural modeling based Verilog HDL programs
   c. Experiment: Combinational and sequential Digital logic implementation withFPGA.
   d. Implementation of carry look ahead adder with FPGA
   e. Implementation of ALU with FPGA
2. Assignment : Low Power VLSI.
3. FPGA based Mini project.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Develop CMOS design techniques.
CO2 Learn and build IC fabrication.
CO3 Explain the need of reconfigurable computing with PLDs.
CO4 Design and development of reprogrammable FPGA.
CO5 Illustrate and develop HDL computational processes with improved design strategies.

TEXTBOOKS:

1. M.J.S Smith, “Application Specific integrated circuits”,Addition Wesley Longman Inc. 1st Edition2010.
2. Kamran Eshraghian,Douglas A.pucknell and Sholeh Eshraghian,”Essentials of VLSI circuits andsystem”, Prentice Hall India,2005, 1st Edition.

REFERENCES:

1. Donald G. Givone, “Digital principles and Design”, Tata McGraw Hill 2002, 1st Edition.
2. Charles H. Roth Jr., “Fundamentals of Logic design”, Thomson Learning, 7th Edition 2013.
3. Nurmi, Jari (Ed.) "Processor Design System-On-Chip Computing for ASICs and FPGAs"Springer, 2007, 1st Edition.
4. Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011, 1st Edition.
5. Pierre-Emmanuel Gaillardon, Reconfigurable Logic: Architecture, Tools, and Applications,1st Edition, CRC Press , 2018.

List of Open Source Software/ Learning website:

https://archive.nptel.ac.in/courses/108/107/108107129/
http://gn.dronacharya.info/ ECEDept/Downloads/QuestionPapers/ 7th_Sem/VLSI-DESIGN/UNIT-1/Lecture-3.pdf
https://web.itu.edu.tr/~ateserd/vlsi2/2007/FPGAs&CPLD.pdf
https://kanchiuniv.ac.in/coursematerials/GSK_Notes_on_PLD_in_VLSI_design.pdf
https://www.xilinx.com/products/silicon-devices/resources/programming-an-fpga-an- introduction-to-how-it-works.html
https://www.allaboutcircuits.com/technical-articles/what-is-an-fpga-introduction-to- programmable-logic-fpga-vs-microcontroller/
https://www.tutorialspoint.com/vlsi_design/vlsi_design_vhdl_introduction.htm#:~:text=VHDL%20stands%20for%20very%20high,DoD)%20under%20the%20VHSIC%20program

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	2	-	1	-	1	-	1	1	3	2	1	1
CO2	3	3	1	1	1	-	1	-	1	-	1	1	3	3	1	1
CO3	2	2	1	1	3	-	1	-	1	-	1	1	3	3	1	1
CO4	2	2	2	1	2	-	1	-	1	-	1	1	3	3	1	2
CO5	2	2	1	1	3	-	1	-	1	-	1	1	3	3	1	2
Avg	2.2	2.4	1.4	1.2	2.2	-	1	-	1	-	1	1	3	2.8	1	1.4

PTEE3026 MEMS AND NEMS L T P C
2 0 2 3

UNIT I INTRODUCTION TO MEMS and NEMS 6

Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling- Materials for MEMS and NEMS - Applications of MEMS and NEMS.

UNIT II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES 6

Photolithography- Micro manufacturing, Bulk micro machining, surface micro machining, LIGA.

UNIT III MICRO SENSORS AND MICRO ACTUATORS 6

Micromachining : Capactive Sensors- Piezoresistive Sensors- Piezoelectric actuators.

UNIT IV NEMS TECHNOLOGY 6

Atomic scale precision engineering- Nano Fabrication techniques – NEMS for sensors andactuators.

UNIT V MEMS and NEMS APPLICATION 6

Bio MEMS- Optical NEMS- Micro motors- Smart Sensors - Recent trends in MEMS and NEMS.

LAB COMPONENTS: 30

1. Laboratory experiment: Simulation of MEMS sensors and actuators using Multi physics tool
    a. Simulation of a typical piezo resistive sensor
    b. Simulation of a typical Piezoelectric actuator
    c. Simulation study of a bio sensor
    d. Simulation study of a micro motor
2. Assignment: Role of MEMS AND NEMS devices for Industry Standard 5.0.
3. Mini project : Design and analysis of any MEMS/NEMS device using multi physics tool

TOTAL:60 PERIODS

COURSE OUTCOMES:

CO1 Explain the material properties and the significance of MEMS and NEMS for industrial automation.
CO2 Demonstrate knowledge delivery on micromachining and micro fabrication.
CO3 Apply the fabrication mechanism for MEMS sensor and actuators.
CO4 Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation onMEMS and NEMS technology.

TEXTBOOKS:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2011, 2nd Edition.
2. Tai-.Ran Hsu, “MEMS and Microsystems: design , manufacture, and Nanoscale”- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
3. Lyshevski, S.E. “ Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering “ (2nd ed.). CRC Press,2005.
4. Julian W Gardner and Vijay K Varadan, “ Microsensors, MEMS and Smart Devices”, John Wiley and Sons Ltd, 2001, 1st Edition.

REFERENCES:

1. Marc F madou“ Fundamentals of micro fabrication” CRC Press 2002 2nd Edition Marc Madou.
2. M.H.Bao “Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes”,Elsevier, Newyork, 16 Oct 2000, 1st Edition.
3. Maluf, Nadim “An introduction to Micro Electro-mechanical Systems Engineering “AR Tech house, Boston, June 30 2004, 2nd Edition.
4. Mohamed Gad – el – Hak “MEMS Handbook” Edited CRC Press 2001, 1st Edition.

List of Open Source Software/ Learning website:

https://www.academia.edu/Lectures_on_MEMS_and
_MICROSYSTEMS_DESIGN_AND_M ANUFACTURE
https://nptel.ac.in/courses
https://www.iitk.ac.in/me/mems-fabrication
http://mems.iiti.ac.in/
https://onlinecourses.nptel.ac.in/noc22_ee36/preview

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	2	1	-	-	1	-	1	1	3	2	1	1
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CO3	2	2	1	1	3	1	-	-	1	-	1	1	3	3	1	1
CO4	3	1	2	1	2	1	-	-	1	-	1	1	3	2	1	2
CO5	1	2	1	1	3	1	-	-	1	-	1	1	3	3	1	2
Avg	2.2	2.2	1.4	1.2	2.2	1	-	-	1	-	1	1.2	3	2.4	1	1.4

PTEE3027 DIGITAL SIGNAL PROCESSING LT P C
2 0 2 3

UNIT I INTRODUCTION 6

Classification of systems: Continuous, discrete, linear, causal, stable, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect. Digital signal representation.

UNIT II DISCRETE TIME SYSTEM ANALYSIS 6

Z-transform and its properties, inverse z-transforms; difference equation – Solution by z-transform, application to discrete systems - Stability analysis, frequency response – Convolution – Introduction to Fourier Transform– Discrete time Fourier transform.

UNIT III DISCRETE FOURIER TRANSFORM & COMPUTATION 6

DFT properties, magnitude and phase representation - Computation of DFT using FFT algorithm –DIT & DIF - FFT using radix 2 — Butterfly structure.

UNIT IV DESIGN OF DIGITAL FILTERS 6

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

UNIT V DIGITAL SIGNAL PROCESSORS 6

Introduction – Architecture of one DSP processor for motor control – Features – AddressingFormats– Functional modes - Introduction to Commercial Processors.

LAB COMPONENTS: 30

1. Laboratory exercise : Use any DSP processor/MATLAB/open source platform to givehands on

training on basic concepts of Digital Signal Processing

a. To determine impulse and step response of two vectors
b. To perform convolution between two vectors .
c. To compute DFT and IDFT of a given sequence.
d. To perform linear convolution of two sequence using DFT
e. Design and Implementation of FIR Filter
f. Design and Implementation of IIR Filter
g. To determine z-transform from the given transfer function and its ROC

2. Assignment: Implementation of FIR/IIR filter with FPGA.
3. DSP processors based Mini project

TOTAL:60 PERIODS

COURSE OUTCOMES:

CO1 Explain the concepts of digital signal processing.
CO2 Illustrate the system representation using transforms.
CO3 Learn the transformation techniques for time to frequency conversion.
CO4 Design suitable digital FIR, IIR algorithm for the given specification.
CO5 Use digital signal processor for application development.

TEXTBOOKS:

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, 4th Edition 2007.
2. Robert J.Schilling & Sandra L.Harris ,' Introduction to Digital Signal Processing usingMATLAB', Cengage Learning, 2nd Edition 2013.

REFERENCES:

1. Emmanuel C Ifeachor and Barrie W Jervis ,"Digital Signal Processing – A Practical approach" Pearson Education, Second edition, 2002.
2. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, 'Discrete – Time Signal Processing',Pearson Education, New Delhi, 2nd Edition 2012.
3. SenM.kuo, Woonseng…s.gan, "Digital Signal Processors, Architecture, Implementations & Applications, Pearson, 1st Edition 2004.
4. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', Tata McGraw Hill, New Delhi, 4th Edition 2013.
5. B. Venkataramani, M. Bhaskar, 'Digital Signal Processors, Architecture, Programming and Applications', Tata McGraw Hill, New Delhi, 2003, 1st Edition.

List of Open Source Software/ Learning website:

https://nptel.ac.in/courses/117102060
https://www.tutorialspoint.com/digital_signal_processing/index.htm
https://www.elprocus.com/digital-signal-processor/
https://www.sciencedirect.com/topics/computer-science/digital-signal-processing- algorithm#:~:text =Digital%20signal%20processing%20algorithms%20are,known%20as%20 operations%20or%20ops
https://www.electronicshub.org/introduction-to-fpga/

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	2	1	-	-	1	-	1	1	3	2	1	1
CO2	3	3	1	1	1	1	-	-	1	-	1	1	3	3	1	1
CO3	2	2	1	1	3	1	-	-	1	-	1	1	3	3	1	1
CO4	2	2	2	1	2	1	-	-	1	-	1	1	3	3	1	2
CO5	2	2	1	1	3	1	-	-	1	-	1	1	3	3	1	2
Avg	2.2	2.4	1.4	1.2	2.2	1	-	-	1	-	1	1	3	2.8	1	1.4

PTEE3028 PLC PROGRAMMING LT P C
3 0 0 3

UNIT I INTRODUCTION 7

Programmable Logic Controller (PLC)- Block diagram of PLC- Programming languages of PLC-Basic instruction sets- Design of alarm and interlocks- Networking of PLC- Overview of safety ofPLC with case studies- Process Safety Automation: Levels of process safety through use of PLCs- IEC 61131-3 Standard - Application of international standards in process safety control.

UNIT II IEC 61131-3 7

Rails- Rungs- Relay Logic- Latch switch- Timers- Counters- Boolean logics- Math Instructions- Data manipulation Instructions- Requirement of communication networks for PLC, PLC to PC Communication to computer- FBD equivalent to LL- FBD Programming- IL- SFC-ST.

UNIT III SCADA 7

Elements of SCADA system- History of SCADA, Remote Terminal Unit- Discrete control- Analogcontrol, Master Terminal Unit- Operator interface.

UNIT IV HART and Field Bus 7

Introduction- Evolution of signal standards- HART communication protocol- communication modes- HART networks- HART commands- HART and OSI model- Field bus- Architecture- Basic requirements of field Busstandard- Field bus Topology- Interoperability- Interchangeability.

UNIT V PLC PROGRAMMING 7

Exercise in Programming Languages from IEC 61131-3: Traffic Light Control- Two way- Four way — Water Level Control- Automatic Material Sorting System- Automatic Bottle Filling System, Code Converters- DC motor Control- Alarm Circuit.

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

10

1. Taking Local area to implement simple closed loop system for any system using PLC.
2. Making a complete automated control loop with Supervisory and HMI system.
3. Implementing an Alarm based control scheme and run in a simulated environment.
4. Designing an entire PLC logic for filling and draining water tank automatically.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 Understand the basics and need for Automation in industries.
CO2 Explain the logic and flow of any particular programming written for a process.
CO3 Apply the knowledge to design or improve an existing program to increase productivity of any process.
CO4 Breakdown SCADA architecture and communication protocols.
CO5 Build and logic in any of the programming languages from IEC- 61131- 3 standard.

TEXT BOOKS:

1. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York,2019.
2. Stuart Boyer A, “SCADA: Supervisory control and data Acquisition”, Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society,2010.

REFERENCES:

1. Bolton. W, “Programmble Logic Controllers”, Elsevier Newnes, 6th Edition 2015.

List of Open Source Software/ Learning website:

https://nptel.ac.in/courses/108105062
https://nptel.ac.in/courses/108105088
http://www.nitttrc.edu.in/nptel/courses/video/105105201/lec56.pdf
https://nptel.ac.in/courses/108106022
https://new.siemens.com/global/en/products/
automation/systems/industrial/plc/logo/logo- software.html

https://componentsearchengine.com/library/proteus?gclid=CjwKCAjw_ISWBhBkEiwAdqxb9okU2ZZHcQoa9fSRK2Uq41Rq0GZxdGUP6_6GIBv77p4JqGt_iDAljhoCksEQAvD_BwE

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	1	-	-	1	-	1	2	3	3	2	1
CO2	2	2	3	2	2	1	-	-	1	-	1	2	2	3	2	2
CO3	2	3	1	2	1	1	-	-	1	-	1	1	1	1	1	2
CO4	3	2	1	1	2	1	-	-	1	-	1	1	1	2	1	1
CO5	2	1	2	3	3	1	-	-	1	-	1	1	2	2	1	3
Avg	2.4	2.2	1.8	2	2.2	1	-	-	1	-	1	1.3	1.8	2.2	1.4	1.8

PTEE3029 BIG DATA ANALYTICS LT P C
2 0 2 3

UNIT I UNDERSTANDING BIG DATA 5

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics.

UNIT II NOSQL DATA MANAGEMENT 7

Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schemaless databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients.

UNIT III MAP REDUCE APPLICATIONS 6

MapReduce workflows — unit tests with MRUnit — test data and local tests — anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN –job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.

UNIT IV BASICS OF HADOOP 6

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow-Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures - Cassandra — Hadoop integration.

UNIT V HADOOP RELATED TOOLS 6

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis. Pig – Grunt– pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and fileformats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

LAB COMPONENTS: 30

Software Requirements:

Cassandra, Hadoop, Java, Pig, Hive and HBase.

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories, retrieving files and Deleting files
3. Implement of Matrix Multiplication with Hadoop Map Reduce
4. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
5. Installation of Hive along with practice examples.
6. Installation of HBase, Installing thrift along with Practice examples
7. Practice importing and exporting data from various databases.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 Describe big data and use cases from selected business domains.
CO2 Explain NoSQL big data management.
CO3 Install, configure, and run Hadoop and HDFS.
CO4 Perform map-reduce analytics using Hadoop.
CO5 Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.

TEXT BOOKS:

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
3. Sadalage, Pramod J. “NoSQL distilled”, 2013.

REFERENCES:

1. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
2. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
3. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
4. Alan Gates, "Programming Pig", O'Reilley, 2011.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	1	-	1	1	-	1	2	1	2	1	3
CO2	2	2	2	3	2	1	-	1	1	-	1	1	1	2	2	2
CO3	3	1	2	1	1	1	-	1	1	-	1	2	1	1	1	2
CO4	2	3	3	1	1	1	-	1	1	-	1	2	1	2	1	3
CO5	2	2	2	3	2	1	-	1	1	-	1	1	1	2	1	3
Avg	2.4	2.2	2.2	2	1.8	1	-	1	1	-	1	1.6	1	1.8	1.2	2.6

ELECTRIC VEHICLE TECHNOLOGY

PTEE3030 ELECTRIC VEHICLE ARCHITECTURE **L T P C**
3 0 0 3

UNIT I VEHICLE ARCHITECTURE AND SIZING **7**

Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

UNIT II VEHICLE MECHANICS **7**

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT III POWER COMPONENTS AND BRAKES **7**

Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.

UNIT IV HYBRID VEHICLE CONTROL STRATEGY **7**

Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE **7**

Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) Basics of MATLAB simulation **10**

1. Variables and Expressions Formats,

2. Arrays, Vectors,
3. Matrices, Built-in functions, Trigonometric functions,
4. Data types and Plotting,
5. Simulation of drive cycles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs
CO2 Describe the various EV components
CO3 Describe the concepts related in the Plug-In Hybrid Electric Vehicles
CO4 Analyse the details and Specifications for the various EVs developed
CO5 Describe the hybrid vehicle control strategy

REFERENCES:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.
3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
4. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.
5. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021.
6. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020.
7. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, Thermo, 2021.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-	1
CO2	3	-	2	-	-	-	-	1	-	-	-	2	3	3	3	3
CO3	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-	3
CO4	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-	3
CO5	3	-	3	3	3	-	-	1	-	-	-	2	3	3	3	3
Avg	3	-	2.2	3	3	-	-	1	-	-	-	2	3	3	3	2.6

PTEE3031 DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES **L T P C**
2 0 2 3

UNITI ELECTRIC VEHICLE DYNAMICS 6
Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs.

UNIT II MOTORS FOR ELECTRIC VEHICLES 6
Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

UNIT III BASICS OF SIMULATION IN CONTROL SYSTEMS 6
Transfer Function-How to build transfer function, identify poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT IV MODELING OF DC-DC CONVERTERS 6

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter.

UNIT V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS 6

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

LAB COMPONENT: 30

1. Simple simulation exercises of basic control systems.
2. Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.
3. Design of buck converter.
4. Design of boost converter.
5. Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

TOTAL:60 PERIODS

COURSE OUTCOMES:

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

CO1 use appropriate electric machine for electric vehicle application.
CO2 compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators).
CO3 compute transfer function from state models.
CO4 design buck, boost and buck-boost converter.
CO5 compute a power stage transfer functions for DC-DC converters.
CO6 simulate DC-DC converters and to obtain gain margin and phase margin.

REFERENCES:

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
2. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications
3. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.
4. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.
5. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.
6. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition.
7. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC Press, Taylor & Francis Group, Third Edition 2021.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	3	-	-	-	-	1	-	3	-	3	3	-	1	3
CO2	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3	3
CO3	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3	3
CO4	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3	3
CO5	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3	3
CO6	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3	3
Avg	3	3	3	3	3	-	-	1	-	3	-	3	3	3	2.6	3

PTEE3032 ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL **LT P C**
2 0 2 3

UNIT I INTERNAL COMBUSTION ENGINES **6**
IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

UNIT II ELECTRIC VEHICLES AND VEHICLE MECHANICS **6**
Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT III BATTERY MODELING, TYPES AND CHARGING **6**
Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

UNIT IV CONTROL PRELIMINARIES **6**
Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

UNIT V CONTROL OF AC MACHINES **6**
Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control.

LAB COMPONENT: **30**
1. Develop a model that could estimate Soc and SoH of Li-Ion Battery.
2. Modelling and thermal analysis of Li-Ion Battery.
3. Simulation of boost converter and calculating gain and phase margin from the transfer function.
4. Simulation of vector control of induction motor.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles.
CO2 find gain margin & phase margin for various types of transfer functions of boost converter.
CO3 demonstrate the Control of A C Machines.
CO4 explain the concepts related with batteries and parameters of battery.
CO5 module the battery and to study the research and development for batteries.

REFERENCES:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. Power Electronic Converters,: Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.
3. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.
4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.
5. Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley & Sons, 2017, 2nd Edition.
6. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall,1997, 1st Edition.
7. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	1	2	-	2	3	-	3	-
CO2	3	3	3	3	3	-	-	-	1	3	-	2	3	-	3	3
CO3	3	-	1	3	3	-	3	-	1	2	-	2	3	-	3	3
CO4	3	-	-	-	3	-	3	-	1	2	-	2	3	-	3	3
CO5	3	-	3	-	-	-	3	-	1	2	-	2	3	2	3	3
Avg	3	3	2.3	3	3	-	3	-	1	2.2	-	2	3	2	3	3

PTEE3033 DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM **LT P C**
2 0 2 3

UNIT I CHARGING STATIONS AND STANDARDS **6**
Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations.

UNIT II POWER ELECTRONICS FOR EV CHARGING **6**
Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS **6**
Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVC-HSP system - fast-charging infrastructure with solar PV and energy storage.

UNIT IV WIRELESS POWER TRANSFER **6**
Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363.

UNIT V POWER FACTOR CORRECTION IN CHARGING SYSTEM **6**
Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

LAB COMPONENT: **30**
1. Simulation and analysis for bi-directional charging V2G and G2V.
2. Design and demonstrate solar PV based EV charging station.
3. Simulate and infer wireless power charging station for EV charging.
4. Simulation of boost converter based power factor correction.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 illustrate various charging techniques and to know charging standards and regulations.
CO2 demonstrate the working o DC-DC converters used for charging systems and principles.
CO3 illustrate the advantages of renewable system based charging systems.
CO4 demonstrate the principles of wireless power transfer.
CO5 analyze the standards for wireless charging.
CO6 design and simulate boost converter based power factor correction.

REFERENCES:

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.
2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.
3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.
4. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.
5. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.
6. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	-	-	2	2	-	3	-	3	3	-	-	3
CO2	3	3	3	3	-	-	2	2	-	3	-	3	3	3	3	3
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	-	-	2	2	-	2	-	1	3	3	3	3
CO5	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3
CO6	3	3	3	3	3	-	2	2	-	3	-	2	3	3	3	3
Avg	3	3	3	3	3	-	2	2	-	2.75	-	2.25	3	3	3	3

PTEE3034 TESTING OF ELECTRIC VEHICLES LT P C
2 0 2 3

UNIT I EV STANDARDIZATION 6

Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

UNIT II TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES 6

Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

UNIT III FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC 6

Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management - Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles.

UNIT IV EMC IN ELECTRIC VEHICLES 6

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements.

UNIT V EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM 6

Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI

Coupling Path.

LAB COMPONENT: **30**

1. Design and simulate motor controller for hybrid electric vehicle applications
2. Simulation of EMC analysis for Wireless power transfer EV charging.
3. Design and simulation of EMI filter

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 describe the status and other details of standardization of EVs
CO2 illustrate the testing protocols for EVs and HEV components
CO3 analyze the safety cycle and need for functions safety for EVs
CO4 analyze the problems related with EMC for EV components
CO5 evaluate the EMI in motor drive and DC-DC converter system

REFERENCES:

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.
2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.
3. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1st Edition.
4. EMI/EMC Computational Modeling Handbook, Druce Archam beault, colin branch, Omar M.Ramachi ,Springer 2012, 2nd Edition.
5. Automotive EMC, Mark Steffika, Springer 2013, 1st Edition.
6. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	-	-	-	2	-	-	-	-	-	3	-	2	1
CO2	3	1	1	-	-	-	1	-	-	-	-	-	3	-	2	3
CO3	3	1	1	-	-	-	2	-	-	-	-	-	3	-	2	3
CO4	3	1	1	-	-	-	1	-	-	-	-	-	3	-	2	3
CO5	3	1	1	-	-	-	2	-	-	-	-	-	3	-	3	3
Avg	3	1	1	-	-	-	1.6	-	-	-	-	-	3	-	2.2	2.6

PTEE3035 GRID INTEGRATION OF ELECTRIC VEHICLES LT P C
3 0 0 3

UNIT I DEFINITION, And STATUS Of V2G 7

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications. Electricity Markets and V2G Suitability, Long-Term Storage, Renewable Energy, and Other Grid Applications, Beyond the Grid.

UNIT II BENEFITS OF V2G 7

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.

UNIT III CHALLENGES TO V2G 7

Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. Evaluating V2G Costs and Revenues , EV Costs and Benefits, V2G and Regulatory Frameworks , Market Design Challenges. Other V2G Regulatory and Legal Challenges.

UNIT IV IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS 7

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

UNIT V GRID INTEGRATION AND MANAGEMENT OF EVS 7

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) 10

1. Simulation of connecting three phase inverter to the grid.
2. Simulate and analyse the power quality issues of V2G systems
3. Design and simulate battery management system for smart grid with distributed generation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 explain the concepts related with V2G
CO2 study the grid connection of 3 phase Q inverter
CO3 explain the technical, economics. business, regulatory & political challenges related with V2G
CO4 demonstrate the impact of EV and V2G on smart grid and renewable energy system
CO5 explain the concept of grid integration and management of EVs

REFERENCES:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2. Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna , Farhad Shahnia and Arindam Ghosh,Springer,2015, 1st Edition.
3. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor [1;] Jesus Fraile-Ardanuy, IET 2020, 1st Edition.
4. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
5. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle-to-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	2	1	-	2	-	-	3	3	1	3
CO2	3	3	-	-	3	-	2	1	-	2	-	-	3	-	-	3
CO3	3	-	-	-	-	-	2	1	-	2	-	-	3	-	-	3
CO4	3	-	-	-	-	-	2	1	-	2	-	-	3	-	2	3
CO5	3	-	-	-	-	-	2	1	-	2	-	-	3	-	3	3
Avg	3	3	-	-	3	-	2	1	-	2	-	-	3	3	2	3

PTEE3036 INTELLIGENT CONTROL OF ELECTRIC VEHICLES L T P C
2 0 2 3

UNIT I MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR 6
Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients.

UNIT II SPEED CONTROL FOR ELECTRIC DRIVES 6
Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

UNIT III FUZZY LOGIC 6
Membership functions: features, fuzzification, methods of membership value assignments Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system-fuzzy decision making.

UNIT IV FPGA AND VHDL BASICS 6
Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

UNIT V REAL TIME IMPLEMENTATION 6
Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

LAB COMPONENT: 30
1. Design and simulate speed controller for induction motors in EV for both dynamic and steady state performance
2. Simulate a fuzzy logic controller based energy storage system for EV.
3. Fuzzy logic control of BLDC motor using FPGA in real time

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to:
CO1 design the mathematical model of a BLDC motor and to discuss about its characteristics
CO2 demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor
CO3 illustrate the basics of fuzzy logic system
CO4 describe the basics of VHDL & FPGA applied to control of EVs
CO5 design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time

REFERENCES:

1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.
2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.
3. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Third Edition” CRC Press, Taylor & Francis Group, 2021, 1st Edition.
4. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley 2012, 1st Edition.
5. M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
6. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, Wiley 2017, 2nd Edition
7. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi • Robert Shorten, Sonja Stüdli • Fabian Wirth, CRC Press, 1st Edition. 2018.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	-	-	-	3	-	2	-	3	3	3	-	3
CO2	3	3	2	2	-	-	-	3	-	2	-	3	3	3	3	3
CO3	3	3	3	3	-	-	-	-	-	2	-	3	3	2	3	3
CO4	3	3	3	3	-	-	-	-	-	2	-	3	3	3	3	3
CO5	3	3	3	3	3	-	-	3	-	2	-	3	3	3	3	3
Avg	3	3	2.6	2.6	3	-	-	3	-	2	-	3	3	2.8	3	3

PTEE3037 ENERGY STORAGE SYSTEMS LT P C
3 0 0 3

UNIT I INTRODUCTION 7

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.

UNIT II THERMAL STORAGE SYSTEM 7

Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

UNIT III ELECTRICAL ENERGY STORAGE 7

Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV FUEL CELL 7

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages.

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES 7

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) 10

1. Model, simulate and analyze the performance characteristics of thermal storage systems
2. Develop a model for latent heat storage in phase changing materials.
3. Model, simulate and analyze the performance characteristics of Lead Acid Batteries
4. Model, simulate and analyze the performance characteristics of Fuel Cell
5. Techno-economic analysis of different types of storage systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand different types storage technologies
CO2 Design a thermal storage system
CO3 Model battery storage system
CO4 Analyze the thermodynamics of fuel cell
CO5 Analyze the appropriate storage technologies for different applications
CO6 explore the alternate energy storage technologies.

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley & Sons, 3rd Edition, 2021.
2. Ru-shi Liu, Lei Zhang and Xueliang sun, 'Electrochemical technologies for energy storage and conversion', Wiley publications, 2nd Volume set, 2012.
3. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 3rd Edition, 2018.

REFERENCES:

1. Lunardini. V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981, 1st Edition.
2. Schmidt.F.W. and Willmott.A.J, 'Thermal Energy Storage and Regeneration', Hemisphere Publishing Corporation, 1981, 1st Edition.

List of Open Source Software/Learning website:

1. Prof.Subhasish Basu Majumder, "Electrochemical Energy Storage", NPTEL Course, https://nptel.ac.in/courses/113105102.
2. Prof. PK Das, "Energy conservation and waste heat recovery", NPTEL Course, https://nptel.ac.in/courses/112105221.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	3	3
CO2	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3	3
CO3	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3	3
CO4	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3	3
CO5	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3	3
CO6	-	3	-	-	-	2	-	1	-	-	-	-	2	-	3	3
Avg	3	2	2	-	-	2	-	1	-	-	-	-	2	-	3	3

PTEE3038 HYBRID ENERGY TECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION TO HYBRID ENERGY SYSTEMS 7

Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, WindBiomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems – Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects of renewable energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Ocean energy, Hydel Energy - Wind Energy, Biomass energy, Hydrogen energy - Solar Photovoltaic (PV) and Fuel cells: Operating principles and characteristics.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 7

Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 7

Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buckboost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems - Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems.

UNIT IV ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS 7

Introduction to Power Converters – Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter – Merits and Limitations.

UNIT V CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS 7

Hybrid Systems- Range and type of Hybrid systems – Performance Analysis – Cost Analysis - Case studies of Diesel-PV, Wind-PV-Fuel-cell, Micro-hydel-PV, Biomass-Diesel-Fuel-cell systems.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / etc) 10

1. Simulation of Wind energy conversion system
2. Simulation of power converters
3. Simulations of AC-DC-AC converters, PWM inverters and Matrix Converters with Resistive and dynamic loads

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 analyze the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power

CO2 select a suitable Electrical machine for Wind Energy Conversion Systems and simulate wind energy conversion system

CO3 design the power converters such as AC-DC, DC-DC, and AC-AC converters for SPV systems

CO4 analyze the power converters such as AC-DC, DC-DC, and AC-AC converters for Hybrid energy systems

CO5 interpret the hybrid renewable energy systems.

TEXTBOOKS:

1. Bahman Zohuri, “Hybrid Energy Systems”, Springer, First Edition, 2018.
2. S.M. Muyeen, “Wind Energy Conversion Systems”, Springer First Edition, 2012
3. Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd Hasan Ali, "Emerging Power Converters for Renewable Energy and Electric Vehicles", CRC Press, First Edison, 2021

REFERENCES:

1. Ernst Joshua, Wind Energy Technology, PHI, India, 2018, 3rd Edition.
2. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 7th Impression, 2005.
3. Rashid.M. H “Power electronics Hand book”, Academic press,4th Edition, 2018.
4. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017.
5. Rai. G.D, “Solar energy utilization”, Khanna publishers, 3rd Edition, 1987.
6. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 2nd Edition, 2006.
7. B.H.Khan "Non-conventional Energy sources", Tata McGraw hill Publishing Company, New Delhi, 2017, 3rd Edition.

List of Open Source Software/ Learning website:

1. https://www.sciencedirect.com/topics/engineering/hybrid-energy-system
2. https://www.sciencedirect.com/topics/engineering/wind-energy-conversion-system
3. https://www.academia.edu/35619294/ Modeling_and_Performance_Analysis_of_Solar_PV_System_and_DC_DC_Converters
4. https://www.mdpi.com/journal/energies/special_issues/ Power_Converter_Electric_Machines_Renewable_Energy_Systems_Transportation
5. https://www.intechopen.com/chapters/64317

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	-	-	-	-	-	3	-	3	3	3	3	3
CO2	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3	3
CO3	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3	3
CO4	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3	3
CO5	3	3	3	2	-	-	-	-	-	3	-	3	3	3	3	3
Avg	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3	3

MODERN CONTROL AND INDUSTRIAL AUTOMATION

PTEE3039 INDUSTRIAL AUTOMATION SYSTEMS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Need for automation systems - Architecture of Industrial Automation system. Introduction to PLC, SCADA and DCS – Introduction to Industrial Data Networks: - Foundation Field Bus and Profibus.

UNIT II FIELD DEVICES 9

Conventional / Smart Process Transmitters: - Temperature, Pressure, Flow, Level and pH Measurement - Final Control Elements: - Actuators: Pneumatic and electric actuators - Control Valves - Thyrister Power Controller. Introduction to DC and AC Servo Drives for motion control – Interfacing Field devices with I/O Sub Systems.

UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9

Role of computers in measurement and control - Elements of computer aided measurement and control:- Man-Machine interface, computer aided process control hardware and software – Industrial Internet of things (I2oT) – Cyber Security for Industrial automation.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Programmable Logic Controllers: - Hardware of PLC - PLC programming:-Ladder diagram with examples - PLC Communication and networking - Case studies: - Bottle filling application and Elevator control.

UNIT V DISTRIBUTED CONTROL SYSTEM 9

DCS: - LCU-Shared communication facility- Display Hierarchy- High Level and Low Level interfaces - Case studies: - DCS in cement plant and thermal power plant.

TOTAL 45 PERIODS

COURSE OUTCOMES:

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

CO1 Recall the basics of Industrial Automation.(L1)

CO2Select appropriate Transmitters, Final control elements and Controllers for different application.(L3)

CO3 Analyse the Computer aided measurement and control. (L4)

CO4 Design Ladder programmes for PLC.(L5)

CO5 Explain about basic concepts of Distributed Control System.(L2)

CO6Will be able to recommend right choice of automation systems for a given application.(L2)

REFERENCES:

1. S.K.Singh, "Industrial Instrumentation", Tata McGraw Hill, 2nd edition companies,2003
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India, 8th Edition, 2006.
3. E.A.Parr, Newnes, NewDelhi, "Industrial Control Handbook", 3rd Edition, 2000.
4. Gary Dunning, Thomson Delmar, "Programmable Logic Controller", Ceneage Learning, 3rd Edition, 2005.
5. .2. 3. 4. 5. Lucas, M.P., "Distributed Control System", Van Nostrand Reinhold Company, New York, 1986.

MAPPING OF COs WITH POs AND PSOs

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	-	2	-	-	2	-	-	-	-	-	-	-	-	3
CO2	3	3	3	-	-	2	2	-	-	-	-	-	-	-	3
CO3	3	3	3	-	3	2	-	-	-	-	-	-	-	-	3
CO4	3	3	3	3	3	2	-	-	-	-	-	-	-	-	3
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO6	3	3	3	3	2	2	-	2	-	-	-	-	-	-	3
Avg.	3	3	2.8	3	2.7	2	2	2	-	-	-	-	-	-	3

1-low, 2-medium, 3-high, '-" - no correlation

PTEE3040 ROBOTICS AND AUTOMATION

	L	T	P	C
	3	0	0	3

UNIT I BASICS CONCEPTS (7+2 SKILL) 9

Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Robot classifications and specifications- Asimov's laws of robotics – dynamic stabilization of robots.

UNIT II POWER SOURCES, SENSORS AND ACTUATORS (7+2 SKILL) 9

Hydraulic, pneumatic and electric drives: Design and control issues – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fiber optic and tactile sensors.

UNIT III MANIPULATORS AND GRIPPERS DIFFERENTIAL MOTION (7+2 SKILL) 9

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

UNIT IV KINEMATICS AND PATH PLANNING (7+2 SKILL) 9

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance Solution kinematics problem – robot programming languages.

UNIT V DYNAMICS AND CONTROL AND APPLICATIONS (7+2 SKILL) 9

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler Formulation-Dynamic model – Manipulator control problem-Linear control schemes - PID control scheme-Force control of robotic manipulator .Multiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Learn any one programming language (C/C++, Python, Java etc.)
2. Kinds of sensors for industrial robot applications.
3. Familiarization with relevant software tool (MATLAB) and programming language
4. Controlling Arduino Robot using Android Smartphone
5. Real time robotics projects (Soccer robots, line follower etc.)

COURSE OUTCOMES (COs)

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

CO 1 Understand the evolution of robot technology and mathematically represent different types of robots. (L2)
CO 2 Get exposed to the case studies and design of robot machine interface. (L3)
CO 3 Analyze various control schemes of Robotics control. (L4)
CO 4 Ability to select appropriate configuration of rotor for a specific application. (L5)
CO 5 Ability to choose actuator/sensor for robot. (L1)

TEXT BOOKS:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 2015.
2. Saeed B Niku, Introduction to Robotics, Analysis, Systems, Applications Prentice Hall, 3rd edition 2014.

REFERENCE BOOKS:

1. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 2nd edition (2017)
2. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An integrated approach, Prentice Hall of India, New Delhi, 1994.
3. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005
4. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.

List of Open-Source Software/ Learning website:

1. https://nptel.ac.in/courses/112105249
2. https://nptel.ac.in/courses/107106090
3. https://nptel.ac.in/courses/112101098

4. http://site.ieee.org/scv-css/files/2015/04/IEEE-Robotics-Talk.pdf
5. https://www.intel.com/content/www/us/en/robotics/types-and-applications.html
6. https://nitc.ac.in/app/webroot/img/upload/M4P3.pdf

MAPPING OF COs WITH POs AND PSOs

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1	1	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-	3	-	-
Avg.	2.8	2.6	2.4	1.8	-	-	-	-	-	-	-	-	3	-	-

1-low, 2-medium, 3-high, '-" - no correlation

PTEE3041 MODEL BASED CONTROL | L T P C: 3 0 0 3

UNIT I INTRODUCTION TO MIMO CONTROL (7+2 SKILL) 9

Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC-IMCPID-Case studies.

UNIT II MODEL PREDICTIVE CONTROL SCHEMES (7+2 SKILL) 9

Introduction to Model Predictive Control - Model Predictive Control Elements - Generalized Predictive Control Scheme – Multivariable Generalized Predictive Control Scheme – Multiple Model based Model Predictive Control Scheme Case Studies.

UNIT III STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME (7+2 SKILL) 9

State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies.

UNIT IV CONSTRAINED MODEL PREDICTIVE CONTROL SCHEME (7+2 SKILL) 9

Constraints Handling: Amplitude Constraints and Rate Constraints –Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies.

UNIT V ADAPTIVE CONTROL SCHEME (7+2 SKILL) 9

Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–MARS-Adaptive Model Predictive Control Scheme —Case Studies

TOTAL:45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Explore various MIMO controllers presently used in industries.
2. Develop MPC, Adaptive and MIMO controllers for industrial processes.
3. Implement the controllers for MIMO systems.
4. Using software tools for practical exposures to the controllers used in industries by undergoing training.
5. Realisation of various optimization techniques for economical operation of process.

COURSE OUTCOMES:

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

CO1 Explain various control schemes on MIMO systems. (L1,L2)
CO2 Design controller for MIMO system. (L5)
CO3 Analyze the control schemes available in industries. (L4)
CO4 Design MPC, Adaptive controllers for practical engineering problems. (L5)
CO5 Choose suitable controllers for the given problems. (L3)

TEXT BOOKS:

1. Coleman Brosilow, Babu Joseph, "Techniques of Model-Based Control", Prentice Hall PTR Pub

2002.
2. E. F. Camacho, C. Bordons, “Model Predictive Control”, Springer-Verlag London Limited 2007.
3. K.J. Astrom and B. J. Wittenmark, “Adaptive Control”, Second Edition, Pearson Education Inc., second Edition 2008.

REFERENCES:

1. Paul Serban Agachi, Zoltan K. Nagy, Mircea Vasile Cristea, and Arpad Imre-Lucaci Model Based Control Case Studies in Process Engineering, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim 2006.
2. Ridong Zhang, Anke Xue Furong Gao,“Model Predictive Control Approaches Based on the Extended State Space Model and Extended Non-minimal State Space Model”, Springer Nature Singapore Pte Ltd. 2019
3. J.A. ROSSITER “Model-Based Predictive Control A Practical Approach”, Taylor & Francis e-Library, 2005.

List of Open-Source Software/ Learning website:

1. https://nptel.ac.in/courses/103103037
2. https://nptel.ac.in/courses/108103007
3. https://onlinecourses.nptel.ac.in/noc21_ge01/preview
4. https://nptel.ac.in/courses/127106225

MAPPING OF COs WITH POs AND PSOs

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	-	-	-	1	-	1	-	-	-	-	3
CO2	3	3	3	3	-	-	-	1	-	1	-	-	-	-	3
CO3	3	3	3	2	-	-	-	1	-	1	-	-	-	-	3
CO4	3	3	3	3	-	-	-	1	-	1	-	-	-	-	3
CO5	3	3	3	3	-	-	-	1	-	1	-	-	-	-	3
Avg.	3	2.8	2.8	2.6	-	-	-	1	-	1	-	-	-	-	3

1-low, 2-medium, 3-high, ‘-“- no correlation

PTEE3042	NON LINEAR CONTROL	L	T	P	C
		3	0	0	3

UNIT I STATE VARIABLE DESIGN (7+2 SKILL) 9

Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition for Arbitrary Pole-placement- pole placement Design- design of state Observers- separation principle- servo design: -State Feedback with integral control.

UNIT II PHASE PLANE ANALYSIS(7+2 SKILL) 9

Features of linear and non-linear systems - Common physical non-linearities – Methods of linearization Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT III DESCRIBING FUNCTION ANALYSIS (7+2 SKILL) 9

Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems – limit cycles – Stability of oscillations.

UNIT IV OPTIMAL CONTROL (7+2 SKILL) 9

Introduction - Time varying optimal control – LQR steady state optimal control – Solution of Ricatti’s equation – Application examples.

UNIT V OPTIMAL ESTIMATION (7+2 SKILL) 9

Optimal estimation – KalmanBucy Filter-Solution by duality principle-Discrete systems-Kalman Filter-Application examples.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Design of linear quadratic regulator (LQR) control system for any application of your own

2. Familiarization of Kalman filter in MATLAB
3. Seminar on pole placement design

COURSE OUTCOMES:

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

CO1 Apply the knowledge gained on state feedback control and nonlinear control. (L3)
CO2 Carryout analysis for common nonlinearities in a system. (L4)
CO3 Apply advanced control theory to practical engineering problems. (L3)
CO4 Design optimal controller. (L5)
CO5 Understand the basics and Importance of Kalman filter. (L1,L2)

TEXT BOOKS:

1. G. J. Thaler, "Automatic Control Systems", Jaico Publishing House 1993.
2. M.Gopal, Modern Control System Theory, New Age International Publishers, 2002
3. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.
4. G. J. Thaler, "Automatic Control Systems", Jaico Publishing House 1993.
5. M.Gopal, Modern Control System Theory, New Age International Publishers, 2002
6. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.

REFERENCES:

1. Ashish Tewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.
2. K. Ogata, 'Modern Control Engineering', 4th Edition, PHI, New Delhi, 2002.
3. T. Glad and L. Ljung, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002.
4. D.S.Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press, 2009.
5. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2011.

List of Open-Source Software/ Learning website:

1. https://in.mathworks.com/discovery/kalman-filter.html
2. https://in.mathworks.com/help/control/getstart/design-an-lqr-servo-controller-insimulink.html
3. https://onlinecourses.nptel.ac.in/noc22_ee24/preview
4. http://www.nitttrc.edu.in/nptel/courses/video/101108047/lec22.pdf

MAPPING OF COs WITH POs AND PSOs

CO's	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2	-	-	-	3	-	3	-	1	-	-	3
CO2	3	3	3	2	-	-	-	3	-	3	-	1	-	-	3
CO3	3	2	2	2	-	-	-	3	-	3	-	1	-	-	3
CO4	3	3	3	3	-	-	-	3	-	3	-	1	-	-	3
CO5	2	1	2	1	-	-	-	2	-	2	-	1	-	-	3
Avg.	2.8	2.2	2.4	2	-	-	-	2.8		2.8	-	1	-	-	3

1. low, 2-medium, 3-high, '-"- no correlation

PTEE3043 **SYSTEM IDENTIFICATION** **L T P C**
3 0 0 3

UNIT I NON PARAMETRIC METHODS 7

Nonparametric methods: Transient analysis - frequency analysis - Correlation analysis - Spectral analysis.

UNIT II PARAMETRIC METHODS 7

Parametric model structures: ARX, ARMAX, OE, BJ models - The Least square estimate - Best linear unbiased estimation under linear constraints - Updating the Parameter estimates for linear regression models - Prediction error methods: Description of Prediction error methods - Optimal Prediction — Relationships between prediction error methods and other identification methods - theoretical analysis. Instrumental variable methods: Description of Instrumental variable methods - Theoretical analysis - covariance matrix of IV estimates - Comparison of optimal IV and prediction error methods.

UNIT III RECURSIVE IDENTIFICATION METHODS 7

The recursive least squares method - Recursive Instrumental variable method-the recursive prediction error method-model validation and model structure determination. Identification of systems operating in closed loop: Identifiability considerations - Direct identification - Indirect identification - Joint input — Output identification.

UNIT IV CLOSED- LOOP IDENTIFICATION 7

Identification of systems operating in closed loop: direct identification and indirect identification – Subspace Identification methods: classical and innovation forms – Relay feedback identification of stable processes.

UNIT V NONLINEAR SYSTEM IDENTIFICATION 7

Modeling of nonlinear systems using ANN- NARX & NARMAX - Training Feed-forward and Recurrent Neural Networks – TSK model – Adaptive Neuro-Fuzzy Inference System (ANFIS) - Introduction to Support Vector Regression.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Familiarization of various system identification methods in MATLAB.
2. Seminar on ANFIS.
3. Exploration of other advanced system identification methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 design and implement state estimation schemes.
CO2 develop various models (Linear & Nonlinear) from the experimental data.
CO3 choose a suitable model and parameter estimation algorithm for the identification of systems.
CO4 illustrate verification and validation of identified model.
CO5 develop the model for prediction and simulation purposes using suitable control schemes.

TEXT BOOKS:

1. Lennart Ljung, "System Identification: Theory for the user", 2nd Edition, Prentice Hall, 1999.
2. Dan Simon, "Optimal State Estimation Kalman, H-infinity and Non-linear Approaches", JohnWiley and Sons, 2006,
3. Tangirala, A.K., "Principles of System Identification: Theory and Practice", CRC Press,2014, 1st Edition.

REFERENCE:

1. Cortes, C., and Vapnik, V., "Support-Vector Networks, Machine Learning", 1995, 1st Edition.
2. Miller, W.T., Sutton, R.S., and Webrose, P.J., "Neural Networks for Control", MIT Press, 1996, 1st Edition.
3. Van der Heijden, F., Duin, R.P.W., De Ridder, D., and Tax, D.M.J., "Classification, Parameter Estimation and State Estimation", An Engineering Approach Using MATLAB, John Wiley & Sons

Ltd., 2017, 2nd Edition.
4. Karel J. Keesman, "System Identification an Introduction", Springer, 2011, 1st Edition.
5. Tao Liu and Furong Gao, "Industrial Process Identification and control design, Step-test andrelay-experiment-based methods", Springer- Verlag London Ltd., 2012, 1st Edition.

List of Open Source Software/ Learning website:

1. https://in.mathworks.com/help/ident/
2. https://nptel.ac.in/courses/103106149
3. https://in.mathworks.com/help/curvefit/nonparam etric-fitting.html
4. https://nptel.ac.in/courses/111102143

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2	2
CO2	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2	2
CO3	3	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2
CO4	3	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2	2
Avg	3	2.6	2.6	2.6	1	1	1	1	1	1	1	1	2	2	2	2

PTEE3044 ADAPTIVE CONTROL L T P C
3 0 0 3

UNIT I INTRODUCTION 7

Introduction - Adaptive Schemes - The adaptive Control Problem – Applications-Parameter estimation:-LS, RLS: and ERLS.

UNIT II GAIN SCHEDULING 7

Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations -application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback.

UNIT III DETERMINISTIC SELF-TUNING REGULATORS 7

Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuningregulators — Disturbances with known characteristics.

UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS 7

Introduction – Design of minimum variance controller - Design of moving average controller -stochastic self-tuning regulators.

UNIT V MODEL – REFERENCE ADAPTIVE SYSTEM 7

Introduction- MIT rule — Determination of adaptation gain - Lyapunov theory –Design ofMRAS using Lyapunov theory – Relations between MRAS and STR.

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Learn any one relevant software tool (MATLAB/ SCILAB/ LABVIEW/ Equivalent opensource software)
2. Design of gain scheduling adaptive control using any one software tool
3. Analysis/Problem Solving - Ability to identify and define problems and solutions
4. Design and verification of MRAC by simulation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 apply the estimation algorithm to estimate the parameters of the process.

CO2 apply the adaptive control concepts to control a process.

CO3 use appropriate software tools for design of adaptive controllers and analysis of the process.

CO4 identify, formulate, carry out research by designing suitable adaptive schemes for complex instrumentation problem.

CO5 apply the concepts to design adaptive control for multidisciplinary problem.

CO6 choose the techniques for self and lifelong learning to keep in pace with the new technology.

TEXT BOOKS:

1. K.J. Astrom and B. J. Wittenmark, "Adaptive Control", Second Edition, PearsonEducation Inc., second Edition 2013.

REFERENCES:

1. T. Soderstorm and Petre Stoica, "System Identification", Prentice Hall International(UK)Ltd., 1989, 1st Edition.
2. Lennart Ljung, "System Identification: Theory for the User", Second Edition, PrenticeHall, 1999.

List of Open Source Software/ Learning website:

1. https://archive.nptel.ac.in/courses/108/102/108102113/
2. https://in.mathworks.com/help/slcontrol/adaptive-control-design.html
3. https://in.mathworks.com/videos/nonlinear-model-based-adaptive-robust-controller-in-an-oil-and-gas-wireline-operation-1637577967956.html
4. https://www.dynalog-us.com/adaptive-robot-control.htm
5. https://www.vlab.co.in/

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2	2
CO2	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2	2
CO3	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2	2
CO4	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2	2
CO5	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2	2
CO6	3	2	2	2	1	1	1	3	1	1	1	1	2	2	2	2
Avg	3	2.3	2.3	2.3	1	1	1	3	1	1.6	1	1	2	2	2	2

PTEE3045	PROCESS MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

UNIT I GENERAL PRINCIPLES OF MODELLING(7+2 SKILL) 9

Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models: Linear vs Nonlinear, Lumped parameter vs. Distributed parameter; Static vs. Dynamic, Continuous vs. Discrete; Numerical Methods: Iterative convergence methods, Numerical integration of ODE- IVP and ODEBVP.

UNIT II MODELLING OF DISTRIBUTED PROCESSES(7+2 SKILL) 9

Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based Approaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries.

UNIT III INTRODUCTION TO PROCESS MODELLING (7+2 SKILL) 9

Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g., Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle.

UNIT IV MODELLING OF INDUSTRIAL PROCESSES(7+2 SKILL) 9

Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, -steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries.

UNIT V SIMULATION OF MATHEMATICAL MODELLING(7+2 SKILL) 9

Simulation and their approaches, Modular, Sequential, Simultaneous and Equation solving approach, Simulation softwares and their applications, Review of solution techniques and available numerical software libraries - Case Studies.

TOTAL : 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 10

1. Developing steady state /Dynamic mathematical model of different unit processes (ODE or PDE)
2. Simulation of steady state/ dynamic models using appropriate software
3. Open loop study based on the developed mathematical model.
4. Development and simulation of unsteady state models for simple processes.

COURSE OUTCOMES:

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

CO1	Understand different methods of developing models for industrial processes. (L1)
CO2	Build mathematical models by applying relevant mathematics. (L3)
CO3	Implement mathematical models using relevant software. (L4)
CO4	Effectively perform analysis and subsequent conclusion for the developed mathematical models. (L5)
CO5	Interpret the results obtained from the mathematical model in terms of original real-world problem. (L2)

TEXT BOOKS:

1. Denn M. M.,"Process Modeling", Longman, 1986
2. Aris R.,"Mathematical Modeling, A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999.

REFERENCES:

1. Luyben W.L., “Process Modeling, Simulation, and Control for Chemical Engineering”, McGraw Hill.
2. D. F. Rudd and C. C. Watson, “ Strategy of Process Engineering”, Wiley international.
3. M.M. Denn, “Process Modelling”, Wiley, New York,
4. A. K. Jana, “Chemical Process Modelling and Computer Simulation”, PHI
5. C.D. Holland, “Fundamentals of Modelling Separation Processes”, Prentice Hall,
6. HussainAsghar, “Chemical Process Simulation”, Wiley Eastern Ltd., New Delhi,

List of Open-Source Software/ Learning website:

1. https://archive.nptel.ac.in/courses/103/107/103107096/
2. https://nptel.ac.in/courses/103101111
3. https://nptel.ac.in/courses/111107105
4. https://www.academia.edu/37228967/Process_Modeling_Simulation_and_Control_for_ Chemical_Engineers

MAPPING OF COs WITH POs AND PSOs

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	1	-	-	2	-	-	-	-	-	-	-	-	-	3
CO2	3	1	2	-		-	-	-	-	-	-	-	-	-	3
CO3	1	-	2	3	3	-	-	-	-	-	-	-	-	-	3
CO4	1	-	3	-	-	-	2	-	-	-	-	-	-	-	3
CO5	1	2	-	3	-	-	-	-	-	-	-	-	-	-	3
Avg.	1.8	1.3	2.3	3	2.5	-	2	-	-	-	-	-	-	-	3

1-low, 2-medium, 3-high, ‘-“- no correlation

PTEE3046 COMPUTER CONTROL OF PROCESSES

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

UNIT I DISCRETE STATE-VARIABLE TECHNIQUE 9

State equation of discrete time system with sample and hold – State transition equation – Methods of computing the state transition matrix – Decomposition of discrete time transfer functions – State diagram representations of Discrete time systems - Controllability and observability of linear time invariant discrete time system – Stability tests of discrete time system – State Observer.

UNIT II SYSTEM IDENTIFICATION 9

Non-Parametric methods: Transient analysis – Frequency analysis – correlation analysis – Spectral analysis – Parametric methods: Least square method – Recursive least square method.

UNIT III DIGITAL CONTROLLER DESIGN 9

Review of z-transform – Modified of z-transform – Pulse transfer function – Digital PID controller – Dead-beat controller, Dahlin's controller and Kalman's approach – Smith Predictor – Digital Feed-forward controller – Internal Model Controller.

UNIT IV MULTI-LOOP REGULATORY CONTROL 9

Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs -The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method - Decoupling Control.

UNIT V MULTI-VARIABLE REGULATORY CONTROL 9

Introduction to Multivariable control – Multivariable PID Controller – Multivariable Internal Model Controller – Multivariable Dynamic Matrix Controller – Generalized Predictive Controller. Case Studies: - Computer control of a thermal process.

TOTAL : 45 PERIODS

COURSE OUTCOMES (COs)

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

CO 1 alyze the solution for discrete time systems and test the stability of the systems(L4)

CO 2 late the controllability, observability and stability of discrete time systems. (L1)
CO 3 ild empirical models by parametric and non parametric methods(L3)
CO 4 sign and analysis of various digital control techniques for SISO system. (L5)
CO 5 monstrate the concept of RGA and decoupler for MIMO system. (L2)
CO 6 sign a multiloop and multivariable control for industrial processes. (L6)

TEXT BOOKS:

1. pal, M., “Digital Control and State Variable Methods”, Tata McGraw-Hill, 2003.
2. shpande P.B. & Ash R.H, "Computer Process Control", ISA publication, USA 1995.
3. le E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, “Process Dynamics and Control”, Wiley John and Sons, 3rd Edition, 2010.
4. jurd Skogestad, Ian Postlethwaite, “Multivariable Feedback Control: Analysis and Design”, John Wiley and Sons, 2005.

REFERENCE BOOKS:

1. ephanopoulos, G., “Chemical Process Control - An Introduction to Theory and Practice”, Prentice Hall of India, 2005.
2. derstorm, T. and Stoica, P., “System Identification”, Prentice Hall International Ltd., UK., 1989.
3. quette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India,2008.
4. Albertos and A. Sala, “Multivariable Control Systems an Engineering Approach”, Springer Verlag, 2006.

MAPPING OF COs WITH POs AND PSOs

CO’s	PO’s												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	2	2	-	-	-	1	-	-	3	-	-	-	-
CO 2	3	-	1	-	-	-	-	2	-	-	3	1	1	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	3	3	2	-	-
CO 4	3	-	3	3	-	2	1	1	-	-	2	1	3	2	3
CO 5	3	-	-	-	-	-	-	-	-	-	1	2	-	-	-
CO 6	3	3	3	3	-	2	1	-	-	-	2	-	2	2	3
Avg.	3	2.3	2.25	2.6	-	2	1	1.3	-	-	2.3	1.75	2	2	3

1 - Low, 2-medium, 3-high, ‘-“- no correlation

PTEE3047 FLIGHT INSTRUMENTATION **L T P C**
3 0 0 3

UNIT I MEASUREMENT SCIENCE AND DISPLAYS 9

Instrumentation brief review-Concept of measurement - Functional elements of an instrument system – Transducers - classification - classification of aircraft instruments-Instrument displays panels andcockpit layout, Electronic Flight Instrument System.

UNIT II AIR DATA INSTRUMENTS AND SYNCHRO TRANSMISSION SYSTEMS 9

Air data instruments-airspeed, altitude, Vertical speed indicators, Altitude alerting systems, Machmeter, Mach Warning system, Static Air temperature, Angle of attack measurement, Stall Warning system, Synchronous data transmission system.

UNIT III GYROSCOPIC AND ADVANCED FLIGHT INSTRUMENTS 9

Gyroscope and its properties, gyro system, Gyro horizon, Erection systems for Gyro Horizons- Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, Turn coordinator, acceleration and turning errors, Standby Attitude Director Indicator, Gyro stabilized Direction Indicating Systems, Advanced Direction Indicators, Horizontal Situation Indicator.

UNIT IV AIRCRAFT COMPASS SYSTEMS & FLIGHT MANAGEMENT SYSTEM 9

Direct reading compass, magnetic heading reference system-detector element, monitored gyroscope system, DGU, RMI, deviation compensator. FMS- Flight planning-flight path optimization-operational modes-4D flight management.

UNIT V POWER PLANT INSTRUMENTS & FLIGHT DATA RECORDING 9

Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR,Engine Fuel Indicators, engine vibration monitoring, Cockpit Voice Recorder and Flight Data Recorder.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 design the error model and estimate the error in the aircraft instruments
CO2 explain about the various air data systems and synchronous data transmissions systems.
CO3 apply the principle of gyroscope, DGU, RMI, FMS in 4D flight management in the Avionics domain requirements.
CO4 Classify the different sensors and select the appropriate one for the given requirements.
CO5 Explain the operation and importance of engine instruments and flight data recorder.

REFERENCES:

1. David Wyatt. ‘Aircraft Flight Instruments and Guidance Systems’, Routledge, Taylor & FrancisGroup, 2015.
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MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	3	2	-	2	-	-	-	3	3	3	3	3
CO2	3	3	3	2	-	2	-	-	-	3	-	3	3	3	3	3
CO3	3	3	3	-	3	2	-	-	-	-	-	3	3	3	3	3
CO4	3	3	3	-	-	-	-	2	-	3	-	3	3	3	3	3
CO5	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3	3
Avg	3	3	3	2	3	2	-	2	-	3	-	3	3	3	3	3

1 - Low, 2-medium, 3-high, ‘-“- no correlation