DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
Periyar Nagar, Vallam, Thanjavur - 613 403, Tamil Nadu, India
Phone: +91 - 4362 - 264600 Fax: +91 - 4362 – 264660
Email: headeee@pmu.edu Web: www. pmu.edu

INSTITUTE VISION & MISSION

VISION	To be a Institution of global dynamism with excellence in knowledge and innovation ensuring social responsibility for creating an egalitarian society.	
MISSION	**IM1**	Offering well balanced Programmes with scholarly faculty and state-of-art facilities to impart high level of knowledge.
	IM2	Providing student - centred education and foster their growth in critical thinking, creativity, entrepreneurship, problem solving and collaborative work.
	IM3	Involving progressive and meaningful research with concern for sustainable development.
	IM4	Enabling the students to acquire the skills for global competencies.
	IM5	Inculcating Universal values, Self-respect, Gender equality, Dignity and Ethics.

CORE VALUES

- Student – centric vocation
- Academic excellence
- Social Justice, equity, equality, diversity, empowerment, sustainability
- Skills and use of technology for global competency.
- Continual improvement
- Leadership qualities.
- Societal needs
- Learning, a life – long process
- Team work
- Entrepreneurship for men and women
- Rural development
- Basic, Societal, and applied research on Energy, Environment, and Empowerment.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION	To become a leader in providing education, training and research in the field of Electrical and Electronics Engineering to the aspiring graduates to be competent in their profession and render best service to the society.	
MISSION	**DM1**	To provide affordable, quality undergraduate and graduate education in the areas of electrical engineering.
	DM2	To provide service to the profession, the university, the community, and society
	DM3	To conduct scholarly research at the frontiers of electrical engineering.
	DM4	To instil our graduates the need for life-long learning
	DM5	To promote personal and intellectual growth to reinforce a commitment to ethical and professional practices.

TABLE 1: MAPPING OF INSTITUTION MISSION (IMs) AND DEPARTMENT MISSION (DMs)

	DM1	DM2	DM3	DM4	DM5
IM1	**3**	**1**	**1**	**0**	**0**
IM2	**1**	**3**	**1**	**0**	**0**
IM3	**0**	**2**	**3**	**2**	**0**
IM4	**0**	**0**	**2**	**3**	**1**
IM5	**0**	**1**	**0**	**1**	**3**

0 –No Relation1 – Low Relation2 – Medium Relation 3 – High Relation

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Based on the Mission of the Department, the Programme Educational Objectives are formulated as

PEO1	Our Graduates are professionally competent and apply the concepts of mathematics, science and engineering to solve problems in Electrical and Electronics Engineering and related fields.
PEO2	Our Graduates stay relevant in their chosen profession through lifelong learning and

	demonstrate social and ethical responsibility.

TABLE 2: MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) WITH DEPARTMENT MISSION (DMs)

	DM 1	DM 2	DM3	DM 4	DM 5
PEO 1	2	0	1	1	1
PEO 2	1	3	1	3	3
	3	**3**	**2**	**4**	**4**

1- Low 2 – Medium 3-High

GRADUATE ATTRIBUTES (GAs)

1. **Knowledge base for Engineering:** Demonstrate competence in mathematics, natural sciences, engineering fundamentals and specialized engineering knowledge appropriate to the programme.

2. **Analytical Skills:** Identify, formulate, analyse and solve diverse engineering problems.

3. **Design:** Solution for complicated open–ended engineering problems and design the components with appropriate standards to meet specified needs with proper attention to public health, safety, environment and society.
4. **Experimental Investigation:** Technical skills to conduct investigation, interpretation of observed data and provide solution for multifaceted problems.
5. **Modern Engineering tools usage**: Acquire, select, manipulate relevant techniques, resources and advanced engineering ICT tools to operate simple to complex engineering activities.
6. **Impact of engineering on society:** Provide a product / project for use by the public towards their health, welfare, safety and legal issues to serve the society effectively.
7. **Environment and Sustainability:** Design eco-friendly and sustainable products in demonstrating the technology development to meet present and future needs.
8. **High Ethical Standards:** Practice ethical codes and standards endorsed by professional engineers.

9. **Leadership and team work:** Perform as an individual and as a leader in diverse teams and in multi-disciplinary scenarios.
10. **Communication Skills:** Professional communication with the society to comprehend and formulate reports, documentation, effective delivery of presentation and responsible to clear instructions.
11. **Project management and Finance:** Appropriate in incorporating finance and business practices including project, risk and change management in the practice of engineering by understanding their limitations.
12. **Life-long learners:** Update the technical needs in a challenging world in equipping themselves to maintain their competence.

PROGRAMME OUTCOMES (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, to the solution of complex problems in Electrical and Electronics Engineering.

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

3. Design solutions for complex Electrical and Electronics 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. 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, related to Electrical and Electronics Engineering.

5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex Electrical and Electronics Engineering activities with an understanding of the limitations.

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

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

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

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

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

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

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1	Ability to design and answer the problems in the field of Power Engineering by applying the knowledge acquired from Electrical Machines, Power Electronics, Electric Circuit Analysis, Power Systems & other related topics.
PSO2	Graduates will be able to develop and support Renewable based systems.

TABLE 3: GAs VERSUS POs and PSOs MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
GA1	3	2	2	2	2	3	2	2	2	2	2	2	3	3
GA2	2	3	2	2	1	2	2	1	1	2	1	2	3	3
GA3	2	3	2	3	3	2	1	1	1	1	2	2	3	3

GA4	1	2	3	3	2	1	1	2	2	1	3	3	3	3
GA5	1	1	3	1	3	1	2	1	3	2	2	3	2	2
GA6	2	2	1	2	3	2	3	3	3	3	3	1	3	3
GA7	1	1	2	1	3	1	2	2	2	2	1	2	3	3
GA8	1	1	1	1	2	1	3	2	2	3	3	1	3	3
GA9	1	2	1	2	2	1	2	2	3	2	3	1	2	2
GA10	2	1	2	2	3	2	1	3	3	1	2	2	3	3
GA11	2	1	1	1	1	2	2	1	1	2	1	1	2	2
GA12	1	2	2	2	2	1	2	2	3	2	3	2	3	3

TABLE 4: MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) WITH PROGRAMME OUTCOMES (POs)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
PEO 1	3	3	3	2	2	1	1	1	1	2	2	1
PEO 2	3	2	1	3	1	3	3	2	3	2	2	3

0 –No Relation 1 – Low Relation 2 – Medium Relation 3 – High Relation

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DISTRIBUTION OF SUBJECTS TO BE INCLUDED AS PER UGC AND NAAC

S.No.	Category	Symbol
1.	Humanities and Social Sciences including Management Courses	HSMC
2.	Basic Science Courses	BSC
3.	Engineering Science Courses including Workshop, Drawing, Basics of Electrical and Electronics / Mechanical / Computer etc.	ESC
4.	Professional Core Courses	PCC
5.	Professional Elective Courses relevant to chosen specialization/branch	PEC
6.	Open Subjects- Electives from other technical and/or emerging subjects	OE
7.	Project Work, Seminar and/or Internship in Industry or elsewhere	PROJ
8.	Mandatory Courses [Environmental Sciences, Induction Training, Indian Constitution, Essence of Indian Traditional Knowledge] (non-credit)	MC

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STRUCTURE OF B.TECH.

ELECTRICAL AND ELECTRONICS ENGINEERING PROGRAMME

S.No.	Category	Suggested by AICTE Breakup of Credits	Implementation in Curriculum 2021
1.	Humanities and Social Sciences including Management Courses	12	13
2.	Basic Science courses	25	24
3.	Engineering Science Courses including Workshop, Drawing, Basics of Electrical and Electronics / Mechanical / Computer etc.	24	18
4.	Professional Core Courses	48	63
5.	Professional Elective Courses relevant to chosen specialization / branch	18	12
6.	Open Subjects - Electives from other technical and / or emerging subjects	18	15
7.	Project Work, Seminar and / or Internship in Industry or elsewhere	15	15
8.	Mandatory Courses [Universal Human Values 2: Understanding Harmony]	03	03
9.	Mandatory Courses [Environmental Sciences, Induction Training, Indian Constitution, Essence of Indian Traditional Knowledge] (non-credit)	(non-credit)	(non-credit)
	Total	**163**	**163**

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HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT

S. No.	Course Title	Hrs. / Week L: T: P	Credits	Preferred Semester
1.	Speech Communication	0 : 1 : 2	3	I
2.	Technical Communication	2 : 0 : 0	2	II
3.	Entrepreneurship Development	2 : 0 : 0	2	III
4.	Economics for Engineers	3 : 0 : 0	3	IV
5.	Professional Skills	1 : 0 : 2	3	VI
		Total	**13**	

BASIC SCIENCE COURSES

S. No.	Course Title	Hrs. / Week L: T: P	Credits	Preferred Semester
1.	Calculus and Linear Algebra	3 : 1 : 0	4	I
2.	Chemistry	3 : 1 : 1	5	I
3.	Calculus, Ordinary Differential Equations and Complex Variables	3 : 1 : 0	4	II
4.	Applied Physics for Engineers	3 : 1 : 1	5	II
5.	Transforms and Partial Differential Equations	3 : 0 : 0	3	III
6.	Probability and Statistics	3 : 0 : 0	3	IV
		Total	**24**	

ENGINEERING SCIENCE COURSES

S. No.	Course Title	Hrs. / Week L: T: P	Credits	Preferred Semester
1.	Electrical and Electronics Engineering Systems	3 : 1 : 1	5	I
2.	Engineering Graphics and Design	1 : 0 : 2	3	I
3.	Programming for Problem Solving	3 : 0 : 1	4	II
4.	Workshop Practices	1 : 0 : 2	3	II
5.	Engineering Mechanics	3 : 0 : 0	3	II
		Total	**18**	

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PROFESSIONAL CORE COURSES

S. No.	Course Title	Hrs. / Week L: T: P	Credits	Preferred Semester
1.	Electromagnetic Fields	3 : 1 : 0	4	**III**
2.	Digital Logic Circuits	3 : 0 : 0	3	
3.	Electrical Circuit Analysis	3 : 1 : 1	5	
4.	Electrical Machines - I	3 : 1 : 1	5	
5.	Analog Electronics	3 : 0 : 1	4	**IV**
6.	Control Systems	3 : 1 : 1	5	
7.	Electrical Machines - II	3 : 1 : 1	5	
8.	Transmission and Distribution	3 : 0 : 0	3	**V**
9.	Power System Analysis	3 : 1 : 0	4	
10.	Digital Electronics	3 : 0 : 1	4	
11.	Measurements and Instrumentation	3 : 0 : 1	4	
12.	Power Electronics	3 : 0 : 1	4	**VI**
13.	Microprocessors and Microcontrollers	3 : 0 : 1	4	
14.	Power Systems Operation and Control	3 : 1 : 1	5	**VII**
15.	Industrial Automation	3 : 0 : 1	4	
		Total	**63**	

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PROFESSIONAL ELECTIVE COURSE

S. No.	Course Code	Course Title	Hrs. / Week L : T : P	Credits	Preferred Semester
1.	XEE E11	Protection and Switchgear	3 : 0 : 0	3	V onwards
2.	XEE E12	Electrical Machine Design	3 : 0 : 0	3	V onwards
3.	XEE E13	Embedded System	3 : 0 : 0	3	V onwards
4.	XEE E14	Electrical Energy Conservation and Auditing	3 : 0 : 0	3	V onwards
5.	XEE E21	Signals and Systems	3 : 0 : 0	3	VI onwards
6.	XEE E22	Special Electrical Machines	3 : 0 : 0	3	VI onwards
7.	XEE E23	Electrical Power Quality	3 : 0 : 0	3	VI onwards
8.	XEE E24	Sustainable Energy Utilization	3 : 0 : 0	3	VI onwards
9.	XEE E31	Solid State Drives	3 : 0 : 0	3	VII onwards
10.	XEE E32	High Voltage Engineering	3 : 0 : 0	3	VII onwards
11.	XEE E33	Power Quality and FACTS	3 : 0 : 0	3	VII onwards
12.	XEE E34	Smart Grids	3 : 0 : 0	3	VII onwards
13.	XEE E41	Electrical and Hybrid Vehicles	3 : 0 : 0	3	VIII onwards
14.	XEE E42	Wind and Solar Systems	3 : 0 : 0	3	VIII onwards
15.	XEE E43	Pollution Performance of Power Apparatus and Systems	3 : 0 : 0	3	VIII onwards
16.	XEE E44	Bio-Medical Instrumentation	3 : 0 : 0	3	VIII onwards

PROJECT WORK & INTERNSHIP IN INDUSTRY

S. No.	Course Title	Hrs. / Week L: T: P	Credits	Preferred Semester
1.	In-plant Training - I	0 : 0 : 0	1	III
2.	In-plant Training - II	0 : 0 : 0	1	V
3.	In-plant Training - III	0 : 0 : 0	2	VII
4.	Project Work (Phase - I)	0 : 0 : 2	2	VII
5.	Project Work (Phase - II)	0 : 0 : 9	9	VIII
		Total	**15**	

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SEMESTER-WISE STRUCTURE OF CURRICULUM

REGULATION – 2021

(Applicable to the students admitted from the Academic year 2021-22 onwards)

SEMESTER I

Code No.	Course Title	L	T	P	C	TCH
XMA101	Calculus and Linear Algebra	3	1	0	4	4
XBE102	Electrical and Electronics Engineering Systems	3	1	0	4	4
XAC103	Applied Chemistry for Engineers	3	1	0	4	4
XEG104	Engineering Graphics and Design	1	0	2	3	5
XGS105	Speech Communication	0	1	2	3	5
XUM106	Constitution of India	0	0	0	0	3
XBE107	Electrical and Electronics Engineering Systems Laboratory	0	0	1	1	2
XAC108	Applied Chemistry for Engineers Laboratory	0	0	1	1	2
	TOTAL	**10**	**4**	**6**	**20**	**29**

SEMESTER II

Code No.	Course Title	L	T	P	C	TCH
XMA201	Calculus, Ordinary Differential Equations and Complex Variable	3	1	0	4	4
XCP202	Programming for Problem Solving	3	0	0	3	3
XAP203	Applied Physics for Engineers	3	1	0	4	4
XGS204	Technical Communication	2	0	0	2	2
XWP205	Workshop Practices	1	0	2	3	5
XEM206	Engineering Mechanics	3	0	0	3	3
XCP207	Programming for Problem Solving Laboratory	0	0	1	1	2
XAP208	Applied Physics for Engineers Laboratory	0	0	1	1	2
	TOTAL	**15**	**2**	**4**	**21**	**25**

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SEMESTER III

Code No.	Course Title	L	T	P	C	TCH
XMA301	Transforms and Partial Differential Equations	3	0	0	3	3
XEE302	Electromagnetic Fields	3	1	0	4	4
XEE303	Digital Logic Circuits	3	0	0	3	3
XEE304	Electrical Circuit Analysis	3	1	0	4	4
XEE305	Electrical Machines - I	3	1	0	4	4
XUM306	Entrepreneurship Development	2	0	0	2	2
XUM307	Universal Human Values 2: Understanding Harmony	2	1	0	3	3
XEE308	Electrical Circuit Analysis Laboratory	0	0	1	1	2
XEE309	Electrical Machines - I Laboratory	0	0	1	1	2
XEE310	In-plant Training - I	-	-	-	1	-
	TOTAL	**19**	**4**	**2**	**26**	**27**

SEMESTER IV

Code No.	Course Title	L	T	P	C	TCH
XMA401	Probability Distributions And Statistical Methods	3	0	0	3	3
XEE402	Analog Electronics	3	0	0	3	3
XEE403	Control Systems	3	1	0	4	4
XEE404	Electrical Machines - II	3	1	0	4	4
XUM405	Economics for Engineers	3	0	0	3	3
XUM406	Disaster Management	0	0	0	0	3
XEE407	Analog Electronics Laboratory	0	0	1	1	2
XEE408	Control Systems Laboratory	0	0	1	1	2
XEE409	Electrical Machines – II Laboratory	0	0	1	1	2
	TOTAL	**15**	**2**	**3**	**20**	**26**

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SEMESTER V

Code No.	Course Title	L	T	P	C	TCH
XEE501	Transmission and Distribution	3	0	0	3	3
XEE502	Power System Analysis	3	1	0	4	4
XEE503	Digital Electronics	3	0	0	3	3
XEE504	Measurements and Instrumentation	3	0	0	3	3
XEEE1*	Professional Elective - 1	3	0	0	3	3
X**OE*	Open Elective - 1	3	0	0	3	3
XEE506	Digital Electronics Laboratory	0	0	1	1	2
XEE507	Measurements and Instrumentation Laboratory	0	0	1	1	2
XEE508	In-plant Training - II	-	-	-	1	-
	TOTAL	**18**	**1**	**2**	**22**	**23**

SEMESTER VI

Code No.	Course Title	L	T	P	C	TCH
XEE601	Power Electronics	3	1	0	4	4
XEE602	Microprocessors and Microcontrollers	3	0	0	3	3
XEEE2*	Professional Elective - 2	3	0	0	3	3
X**OE*	Open Elective - 2	3	0	0	3	3
XGS605	Professional Skills	1	0	2	3	5
XUM606	Cyber Security	0	0	0	0	3
XEE607	Power Electronics Laboratory	0	0	1	1	2
XEE608	Microprocessors and Microcontrollers Laboratory	0	0	1	1	2
	TOTAL	**13**	**1**	**4**	**18**	**25**

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SEMESTER VII

Code No.	Course Title	L	T	P	C	TCH
XEE701	Power Systems Operation and Control	3	0	0	3	3
XEE702	Industrial Automation	3	0	0	3	3
XEEE3*	Professional Elective - 3	3	0	0	3	3
X**OE*	Open Elective - 3	3	0	0	3	3
XUM705	Environmental Studies	0	0	0	0	3
XEE706	Power System Simulation Laboratory	0	0	1	1	2
XEE707	Industrial Automation Laboratory	0	0	1	1	2
XEE708	Project Work (Phase - I)	0	0	2	2	4
XEE709	In-plant Training - III	-	-	-	2	-
	TOTAL	**12**	**0**	**4**	**18**	**23**

SEMESTER VIII

Code No.	Course Title	L	T	P	C	TCH
XEEE4*	Professional Elective - 4	3	0	0	3	3
X**OE*	Open Elective -4	3	0	0	3	3
X**OE*	Open Elective -5	3	0	0	3	3
XEE804	Project Work (Phase - II)	0	0	9	9	18
	TOTAL	**9**	**0**	**9**	**18**	**27**

OVER ALL CREDITS = 163 CREDITS

VALUE ADDED COURSES:

Code No.	Course Title
VAC1	Communications Skills and Development
VAC2	Fundamental of C / C++
VAC3	Auto CAD - Electrical
VAC4	Electrical System Design Using Internet of Things / Aurdino
VAC5	Advanced Placements Skills and Training
VAC6	Energy Auditing and Management

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LIST OF ELECTIVES

ELECTIVE GROUP – 1: (5th Semester)

Code No.	Course Title	L	T	P	C
E11	Protection and Switchgear	3	0	0	3
E12	Electrical Machine Design	3	0	0	3
E13	Embedded System	3	0	0	3
E14	Electrical Energy Conservation and Auditing	3	0	0	3

ELECTIVE GROUP – 2: (6th Semester)

Code No.	Course Title	L	T	P	C
E21	Signals and Systems	3	0	0	3
E22	Special Electrical Machines	3	0	0	3
E23	Electrical Power Quality	3	0	0	3
E24	Sustainable Energy Utilization	3	0	0	3

ELECTIVE GROUP – 3: (7th Semester)

Code No.	Course Title	L	T	P	C
E31	Solid State Drives	3	0	0	3
E32	High Voltage Engineering	3	0	0	3
E33	Power Quality and FACTS	3	0	0	3
E34	Smart Grids	3	0	0	3

ELECTIVE GROUP – 4: (8th Semester)

Code No.	Course Title	L	T	P	C
E41	Electrical and Hybrid Vehicles	3	0	0	3
E42	Wind and Solar Systems	3	0	0	3
E43	Pollution Performance of Power Apparatus and Systems	3	0	0	3
E44	Bio-Medical Instrumentation	3	0	0	3

OPEN ELECTIVES:

Code No.	Course Title	L	T	P	C
OE1	Industrial Automation	3	0	0	3
OE2	Energy Management and Auditing	3	0	0	3
OE3	Renewable Energy Technology	3	0	0	3
OE4	Solar and Energy Storage System	3	0	0	3
OE5	Electric Vehicles and Power Management	3	0	0	3

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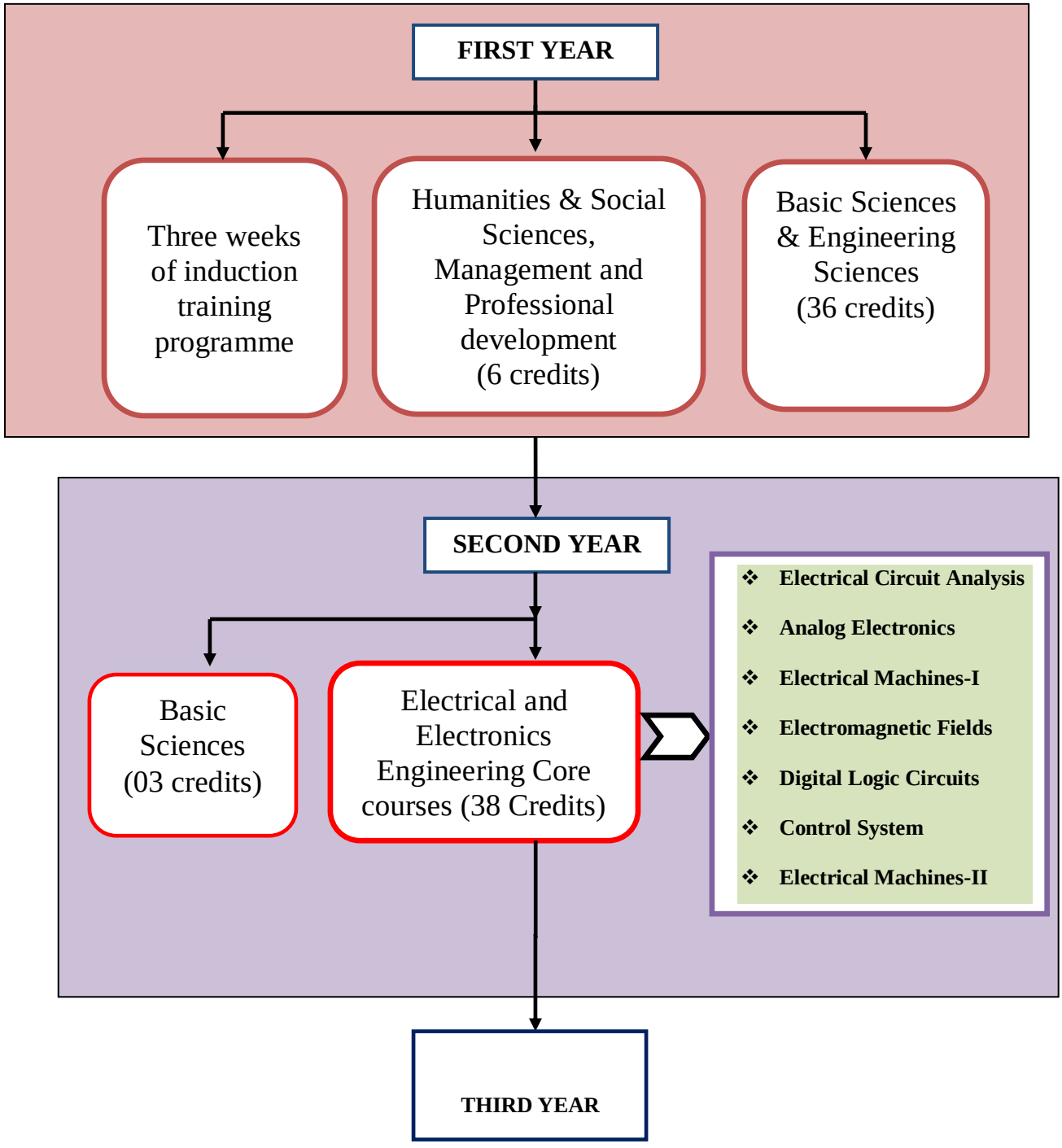
FLOW CHART FOR THE ENTIRE PROGRAMME



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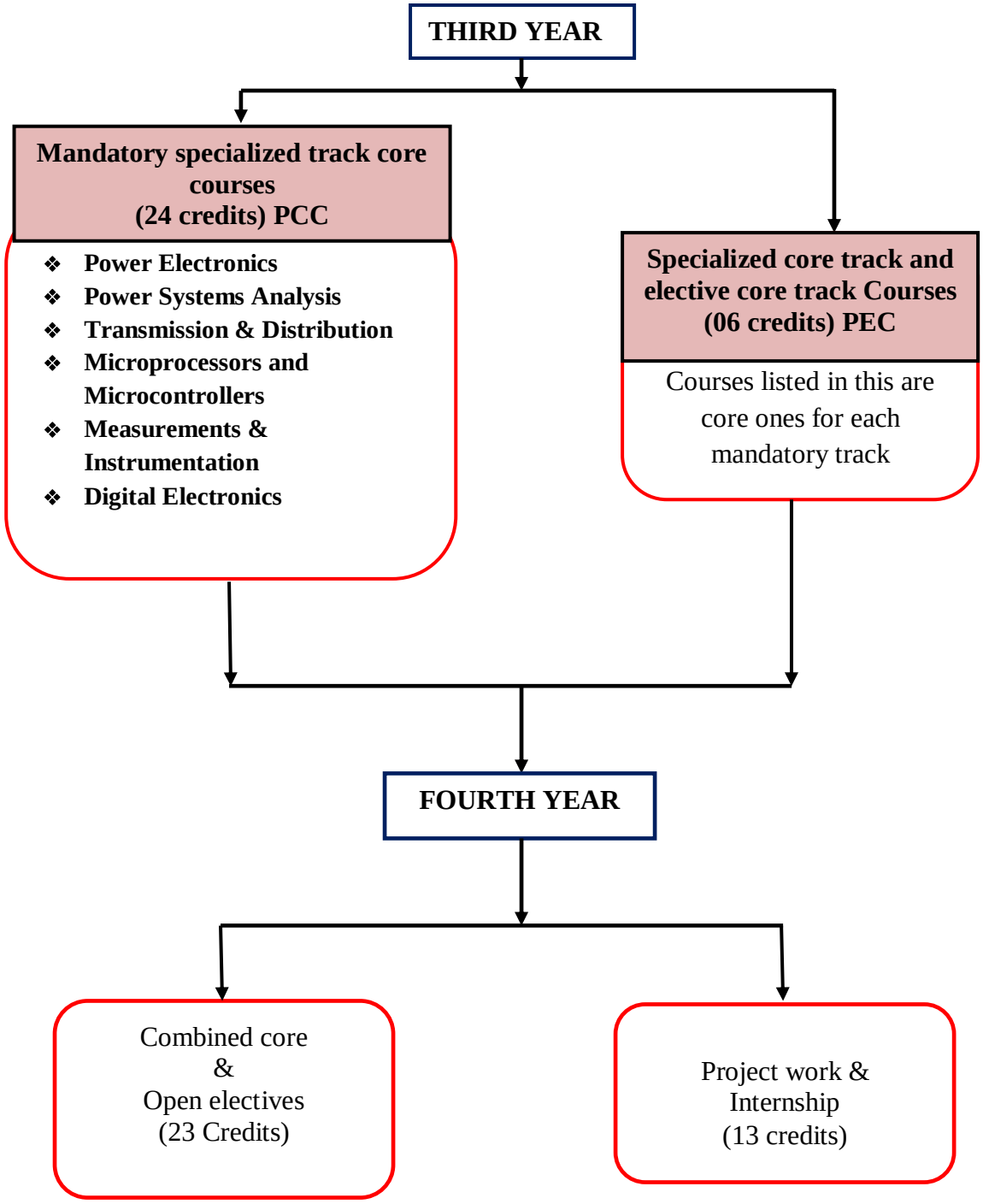

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SYLLABUS 2021

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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SEMESTER - I

COURSE CODE	COURSE NAME	L	T	P	C
XMA101	CALCULUS AND LINEAR ALGEBRA	3	1	0	4
Prerequisite	Differentiation and Integration	L	T	P	H
C : P : A		3	1	0	4
3 : 0.5 : 0.5					

Course Outcomes :		Domain	Level
CO1	**Apply** orthogonal transformation to reduce quadratic form to canonical forms.	Cognitive	Remembering Applying
CO2	**Apply** power series to tests the convergence of the sequences and series. Half range Fourier sine and cosine series.	Cognitive Psychomotor	Applying Remembering Guided Response
CO3	**Find** the derivative of composite functions and implicit functions. Euler's theorem and Jacobian.	Cognitive Psychomotor	Remembering Guided Response
CO4	**Explain** the functions of two variables by Taylors expansion, by finding maxima and minima with and without constraints using Lagrangian Method. Directional derivatives, Gradient, Curl and Divergence.	Cognitive Affective	Remembering Understanding Receiving
CO5	**Apply** Differential and Integral calculus to notions of Curvature and to improper integrals.	Cognitive	Applying

UNIT - I: MATRICES	**9 + 3**
Linear Transformation - Eigen values and Eigen vectors -Properties of Eigen values and Eigen vectors - Cayley-Hamilton Theorem – Diagonalisation of Matrices – Real Matrices: Symmetric - Skew-Symmetric and Orthogonal Quadratic form – canonical form - Nature of Quadratic form and Transformation of Quadratic form to Canonical form (Orthogonal only).	
UNIT - II: SEQUENCES AND SERIES	**9 + 3**
Sequences: Definition and examples-Series: Types and convergence- Series of positive terms – Tests of convergence: Comparison test, Integral test and D'Alembert's ratio test-. Fourier series: Half range sine and cosine series- Parseval's Theorem.	
UNIT - III: MULTIVARIABLE CALCULUS: PARTIAL DIFFERENTIATION	**9 + 3**
Limit and continuity –Partial differentiation – Total Derivative – Partial differentiation of Composite Functions: Change of Variables – Differentiation of an Implicit Function - Euler's Theorem- Jacobian.	
UNIT - IV: MULTIVARIABLE CALCULUS: MAXIMA AND MINIMA AND VECTOR CALCULUS	**9 + 3**
Taylor's theorem for function of Two variables- Maxima, Minima of functions of two variables: with	

and without constraints - Lagrange's Method of Undetermined Multipliers – Directional Derivatives - Gradient, Divergence and Curl.	
UNIT - V: DIFFERENTIAL AND INTEGRAL CALCULUS	**9 + 3**
Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.	

	LECTURE	TUTORIAL	TOTAL
	45	15	60

TEXT BOOKS:

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint, 2015**. (Unit-1, Unit-3 and Unit-4).**
2. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2014. **(Unit-2).**
3. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40th Edition,2010. **(Unit-5).**

REFERENCE BOOKS:

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson Reprint, 2002.
2. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi,2008.
3. D. Poole, "Linear Algebra: A Modern Introduction", 2nd Edition, Brooks/Cole, 2005.
4. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons,2006.

Mapping of COs with GAs

	GA 1	GA 2	GA 3	GA 4	GA 5	GA 6	GA 7	GA 8	GA 9	GA 10	GA 11	GA 12
CO 1	3	2	0	0	2	0	0	0	0	1	0	2
CO 2	3	2	0	0	0	0	0	0	0	1	0	1
CO 3	3	2	0	0	0	0	0	0	0	1	0	1
CO 4	3	2	0	0	0	0	0	0	0	1	0	1
CO 5	3	2	0	0	1	0	0	0	0	1	0	2
Total	**15**	**10**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**5**	**0**	**7**
Scaled	**3**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**2**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

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COURSE CODE	COURSE NAME	L	T	P	C
XBE102	ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS	3	1	0	4
Prerequisites	**Physics**	**L**	**T**	**P**	**H**
C : P : A		3	1	0	4
3 : 0 : 0					

Course Outcomes :		Domain	Level
CO1	**Define and Relate** the fundamentals of electrical parameters and **build** and **explain** AC, DC circuits by Using measuring devices	Cognitive	Understand
CO2	**Define and Explain** the operation of DC and AC machines.	Cognitive	Understand
CO3	**Recall and Illustrate** various semiconductor devices and their applications and displays the input output characteristics of basic semiconductor devices.	Cognitive	Understand
CO4	**Relate and Explain the** number systems and logic gates. **Construc**t the different digital circuit.	Cognitive	Understand
CO5	**Label and Outline the** different types of microprocessors and their applications.	Cognitive	Understand

UNIT - I: FUNDAMENTALS OF DC AND AC CIRCUITS, MEASUREMENTS	9 + 3

Fundamentals of DC– Ohm's Law – Kirchhoff's Laws - Sources - Voltage and Current Relations – Star/Delta Transformation - Fundamentals of AC – Average Value, RMS Value, Form Factor - AC power and Power Factor, Phasor Representation of sinusoidal quantities, Simple Series, Parallel, Series Parallel Circuit - Operating Principles of Moving coil and Moving Iron Instruments (Ammeter, Voltmeter) and Dynamometer type meters (Watt meter and Energy meter).

UNIT - II: ELECTRICAL MACHINES	9 + 3

Construction, Principle of Operation, Basic Equations, Types and Application of DC Generators, DC motors - Basics of Single-Phase Induction Motor and Three Phase Induction Motor- Construction, Principle of Operation of Single-Phase Transformer, Three phase transformers, Auto transformer.

UNIT - III: SEMICONDUCTOR DEVICES	9 + 3

Classification of Semiconductors, Construction, Operation and Characteristics: PN Junction Diode – Zener Diode, PNP, NPN Transistors, Field Effect Transistors and Silicon Controlled Rectifier – Applications

UNIT - IV: DIGITAL ELECTRONICS	9 + 3

Basic of Concepts of Number Systems, Logic Gates, Boolean Algebra, Adders, Subtractors, multiplexer, demultiplexer, encoder, decoder, Flipflops, Up/Down counters, Shift Registers.

UNIT - V: MICROPROCESSORS	**9 + 3**

Architecture, 8085, pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, Instruction types, classification of instructions, addressing modes, Interfacing Basics: Data transfer concepts – Simple Programming concepts.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

TEXT BOOKS:

1. Metha V.K, Rohit Mehta, 2020. Principles of Electronics,12th ed, S Chand Publishing.
2. Albert Malvino, David J.Bates., 2017. Electronics Principles. 7th ed, Tata McGraw-Hill. New Delhi.
3. Rajakamal, 2014. Digital System-Principle & Design. 2nd ed. Pearson education.
4. Morris Mano, 2015. Digital Design. Prentice Hall of India.
5. Ramesh, S. Gaonkar, 2013, Microprocessor Architecture, Programming and its Applications with the 8085, 6th ed , India: Penram International Publications.

REFERENCE BOOKS:

1. Cotton, H.,2005 Electrical Technology. CBS Publishers & Distributors Pvt Ltd.
2. Syed, A. Nasar, 1998, Electrical Circuits. Schaum Series.
3. Jacob Millman and Christos, C. Halkias, 1967, Electronics Devices, New Delhi: Tata McGraw-Hill.
4. Millman, J. and Halkias, C. C., 1972. Integrated Electronics: Analog and Digital Circuits and Systems, Tokyo: McGraw-Hill, Kogakusha Ltd.
5. Mohammed Rafiquzzaman, 1999. Microprocessors - Theory and Applications: Intel and Motorola. Prentice Hall International.

E-REFERENCES:

1. NTPEL, Basic Electrical Technology (Web Course), Prof. N. K. De, Prof. T. K. Bhattacharya and Prof. G.D. Roy, IIT Kharagpur.
2. Prof.L.Umanand, http://freevideolectures.com/Course/2335/Basic-Electrical-Technology#, IISc Bangalore.
3. http://nptel.ac.in/Onlinecourses/Nagendra/, Dr. Nagendra Krishnapura, IIT Madras.
4. Dr.L.Umanand, http://www.nptelvideos.in/2012/11/basic-electrical-technology.html, IISC Bangalore.

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Mapping of COs with GAs

	GA 1	GA 2	GA 3	GA 4	GA 5	GA 6	GA 7	GA 8	GA 9	GA 10	GA 11	GA 12
CO 1	3	3	1	1	1	1	0	0	1	1	1	0
CO 2	3	3	1	1	1	1	0	0	1	1	1	0
CO 3	2	2	2	1	2	2	1	1	1	1	1	0
CO 4	2	2	1	1	1	1	1	1	1	1	1	0
CO 5	2	2	1	1	1	1	1	1	1	1	1	0
Total	**12**	**12**	**6**	**5**	**6**	**6**	**3**	**3**	**5**	**5**	**5**	**0**
Scaled	**3**	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**0**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	COURSE NAME	L	T	P	C
XAC103	Applied Chemistry for Engineers	3	1	1	5
PREREQUISITES	Nil	L	T	P	H
C:P:A	3.5:1.0:0.5	3	1	3	7

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	**Understand**the address of the electron and know the trend of periodic properties; **Recall** the water treatment methods.	Cognitive Psychomotor	Remember Perception
CO2	**Understand**the laws of chemical thermodynamics; **Classify** the compounds as acids and bases	Cognitive Psychomotor	Understand Set
CO3	**Determine** the stability and reactions of co-ordination compounds; **Explain** and **Measure** microscopic chemistry in terms of atomic, molecular orbitals and intermolecular forces	Cognitive Psychomotor Affective	Apply Mechanism Receive
CO4	**Apply, Measure** and **Distinguish** the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques; **Construct** the MO theory to diatomic molecules.	Cognitive Psychomotor Affective	Remember Analyze Perception Respond
CO5	**Knowledge** about aliphatic and aromatic substitution reactions, oxidation and reduction, addition and elimination reactions will kindle the mind for proposing the new reactions and mechanisms.	Cognitive Psychomotor	Remember Apply Mechanism
	Theory Part		

UNIT – I	PERIODIC PROPERTIES AND WATER CHEMISTRY	8+3+6

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries,

hard soft acids and bases, molecular geometries. **Water Chemistry**-Water quality parameters-Definition and explanation of hardness, determination of hardness by EDTA method-Introduction to alkalinity.

UNIT–II	**USE OF FREE ENERGY IN CHEMICAL EQUILIBRIA**	**12+3+6**

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Corrosion-Types, factors affecting corrosion rate and Control methods. Use of free energy considerations in metallurgy through Ellingham diagrams. Advantages of electroless plating, electroless plating of nickel and copper on Printed Circuit Board (PCB).

UNIT–III	**ATOMIC AND MOLECULAR STRUCTURE**	**10+3+6**

Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic molecules. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Intermolecular forces and potential energy surfaces

Ionic, dipolar and Vander waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H_3, H_2F and HCN and trajectories on these surfaces.

UNIT-IV	**SPECTROSCOPIC TECHNIQUES AND APPLICATIONS**	**7+3+6**

Principles of spectroscopy and selection rules. Electronic spectroscopy-chromophore, auxochromes, types of electronic transition and application. Fluorescence and its applications in medicine. Vibrational spectroscopy-types of vibrations, Instrumentation and applications. Rotational spectroscopy of diatomic molecules. Nuclear magnetic resonance spectroscopy-concept of chemical shift and applications-magnetic resonance imaging. Diffraction and scattering.

UNIT–V	**STEREOCHEMISTRY AND ORGANIC REACTIONS**	**8+3+6**

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Organic reactions and synthesis of a drug molecule

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization reactions and ring opening reactions. Synthesis of a commonly used drug molecule- Aspirin and paracetamol.

	LECTURE	TUTORIAL	PRACTICAL	TOTAL HOURS
Hours	**45**	**15**	**30**	**90**

TEXT BOOKS

1. Puri B.R. Sharma, L.R., Kalia K.K. Principles of Inorganic Chemistry, (23rd edition), New Delhi, Shoban Lal Nagin Chand & Co., 1993
2. Lee. J.D. Concise Inorganic Chemistry, UK, Black well science, 2006.
3. Trapp. C, Cady, M. Giunta. C, Atkins's Physical Chemistry, 10th Edition, Oxford publishers, 2014.
4. Glasstone S., Lewis D., Elements of Physical Chemistry, London, Mac Millan & Co. Ltd, 1983.
5. Morrison R.T. and Boyd R.N. Organic Chemistry (6th edition), New York, Allyn & Bacon Ltd., 1976.
6. Banwell. C.N, Fundamentals of Molecular Spectroscopy, (3th Edition), McGraw-Hill Book Company, Europe 1983.
7. Bahl B.S. and Arun Bahl, Advanced Organic Chemistry, (4th edition), S./ Chand & Company Ltd. New Delhi, 1977.
8. P. S. Kalsi, Stereochemistry: Conformation and mechanism, (9th Edition), New Age International Publishers, 2017.

REFERENCE BOOKS

1. Puri B R Sharma L R and Madan S Pathania, " Principles of Physical Chemistry", Vishal publishing Co., Edition 2004
2. Kuriocose, J C and Rajaram, J, "Engineering Chemistry", Volume I/II, Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 2000

E Resources - MOOCs:

1. http://www.mooc-list.com/course/chemistry-minor-saylororg
2. https://www.canvas.net/courses/exploring-chemistry
3. http://freevideolectures.com/Course/2263/Engineering-Chemistry-I
4. http://freevideolectures.com/Course/3001/Chemistry-I
5. http://freevideolectures.com/Course/3167/Chemistry-II
6. http://ocw.mit.edu/courses/chemistry/

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COURSE CODE	COURSE NAME	L	T	P	C
XGS105	SPEECH COMMUNICATION	0	1	2	3
Prerequisite	Basic Understanding Skills	L	T	P	H
C : P : A		0	1	4	5
2.6 : 0.4 : 0					

Course Outcomes:		Domain	Level
CO1	**Ability** to recall the types of speeches.	Cognitive	Remember
CO2	**Apply** the techniques in public speaking.	Cognitive	Apply
CO3	**Identify** the common patterns in organizing a speech.	Cognitive	Remember
CO4	**Construct** the nature and style of speaking.	Cognitive	Create
CO5	**Practicing** the speaking skills.	Psychomotor	Guided Response

UNIT – I: TYPES OF SPEECHES	**9**
1.1 – Four types of speeches 1.2 – Analyzing the audience 1.3 - Developing ideas and supporting materials	
UNIT – II: PUBLIC SPEAKING	**9**
2.1 - Introduction to Public Speaking 2.2 - Competencies Needed for successful speech making 2.3 – Speaking about everyday life situations	
UNIT – III: ORGANIZATION OF SPEECH	**9**

3.1 – Developing a speech out line 3.2 - Organizing the speech 3.3 – Introduction - development – conclusion	
UNIT – IV: PRESENTATION	**9**
4.1 - Tips for preparing the draft speech 4.2 – Presentation techniques using ICT tools 4.3 – Using examples from different sources	
UNIT – V: ACTIVITIES	**9**
5.1 – Reading activities 5.2 – Creative presentations 5.3 – Media presentation techniques	
	TOTAL
	45

SUGGESTED READINGS:

1. Michael Swan. Practical English Usage. OUP. 1995.
2. Sanjay Kumar and Pushp Lata. Communication Skills. Oxford University Press. 2011.

COURSECODE	**COURSENAME**	**L**	**T**	**P**	**C**
XUM106	**CONSTITUTIONOFINDIA**	**3**	**0**	**0**	**3**
PREREQUISITE:	**NIL**	**L**	**T**	**P**	**H**
C:P:A	**3:0:0**	**3**	**0**	**0**	**3**

COURSEOUTCOMES		**Domain**	**Level**
CO1	To Study History of Constitution	Cognitive	Understanding
CO2	To Explain the Union Executive	Cognitive	Remembering
CO3	To Identify the concept of Union Legislature	Cognitive	Applying
CO4	To Analysis the Union Judiciary	Cognitive	Analyzing
CO5	To Explain the Centre State Relation	Cognitive	Evaluating

UNITI	**08**
ConstitutionalHistory-TheConstitutionalRights-Preamble-FundamentalRights-FundamentalDuties-Directiveprinciples of State Policy.	
UNITII	**09**
The Union Executive- The President of India (powers and functions)- Vice-President of India-The Council of Ministers-Prime Minister-Powers and Functions.	
UNITIII	**10**
Union Legislature- Structure and Functions of Lok Sabha- Structure and Functions of Rajya Sabha- Legislative Procedure in India- Important Committes of LokSabha- Speaker of the LokSabha.	
UNITIV	**09**
The Union Judiciary- Powers of the Supreme Court- Original Jurisdiction-Appeletejurisdictions-Advisory Jurisdiction-Judicial review.	
UNITV	**09**
Centre State relations- Political Parties- Role of governor, powers and functions of Chief Minister-LegislativeAssembly-State Judiciary-Powers and Functionsofthe High Courts.	

LECTURE	TUTORIAL	PRACTICAL	TOTAL
45	0	0	45

REFERENCES

1. W.H.MorrisShores- GovernmentandpoliticsofIndia,NewDelhi,B.1.Publishers,1974.
2. M.V.Pylee- Constitutional Government in India, Bombay, Asia Publishing House,1977.
3. R.Thanker-TheGovernmentandpoliticsofIndia,London:Macmillon,1995.
4. A.C.Kapur-SelectConstitutionsS,Chand&Co.,NewDelhi,1995
5. V.D.Mahajan-Select ModernGovernments,S,Chand&Co,NewDelhi,1995.
6. B.C.Rout-DemocracticConstitutionofIndia.
7. GopalK.Puri-Constitution ofIndia,India2005.

COURSE CODE	COURSE NAME	L	T	P	C
XBE107	ELECTRICAL AND ELECTRONICS ENGINEERING SYSTEMS LABORATORY	0	0	1	1
Prerequisite	**Physics**	**L**	**T**	**P**	**H**
C : P : A		0	0	2	2
1.5 : 1 : 0.5					

COURSE OBJECTIVES:

The course helps to

a. Learn the basic concepts of electrical and electronics components.
b. Understand the basic wiring methods and connection.
c. Study the characteristics of diodes, Zener diodes, NPN transistors.
d. Verify the working of simple logic gates, adders and subtractors.

Course Outcomes:		Domain	Level
CO1	**Apply** the fundamental electrical concepts and **differentiate** the various electronic components.	Cognitive Psychomotor Affective	Understand Set Valuing
CO2	**Implement** and **execute** the different types of wiring connections.	Cognitive Psychomotor Affective	Understand Set Valuing
CO3	**Demonstrate** the Fluorescent lamp connection with choke.	Cognitive Psychomotor Affective	Understand Set Valuing
CO4	**Characterize** and **display** the basic knowledge on the working of PN junction and Zener diode.	Cognitive Psychomotor Affective	Understand Set Valuing

CO5	**Implement** and **execute** the various digital electronic circuits such as Adders and Subtractors.	Cognitive Psychomotor Affective	Understand Set Valuing

List of Experiments:

Study of Electrical Symbols, Tools and Safety Precautions, Power Supplies.

1. Study of Active and Passive elements – Resistors, Inductors and Capacitors, Bread Board.
2. Testing of DC Voltage and Current in series and parallel resistors which are connected in breadboard by using Voltmeter, Ammeter and Multimeter.
3. Fluorescent lamp connection with choke.
4. Staircase Wiring
5. Forward and Reverse bias characteristics of PN junction diode.
6. Forward and Reverse bias characteristics of zener diode.
7. Input and Output Characteristics of NPN transistor.
8. Construction and verification of simple logic gates.
9. Construction and verification of adders and subtractors.

	PRACTICAL	**TOTAL**
	30	**30**

SEMESTER – II

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XMA201	**CALCULUS, ORDINARY DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLE**	**3**	**1**	**0**	**4**
Prerequisite	**Mathematics - I (Calculus and Linear Algebra)**	**L**	**T**	**P**	**H**
C : P : A		**3**	**1**	**0**	**4**
3 : 0 : 0					

Course Outcomes:		**Domain**	**Level**
CO1	**Find** double and triple integrals and to find line, surface and volume of an integral by **Applying** Greens, Gauss divergence and Stokes theorem.	Cognitive	Applying Remembering
CO2	**Solve** first order differential equations of different types which are solvable for p, y, x and Clairaut's type.	Cognitive	Applying
CO3	**Solve** Second order ordinary differential equations with variable coefficients using various methods.	Cognitive	Remembering
CO4	**Use** CR equations to verify analytic functions and to find harmonic functions and harmonic conjugate. Conformal mapping of translation and rotation. Mobius transformation.	Cognitive Psychomotor	Understanding Remembering Guided Response

CO5	**Apply** Cauchy residue theorem to evaluate contour integrals involving sine and cosine function and to state Cauchy integral formula, Liouvilles theorem. Taylor's series, zeros of analytic functions, singularities, Laurent's series.	Cognitive Affective	Applying Receiving

UNIT - I: MULTIVARIABLE CALCULUS (INTEGRATION)	**9 + 3**
Multiple Integration: Double integrals (Cartesian) - change of order of integration in double integrals - Change of variables (Cartesian to polar) - Triple integrals (Cartesian), Scalar line integrals - vector line integrals - scalar surface integrals - vector surface integrals - Theorems of Green, Gauss and Stokes.	
UNIT - II: FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS	**9 + 3**
Exact - linear and Bernoulli's equations - Euler's equations - Equations not of first degree: equations solvable for p - equations solvable for y- equations solvable for x and Clairaut's type.	
UNIT - III: ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDERS	**9 + 3**
Second order linear differential equations with variable coefficients- method of variation of parameters - Cauchy-Euler equation- Power series solutions- Legendre polynomials- Bessel functions of the first kind and their properties.	
UNIT - IV: COMPLEX VARIABLE – DIFFERENTIATION	**9 + 3**
Differentiation – Cauchy - Riemann equations - analytic functions - harmonic functions - finding harmonic conjugate - elementary analytic functions (exponential, trigonometric, logarithm) and their properties - Conformal mappings - Mobius transformations and their properties.	
UNIT - V: COMPLEX VARIABLE – INTEGRATION	**9 + 3**
Contour integrals - Cauchy-Goursat theorem (without proof) - Cauchy Integral formula (without proof)- Liouville's theorem (without proof)- Taylor's series- zeros of analytic functions- singularities- Laurent's series – Residues- Cauchy Residue theorem (without proof)- Evaluation of definite integral involving sine and cosine- Evaluation of certain improper integrals using the Bromwich contour.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

TEXT BOOKS:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 40thth Edition, 2008.

REFERENCE BOOKS:

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Edition, Pearson, Reprint, 2002.
2. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
3. W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", 9thEdn. Wiley India, 2009.
4. S. L. Ross, "Differential Equations", 3rd Ed., Wiley India, 1984.
5. E. A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall India, 1995.
6. E. L. Ince, "Ordinary Differential Equations", Dover Publications, 1958.
7. J. W. Brown and R. V. Churchill, "Complex Variables and Applications", 7th Ed., McGraw Hill, 2004.
8. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.

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COURSE CODE	COURSE NAME	L	T	P	C
XCP202	PROGRAMMING FOR PROBLEM SOLVING	3	0	0	3
Prerequisites	Basic Understanding Skills	L	T	P	H
C : P : A		3	0	0	3
3 : 0 : 0					

Course Outcomes :		Domain	Level
CO1	**Define** programming fundamentals and **Solve** simple programs using I/O statements	Cognitive	Remember Understand Apply
CO2	**Define** syntax and **write simple programs** using control structures and arrays	Cognitive	Remember Understand Apply
CO3	**Explain** and **write simple programs** using functions and pointers	Cognitive	Remember Understand Apply
CO4	**Explain** and **write simple programs** using structures and unions	Cognitive	Remember Understand Apply
CO5	**Explain** and **write simple programs** using files and **Build** simple projects	Cognitive	Remember Understand Apply

UNIT - I: PROGRAMMING FUNDAMENTALS AND I/O STATEMENTS	**9**
Introduction to components of a computer system, Program – Flowchart – Pseudo code – Software – Introduction to C language – Character set – Tokens: Identifiers, Keywords, Constants, and Operators – sample program structure -Header files – Data Types- Variables - Output statements – Input statements.	
UNIT - II: CONTROL STRUCTURE AND ARRAYS	**9**
Control Structures – Conditional Control statements: Branching, Looping - Unconditional control structures: switch, break, continue, goto statements – Arrays: One Dimensional Array – Declaration – Initialization – Accessing Array Elements – Searching – Sorting – Two Dimensional arrays - Declaration – Initialization – Matrix Operations – Multi Dimensional Arrays - Declaration – Initialization. Storage classes: auto – extern – static. Strings: Basic operations on strings.	
UNIT - III: FUNCTIONS AND POINTERS	**9**
Functions: Built in functions – User Defined Functions - Parameter passing methods - Passing arrays to fun Recursion - Programs using arrays and functions. Pointers - Pointer declaration - Address operator - expressions & pointer arithmetic - Pointers and function - Call by value - Call by Reference - Pointer to arra of Pointers in self-referential structures-Notion of linked list.	
UNIT - IV: STRUCTURES AND UNIONS	**9**

Structures and Unions - Giving values to members - Initializing structure - Functions and structures - Passing structure to elements to functions - Passing entire function to functions - Arrays of structure - Structure within a structure and Union.		
UNIT - V: FILES		**9**
File management in C - File operation functions in C - Defining and opening a file - Closing a file - The getw and putw functions - The fprintf & fscanf functions - fseek function – Files and Structures.		

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Byron Gottfried, "Programming with C", III Edition, (Indian Adapted Edition), TMH publications, 2010.
2. Yeshwant Kanethker, “Let us C”, BPB Publications, 2008.

REFERENCE BOOKS:

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill, 7th edition 2017.
2. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", Pearson Education Inc. 2005.
3. Johnson baugh R. and Kalin M., “Applications Programming in ANSI C”, III Edition, Pearson Education India, 2003.

E-REFERENCES:

1. https://www.indiabix.com/c-programming/questions-and-answers/
2. https://www.javatpoint.com/c-programming-language-tutorial
3. https://www.w3schools.in/c-tutorial/

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XAP203	**APPLIED PHYSICS FOR ENGINEERS**	**3**	**1**	**0**	**4**
Prerequisite	**Basic Physics in HSC Level**	**L**	**T**	**P**	**H**
C : P : A		**3**	**1**	**0**	**4**
2.8 : 0.8 : 0.4					

Course Outcomes:		**Domain**	**Level**
CO1	**Identify** the basics of mechanics, **explain** the principles of elasticity and **determine** its significance in engineering systems and technological advances.	Cognitive Psychomotor	Remember Understand Mechanism
CO2	**Illustrate** the laws of electrostatics, magneto-statics and electromagnetic induction; **use** and **locate** basic applications of electromagnetic induction to technology.	Cognitive Psychomotor Affective	Remember Analyze Mechanism Respond
CO3	**Understand** the fundamental phenomena in optics by measurement and **describe** the working principle and application of various lasers and fiber optics.	Cognitive Psychomotor Affective	Understand Apply Mechanism Receive
CO4	**Analyze** energy bands in solids, **discuss** and **use** physics	Cognitive	Understand

	principles of latest technology using semiconductor devices.	Psychomotor Affective	Analyze Mechanism Receive
CO5	**Develop** Knowledge on particle duality and **solve** Schrodinger equation for simple potential.	Cognitive	Understand Apply

UNIT – I: MECHANICS OF SOLIDS	**9 + 3**
Mechanics: Force - Newton's laws of motion - work and energy - impulse and momentum - torque - law of conservation of energy and momentum - Friction. **Elasticity:** Stress - Strain - Hooke's law - Stress strain diagram - Classification of elastic modulus - Moment, couple and torque - Torsion pendulum - Applications of torsion pendulum - Bending of beams - Experimental determination of Young's modulus: Uniform bending and non-uniform bending.	
UNIT – II: ELECTROMAGNETIC THEORY	**9 + 3**
Laws of electrostatics - Electrostatic field and potential of a dipole; Dielectric Polarization, Dielectric constant, internal field - Clausius Mossotti Equation - Laws of magnetism - Ampere's Faraday's law; Lenz's law - Maxwell's equation - Plane electromagnetic waves; their transverse nature - expression for plane, circularly and elliptically polarized light - quarter and half wave plates - production and detection of plane, circularly and elliptically polarized light.	
UNIT – III: OPTICS, LASERS AND FIBRE OPTICS	**9 + 3**
Optics: Dispersion- Optical instrument: Spectrometer - Determination of refractive index and dispersive power of a prism- Interference of light in thin films: air wedge - Diffraction: grating. **LASER**: Introduction - Population inversion -Pumping - Laser action - Nd-YAG laser - CO_2 laser – Applications. **Fibre Optics:** Principle and propagation of light in optical fibre - Numerical aperture and acceptance angle - Types of optical fibre - Fibre optic communication system (Block diagram).	
UNIT – IV: SEMICONDUCTOR PHYSICS	**9 + 3**
Semiconductors: Energy bands in solids - Energy band diagram of good conductors, insulators and semiconductors - Concept of Fermi level - Intrinsic semiconductors - Concept of holes - doping - Extrinsic semiconductors - P type and N type semiconductors - Hall effect. **Diodes and Transistors**: P-N junction diode - Forward bias and reverse bias - Rectification action of diode - Working of full wave rectifier using P N junction diodes - PNP and NPN transistors - Three different configurations - Advantages of common emitter configuration - working of NPN transistor as an amplifier in common emitter configuration.	
UNIT – V: QUANTUM PHYSICS	**9 + 3**
Introduction to quantum physics, black body radiation, Compton effect, de Broglie hypothesis, wave – particle duality, uncertainty principle, Schrodinger wave equation (Time dependent and Time independent), particle in a box, Extension to three dimension - Degeneracy.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

TEXT BOOKS:

2. Gaur R. K. and Gupta S. L., "Engineering Physics", Dhanpat Rai Publications, 2009.
3. Avadhanulu M. N. "Engineering Physics" (Volume I and II), S. Chand & Company Ltd., New Delhi, 2010.

REFERENCE BOOKS:

1. Palanisamy P. K., "Engineering Physics", Scitech Publications (India) Pvt. Ltd, Chennai.
2. Arumugam M., "Engineering Physics" (Volume I and II), Anuradha Publishers, 2010.
3. Senthil Kumar G., " Engineering Physics", 2nd Enlarged Revised Edition, VRB Publishers, Chennai, 2011.
4. Mani P., "Engineering Physics", Dhanam Publications, Chennai, 2007.

E-RESOURCES:

1. NPTEL , Engineering Physics, Prof. M. K. Srivastava, Department of Physics, IIT, Roorkee.

Mapping of COs with GAs

	GA 1	GA 2	GA 3	GA 4	GA 5	GA 6	GA 7	GA 8	GA 9	GA 10	GA 11	GA 12
CO1	3	2	2	2	1	0	0	0	1	0	0	1
CO2	3	0	1	0	1	0	0	0	0	0	0	1
CO3	3	2	2	2	1	0	0	0	1	0	0	1
CO4	3	2	2	2	1	0	0	0	1	0	0	1
CO5	3	0	2	0	0	0	0	0	0	0	0	1
Total	**15**	**6**	**9**	**6**	**4**	**0**	**0**	**0**	**3**	**0**	**0**	**5**
Scaled	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	COURSE NAME	L	T	P	C
XGS204	**TECHNICAL COMMUNICATION**	**2**	**0**	**0**	**2**
Prerequisite	**Basic English in HSC level**	**L**	**T**	**P**	**H**
C : P : A		**2**	**0**	**0**	**2**
3 : 0 : 0					

Course Outcomes:		**Domain**	**Level**
CO1	**Ability** to understand the basic principles.	Cognitive	Remember
CO2	**Apply** the techniques in writing.	Cognitive	Apply
CO3	**Identify** communicative styles.	Cognitive	Remember
CO4	**Construct** the nature of writing.	Cognitive	Create

UNIT – I: BASIC PRINCIPLES	**9**
1.1 – Basic Principles of Technical Writing 1.2 – Styles used in Technical Writing	

1.3 – Language and Tone	
UNIT – II: TECHNIQUES	**9**
2.1 – Special Techniques used in writing 2.2 – Definition & Description of mechanism 2.3 – Description- Classification-Interpretation	
UNIT – III: COMMUNICATION	**6**
3.1 – Modern development in style of writing 3.2 - New letter writing formats	
UNIT – IV: REPORT WRITING	**6**
4.1 – Types of Report writing 4.2 – Project writing formats	

	LECTURE	**TOTAL**
	30	**30**

SUGGESTED READINGS:

1. John Sealy, Writing and Speaking Author; Oxford University Press, New Delhi, 2009.
2. Williams K.S, Communicating Business. Engage Learning India Pvt Ltd, 2012.

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
XWP205			**Workshop Practices**	**1**	**0**	**2**	**3**
C	**P**	**A**		**L**	**T**	**P**	**H**
1	**3**	**0**		**1**	**0**	**4**	**5**

PREREQUISITE:

Course outcomes:		**Domain**	**Level**
CO1:	**Summarize** the machining methods and **Practice** machining operation.	Cognitive Psychomotor	Understanding Guided response
CO2:	**Defining**metal casting process, moulding methodsand **relates**Casting and Smithy applications.	Cognitive Psychomotor	Remembering Perception
CO3:	**Plan** basic carpentry and fitting operation and **Practice** carpentry and fitting operations.	Cognitive Psychomotor	Applying Guided response

CO4:	**Summarize** metal joining operation and **Practice** welding operation.	Cognitive Psychomotor	Understanding Guided response
CO5:	**Illustrate**the, electrical and electronics basics and **Makes** appropriate connections**.**	Cognitive Psychomotor	Understanding Origination

COURSE CONTENT		
EXP.NO	**TITLE**	**CO RELATION**
1	**Introduction to machining process**	**CO1**
2	**Plain turining using lathe operation**	**CO1**
3	**Introduction to CNC**	**CO1**
4	**Demonstration of plain turning using CNC**	**CO1**
5	**Study of metal casting operation**	**CO2**
6	**Demonstration of moulding process**	**CO2**
7	**Study of smithy operation**	**CO2**
8	**Study of carpentry tools**	**CO3**
9	**Half lap joint – Carpentry**	**CO3**
10	**Mortise and Tenon joint – Carpentry**	**CO3**
11	**Study of fitting tools**	**CO3**
12	**Square fitting**	**CO3**
13	**Triangular fitting**	**CO3**
14	**Study of welding tools**	**CO4**
15	**Square butt joint – welding**	**CO4**
16	**Tee joint – Welding**	**CO4**
17	**Introduction to house wiring**	**CO5**
18	**One lamp controlled by one switch**	**CO5**

19	**Two lamps controlled by single switch**	**CO5**
20	**Staircase wiring**	**CO5**

TEXT BOOKS

1. Workshop Technology I,II,III, by S K Hajra, Choudhary and A K Chaoudhary. Media Promoters and Publishers Pvt. Ltd., Bombay

2. Workshop Technology by Manchanda Vol. I,II,III India Publishing House, Jalandhar.

REFERENCES

1. Manual on Workshop Practice by K Venkata Reddy, KL Narayana et al; MacMillan India Ltd.

2. Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd.,New Delhi

3. Workshop Technology by B.S. Raghuwanshi, Dhanpat Rai and Co., New Delhi.

4. Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.

E RESOURCES

1. **http://nptel.ac.in/courses/112107145/**

Mapping of CO's with PO'S:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	1	2	2	1			1	1		1	2
CO2	2	1	2	2	1			1	1		1	2
CO3	2	1	2	2	1			1	1		1	2
CO4	2	1	2	2	1			1	1		1	2
CO5	2	1	2	2	1			1	1		1	2
Total												
Scaled												

0- No relation 1- Low relation 2- Medium relation 3- High relation

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COURSE CODE	XEM206	L	T	P	C
COURSE NAME	ENGINEERING MECHANICS	3	0	0	3
PREREQUISITES	NIL	L	T	P	H
C:P:A= 3:0:0		3	0	0	3

COURSE OBJECTIVES

Upon successful completion of the course, student will have:

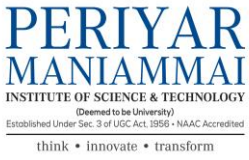
- Ability to apply knowledge of mathematics, science, and engineering.
- Ability to design as well as to analyse and inter pre-data.
- Ability to identify, formulates, and solves engineering problems.
- Ability to apply techniques and resources to solve complex mechanical engineering activities with an understanding of the limitations.

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	**Explain** the principles forces, laws and their applications.	Cognitive	Understanding, Apply
CO2	**Classification** of friction, and **apply** the forces in Trusses and beams.	Cognitive	Understanding, Apply
CO3	**Explain** and **Apply** moment of Inertia and Virtual work	Cognitive	Understanding, Apply
CO4	**Outline** and **Examine** Dynamics	Cognitive	Understanding, Apply
CO5	**Explain** free and forced vibration	Cognitive	Remember, Understanding

UNIT I	INTRODUCTION TO ENGINEERING MECHANICS	9

Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and

its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static indeterminacy.		
UNIT II	**FRICTION AND BASIC STRUCTURAL ANALYSIS**	**9**
Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack; Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines.		
UNIT III	**CENTROID , CENTRE OF GRAVITY AND VIRTUAL WORK AND ENERGY METHOD**	**9**
Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook. Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.		
UNIT IV	**REVIEW OF PARTICLE DYNAMICS AND INTRODUCTION TO KINETICS OF RIGID BODIES**	**9**
Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid bodyrotation.		
UNIT V	**MECHANICAL VIBRATIONS**	**9**
Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums.		



TEXT BOOKS			
1.	Hisrich, 2016, Entrepreneurship, Tata McGraw Hill, New Delhi.		
2.	S.S.Khanka, 2013, Entrepreneurial Development, S.Chand and Company Limited, New Delhi.		
REFERENCE BOOKS			
1.	Mathew Manimala, 2005, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition.		
2.	Prasanna Chandra, 2009, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill.		
3.	P.Saravanavel, 1997, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai.		
4.	Arya Kumar,2012, Entrepreneurship: Creating and Leading an Entrepreneurial organisation, Pearson Education India.		
5.	Donald F Kuratko, T.V Rao, 2012, Entrepreneurship: A South Asian perspective, Cengage Learning India.		
6.	Dinesh Awasthi, Raman Jaggi, V.Padmanand, Suggested Reading / Reference Material for Entrepreneurship Development Programmes (EDP/WEDP/TEDP), EDI Publication, Entrepreneurship Development Institute of India, Ahmedabad.		
E-REFERENCES			
1.	Jeff Hawkins, “Characteristics of a successful entrepreneur”, ALISON Online entrepreneurship courses, “https://alison.com/learn/entrepreneurial-skills		
2.	Jeff Cornwall, “Entrepreneurship -- From Idea to Launch”, Udemy online Education, https://www.udemy.com/entrepreneurship-from-idea-to-launch/		
LECTURE: 45	**TUTORIAL: 0**	**PRACTICAL: 0**	**TOTAL:45**

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COURSE CODE	COURSE NAME	L	T	P	C
XCP207	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	0	0	1	1
Prerequisites	**Basic Understanding Skills**	**L**	**T**	**P**	**H**
C : P : A		0	0	2	2
0.75 : 0.25 : 0					

COURSE OBJECTIVES:

- To learn programming language basics and syntax.
- To ignite logical thinking.
- To understand structured programming approach.
- To deal with user defined data types.
- To know about data storage in secondary memory.

Course Outcomes:		Domain	Level
CO1	**Solve** simple programs using I/O statements.	Cognitive Psychomotor	Apply Responding
CO2	**Solve** programs using control structures and arrays.	Cognitive Psychomotor	Apply Responding
CO3	**Solve** programs using functions and pointers.	Cognitive Psychomotor	Apply Responding
CO4	**Solve** programs using structures.	Cognitive Psychomotor	Apply Responding
CO5	**Solve** programs using files.	Cognitive Psychomotor	Apply Responding

Sl. No.	List of Experiments	COs
1	Program to display a Leave Letter as per proper format	CO1
2	i. Program for addition of two numbers ii. Program to solve any mathematical formula.	CO1
3	Program to find greatest of 3 numbers using Branching Statements	CO2
4	Program to display divisible numbers between n1 and n2 using looping Statement	CO2
5	Program to search an array element in an array.	CO2
6	Program to find largest / smallest element in an array.	CO2
7	Program to perform string operations.	CO3
8	Program to find area of a rectangle of a given number use four function types.	CO3

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9	Programs to pass and receive array and pointers using four function types	CO3
10	Programs using Recursion for finding factorial of a number	CO3
11	Program to read and display student mark sheet of a student structures with variables	CO4
12	Program to read and display student marks of a class using structures with arrays	CO4
13	Program to create linked list using structures with pointers	CO4
14	Program for copying contents of one file to another file.	CO5
15	Program using files to store and display student mark list of a class using structures with array	CO5

	PRACTICAL	**TOTAL**
	30	**30**

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COURSE CODE	COURSE NAME	L	T	P	C
XAP208	APPLIED PHYSICS FOR ENGINEERS LABORATORY	0	0	1	1
Prerequisite	Basic Physics in HSC level	L	T	P	H
C : P : A		0	0	2	2
0 : 1.5 : 0.5					

Course Outcomes:		Domain	Level
CO1	**Identify** the basics of mechanics, and **determine** its significance in engineering systems and technological advances.	Psychomotor	Mechanism
CO2	**Use** and **locate** basic applications of electromagnetic induction to technology.	Psychomotor Affective	Analyze Mechanism Respond
CO3	**Describe** the working principle and application of various lasers and fibre optics.	Psychomotor Affective	Apply Mechanism Receive
CO4	**Analyze** energy bands in solids, **discuss** and **use** physics principles of latest technology using semiconductor devices.	Psychomotor Affective	Analyze Mechanism Receive

List of Experiments:

1. Torsional Pendulum - Determination of moment of inertia and rigidity modulus of the given material of the wire.
2. Uniform Bending - Determination of the Young's Modulus of the material of the beam.
3. Non-Uniform Bending - Determination of the Young's Modulus of the material of the beam.
4. Meter Bridge - Determination of specific resistance of the material of the wire.
5. Spectrometer - Determination of dispersive power of the give prism.
6. Spectrometer - Determination of wavelength of various colours in Hg source using grating.
7. Air wedge - Determination of thickness of a given thin wire.
8. Laser - Determination of wavelength of given laser source and size of the given micro particle using Laser grating.
9. Post office Box - Determination of band gap of a given semiconductor.

10. PN Junction Diode - Determination of V-I characteristics of the given diode.		
	PRACTICAL	**TOTAL**
	30	**30**

III SEMESTER

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XMA 301	**Transforms and Partial Differential Equations**	**3**	**0**	**0**	**3**
PREREQUISITES	Algebra , Calculus and Laplace Transforms	**L**	**T**	**P**	**C**
C:P:A	**2.5 : 0.25 : 0.25**	**3**	**0**	**0**	**3**

Learning Objectives

1. Introduction of methods to solve linear partial differential equations of second order and higher order.
2. Find the solutions of pde's are determined by conditions at the boundaries of the spatial domain and initial conditions at time zero.
3. Provide sufficient knowledge to engineering students in the specific mathematical tools and techniques such as Fourier series, Fourier transform and Z transform.
4. To enable students to use Fourier series method both in the solution of pde and other wider context.

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	Solve standard types of first order and second order partial differential equations with constant coefficients. Elimination of arbitrary constants and functions.	Cognitive	Applying

CO2	State Dirichlet's condition. Explain general Fourier series of the curve y = f(x) in the interval $(0,2\pi)$ $(-\pi, \pi)$, $(0, 2\ell)$, $(-\ell,\ell)$, $(0, \pi)$ and $(0,\ell)$. Perform harmonic analysis.	Cognitive Psychomotor	Understanding Guided Response
CO3	Solve one dimensional Wave equation and Heat flow equation by Fourier series method in Cartesian coordinates. Classify second order quasi pde.	Cognitive Affective	Applying Receiving
CO4	Find the Fourier transform and Fourier sine and cosine transforms of simple functions using definition and its properties.	Cognitive	Applying
CO5	**Apply** the properties of Z transform to **find** the Z transform and inverse Z transform of sequence and functions, and to solve the difference equation using them.	Cognitive	Applying

UNIT I PARTIAL DIFFERENTIAL EQUATIONS	**9**
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second order with constant coefficients.	
UNIT II FOURIER SERIES	**9**
Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Harmonic Analysis.	
UNIT III APPLICATIONS TO BOUNDARY VALUE PROBLEMS	**9**
Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state conditions (zero Boundary conditions only).	
UNIT IV FOURIER TRANSFORM	**9**
Fourier transform pairs – Fourier Sine and Cosine transforms – properties – Transforms of simple functions – Parseval's identity.	
UNIT V Z TRANSFORM AND DIFFERENCE EQUATIONS	**9**
Z-transform – Elementary properties – Inverse Z – transform – Convolution theorem - Solution of difference equations using Z-transform.	

	LECTURE	TUTORIAL	PRACTICAL	TOTAL
HOURS	**45**	**-**	**-**	**45**

TEXT BOOKS

1. Grewal, B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, New Delhi (2012).
2. Veerarajan. T., "Engineering Mathematics Volume III", Second reprint, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

REFERENCES

1. Churchill, R.V. and Brown, J.W., "Fourier Series and Boundary Value Problems", Fourth Edition, McGraw Hill Book Co., Singapore (1987).
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., "Engineering Mathematics Volume III", S. Chand & Company Ltd., New Delhi (1996).
3. Bali N.P. and Manish Goyal, "A Text Book of Engineering Mathematics" 7th Edition Lakshmi Publications (P) Limited, New Delhi (2007).
4. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
6. Narayanan, S., ManicavachagomPillay, T.K. and Ramaniah, G., "Advanced Mathematics for Engineering Students", Volume: II and III, S.Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai (2002).

E-REFERENCES

nptel:Advanced Engineering Mathematics, Prof. Jitendra Kumar, Department of Mathematics, Indian Institute of Technology, Kharagpur, India.

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COURSE CODE	COURSE NAME	L	T	P	C
XEE302	ELECTROMAGNETIC FIELDS	3	1	0	4
C : P : A		L	T	P	H
3 : 0 : 0		3	1	0	4

Course Outcomes:		Domain	Level
CO1	To understand the basics of vector and outline different coordinate system.	Cognitive	Remembering Understanding
CO2	To understand the concept of static electric field for simple configuration using gauss and Coulombs law.	Cognitive	Understanding
CO3	Define the knowledge of electrostatics using, boundary conditions, Poissons and Laplace equation.	Cognitive	Understanding
CO4	Recall the magnetic field configuration using Different laws and outline time varying electric and magnetic fields using Maxwell's equation.	Cognitive	Remembering Understanding
CO5	Recall the concept of magnetization and magnetic field configuration using boundary condition.	Cognitive	Understanding

UNIT - I: REVIEW OF VECTOR CALCULUS	9 + 3
Vector algebra-addition, subject traction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.	
UNIT - II: STATIC ELECTRIC FIELD	**9 + 3**

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

UNIT - III: CONDUCTORS, DIELECTRICS AND CAPACITANCE	**9 + 3**

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two-wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

UNIT - IV: STATIC MAGNETIC FIELDS, TIME VARYING FIELDS AND MAXWELL'S EQUATIONS	**9 + 3**

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors. Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions. Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic circuits, inductances and mutual inductances.

UNIT - V: ELECTROMAGNETIC WAVES	**9 + 3**

Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

TEXT BOOKS:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A.Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A.Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.

REFERENCE BOOKS:

1. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
2. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
3. E. G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press,1966.
4. B. D. Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.
5. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.

E-RESOURCES:

1. NPTEL: http://nptel.ac.in/courses

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COURSE CODE	COURSE NAME	L	T	P	C
XEE303	DIGITAL LOGIC CIRCUITS	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Ability to design combinational and sequential Circuits.	Cognitive	Remembering Understanding
CO2	Ability to study various number systems and simplify the logical expressions using Boolean functions.	Cognitive	Understanding
CO3	Ability to design various synchronous and asynchronous circuits.	Cognitive	Understanding
CO4	Ability to introduce asynchronous sequential circuits and PLDs.	Cognitive	Remembering Understanding
CO5	Ability to introduce digital simulation for development of application oriented logic circuits.	Cognitive	Understanding

UNIT – I: NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES	9
Review of number systems, binary codes, error detection and correction codes (Parity and Hamming code) - Digital Logic Families -comparison of RTL, DTL, TTL, ECL and MOS families - operation, characteristics of digital logic family.	
UNIT – II: COMBINATIONAL CIRCUITS	**9**
Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps - simplification and implementation of combinational logic – multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders.	

UNIT – III: SYNCHRONOUS SEQUENTIAL CIRCUITS	**9**
Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters - asynchronous and synchronous type - Modulo counters - Shift registers - design of synchronous sequential circuits – Moore and Melay models- Counters, state diagram; state reduction; state assignment.	
UNIT – IV: ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABILITY LOGIC DEVICES	**9**
Asynchronous sequential logic circuits-Transition tability, flow tability-race conditions, hazards &errors in digital circuits; analysis of asynchronous sequential logic circuits introduction to Programmability Logic Devices: PROM – PLA –PAL, CPLD-FPGA.	
UNIT – V: VHDL	**9**
RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages – Subprograms – Test bench. (Simulation /Tutorial Examples: adders, counters, flip flops, Multiplexers & De multiplexers).	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. James W. Bignel, Digital Electronics, Cengage learning, 5th Edition, 2007.
2. M. Morris Mano, 'Digital Design with an introduction to the VHDL', Pearson Education, 2013.
3. Comer "Digital Logic & State Machine Design, Oxford, 2012.

REFERENCE BOOKS:

1. Mandal, "Digital Electronics Principles & Application, McGraw Hill Edu, 2013.
2. William Keitz, Digital Electronics-A Practical Approach with VHDL, Pearson, 2013.
3. Thomas L.Floyd, 'Digital Fundamentals', 11th edition, Pearson Education, 2015.
4. Charles H.Roth, Jr, Lizy Lizy Kurian John, 'Digital System Design using VHDL, Cengage, 2013.
5. D.P.Kothari,J.S.Dhillon, 'Digital circuits and Design',Pearson Education, 2016.

COs versus POs Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	3	3	2	1	1	-	2	1	1	-	-	1
CO2	3	2	2	3	2	1	-	1	-	1	3	2	1	1
CO3	2	3	2	3	3	1	1	-	-	-	-	1	-	2
CO4	2	3	3	3	3	2	2	2	2	-	1	1	-	3
CO5	2	2	3	3	3	2	2	2	2	-	1	1	-	3
Total	**12**	**12**	**13**	**15**	**13**	**7**	**6**	**5**	**6**	**2**	**6**	**5**	**1**	**10**

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Scaled	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**0**	**3**

0 –No Relation 1 – Low Relation 2 – Medium Relation 3 – High Relation

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COURSE CODE	COURSE NAME	L	T	P	C
XEE304	ELECTRICAL CIRCUIT ANALYSIS	3	1	0	4
C : P : A		L	T	P	H
3 : 1 : 0		3	1	0	4

Course Outcomes:		Domain	Level
CO1	**Illustrate** network theorems for the analysis of electrical circuits.	Cognitive	Apply
CO2	**Obtaining** the transient and steady-state response of R, RL and RLC electrical circuits.	Cognitive	Understanding
CO3	**Analyze** circuits in the sinusoidal steady-state (single-phase and three-phase).	Cognitive	Analyze
CO4	**Analysis** of AC circuits using Laplace transforms.	Cognitive	Analyze
CO5	To **Understand** the behavior of one port and two port network functions.	Cognitive	Understanding

UNIT - I: NETWORK THEOREMS	**9 + 3**
Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks.	
UNIT - II: SOLUTION OF FIRST AND SECOND ORDER NETWORKS	**8 + 3**
Solution of first and second order differential equations for Series and parallel R-L, R-C, RL-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.	
UNIT - III: SINUSOIDAL STEADY STATE ANALYSIS	**8 + 3**
Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective or RMS values, average power and complex power. Three-phase circuits. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer.	
UNIT - IV: ELECTRICAL CIRCUIT ANALYSIS USING LAPLACE TRANSFORMS	**8 + 3**
Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances.	
UNIT- V: NETWORK FUNCTIONS AND TWO PORT NETWORKS	**12 + 3**
Concepts of complex frequency, Transform impedance, Networks function of one port and two port networks, concepts of poles and zeros, property of driving point and transfer function. Two Port Networks, terminal pairs, Relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks.	

	LECTURE	TUTORIAL	TOTAL
	45	15	60

TEXT BOOKS:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2019.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 2013.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.

REFERENCE BOOKS:

1. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2013.
2. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
3. Sudhakar.A and ShyamMohan.S.P, "Circuits and Networks Analysis and Synthesis", Fourth edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.

E-RESOURCES:

1. NPTEL: http://nptel.ac.in/courses/108102042/
2. MOODLE: http://moodle.cecs.pdx.edu/course/view.php?id=16

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COURSE CODE	COURSE NAME	L	T	P	C
XEE305	ELECTRICAL MACHINES - I	3	1	0	4
C : P : A		L	T	P	H
3 : 0 : 0		3	1	0	4

Course Outcomes:		Domain	Level
CO1	Understand the operation of DC machines.	Cognitive Psychomotor	Understand Perception
CO2	Understand the winding concepts of DC machine.	Cognitive Psychomotor	Understand Complex Overt Response
CO3	Understand the motoring and generating concepts of DC machine.	Cognitive Psychomotor	Understand Set
CO4	Analyse single phase and three phase transformers circuits.	Cognitive Psychomotor	Analyse Set
CO5	Understand the various loss in magnetic circuits	Cognitive Psychomotor	Understand Set

UNIT - I: INTRODUCTION TO DC MACHINES	9 + 3
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.	
UNIT - II: DC MACHINES – ARMATURE AND WINDING	**9 + 3**
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 - III: DC MACHINE - MOTORING AND GENERATION	**8 + 3**
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. Losses, load testing and back-to-back testing of DC machines.	
UNIT - IV: TRANSFORMERS AND TEST	**10 + 3**
Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test- separation of hysteresis and eddy current losses.	
UNIT - V: AUTOTRANSFORMERS	**9 + 3**
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.	

	LECTURE	TUTORIAL	TOTAL
	45	15	60

TEXT BOOKS:

1. A.E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2018.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

REFERENCE BOOKS:

1. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

COURSE CODE	COURSE NAME	L	T	P	C
XUM306	ENTREPRENEURSHIP DEVELOPMENT	2	0	0	2
PREREQUISITES	NIL	L	T	SS	H
C:P:A= 2.7:0:0.3		2	0	1	3

COURSE OUTCOMES		DOMAIN	LEVEL
CO1	**Recognise** and **describe** the role of innovation and motivation for an entrepreneur.	Cognitive	Understanding
CO2	**Self-assess** and **appraise** your entrepreneurship interest with your chosen entrepreneur.	Cognitive/ Affective	Evaluate/ Verify
CO3	**Outline** the importance of generation of new ideas for entrepreneurship and **illustrate** market assessment.	Cognitive	Analyzing
CO4	**Explain** the competition in business and **sketch/demonstrate/comply** business model for dealing with competition.	Cognitive/ Affective	Understanding, Apply/ Value, Response
CO5	**Describe** and **Explain** venture creation and launching of small business and its management.	Cognitive	Remembering, Understanding
CO6	**Describe** and **Discuss** various government policies and global opportunities for Entrepreneurship Development	Cognitive/ Affective	Remembering, Understanding/ Integrating

UNIT I	INNOVATION AND ENTREPRENEURSHIP	5

Definition of Innovation, Creativity and Entrepreneurship; role of innovation in entrepreneurship development (2)- Entrepreneurial motivation (1)-Competencies and traits of an entrepreneur (1)-Role of Family and Society; Entrepreneurship as a career and its role in national development (1)

UNIT II	SELF ASSESSMENT OF ENTREPRENEURIAL INCLININATION	4

Self-assessment of entrepreneurial inclination (1)-Presentation by students on their entrepreneurial inclination rating (2)-Case study of successful entrepreneurs (1)

UNIT III	NEW IDEA GENERATION TO MARKET ASSESSMENT	9

Importance of Idea generation-filtering-refinement (1)-opportunity recognition (1)-Description of chosen idea - value proposition, customer-problem-Solution statement) (1)-benefits; development status; IP ownership (1)-Market Validation- Technology/ user/decision makers/ partners (1)-market need; segmentation (1)-market TAM,SAM and SOM (1)-case study on market segmentation by popular companies (1)

UNIT IV	CUSTOMER – COMPETITION- BUSINESS MODEL	9

Customer-Target primary customer research, Decision making unit/ process-Beach head market; Cost of Customer Acquisition (2)-Competition- comparative analysis, competitive advantages-; (2)-Business model (1) -Financial planning (1)-Pitch documentation and presentation (3)		
UNIT V	**VENTURE CREATION AND LAUNCHING OF SMALL BUSINESS AND ITS MANAGEMENT**	**9**
New enterprise creation - organizational and legal matters (1)-Operational plan (1)-Sales and distribution plan (1)-Accounting (1)-Team recruitment and management (1)-Fund raising and management (1)-Profile of a startup – case studies (2)		
UNIT VI	**GOVERNMENT INITIATIVES AND GLOBAL OPPORTUNITIES**	**9**
Incubators and accelerators - capacity building (2)-Startup policies- Startup India (2)-Support for MSME; GeM Portal(2) Funding–national and international sources(2)-Bilateral programmes by Govt. of India -Global reach for promoting cross-cultural entrepreneurship (1)		

LECTURE: 45	**TUTORIAL: 0**	**PRACTICAL:0**	**TOTAL: 45**

REFERENCE

1.	A.P.Aruna, " Lecture Notes on Entrepreneurship Development" , available as softcopy @ www.brain.net
2.	Thomas W. Zimmerer, Norman M. Scarborough, "Essentials of Entrepreneurship and Small Business Management", Pearson; 3rd edition, 2001.
3.	John Burnett, "Introducing Marketing", Open Text Book available at http://solr.bccampus.ca:8001/bcc/file/ddbe3343-9796-4801-a0cb-7af7b02e3191/1/Core%20Concepts%20of%20Marketing.pdf
4.	Toubia, Olivier. "Idea Generation, Creativity, and Incentives", Marketing Science. Vol. 25. pp.411-425. 10.1287/mksc.1050.0166, 2006.
5.	Alexander Osterwalder and Yves Pigneur, "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers", Wiley; 1st edition, 2010.
6.	Gerardus Blokdyk,"3C's model The Ultimate Step-By-Step Guide"5starcooks, 2018.

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XUM307	UNIVERSAL HUMAN VALUES 2: UNDERSTANDING	L	T	P	C

		2	**1**	**0**	**3**
		L	**T**	**P**	**H**
		2	**1**	**0**	**3**

PREREQUISITE: None. Universal Human Values 1 (desirable)

Course Objective:

1.Development of a holistic perspective based on self-exploration aboutthemselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcome:

On the successful completion of the course, students will be able to

1. **Present** sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.
2. **Grasp** the right utilization of their knowledge in their streams of Technology/Engineering/Management/any other area of study to ensure mutual fulfilment. Ex.mutually enriching production system with rest of nature.
3. **Evaluate** the course and share with their friends. They are also able to **suggest** measures to make the course more effective and relevant. They are also able to **make use of** their understanding in the course for the happy and prosperous family and society.

UNIT - I :	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education**	**6+3**

Purpose and motivation for the course, recapitulation from Universal Human ValuesI - Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’ and ExperientialValidation- as the process for self-exploration - Continuous Happiness and Prosperity - A look at basic Human Aspirations - Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority - Understanding Happiness and Prosperity correctly - A critical appraisal of the current scenario - Method to fulfil the above human aspirations: understanding and living in harmony at various levels.
Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT - II :	**Understanding Harmony in the Human Being - Harmony in Myself**	**6+3**

Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’ - Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility - Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer) - Understanding the

characteristics and activities of 'I' and harmony in 'I' - Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail - Programs to ensureSanyam and Health.

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT - III :	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship**	**5+3**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship - Understanding the meaning of Trust; Difference between intention and competence - Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship - Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals - Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

UNIT - IV :	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence**	**4+2**

Understanding the harmony in the Nature 1 - Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and selfregulation in nature - Understanding Existence as Co-existence of mutually interacting units in all-pervasive space - Holistic perception of harmony at all levels of existence.

Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT - V :	**Implications of the above Holistic Understanding of Harmony on Professional Ethics**	**7+3**

Natural acceptance of human values - Definitiveness of Ethical Human Conduct - Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order - Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of peoplefriendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. - Case studies of typical holistic technologies, management models and production systems -Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations - Sum up. Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. to discuss the conduct as an engineer or scientist etc.

LECTURE	TUTORIAL	PRACTICAL	TOTAL
28	14	0	42+3(SS)

TEXT BOOKS:

1.	Human Values and Professional Ethics - R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

REFERENCE BOOKS :

1.	Jeevan Vidya Ek- Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2.	Human Values - A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3.	Leonard, Annie. 2011. The Story of Stuff. New York, NY: Simon & Schuster.
4.	The Story of My Experiments with Truth - Mohandas Karamchand Gandhi AICTE Model Curriculum in Humanities, Social Science and Management Courses (UG Engineering & Technology)
5.	Small is Beautiful - E. F Schumacher.
6.	Slow is Beautiful - Cecile Andrews.
7.	Economy of Permanence - J C Kumarappa.
8.	Bharat Mein Angreji Raj –PanditSunderlal.
9.	Rediscovering India - by Dharampal.
10.	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
11.	India Wins Freedom - Maulana Abdul Kalam Azad
12.	Vivekananda - Romain Rolland (English)
13.	Gandhi - Romain Rolland (English)

COURSE	COURSE NAME	L	T	P	C

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CODE					
XEE308	ELECTRICAL CIRCUIT ANALYSIS LABORATORY	0	0	1	1
C : P : A		L	T	P	H
3 : 2 : 1		0	0	2	2

Course Outcomes:		Domain	Level
CO1	To understand & verify the network theorems for the analysis of electrical circuits.	Psychomotor	Understanding Guided Response
CO2	To understand & validate the network theorems for the analysis of electrical circuits.	Psychomotor	Understanding Guided Response
CO3	To understand &analyze electrical circuits in both sinusoidal and transient modes.	Psychomotor	Understanding Guided Response
CO4	To understand &measure the power and inductance of AC circuit.	Psychomotor	Understanding Guided Response
CO5	To understand & analyze the concept of RLC Series and parallel resonance circuits.	Psychomotor	Understanding Guided Response

Sl. No.	List of Experiments	COs
1.	Verification of KVL and KCL.	CO1
2.	Verification of Thevenin theorem.	CO1
3.	Verification of Norton theorem.	CO2
4.	Verification of Maximum power transfer theorem.	CO2
5.	Transient analysis of Series RL, RC circuits.	CO3
6.	Sinusoidal analysis of Series RL, RC circuits.	CO3
7.	Measurement of active power for star and delta connected balanced loads.	CO4
8.	Verification of self, mutual inductance and coefficient of coupling.	CO4
9.	Series Resonance Circuit.	CO5
10.	Parallel Resonance Circuit.	CO5
	PRACTICAL	TOTAL
	30	30

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COURSE CODE	COURSE NAME	L	T	P	C
XEE309	ELECTRICAL MACHINES – I LABORATORY	0	0	1	1
C : P : A		L	T	P	H
0 : 1 : 0		0	0	2	2

COURSE OBJECTIVES:

- To introduce the different types of DC motor and generator.
- To analysis the various characteristics of performance machines.
- To expose the students to practical implementations.

Course Outcomes:		Domain	Level
CO1	Understand the operation of DC machines.	Cognitive Psychomotor	Understand Perception
CO2	Understand the winding concepts of DC machine.	Cognitive Psychomotor	Understand Complex Overt Response
CO3	Understand the motoring and generating concepts of DC machine.	Cognitive Psychomotor	Understand Set
CO4	Analyse single phase and three phase transformers circuits.	Cognitive Psychomotor	Analyse Set
CO5	Understand the various loss in magnetic circuits.	Cognitive Psychomotor	Understand Set

Sl. No.	List of Experiments	COs
1.	Study of D.C. Motor Starters.	CO1
2.	Open Circuit Characteristics (OCC) and load Characteristics of D.C self-excited generator.	CO2
3.	Load characteristics of D.C shunt generator.	CO2
4.	Load characteristics of D.C. shunt motor.	CO2
5.	Load characteristics of D.C series motor.	CO3
6.	Speed control of D.C shunt motor.	CO4
7.	Load test on single-phase transformer.	CO5
8.	Open circuit and short circuit tests on single phase transformer.	CO5
	PRACTICAL	TOTAL
	30	30

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SEMESTER – IV

COURSE CODE	COURSE NAME	L	T	P	C
XMA401	PROBABILITY AND STATISTICS	3	0	0	3
C : P : A		L	T	P	H
3.5 : 2.5 : 2.5		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Explain** conditional probability, independent events; **find** expected values and Moments of Discrete random variables with their properties.	Cognitive	Understanding Remembering
CO2	**Find** distribution function, Marginal density function, conditional density function and to **define** density function of conditional distribution functions normal, exponential and gamma distributions.	Cognitive	Remembering
CO3	**Determine** the statistical parameters of Binomial, Poisson and Normal and to find correlation, regression and Rank Correlation coefficient of two variables. Moments, skewness and Kurtosis.	Cognitive Psychomotor	Understanding Guided Response
CO4	**Explain** large sample test for single proportion, difference of proportion, single mean, difference of means and difference of standard deviations with simple problems.	Cognitive	Understanding
CO5	**Explain** small sample test for single mean, difference of mean and correlation coefficients, variance test, chi square test with simple problems.	Cognitive Affective	Understanding Receiving

UNIT - I: BASIC PROBABILITY	**9**
Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.	
UNIT - II: CONTINUOUS PROBABILITY DISTRIBUTIONS & BIVARIATE DISTRIBUTIONS	**9**
Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.	
UNIT - III: BASIC STATISTICS	**9**
Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.	
UNIT - IV: APPLIED STATISTICS	**9**
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.	
UNIT - V: SMALL SAMPLES	**9**
Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-	

square test for goodness of fit and independence of attributes.			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.
2. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.
3. Veerarajan T., "Probability, Statistics and Random processes", Tata McGraw-Hill, New Delhi, 2010.

REFERENCE BOOKS:

1. P. G. Hoel, S. C. Port and C. J. Stone, "Introduction to Probability Theory", Universal Book Stall, 2003.
2. S. Ross, "A First Course in Probability", Pearson Education India, 2002.
3. W. Feller, "An Introduction to Probability Theory and its Applications", Vol. 1, Wiley, 1968.
4. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 2006.

E-RESOURCES:

nptel

1. Probability and Statistics by Prof. Someshkumar, Department of Mathematics, IIT Kharagpur. (http://nptel.ac.in/noc/noc_courselist.php).

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COURSE CODE	COURSE NAME	L	T	P	C
XEE402	ANALOG ELECTRONICS	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Understand the characteristics of diodes, Zener and Special diodes and their applications.	Cognitive	Understand
CO2	Understand the characteristics of transistor.	Cognitive	Understand
CO3	Understand the working of MOSFET and its characteristics.	Cognitive	Understand
CO4	Classify and explain different types of amplifier.	Cognitive	Understand
CO5	Recall and explain linear and non-linear application of OP-Amp.	Cognitive	Understand

UNIT – I: DIODE CIRCUITS	**6**
P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, Special diodes, clamping and clipping circuits.	
UNIT – II: BJT CIRCUITS	**8**
Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits.	
UNIT – III: MOSFET CIRCUITS	**8**
MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, transconductance, high frequency equivalent circuit.	
UNIT - IV: DIFFERENTIAL, MULTI-STAGE AND OPERATIONAL AMPLIFIERS	**8**
Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)	
UNIT - V: LINEAR AND NONLINEAR APPLICATIONS OF OP-AMP	**15**
Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wien bridge and phase shift). Analog to Digital Conversion. Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector, Monoshot.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:

1. Electronic Devices and Circuits theory – Robert L. Boylestead, Louis Nashelsky, 11th Edition, 2009, Pearson.
2. Malvino A. and D. J. Bates, Electronic Principles 7/e, Tata McGraw Hill, 2010.
3. Millman J. and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata

McGraw Hill, 2010.

REFERENCE BOOKS:

1. Floyd T. L., Fundamentals of Analog Circuits, Pearson Education, 2012.
2. Bell D. A., Electronic Devices and Circuits, Prentice Hall of India, 2007.
3. Electronics circuits and applications, Md H Rashid, Cengage 2014.
4. Robert T. Paynter and John Clemons, Paynter's Introductory Electronic Devices & Circuits, Prentice Hall Career & Technology, New Jersey.
5. Electronic Devices and Circuits, S. Salivahanan, N. Suresh Kumar, A Vallvaraj, 5th Edition, McGraw Hill Education.
6. Gayakward R. A., Op-Amps and Linear Integrated Circuits, PHI Learning Pvt. Ltd., 2012.
7. Choudhury R., Linear Integrated Circuits, New Age International Publishers. 2008.

E-RESOURCES:

1. www.nptel.ac.in.

COURSE CODE	COURSE NAME	L	T	P	C
XEE403	CONTROL SYSTEMS	3	1	0	4
C : P : A		L	T	P	H
3 : 0 : 0		3	1	0	4

Course Outcomes:		Domain	Level
CO1	**Identify** the basic elements, derive the transfer function and **Compute** the overall gain of the control system and **Construct** the transfer function of DC motors and DC generators.	Cognitive Psychomotor	Understanding
CO2	**Explain** the performance of First and Second order system with static and dynamic error coefficients.	Cognitive Psychomotor	Understanding Set
CO3	**Describe** the frequency domain specifications and show the response of frequency response.	Cognitive Psychomotor	Remembering Understanding Set
CO4	**Determine** the stability of the systems and **Design** the suitable compensator and controller for the given performance criteria of the control system.	Cognitive Psychomotor	Understanding Design Perception
CO5	**Describe** State transition matrix. **Explain** State space model **and construct** and **verify** the canonical state model and Kalman's test for controllability and observability.	Cognitive	Remembering

UNIT - I: SYSTEMS AND THEIR REPRESENTATION	**9 + 3**
Basic elements in control systems – Open and closed loop systems – Principles of feedback, Transfer function Block diagram reduction techniques – Signal flow graphs. Mason gain formula, Modelling of electric systems translation and rotational mechanical systems.	
UNIT – II: TIME RESPONSE ANALYSIS	**9 + 3**

Time response – Time domain specifications - Standard test signals. Time response of first and second order systems for standard test inputs. Error coefficients – Generalized error series – Steady state error.	
UNIT - III: FREQUENCY-RESPONSE ANALYSIS	**9 + 3**
Frequency domain specification – Bode plot – Polar plot – Determination of closed loop response from open loop response – Correlation between frequency domain and time domain specifications.	
UNIT – IV: STABILITY ANALYSIS AND CONTROLLER DESIGN	**9 + 3**
Characteristics equation – Location of roots in S plane for stability –Routh Hurwitz criterion– Root locus construction – Effect of pole, zero addition –Nyquist stability criterion. Introduction to design of Proportional, Integral and Derivative Controllers- Lead and Lag compensator- Analog and Digital implementation of controllers.	
UNIT – V:STATE VARIABLE ANALYSIS	**9 + 5**
Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigen values and Stability Analysis. Physical variable phase variable and canonical variable forms State Space representation of continuous time system. Transfer function from state variable representation –. Concept of controllability and observability.	

	LECTURE	TUTORIAL	TOTAL
	45	15	60

TEXT BOOKS:

1. I.J. Nagrath& M. Gopal, 'Control Systems Engineering', New Age International Publishers Pvt Ltd; Sixth edition (1 September, 2018).
2. Norman S. Nise, "Control System Engineering "Seventh edition, John Wiley &Sons, Inc, 2015.
3. M. Gopal, "Control Systems, Principles & Design", Tata McGraw Hill, New Delhi, 2002.
4. Richard C. Dorf& Robert H. Bishop, "Modern Control Systems", Addison– Wesley, 2012.

REFERENCE BOOKS:

1. B.C. Kuo, 'Automatic Control Systems', Prentice Hall of India Ltd., New Delhi, 2014.
2. K. Ogata, 'Modern Control Engineering', 4th edition, Pearson Education, New Delhi, 2003 / PHI.
3. N. Bandyopadhyay, 'Control Engineering Theory and Practice', Prentice Hall of India, 2009.
4. John J.D'azzo& Constantine H.Houpis, 'Linear control system analysis and design', Tata McGrow-Hill, Inc., 2013.

E-RESOURCES:

2. NTPEL, Control Systems Engineering (Web Course), Prof. M. Gopal, IIT Kharagpur.

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COURSE CODE	COURSE NAME	L	T	P	C
XEE404	ELECTRICAL MACHINES – II	3	1	0	4
C : P : A		L	T	P	H
2 : 1 : 0		3	1	0	4

Course Outcomes:		Domain	Level
CO1	To Understand the fundamentals of different types of slots and windings used for AC machines.	Cognitive Psychomotor	Understanding Mechanism
CO2	To Understand the concepts of pulsating and revolving magnetic fields.	Cognitive Psychomotor	Understanding Mechanism
CO3	To Understand the operation of induction machines, ttorque slip characteristics, equivalent circuit and its phasor diagram.	Cognitive Psychomotor	Understanding Mechanism
CO4	To Understand the different typesof starting, braking and speed control for induction motors. React the generator operation, self-excitation and doubly-fed Induction machines.	Cognitive Psychomotor	Understanding Mechanism
CO5	To Understand the operation of single-phase induction motors and its performance parameters.	Cognitive Psychomotor	Understanding Mechanism

UNIT – I: FUNDAMENTALS OF AC MACHINE WINDINGS	**9 + 3**
Physical arrangement of windings in stator and cylindrical rotor–Slots for windings –Single-turn coil – Active portion and overhang –Full-pitch coils–Types of windings– 3D visualization of the above winding types– Air-gap MMF distribution with fixed current through winding –Winding distribution factor.	
UNIT – II: PULSATING AND REVOLVING MAGNETIC FIELDS	**9 + 3**
Types of magnetic fields –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° – Three windings spatially shifted by 120° (carrying three-phase balanced currents) – Revolving magnetic field.	
UNIT – III: INDUCTION MACHINES	**12 + 3**
Constructional details –Types of rotors (squirrel cage and slip-ring) – Torque Slip Characteristics – Equivalent circuit – Phasor Diagram– Effect of parameter variation on torque speed characteristics – 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 + 3**
Constructional details of single-phase induction motor – Double revolving field theory and operation – Equivalent circuit – Determination of parameters – Split-phase starting methods and applications.	
UNIT – V: SYNCHRONOUS MACHINES	**9 + 3**
Constructional details – Cylindrical rotor synchronous machine– EMF equation –Equivalent circuit – Phasor diagram–Armature reaction–Voltage regulation– V-curves. Salient pole machine – Two reaction theory –Phasor diagram –Power angle characteristics. Synchronizing and parallel operation. (Basic operation of synchronous motors)	

	LECTURE	TUTORIAL	TOTAL
	45	15	60

TEXT BOOKS:

1. I. J. Nagrath and D. P. Kothari, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2017.
2. M. G. Say, 'Performance and Design of AC Machines', CBS Publishers, 2013
3. P. S. Bimbhra, 'Electrical Machinery', Khanna Publishers, 2011.
4. B. L.Theraja, 'A Textbook of Electrical Technology', Vol. I & II, M/s S.Chand, Delhi,2013.

REFERENCE BOOKS:

1. A. E. Fitzgerald, Charles Kingsley, Stephen.D.Umans, 'Electric Machinery', Tata McGraw Hill publishing Company Ltd, 2013.
2. A. S. Langsdorf, 'Alternating Current Machines', Tata McGraw Hill publishing Company Ltd, 1984.
3. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.
4. J.B. Gupta, 'Theory and Performance of Electrical Machines', S.K.Kataria and Sons, 2002.
5. DeshPande M.V., 'Electrical Machines', PHI Learning Pvt Ltd., New Delhi – 2011.
6. A. G. Warren, 'Problems in Electrical Engineering', Parker and Smith Solutions, Newyork, 1940.
7. K. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt Ltd, 2002.
8. Department Laboratory Manual.

E-RESOURCES:

1. http://freevideolectures.com/Course/2335/Basic-Electrical-Technology35-38, Prof. L. Umanand, IISc Bangalore.

COURSE CODE	**XUM405**	**L**	**T**	**P**	**C**
COURSE NAME	**ECONOMICS FOR ENGINEERS**	**3**	**0**	**0**	**3**
PREREQUISITES		**L**	**T**	**P**	**H**
C:P:A	**2.64:0.24:0.12**	**3**	**0**	**0**	**3**
COURSE OUTCOMES		**DOMAIN**		**LEVEL**	
CO1	**Explain** the concepts of economics in engineering and **identify** element of cost to prepare cost sheet	Cognitive Psychomotor		Understand Perception	
CO2	**Calculate and Explain**the Break-even point and marginal costing	Cognitive Psychomotor		Understand &Apply Perception	
CO3	**Summarize**and **Use**value engineering procedure for cost analysis	Cognitive Affective		Understand Receive	
CO4	**Estimate** replacement problem	Cognitive		Understand	

CO5	**Compute, Explain** and **make Use of** different methods ofdepreciation	Cognitive	Understand &Apply

UNIT I INTRODUCTION TO ECONOMICS	**08**
Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- types of costing, element of costs, preparation of cost sheet and estimation, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost	
UNIT IIBREAK-EVEN ANALYSIS&SOCIAL COST BENEFIT ANALYSIS	**12**
Margin of Safety, Profit, Cost & Quantity analysis-Product Mix decisions and CVP analysis, Profit/Volume Ratio (P/V Ratio), Application of Marginal costing, Limitations **Social Cost Benefit Analysis**: compare different project alternatives, Calculate direct, indirect and external effects; Monetizing effects; Result of a social cost benefit analysis.	
UNIT III VALUE ENGINEERING &COST ACCOUNTING:	**10**
Value engineering – Function, aims, Value engineering procedure - Make or buy decision Business operating costs, Business overhead costs, Equipment operating costs	
UNIT IV REPLACEMENT ANALYSIS	**07**
Replacement analysis –Types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset.	
UNIT V DEPRECIATION	**08**
Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the year's digits method of depreciation, sinking fund method of depreciation, Annuity method of depreciation, service output method of depreciation.	

	LECTURE	**TUTORIAL**	**TOTAL**
HOURS	**45**	**0**	**45**

TEXT BOOKS

1. Sp Gupta, Ajay Sharma & Satish Ahuja, "Cost Accounting", V K Global Publications,

Faridabad, Haryana, 2012

2. S.P.Jain&Narang, "Cost accounting – Principles and Practice", Kalyani Publishers, Calcutta, 2012

3. PanneerSelvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.

4. William G.Sullivan, James A.Bontadelli& Elin M.Wicks, "Engineering Economy", Prentice Hall International, New York, 2001.

REFERENCES

1. Luke M Froeb / Brian T Mccann, " Managerial Economics – A problem solving approach" Thomson learning 2007
2. Truett&Truett, "Managerial economics- Analysis, problems & cases " Wiley India 8th edition 2004.
3. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
4. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002

Semester	:	**IV**
Course Code	:	**XUM406**
Course Name	:	**DISASTER MANAGEMENT**
Prerequisite	:	**NIL**

	L	T	P	C			C	P	A			L	T	P	H	
	3	0	0	3			3	0	0			3	0	0	3	

Course Outcome: After the completion of the course, students will be able to		**Domain C or P or A**	**Level**
CO1	Understand the concepts of disasters, their significance and types	Cognitive	Understand
CO2	Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction	Cognitive	Understand
CO3	Able to understanding of preliminary approaches of Disaster Risk Reduction (DRR)	Cognitive	Understand

CO4	Develop awareness of institutional processes in the country	Cognitive	Application
CO5	Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity	Cognitive	Application

COURSE CONTENT

UNIT I	**INTRODUCTION TO DISASTERS**	**6**
	Importance &Significance, Types of Disasters, Climate Change, DM cycle	
UNIT II	**RISK ASSESSMENT**	**12**
	Risk, Vulnerability, Types of Risk, Risk identification, Emerging Risks, Risk Assessment, Damage Assessment, Risk modeling.	
UNIT III	**DISASTER MANAGEMENT**	**10**
	Phases, Cycle of Disaster Management, Institutional Framework, Incident Command System, DM Plan, Community Based DM, Community health and safety, Early Warning and Disaster Monitoring, Disaster Communication, Role of GIS and Remote Sensing, Do's and Don'ts in various disasters.	
UNIT IV	**DISASTER RISK MANAGEMENT IN INDIA**	**10**
	Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness), Disaster Management Act and Policy – Other related policies, plans, programmes and legislation	
UNIT V	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES**	**7**
	Landslide Hazard Zonation, Earthquake Vulnerability Assessment of Buildings and Infrastructure, Drought Assessment, Coastal Flooding, Forest Fire, Man Made disasters, Space Based Inputs for Disaster Mitigation and Management, Cast Study	

	L	**T**	**P**	**Total**
	45	**0**	**0**	**45**

TEXT BOOKS

1. Singhal J.P. Disaster Management, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361)
3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM,

New Delhi, 2011

4. KapurAnu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010

REFERENCE BOOKS

1. Siddhartha Gautam and K Leelakrisha Rao, "Disaster Management Programmes and Policies", Vista International Pub House, 2012
2. Arun Kumar, "Global Disaster Management", SBS Publishers, 2008
3. Pardeep Sahni, Alka Dhameja and Uma medury, "Disaster mitigation: Experiences and reflections", PHI, 2000
4. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
5. Government of India, National Disaster Management Policy, 2009

E-REFERENCES

- NIDM Publications at http://nidm.gov.in- Official Website of National Institute of Disaster Management (NIDM), Ministry of Home Affairs, Government of India
- http://cwc.gov.in , http://ekdrm.net , http://www.emdat.be , http://www.nws.noaa.gov , http://pubs.usgs.gov , http://nidm.gov.ini http://www.imd.gov.ini

COURSE	COURSE NAME	L	T	P	C

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CODE					
XEE407	ANALOG ELECTRONICS LABORATORY	0	0	1	1
C : P : A		L	T	P	H
1 : 0 : 0		0	0	2	2

COURSE OBJECTIVES:

- To introduce the different types of analog and digital modulation and demodulation.
- To convey frequency division multiplexing and demultiplexing.
- To expose the students line coding and decoding.
- To create awareness on the performance of digital modulation techniques in AWGN and Rayleigh channels.

Course Outcomes:		Domain	Level
CO1	**Construct, Demonstrate** and **Simulate** Amplitude Modulation, Demodulation, sensitivity and selectivity of AM receivers.	Cognitive Psychomotor	Mechanism Response
CO2	**Construct, Demonstrate** and **Simulate** Frequency Modulation, Demodulation, sensitivity and selectivity of FM receivers.	Cognitive Psychomotor	Mechanism Responding
CO3	**Construct,** and **Demonstrate** Frequency Division Multiplexing and demultiplexing.	Cognitive Psychomotor	Mechanism Responding
CO4	**Build**, **Demonstrate** and **Simulate** various types of analog and digital Pulse Modulations using trainer kits.	Cognitive Psychomotor	Mechanism Responding
CO5	**Simulate** performance of digital modulation techniques in AWGN and Rayleigh channels.	Cognitive Psychomotor	Mechanism Responding

Sl. No.	List of Experiments	COs
1.	Design of full wave rectifier with and without filter.	CO1
2.	Design of bridge rectifier circuits using with and without filter.	CO1
3.	Conduct an experiment to test clipping and clamping circuits.	CO1
4.	Design of BJT common emitter amplifier using voltage divider bias with and without feedback.	CO2
5.	Plot the drain and transfer characteristics of MOSFET.	CO3
6.	Conduct experiment on differential amplifier	CO4
7.	Design of Phase shift and Wien bridge oscillators using OP-AMP.	CO5
8.	Conduct experiment on Inverting, Non inverting amplifier using OP-AMP.	CO5

9.	Conduct experiment on astable and monostable multivibrator using OP-AMP.	**CO5**
10.	Conduct experiment on integrator and differentiator circuit using OP-AMP.	**CO5**
11.	Conduct experiment on Schmitt trigger circuit using OP-AMP.	**CO5**
	PRACTICAL	**TOTAL**
	30	**30**

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE408	**CONTROL SYSTEMS LABORATORY**	**0**	**0**	**1**	**1**
C : P : A		**L**	**T**	**P**	**H**
0 : 1 : 0		**0**	**0**	**2**	**2**

COURSE OBJECTIVES:

- Control Systems is the engineering discipline that applies control theory to design systems with desired behaviours.
- To make students understand the concept of system representation for stability analysis and state –space analysis.
- To design the compensator in time and frequency domain, to design the PID compensator.

Course Outcomes:		**Domain**	**Level**
CO1	**Identify** the basic elements, derive the transfer function and **Compute** the overall gain of the control system and **Construct** the transfer function of DC motors and DC generators.	Cognitive Psychomotor	Understanding
CO2	**Explain** the performance of First and Second order system with static and dynamic error coefficients.	Cognitive Psychomotor	Understanding Set
CO3	**Describe** the frequency domain specifications and show the response of frequency response.	Cognitive Psychomotor	Remembering Understanding Set
CO4	**Determine** the stability of the systems and **Design** the suitable compensator and controller for the given performance criteria of the control system	Cognitive Psychomotor	Understanding Design Perception
CO5	**Describe** State transition matrix. **Explain** State space model **and construct** and **verify** the canonical state model and Kalman's test for controllability and observability.	Cognitive	Remembering

Sl. No.	**List of Experiments**	**COs**
1.	Transfer function and modelling of separately excited DC Generator.	**CO1**
2.	Transfer function and modelling of Armature & field-controlled DC Motor.	**CO1**
3.	Transfer function of AC Servomotor.	**CO1**

4.	Analysis of Synchro Transmitter and Receiver.	**CO2**
5.	Performance of DC Stepper Motor.	**CO2**
6.	Digital simulation of I order and II order system by using Scilab.	**CO2**
7.	Frequency response of Lag, Lead & Lag – Lead networks.	**CO3**
8.	Determination of Phase margin and Gain margin of the Bode plot using Scilab.	**CO3**
9.	Transfer function and modelling of Ward – Leonard speed control system applied to DC motor.	**CO5**
10.	DC Position using feedback Control system.	**CO5**

PRACTICAL	**TOTAL**
30	**30**

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE409	**ELECTRICAL MACHINES – II LABORATORY**	**0**	**0**	**1**	**1**
C : P : A		**L**	**T**	**P**	**H**
0 : 1 : 0		**0**	**0**	**2**	**2**

COURSE OBJECTIVES:

- To introduce the different types of AC motor and generator.
- To analysis the various characteristics of performance Induction and synchronous machines.
- To expose the students to practical implementations of real time applications.

Course Outcomes:		**Domain**	**Level**
CO1	To Understand the fundamentals of different types of slots and windings used for AC machines.	Cognitive Psychomotor	Understanding Mechanism
CO2	To Understand the concepts of pulsating and revolving magnetic fields.	Cognitive Psychomotor	Understanding Mechanism
CO3	To Understand the operation of induction machines, ttorque slip characteristics, equivalent circuit and its phasor diagram.	Cognitive Psychomotor	Understanding Mechanism
CO4	To Understand the different typesof starting, braking and speed control for induction motors. React the generator operation, self-excitation and doubly-fed Induction machines.	Cognitive Psychomotor	Understanding Mechanism
CO5	To Understand the operation of single-phase induction motors and its performance parameters.	Cognitive Psychomotor	Understanding Mechanism

Sl. No.	**List of Experiments**	**COs**
1.	Load test on three phase squirrel cage induction motor.	**CO1**
2.	Load test on three phase slip ring induction motor.	**CO1**
3.	Load test of a three-phase alternator.	**CO2**
4.	No load and blocked rotor test on three phase induction motor.	**CO3**

5.	Study of induction motor starters.	**CO4**
6.	Load test on single-phase induction motor.	**CO4**
7.	No load and blocked rotor test on single phase induction motor.	**CO4**
8.	Regulation of three phase alternator by EMF /MMF methods.	**CO5**
9.	OCC and load characteristics of three phase alternator	**CO5**
10.	V and inverted V curves of three phase synchronous motor.	**CO5**
	PRACTICAL	**TOTAL**
	30	**30**

SEMESTER – V

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE501	**TRANSMISSION AND DISTRIBUTION**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	**Explain** the major components of Transmission and Distribution Systems (TDS). **Classify** different types of single and three phase transmission line parameters.	Cognitive	Understanding
CO2	**Outline** the types of transmission line efficiency calculations and its performance.	Cognitive	Understanding
CO3	**Explain** the different types of insulators and **solve** for stress and sag in overhead lines.	Cognitive	Understanding Applying
CO4	**Interpret** different type's underground cables.	Cognitive	Understanding
CO5	**Summarize** the latest technologies in the field of distribution systems.	Cognitive	Understanding

UNIT - I: TRANSMISSION LINE PARAMETERS	**9**
Structure of electric power system: Various levels such as generation, transmission and distribution; – Resistance, Inductance and Capacitance calculations – Single-phase and three-phase lines – double circuit lines – effect of earth on transmission line capacitance.	
UNIT - II: PERFORMANCE OF TRANSMISSION LINES	**9**
Regulation and efficiency – Tuned power lines, Power flow through a transmission line – Power circle diagrams, Introduction to Transmission loss and Formation of corona – critical voltages – effect on line performance – travelling waveform phenomena.	
UNIT - III: MECHANICAL DESIGN OF OVERHEAD LINES	**9**
Line supports – Insulators, Voltage distribution in suspension insulators – Testing of insulators – string efficiency – Stress and sag calculation – effects of wind and ice loading.	
UNIT - IV: UNDERGROUND CABLES	**9**
Comparison with overhead line – Types of cables – insulation resistance – potential gradient – capacitance of single-core and three-core cables.	

UNIT - V: DISTRIBUTION SYSTEM			**9**
General aspects – Kelvin's Law – A.C. distribution – Single-phase and three phase – Techniques of voltage control and power factor improvement – Introduction to Distribution loss – Recent trends in transmission and distribution systems.			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. D.P. Kothari and I.J. Nagrath, 'Power System Engineering', Tata McGraw–Hill,2 nd Edition, 2008.
2. B.R.Gupta, 'Power System Analysis and Design', S.Chand, New Delhi, 2003.
3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall India Pvt. Ltd, 2002.

REFERENCE BOOKS:

1. Luces M.Fualkenberry ,Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 1996.
2. Hadisaddak, 'Power System Analysis,' Tata McGraw Hill Publishing Company',2003
3. Central Electricity Authority (CEA), 'Guidelines for Transmission System Planning', New Delhi.
4. Tamil Nadu Electricity Board Handbook', 2012.

E-RESOURCES:

1. NPTEL, Power System Generation, Transmission and Distribution Prof. D. P. Kothari Center for Energy Studies Indian Institute of Technology, Delhi.

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE502	**POWER SYSTEM ANALYSIS**	**3**	**1**	**0**	**4**
C : P : A		**L**	**T**	**P**	**H**
2.5 : 0.5 : 0.5		**3**	**1**	**0**	**4**

Course Outcomes:		**Domain**	**Level**
CO1	**Demonstrate** the per phase analysis of power system.	Cognitive	Understanding
CO2	**Develop** the model of various components of the power system and **Construct** the Y Bus and Z Bus for a power system.	Cognitive	Understanding Applying
CO3	**Analyze** the power system network with symmetrical and unsymmetrical faults. **Calibrate** the fault current in a power system.	Cognitive	Understanding Analyzing
CO4	**Summarize** the power flow equation. **Assess** the voltage profile of a power system by performing the load flow analysis and **Identify** the line loss and line flow.	Cognitive	Understanding Evaluating Perception
CO5	**Classify** and **determine** the stability of power system. **Detect** the transient behavior of power system when it is subjected to a fault.	Cognitive	Understanding Evaluating Perception

UNIT – I: INTRODUCTION	**10 + 3**
Need for system analysis in planning and operation of modern power system–per phase analysis - Single line diagram-Per unit representation and Per unit calculations – Change of base – Introduction to Electricity Deregulation.	
UNIT – II: MODELLING OF POWER SYSTEM COMPONENTS	**8 + 3**
Primitive network and its matrices – bus incidence matrix –bus admittance and bus impedance matrix formation – Z–Bus building algorithm – Modelling of generator, load, transformer, transmission line for different power system studies.	
UNIT – III: FAULT ANALYSIS – UNSYMMETRICAL FAULTS	**9 + 3**
Need for short circuit study - basic assumptions in fault analysis of power systems. Symmetrical (or) balanced three phase faults – problem formulation – fault analysis using Z-bus matrix– algorithm and flow chart. Computations of short circuit capacity, post fault voltage and currents. Introduction to symmetrical components – sequence impedances – sequence networks Unsymmetrical fault analysis: L-G, L-L and L-L-G faults.	
UNIT – IV: POWER FLOW ANALYSIS	**9 + 3**
Need for Power Flow Analysis – bus classification – derivation of power flow equation – solution by Gauss–Seidel, Newton–Raphson and Fast Decoupled Power Flow methods –comparison of three methods.	
UNIT – V: STABILITY ANALYSIS	**9 + 3**
Types of stability - Swing equation in state space form - equal area criterion – stability analysis of single machine connected to infinite bus by modified Euler's method using classical machine model–critical clearing angle and time. Causes of voltage instability – voltage stability proximity indices for two-bus system – methods of improving power system stability.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**15**	**60**

TEXT BOOKS:

1. Hadi Sadaat, "Power System Analysis", Tata McGraw Hill Publishing Company, 2002.
2. John J. Grainger and Stevenson Jr. W.D., "Power System Analysis", McGraw Hill International Edition, 1994.
3. Nagarat .I.J, Kothari .D.P, "Power system Engineering", Tata McGraw Hill Publishing Company, 1994.
4. Pai. M.A "Computer techniques in Power System Analysis" Tata McGraw Hill Publishing Company, 2007.

REFERENCE BOOKS:

1. Stagg, G.W. and El-Abaid, A. H. "Computer Methods in Power System Analysis", McGraw-Hill International Book Company, 1968.
2. Nagarath, I.J., and Kothari, D.P., 'Modern Power System Analysis', Tata McGraw Hill Publishing Company, 1990.
3. Wadhwa C.L. "Electric Power Systems" Willey Eastern, 2007.

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COURSE CODE	COURSE NAME	L	T	P	C
XEE503	DIGITAL ELECTRONICS	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Understand numerical values in various number systems and show number conversions between different number Systems.	Cognitive	Understanding
CO2	Analyze Boolean functions and minimization techniques using k –maps and postulates and theorems of Boolean Algebra, minimization of Boolean functions using basic laws.	Cognitive	Analyze
CO3	To Apply Logic gates and their applications and construct the simple adders and sub tractors using logic gates.	Cognitive	Apply
CO4	To Understand the process of Analog to Digital conversion and its applications.	Cognitive	Understanding
CO5	To Understand the process of Digital to Analog conversion and its applications.	Cognitive	Understanding

UNIT - I: FUNDAMENTALS OF DIGITAL SYSTEMS AND LOGIC FAMILIES	9
Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families.	
UNIT – II: COMBINATIONAL DIGITAL CIRCUITS	**9**
Standard representation for logic functions, K-map representation, and simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders Q-M method of function realization.	
UNIT – III: SEQUENTIAL CIRCUITS AND SYSTEMS	**9**
A 1-bit memory, the circuit properties of Bistable latch, JK, SR, D and T types flip-flops, applications of flip-flops, shift registers, applications of shift registers, Asynchronous counters, synchronous counters design using flip flops, special counter IC's, applications of counters.	
UNIT – IV: A/D AND D/A CONVERTERS	**9**
Digital to analog converters: weighted resistor/converter, R-2R Ladder DAC, specifications for D/A converters, examples of DAC lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator ADC, successive approximation ADC, specifications of ADC, example of ADC ICs.	
UNIT – V: SEMICONDUCTOR MEMORIES AND PROGRAMMABLE LOGIC DEVICES	**9**
Memory organization and operation, expanding memory size, classification and characteristics of	

memories, sequential memory, ROM, RAM, content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, PLA, PAL, CPLDS, and FPGA.			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**
TEXT BOOKS:			
1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009. 2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016. 3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.			
REFERENCE BOOKS:			
1. Taub and Schilling, 'Digital Integrated Circuits', McGraw Hill, 2002. 2. Samuel C. Lee “Digital Circuits and Logic Designs” Prentice Hall of India; 2000. 3. Fletcher, W.I., 'An Engineering Approach to Digital Design', Prentice Hall of India, 2002. 4. Anand Kumar, Fundamental of Digital circuits, PHI 2003.			
E-RESOURCES:			
1. NPTEL, Digital Logic Circuits, Prof. S.Srinivasan, IIT Madras. 2. NPTEL, Digital Logic Circuits, Prof. D. Roychoudhury, IIT Kharagpur.			

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COURSE CODE	COURSE NAME	L	T	P	C
XEE504	MEASUREMENTS AND INSTRUMENTATION	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Describe** the different errors in measurements and **Describe** the working principle of different measuring instruments.	Cognitive Psychomotor	Remembering Perception
CO2	**Understanding** about the instruments used for different types of AC measurements. **Carryout** calibration test for measuring electrical instruments.	Cognitive Psychomotor	Understanding Set
CO3	**Use** different types bridge circuits for the measurements of unknown passive elements. **Relate** the different types of the transducers. **Demonstrate** the use of different bridges and transducers.	Cognitive Psychomotor	Applying Mechanism
CO4	**Explain** the construction and operation of recording and display instruments. **Establish** Relations between analog and digital signal conversions. Recording and display instruments. **Establish** Relations between analog and digital signal conversions.	Cognitive Psychomotor	Understanding Set
CO5	**Explain** the construction and working of different types signal conditioners. **Demonstrate** the recent trends in measurement of AC quantities.	Cognitive Psychomotor	Remembering Mechanism

UNIT - I: INTRODUCTION	**9**
Measurements – Errors & classification, Measurement of voltage & current - permanent magnet moving coil and moving iron meters, Measurement of power and energy - dynamometer and induction instruments, Instrument transformers – Current and Potential transformers.	
UNIT - II: DC AND AC BRIDGES	**9**
Measurement of resistance, inductance and capacitance using dc and ac bridges, Wheatstone bridge, Maxwell bridge, Kelvin's Bridge, Schering Bridge.	
UNIT - III: TRANSDUCERS	**9**
Active and Passive transducers, Piezoelectric transducer, Photoelectric transducers, Thermocouples, Strain gauge transducers, LVDT, differential capacitive transducers, Fiber optic transducers, Resistive, Inductive and capacitive transducers.	
UNIT - IV: SIGNAL CONDITIONING UNITS	**9**
Signal conditioners – Instrumentation amplifiers, voltage–current converters, A/D and D/A converters, voltage-frequency converters, analog multiplexers and de-multiplexers. Microprocessor Based Measurements, Case Studies in Instrumentation.	
UNIT - V: RECORDERS AND DISPLAY	**9**
Signal sources – Oscillators, Function generator and pulse generators. Oscilloscopes - CRO, Digital storage and Analog storage Oscilloscope, Digital Phosphor Oscilloscopes. Analog and Digital Recorders and printers. Spectrum Analyzers, Data and Logic Analyzers.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:

1. K. Sawhney, 'A Course in Electrical and Electronic Measurements and Instrumentation', DhanpatRai & Co., 9th Edition, 2018.
2. Bouwens A. J., 'Digital Instrumentation', Tata McGraw Hill Publications, 16th Reprint (2008).
3. Kalsi H.S, 'Electronic Instrumentation', Tata McGraw-Hill Education, 3rd Edition, 2010.
4. Deobelin, 'Measurements Systems', Tata McGraw Hill Publications, 2nd Edition, 2010.

REFERENCE BOOKS:

1. W. D. Cooper, 'Electronic Instrumentation and Measurement Techniques', Prentice Hall of India Publications, 1st Edition, 2009.
2. Rangan C.S., 'Instruments Devices and System', Tata McGraw Hill Publications, 2nd Edition, 2009.

E-RESOURCES:

1. NTPEL, Electrical Instrumentations (Web Course), Prof. N.K. De, Prof. T.K. Bhattacharyaand Prof. G. D. Roy, IIT Kharagpur.

COURSE CODE			**XEE506**	**L**	**T**	**P**	**C**
COURSE NAME			**DIGITAL ELECTRONICS LAB**	**0**	**0**	**1**	**1**
PREREQUISITES				**L**	**T**	**P**	**H**
C	**P**	**A**		**0**	**0**	**2**	**2**

COURSE OUTCOMES		**DOMAIN**	**LEVEL**
CO1	**Assemble code converter and conform the output**	Psychomotor Affective	Responding
CO2	**Assemble** Combinational logic circuits and **conform the output**	Psychomotor Affective	Responding
CO3	**Assemble** Sequential logic circuits and **conform the output**	Psychomotor Affective	Responding
CO4	**Build** Counters and **conform the output**	Psych	Responding

		omotor Affective	
CO5	**Build** Shift Registers and **conform the output**	Psychomotor Affective	Responding
CO6	**Design** digital circuits using VHDL and **conform the output**	Psychomotor Affective	Responding

LIST OF EXPERIMENTS

1. Study of logic gates.
2. Design and implementation of code converters using logic gates.
3. Design and implementation of Adders using logic gates.
4. Design and implementation Subtractor using logic gates.
5. Design and implementation of Magnitude Comparators.
6. Design and implementation of encoder and decoder.
7. Design and implementation of Multiplexer and De-multiplexer.
8. Implementation of Flip- flops.
9. Construction and verification of counter. (simulation using PSpice).
10. Construction and verification of shift register. (simulation using PSpice).
11. Logic gates using VHDL.
12. Adder and subtractor using VHDL.

	PRACTICAL	TOTAL
HOURS	**30**	**30**

COURSE CODE	COURSE NAME	L	T	P	C

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XEE507	MEASUREMENTS AND INSTRUMENTATION LABORATORY	0	0	1	1
C : P : A		L	T	P	H
0 : 1 : 0		0	0	2	2

COURSE OBJECTIVES:

- Understanding about the instruments used for different types of AC measurements.
- Understanding about various types of AC and DC bridges.
- Understanding about various types of transducers and display units.

Course Outcomes:		Domain	Level
CO1	**Describe** the different errors in measurements and **Describe** the working principle of different measuring instruments.	Cognitive Psychomotor	Remembering Perception
CO2	**Understanding** about the instruments used for different types of AC measurements. **Carryout** calibration test for measuring electrical instruments	Cognitive Psychomotor	Understanding Set
CO3	**Use** different types bridge circuits for the measurements of unknown passive elements. **Relate** the different types of the transducers. **Demonstrate** the use of different bridges and transducers.	Cognitive Psychomotor	Applying Mechanism
CO4	**Explain** the construction and operation of recording and display instruments. **Establish** Relations between analog and digital signal conversions.	Cognitive Psychomotor	Understanding Set
CO5	**Explain** the construction and working of different types signal conditioners. **Demonstrate** the recent trends in measurement of AC quantities.	Cognitive Psychomotor	Remembering Mechanism

Sl. No.	List of Experiments	COs
1.	Calibration of Current Transformer and Potential transformer.	CO1
2.	Measurement of three phase active, Reactive Power and Power factor	CO1
3.	Calibration of Single phase / Three Phase Energy meter	CO1
4.	Resistance measurement using Wheat stone bridge	CO2
5.	Inductance measurement using Maxwell Bridge	CO2
6.	Capacitance measurement using Schering Bridge	CO2
7.	Study of Transducers	CO3
8.	A/D converter	CO4
9.	D/A converters	CO4
10.	Measurement of Current / Voltage / power / Energy using Arduino board.	CO5

	PRACTICAL	TOTAL
	30	30

SEMESTER – VI

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COURSE CODE	COURSE NAME	L	T	P	C
XEE601	POWER ELECTRONICS	3	1	0	4
C : P : A		L	T	P	H
3 : 0 : 0		3	1	0	4

Course Outcomes:		Domain	Level
CO1	To Understand the structure, operation and characteristics of power switching devices.	Cognitive	Understanding
CO2	Determine the operation, characteristics and performance parameters of controlled rectifiers.	Cognitive	Understanding
CO3	Analysis the operation of DC - DC choppers.	Cognitive	Analyzing
CO4	Analysis the operation of various inverters and infer the suitable PWM techniques.	Cognitive	Analyzing
CO5	To Understand the concept of various types of AC voltage controllers.	Cognitive	Understanding

UNIT – I: POWER SWITCHING DEVICES	**9 + 3**
Review on Semiconductor devices – I-V characteristics and Switching Characteristics of power Diodes, SCR, TRIAC, power BJT, power MOSFET and IGBT. Triggering and Commutation Circuits.	
UNIT – II: THYRISTOR RECTIFIERS	**9 + 3**
Single phase half-wave and full-wave thyristor rectifiers – Single phase full-bridge thyristor rectifier with R-load and highly inductive load – Three phase full-bridge thyristor rectifier with R-load and highly inductive load.	
UNIT – III: DC TO DC CHOPPERS	**9 + 3**
Types of Choppers, Class A to E, step-up and step-down choppers – Analysis of Voltage, Current and Load commutated choppers –Introduction to Resonant converters.	
UNIT – IV: INVERTERS	**9 + 3**
Single phase, Three phase voltage source inverters (Both 120º and 180º mode of conductions) – Bipolar sinusoidal modulation and unipolar sinusoidal modulation, Modulation Index - PWM Techniques- Current Source Inverters.	
UNIT – V: AC VOLTAGE CONTROLLERS	**9 + 3**
Single-phase and three phase AC voltage controllers -. Multi-stage sequence control – step-up and step-down cycloconverter – Single phase to single phase and Single phase to Three phase cycloconverters.	

	LECTURE	TUTORIAL	TOTAL
	45	15	60

TEXT BOOKS:

1. Rashid, M.H., ‘Power Electronics: Circuits, Devices and Applications’, Pearson Education India, 2009.
2. Singh, M.D and Kanchandani, ‘Power Electronics’, Tata McGraw Hill & Hill publication Company Ltd New Delhi, 2009.
3. Bimbhra, P.S, ‘Power Electronics’, Khanna Publishers, 2007.

REFERENCE BOOKS:

1. Dubey, G.K., Doradia, S.R., Joshi, A. and Sinha, R.M., ‘Thyristorised Power Controllers’, Wiley

Eastern Limited, 1986.
2. Lander,W., 'Power Electronics', McGraw Hill and Company, Third Edition, 2009.
3. Sen.P.C., 'Power Electronics', Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2005.
4. Joseph Vithayathil, 'Power Electronics', McGraw-Hill New York, 1996.
5. Erickson, R.W and Maksimovic, D., 'Fundamentals of Power Electronics', Springer Science & Business Media, 2007.
6. Umanand, L., 'Power Electronics: Essentials and Applications', Wiley India, 2009.
7. Ned Mohan, Tore M. Undeland and William P.Robbins, 'Power Electronics: Converters, Applications and Design', New Jersey, John Wiley and Sons, 2007.

E-RESOURCES:

1. **Lecture** Series on **Power Electronics** by Prof. B.G. Fernandes, Department of Electrical Engineering, IIT Bombay.
2. http://www.nptel.ac.in/courses/108105066/PDF/L-1(SSG)(PE)%20((EE)NPTEL).pdf

COURSE CODE	COURSE NAME	L	T	P	C
XEE602	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	To understand the fundamentals of microprocessors, microcontrollers and embedded systems.	Cognitive	Understanding
CO2	To explain the architecture, Timing diagrams and Execution cycles of 8051.	Cognitive	Understanding
CO3	To identify the types of addressing modes, recall Instruction types and to understand the basic concepts of programming.	Cognitive	Understanding
CO4	To understand interfacing design of peripherals like I/O, A/D, D/A, timer etc.	Cognitive	Understanding
CO5	To identify and explain various communication protocols and interfacing with external devices.	Cognitive	Understanding

UNIT - I: FUNDAMENTALS OF MICROPROCESSORS	9
Fundamentals of Microprocessor Architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bitmicrocontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. 8085 Hardware Architecture, – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts- Data Transfer, Manipulation, Control Algorithms& I/O instructions, Programming concepts with 8085.	

UNIT - II: THE 8051ARCHITECTURE	**9**
Overview of the 8051 family-Internal Block Diagram, CPU, ALU, address, data and control bus, working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.	
UNIT - III: INSTRUCTION SET AND PROGRAMMING	**9**
8051 Instruction syntax, Data types, Subroutines, Addressing modes, Instruction set, Instruction timings, Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers. Programming and Debugging tools.	
UNIT - IV: MEMORY AND I/O INTERFACING	**9**
Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters and memory devices. Parallel Peripheral Interface8255, Interrupt Controller 8259, Timer / Counter 8254, Keyboard Display Controller 8279.	
UNIT - V: EXTERNAL COMMUNICATION INTERFACE AND APPLICATIONS	**9**
Synchronous and Asynchronous Communication. RS232, SPI, I2C.Introduction and interfacing to protocols like Blue-tooth and Zig-bee LED, LCD and keyboard interfacing, Stepper motor interfacing, DC Motor interfacing, sensor interfacing, Application to automated systems - Introduction to PIC Microcontroller, ARM Processor, ATMEGA Processor.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. R.S. Gaonkar, “Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 6th Edition, 2013.
2. M.A.Mazidi, J.G.Mazidi and R.D.McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education, 2007.
3. K.J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning, 2004.
4. R. Kamal, “Embedded System”, McGraw Hill Education, Third Edition, 2017.

REFERENCE BOOKS:

1. D.A.Patterson and J.H.Hennessy, Computer Organization and Design RISC-V Edition The Hardware/Software Interface, 5th ed., Amsterdam; Boston: Elsevier/Morgan Kaufmann, 2017..
2. D.V.Hall, “Microprocessors &Interfacing”, McGraw Hill Higher Education, 2005.

E-RESOURCES:

1. www.nptel.ac.in
2. https://onlinecourses.nptel.ac.in/noc19_ee11
3. https://nptel.ac.in/courses/Webcourse-contents/IIScBANG/notused/Microprocessors%20and%20Microcontrollers-/Learning%20Material%20-%20Microprocessors%20and%20microcontrollers.pdf

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COURSE CODE	COURSE NAME	L	T	P	C
XGS605	PROFESSIONAL SKILLS	1	0	2	3
C : P : A		L	T	P	H
2.6 : 0.4 : 0		1	0	4	5

Course Outcomes:		Domain	Level
CO1	**Ability** to understand communications	Cognitive	Remember
CO2	**Apply** the known skills for career	Cognitive	Apply
CO3	**Identify** inner strength	Cognitive	Remember
CO4	**Construct** the attitude as a professional	Cognitive	Create
CO5	**Practicing** Etiquettes	Psychomotor	Guided Response

UNIT – I: Communication	**9**
1.1 – Brainstorming 1.2 – LSRW	
UNIT – II: Career Skills	**9**
2.1 – Resume & CV Preparing Skills 2.2 – Interview Skills 2.3 – Exploring Career Opportunities	
UNIT – III: Team Skills	**9**
3.1 – Listening as a Team Skill 3.2 – Team Building at Work Place	
UNIT – IV: Professional Skills	**9**
4.1 – Attitude and Goal Setting 4.2 – Verbal and Non-Verbal Communications	
UNIT – V: Professional Etiquettes	**9**
5.1 – Social Etiquettes 5.2 – Cultural Ethics at work place	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCE BOOKS:

1. Er. A. K. Jain, Dr. Pravin S. R. Bhatia, Dr. A. M. Sheikh Professional Communication Skills S. Chand Publications, 2015.
2. Alan Pannett. Key Skills for Professionals: How to Succeed in Professional Services, Kogan Page; 1st edition, 2013.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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COURSE CODE	COURSE NAME	L	T	P	C
XUM606	CYBER SECURITY	0	0	0	0
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Understand the fundamentals of Cyber Security and the technologies.	Cognitive	Understand
CO2	Understand the organizational structure of Cyber security.	Cognitive	Understand
CO3	Understand the Cyber Security policy development.	Cognitive	Understand
CO4	Understand the Indian IT act and the initiatives.	Cognitive	Understand
CO5	Understand and Apply the Cyber security practices.	Cognitive	Understand Apply

UNIT – I: INTRODUCTION	9
Cyber Security – Cyber Security policy – Domain of Cyber Security Policy – Laws and Regulations – Enterprise Policy – Technology Operations – Technology Configuration - Strategy Versus Policy – Cyber Security Evolution – Productivity – Internet – E commerce – Counter Measures – Challenges.	
UNIT – II: CYBER SECURITY OBJECTIVES AND GUIDANCE	**9**
Cyber Security Metrics – Security Management Goals – Counting Vulnerabilities – Security Frame works – E-Commerce Systems – Industrial Control Systems – Personal Mobile Devices – Security Policy Objectives – Guidance for Decision Makers – Tone at the Top – Policy as a Project– Cyber Security Management – Arriving at Goals – Cyber Security Documentation – The Catalog Approach – Catalog Format – Cyber Security Policy Taxonomy.	
UNIT – III: CYBER SECURITY POLICY CATALOG	**9**
Cyber Governance Issues – Net Neutrality – Internet Names and Numbers – Copyright and Trademarks – Email and Messaging - Cyber User Issues - Malvertising - Impersonation –Appropriate Use – Cyber Crime – Geo location – Privacy - Cyber Conflict Issues – Intellectual property Theft – Cyber Espionage – Cyber Sabotage – Cyber Welfare- Computer Forensics – Steganography	
UNIT – IV: CYBER SECURITY INITIATIVES AND IT ACT	**9**
Counter Cyber Security Initiatives in India, Cyber Security Exercise, Cyber Security Incident Handling, Cyber Security Assurance, IT Act, Hackers-Attacker-Counter measures, Web Application Security, Digital Infrastructure Security and Defensive Programming. Traditional Problems Associated with Computer Crime, Introduction to Incident Response.	
UNIT – V: SECURITY PRACTICES	**9**
Guidelines to choose web browsers, Securing web browser, Antivirus, Email security, Guidelines for setting up a Secure password, Two-steps authentication, Password Manager, Wi-Fi Security, Guidelines for social media security, Tips and best practices for safer Social Networking. Basic Security for Windows, User Account Password. Introduction to mobile Smartphone Security, Android Security, IOS Security Online Banking Security, Mobile Banking Security, Security of Debit and Credit Card, UPI	

Security Security of Micro ATMs e-wallet Security Guidelines Security Guidelines for Point of Sales (POS).

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCE BOOKS:

1. Jennifer L. Bayuk, J. Healey, P. Rohmeyer, Marcus Sachs , Jeffrey Schmidt, Joseph Weiss "Cyber Security Policy Guidebook" John Wiley & Sons 2012.
2. Rick Howard "Cyber Security Essentials" Auerbach Publications 2011.
3. Cyber Laws & Information Technology, Jothi Rathan,Vijay Rathan,Bhrath Pubishers,7th Edition January 2019.
4. Modern Cyber security Practices by Pascal Ackerman, BPB Publications,2020
5. Dan Shoemaker Cyber security The Essential Body Of Knowledge, 1st ed. Cengage Learning 2011.
6. Rhodes-Ousley, Mark, "Information Security: The Complete Reference", Second Edition, McGraw-Hill, 2013.

E-RESOURCES:

1. https://www.coursera.org/specializations/cyber-security
2. www. nptel.ac.in
3. http://professional.mit.edu/programs/short-programs/applied-cybersecurity
4. https://us.norton.com/internetsecurity-how-to-cyber-security-best-practices-for-employees.html
5. https://www.meity.gov.in/content/cyber-laws

COURSE CODE	COURSE NAME	L	T	P	C
XEE607	POWER ELECTRONICS LABORATORY	0	0	1	1
C : P : A		L	T	P	H
0 : 1 : 0		0	0	2	2

COURSE OBJECTIVES:

- To introduce the different types of analog and digital modulation and demodulation.
- To convey frequency division multiplexing and demultiplexing.
- To expose the students line coding and decoding.
- To create awareness on the performance of digital modulation techniques in AWGN and Rayleigh channels.

Course Outcomes:		Domain	Level
CO1	**Construct**, **Demonstrate** and **Simulate** Amplitude Modulation, Demodulation, sensitivity and selectivity of AM receivers.	Cognitive Psychomotor	Mechanism Response
CO2	**Construct**, **Demonstrate** and **Simulate** Frequency Modulation, Demodulation, sensitivity and selectivity of FM receivers.	Cognitive Psychomotor	Mechanism Responding
CO3	**Construct** and **Demonstrate** Frequency Division	Cognitive	Mechanism

	Multiplexing and demultiplexing.	Psychomotor	Responding
CO4	**Build**, **Demonstrate** and **Simulate** various types of analog and digital Pulse Modulations using trainer kits.	Cognitive Psychomotor	Mechanism Responding
CO5	**Simulate** performance of digital modulation techniques in AWGN and Rayleigh channels.	Cognitive Psychomotor	Mechanism Responding

Sl. No.	**List of Experiments**	**COs**
1.	Characteristics of SCR.	**CO1**
2.	Characteristics of MOSFET.	**CO1**
3.	Characteristics of IGBT.	**CO1**
4.	Single phase fully controlled rectifier with R, RL load.	**CO2**
5.	BUCK- BOOST converter using MOSFET.	**CO3**
6.	IGBT based choppers.	**CO3**
7.	Four quadrant chopper.	**CO3**
8.	Single phase IGBT PWM Inverter.	**CO4**
9.	Series Inverter/ Parallel Inverter.	**CO4**
10.	Single phase AC voltage controller using SCR / TRIAC.	**CO5**
11.	Single phase cycloconverter.	**CO5**
	PRACTICAL	**TOTAL**
	30	**30**

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE608	**MICROPROCESSORS AND MICROCONTROLLERS LABORATORY**	**0**	**0**	**1**	**1**
Prerequisite	**Digital Electronics**	**L**	**T**	**P**	**H**
C : P : A		**0**	**1**	**2**	**2**
2 : 1 : 0.5					

Course Outcomes:		**Domain**	**Level**
CO1	**Write** Assembly Language Programs for Arithmetic operations and Data Transfer.	Cognitive Psychomotor Affective	Understand Guided Response Valuing
CO2	**Write** Assembly Language Programs using conditional jump group of instructions and Subroutines.	Cognitive Psychomotor Affective	Understand Guided Response Valuing
CO3	**Write** Assembly Language Programs for Interfacing Converters of 8-bit D/A and A/D as well as Keyboard with 8085.	Cognitive Psychomotor Affective	Understand Guided Response Valuing
CO4	**Program** for Serial communication implementation and I/O	Cognitive Psychomotor	Understand Guided

	interface.	Affective	Response Valuing
CO5	**Program** and **execute** simple applications using microprocessor trainer kits.	Cognitive Psychomotor Affective	Understand Guided Response Valuing

List of Experiments:

1. Simple arithmetic operations with 8085 Microprocessors: Multi precision addition/subtraction/multiplication/division.
2. Programming with control instructions: Increment/Decrement, Ascending/Descending order, Maximum/Minimum of numbers, Rotate instructions.
3. Demonstration of basic instructions with 8051 Micro controller executions, including:
    a. Conditional jumps, looping.
    b. Calling subroutines.
    c. Stack parameter testing.
4. Design program for code conversions.
5. Interfacing Converters of 8-bit D/A and A/D.
6. Interfacing of Keyboard with 8085
7. Interfacing of seven segment display with 8085.
8. Serial communication and I/O Port operations.
9. Design and implementation of Traffic Light control.
10. Design and implementation of Stepper motor control.

	PRACTICAL	**TOTAL**
	30	**30**

SEMESTER – VII

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COURSE CODE	COURSE NAME	L	T	P	C
XEE701	POWER SYSTEMS OPERATION AND CONTROL	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Explain** power system load characteristics and generation reserve requirements.	Cognitive	Understanding
CO2	**Demonstrate** and **Apply** the mathematical knowledge to model and analysis of power system for frequency control.	Cognitive	Understanding Applying
CO3	**Identify** fundamental aspects of reactive power and its effect on system voltage and **Select** the suitable voltage control method for the system operating condition.	Cognitive	Understanding Applying
CO4	**Formulate** economic dispatch and unit commitment problem and its solution.	Cognitive	Understanding Applying
CO5	**Apply** computer control methods for power system operation and control	Cognitive	Understanding

UNIT - I: INTRODUCTION	**9**
Power scenario in Indian grid – National and Regional load dispatching centers – requirements of good power system- system load variation - load characteristics - load curves and load-duration curve - load factor - diversity factor - Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves - Importance of load forecasting - quadratic and exponential curve fitting techniques for forecasting – plant level and system level controls.	
UNIT - II: REAL POWER - FREQUENCY CONTROL	**9**
Basics of speed governing mechanism and modelling - speed-load characteristics – load sharing between two synchronous machines in parallel - concept of control area - LFC control of a single-area system: static and dynamic analysis of uncontrolled and controlled cases - two-area system: modelling - static analysis of uncontrolled case - tie line with frequency bias control - state variable model.	
UNIT - III: REACTIVE POWER–VOLTAGE CONTROL	**9**
Generation and absorption of reactive power - basics of reactive power control - excitation systems– modelling - static and dynamic analysis - stability compensation - methods of voltage control: tap-changing transformer, injection reactive power - SVC (TCR + TSC) and STATCOM – secondary voltage control.	
UNIT - IV: UNIT COMMITMENT AND ECONOMIC DISPATCH	**9**
Formulation of economic dispatch problem – I/O cost characterization – incremental cost curve - coordination equations without and with loss (No derivation of loss coefficients) - solution by direct method and λ-iteration method - statement of unit commitment problem – priority-list method -forward dynamic programming.	
UNIT - V: COMPUTER CONTROL OF POWER SYSTEMS	**9**
Need for computer control of power systems - concept of energy control centre– functions - system monitoring - data acquisition and control - system hardware configuration – SCADA and EMS functions - network topology - state estimation – WLSE - Contingency Analysis - state transition diagram showing various state transitions and control strategies.	

	LECTURE	TUTORIAL	TOTAL

	45	**0**	**45**

TEXT BOOKS:

1. Olle.I.Elgerd, 'Electric Energy Systems theory - An introduction', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
2. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 3rdEdition, 2013.
3. Kundur P, 'Power System Stability and Control, Tata McGraw Hill, New Delhi, 5th reprint, 2014.

REFERENCE BOOKS:

1. Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition, 2011.
2. HadiSaadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21streprint, 2010.
3. Abhijit Chakrabarti, SunitaHalder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

E-RESOURCES:

1. www.nptel.ac.in
2. NPTEL : http://nptel.ac.in/courses/108104052/

COURSE CODE	COURSE NAME	L	T	P	C
XEE702	**INDUSTRIAL AUTOMATION**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	Able to **define** and **explain** the fundamentals of Pneumatics, hydraulics and electrical drives. **List** out the advantages, disadvantages and its application.	Cognitive	Understand
CO2	**Understand** the electrical ladder diagrams for hydraulic and pneumatic system and able to **explain** pressure, proximity switches and intelligent Relays.	Cognitive	Understand
CO3	**Explain** and **categorize** different types of Sensors and their application.	Cognitive	Understand
CO4	**Illustrate** the knowledge in the PLC logic, Architecture and **design** the industrial automated system for specific applications and **apply** the knowledge of PLC programming to interface pneumatics.	Cognitive	Understand
CO5	**Outline** the overview of robotics and their application. **Understand** the operation of robots.	Cognitive	Understand

UNIT – I: INTRODUCTION TO AUTOMATION	**9**
Introduction to Automation - Hydraulic Systems - Pneumatics Systems - Electro pneumatics – Advantages and disadvantages – Applications.	
UNIT – II: APPLICATIONS OF RELAYS	**9**

Introduction to Process Control Philosophies: type of relays, ladder logic methodology, ladder symbols. Essential qualities of relays- NO & NC contacts– Electrical Ladder Diagrams for Pneumatic system and Hydraulic system-pressure switches- Intelligent Relays.	
UNIT – III: SENSORS AND TIMERS IN CONTROLLERS	**9**
Introduction to sensors- proximity sensors -characteristics- types of sensors-resistive - inductive-capacitive- magnetic- ultrasonic - photoelectric-applications of sensors.	
UNIT – IV: PROGRAMMABLE LOGIC CONTROLLERS	**9**
Evolution of PLC – Sequential and Programmable controllers – Architecture–Programming of PLC – Relay logic and Ladder logic – role of timers and counters - Applications – PLC interface to pneumatics.	
UNIT – V: ROBOTICS	**9**
Introduction and overview of Robotics – Terms and Definitions related robotics, classification and configuration of robots, Basic components - Drives, controller gripper, application- programming in Robotics.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Industrial Automation Technologies, Edited By Chanchal Dey, Sunit Kumar Sen ISBN 9780367260422 Published June 10, 2020 by CRC Press.
2. James Dally, W., "Instrumentation for Engineering Measurements", John Wiley & sons.
3. JOHN WEBB: Programmable Logic Controllers Principles & applications, PHI.
4. Programmable Logic Controllers, Sixth Edition, William Bolton, 2015.
5. Patranabis, D., "Sensors and Transducers", Wheeler Publishing, 2000.
6. Harry Colestock, Industrial Robotics, McGraw Hill Book Co., New Delhi, 2005.

REFERENCE BOOKS:

1. Anthony Esposito, Fluid Power with Applications, Pearson Education, 7th Edition, New Delhi, 2014.
2. S. R. Mujumdar, "Pneumatic system", Tata McGraw Hill. ISBN: 0074602314.
3. Stuart A. Boyer., SCADA: Supervisory Control and Data Acquisition, 3rdEdition, The instrumentation systems and Automation Society,2009.
4. W Bolton., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" Prentice-Hall. ISBN: 0131216333.
5. Micro-sensors; principles andapplications-J.W.Gardner.
6. Semiconductor sensors and itsapplication-S.M.Sze.

E-RESOURCES:

1. NPTEL- Industrial automation, Prof. S. Mukhopadhyay - IITKharagpur.
2. Web Course -http://elearning.vtu.ac.in/

Semester	**:**	**VII**
Course Code	**:**	**XUM705**
Course Name	**:**	**Environmental studies**
Prerequisite	**:**	

	L	**T**	**P**	**C**			**C**	**P**	**A**			**L**	**T**	**P**	**H**	
	3	**0**	**0**	**0**			**2,5**	**0**	**0.5**			**3**	**0**	**0**	**3**	

Course Outcome: After the completion of the course, students will be able to	**Domain C or P or A**	**Level**

CO1	**Describe** the significance of natural resources and **explain** anthropogenic impacts.	Cognitive	**Remembering and Understanding**
CO2	**Illustrate** the significance of ecosystem, biodiversity and natural geo bio chemical cycles for maintaining ecological balance.	Cognitive	**Understanding**
CO3	**Identify** the facts, consequences, preventive measures of major pollutions and **recognize** the disaster phenomenon	Cognitive Affecting	**Remembering Receiving**
CO4	**Explain** the socio-economic, policy dynamics and **practice** the control measures of global issues for sustainable development	Cognitive	**Understanding and Analyse**
CO5	**Recognize** the impact of population and **apply** the Environmental ethics towards environmental protection.	Cognitive	**Understanding and Apply**

COURSE CONTENT

UNIT I	**INTRODUCTION TO ENVIRONMENTAL STUDIES AND RESOURCES**	**12**
	Multidisciplinary nature of environmental studies; Scope and importance; Environment education - climate change, pollution, waste management, sanitation, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living. Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over---exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter---state). Energy resources : Renewable and non- renewable energy sources, use of alternate energy sources, growing energy needs, case studies	
UNIT II	**ECOSYSTEMS AND BIODIVERSITY**	**8**
	Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic	

	ecosystem (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity - Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation; Endangered and endemic species of India Threats to biodiversity : Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
UNIT III	**ENVIRONMENTAL POLLUTION**	**8**
	Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: flood, earthquake, cyclone and landslide.	
UNIT IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**
	Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation – Consumerism and waste products – Environment Protection Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. Issues involved in enforcement of environmental legislation – Public awareness.	
UNIT V	**HUMAN POPULATION AND THE ENVIRONMENT**	**8**
	Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and	

	cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).	

		L	T	P	Total
		45	0	0	45

TEXT BOOKS

1. Mahua Basu,S. Xavier,Fundamentals of Environmental Studies, Cambridge University Press, 2019
2. Bharucha Erach,Textbook of Environmental Studies for Undergraduate Courses, Orient Blackswan Pvt Ltd, 2018
3. Anubha Kaushik, C.P. Kaushik, Perspectives in Environmental Studies,New Age International Pvt Ltd Publishers,2018
4. Divan Shyam,Environmental Law and Policy in India, OUP India,2019
5. Varun Dutt Sharma,S.K. Pandey,Vimal Kumar sharma,Environmental Education and Disaster Management, CBS Publishers & Distributors,2019

REFERENCE BOOKS

1. M.V. Subba Rao,Natural Resources, Conservation, Management and Health Care,Discovery Publishing Pvt.Ltd,2020
2. Masters Gilbert M.Introduction to Enviromental Engineering 3rd Edition , Pearson Education India, 3rd edition ,2015.
3. P.D. Sharma, Ecology and Environment Thirteenth Edition, Rastogi Publications,2017
4. Dr. Avneesh Gaur, Environmental Engineering and Disaster Management ,Vayu Education Of India,2021

E-REFERENCES

1. http://www.e-booksdirectory.com/details.php?ebook=10526
2. https://www.free-ebooks.net/ebook/Introduction-to-Environmental-Science
3. https://www.free-ebooks.net/ebook/What-is-Biodiversity
4. https://www.learner.org/courses/envsci/unit/unit_vis.php?unit=4
5. http://bookboon.com/en/pollution-prevention-and-control-ebook
6. http://www.e-booksdirectory.com/details.php?ebook=8557
7. http://www.e-booksdirectory.com/details.php?ebook=6804
8. http://bookboon.com/en/atmospheric-pollution-ebook
9. http://www.e-booksdirectory.com/details.php?ebook=3749
10. http://www.e-booksdirectory.com/details.php?ebook=2604
11. http://www.e-booksdirectory.com/details.php?ebook=2116
12. http://www.e-booksdirectory.com/details.php?ebook=1026
13. http://www.faadooengineers.com/threads/7894-Environmental-Science

COURSE CODE	COURSE NAME	L	T	P	C
XEE706	POWER SYSTEM SIMULATION LABORATORY	0	0	1	1

C : P : A		L	T	P	H
3 : 2 : 0.5		0	0	2	2

Course Outcomes:		Domain	Level
CO1	Ability to acquire knowledge on Formation of Bus Admittance and Impedance Matrices and Solution of Networks.	Cognitive Psychomotor	Understanding Guided Response
CO2	Ability to analyze the power flow using GS and NR method.	Cognitive Psychomotor	Understanding Guided Response
CO3	Ability to find fault in the power system.	Cognitive Psychomotor	Understanding Guided Response
CO4	Ability to model and analysis of power system for frequency control.	Cognitive Psychomotor	Understanding Guided Response
CO5	Ability to solve the economic dispatch & unit commitment problems.	Cognitive Psychomotor	Understanding Guided Response

Sl. No.	List of Experiments	COs
1.	Formation of Bus Admittance Matrix.	CO1
2.	Formation of Bus Impedance Matrix	CO1
3.	Power Flow Analysis using Newton Raphson Method.	CO2
4.	Power Flow Analysis using Gauss-Seidel Method	CO2
5.	Fault Analysis of AC Power System	CO3
6.	Simulink model of single area load frequency control with & without PI controller.	CO4
7.	Simulink model for two area load frequency control.	CO4
8.	Optimum loading of generators with penalty factor.	CO5
9.	Optimum loading of generators neglecting transmission losses.	CO5
10.	Economic load dispatch problem.	CO5
	PRACTICAL	**TOTAL**
	30	**30**

COURSE CODE	COURSE NAME	L	T	P	C
XEE707	INDUSTRIAL AUTOMATION LABORATORY	0	0	1	1
Prerequisite	Digital Electronics, Microprocessors and Microcontrollers	L	T	P	H

C : P : A		0	0	2	2
1.5 : 1 : 0.5					

Course Outcomes:		Domain	Level
CO1	**Assemble** and **understand** the working of Hydraulic and Pneumatic systems and differentiate the various components.	Cognitive Psychomotor Affective	Understand Guided Response Valuing
CO2	**Explain** how to control single acting cylinders and double acting cylinders.	Cognitive Psychomotor Affective	Understand Guided Response Valuing
CO3	**Perform** control of double acting cylinder and **compare** the characteristics of various sensors.	Cognitive Psychomotor Affective	Understand Guided Response Valuing
CO4	**Verify** logical functions using PLCs in industrial applications.	Cognitive Psychomotor Affective	Understand Guided Response Valuing
CO5	**Program** and **execute** simple applications using PLC	Cognitive Psychomotor Affective	Understand Guided Response Valuing

List of Experiments:

1. Study of basic hydraulic circuit for the working of double acting cylinder and a hydraulic motor.
2. Control of Pneumatically operated single acting cylinder and double acting cylinder.
3. Extension and Retraction of double acting cylinder.
4. Control of pneumatically operated double acting cylinder using sensor and timer.
5. Sequential control of two double acting cylinders.
6. Study of various Sensors.
7. AND and OR Logical function PLC.
8. Automatic tank filing control using PLC.
9. Traffic light control using PLC.
10. Starter control of motor using PLC.

PRACTICAL	TOTAL
30	30

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VALUE ADDED COURSES

COMMUNICATIONS SKILLS AND DEVELOPMENT

COURSE CODE	COURSE NAME
VAC1	COMMUNICATIONS SKILLS AND DEVELOPMENT

Topics

Introduction to public speaking; functions of oral communication; skills and competencies needed for successful speech making; importance of public speaking skills in everyday life and in the area of business, social, political and all other places of group work.

Organization of Speech; introduction, development and conclusion; language used in various types of speeches; Adapting the speech structures to the Audience; paralinguistic features.

Basic tips; how to present a paper/assignment etc; using visual aids to the speeches; using body language to communicate.

Introduction to business communication; modern developments in the style of writing letters memos and reports: block letters, semi block letters, full block letters, simplified letters etc.,

The language used in memos/minutes/telephone memos/ letters/ assignments art of writing E-mail etc. Advantages of written and spoken communication.

The use of active and passive voice; the use of grammar, propriety, accuracy, exactness, the tone & other elements of language used in these writings. The format of various types of Reports/ projects etc., Writing Business reports, proposals and minutes.

	LECTURE	TUTORIAL	TOTAL
	30	0	30

FUNDAMENTAL OF C / C++

COURSE CODE	COURSE NAME
VAC2	FUNDAMENTAL OF C / C++

Topics

Overview of C – Constants, Variables and Data Types – Operators and Expressions – Managing Input / Output Operations – Formatted I/O – Decision Making - Branching –- if, nested if , switch, goto and Looping- while, do, for statements.

Arrays – dynamic and multi-dimensional arrays - Character arrays and Strings – String handling Functions - User defined Functions – Categories of Functions – Recursion - Structures and Unions – Array of Structures – Structures and Functions.

Pointers – Declaration, Accessing a variable, character strings, pointers to functions and structures - File Management in C – Dynamic Memory allocation – Linked Lists – Pre-processors.

Overview of C++ - Classes and Objects-Friend Functions-Friend Classes-Inline Function-Static Members-Arrays-Pointers-References-Dynamic Allocation- Function Overloading-Overloading Constructor Functions-Copy Constructors-Default Argument-Operator Overloading-Member Operator Overloading .

Inheritance-Base Class-Access Control-Virtual Functions-Pure Virtual Functions-Templates-Generic Functions-Applying Generic Functions-Generic Classes-Exception Handling-C++ I/O Streams-File I/O-STL-Overview-Container Classes-Lists-Maps-Algorithms Using Functions and Objects-String Class.

	LECTURE	TUTORIAL	TOTAL
	30	0	30

AUTO CAD - ELECTRICAL

COURSE CODE	COURSE NAME
VAC3	AUTO CAD - ELECTRICAL

Topics

Introduction about AutoCAD, Advantages in using AutoCAD, File management, Drawing Tools, Object Properties, Layer Management, Block, Creating & Inserting Blocks, WBlock, Introduction about AutoCAD Electrical, Application of AutoCAD Electrical, Projects, Introduction to Project Manager, Creating an AutoCAD Electrical project, Drawing Properties, Symbol Libraries, Inserting Multiple Components, Circuit Builder, PLC, Point to

Point Wiring Tools, Panel Layout, Generating Reports.

	LECTURE	TUTORIAL	TOTAL
	30	0	30

ELECTRICAL SYSTEM DESIGN USING INTERNET OF THINGS / AURDINO

COURSE CODE	COURSE NAME
VAC4	ELECTRICAL SYSTEM DESIGN USING INTERNET OF THINGS / AURDINO

Topics

Basics of Electronics, Introduction to IoT concepts and Technologies, Internet of Things Architecture and Implementation.

Arduino Programming Language concepts. Introduction to Arduino Embedded Development Board and ATmega Microcontroller.

Working with Arduino IDE 1.8.6 and programming Arduino MEGA Hardware. Interfacing Arduino with LED, Breadboard. Data Representation concepts.

Serial Communication – UART Protocol, USB Protocol. UART to USB Conversion. Working with Serial ports in Arduino. Introduction to Sensors and Concepts. Infra Red Proximity Sensor Principles, working and connecting with Arduino.

IoT Communication Wired and Wireless Protocols Layers and Protocols - TCP/IP Layer, OSI Model. IEEE Standards – Bluetooth Standards. Bluetooth Module – Working of HC05 Module, Bluetooth Standards, Specifications, Protocol Stack, versions, controlling devices using Bluetooth module.

Collecting Real time data using Temperature Sensor (DHT11) – DHT11 libraries and principle. Wireless Technologies & Standards – Node MCUWiFi Development Boards. Connecting Node MCUWiFi module to Internet.

Cloud Computing – Introduction, Services and Importance in IoT. Introduction to ThingSpeak Cloud and Working with ThingSpeak API Keys and Channels. Data collection from Sensors and automatic storage in ThingSpeak Cloud using NodeMCU.

ESP8266 WiFi Chip – Working Principle, pin outs, connection with Arduino MEGA board, AT Commands. Setting up TCP Client using ESP8266. Data collection from Sensors and automatic storage in ThingSpeak Cloud using ESP8266 and Arduino MEGA.

Send Messages to IoT devices using Talkback. REST Client. Control IoT Devices remotely from REST Client in System and Mobile.

Python – Introduction , Environment Setup, Basic Building blocks – Variables, , Operators, IO functions, Data types, Control Structures, Data Structures – List, Tuple, Set, Dictionary, Functions, Modules Python Common Gateway Interface – Introduction, Enabling CGI Server in Windows, Implementing Client – Server Architecture. Raspberry Pi – Introduction, Raspberry pi as an IoT gateway, Connecting with Raspberry pi through VNC. Make Raspberry pi as Server using Python CGI. Integration of Cloud with Raspberry pi as an IoT Gateway. Pubnub Cloud – Publishers and Subscribers Architecture. Publishing data to Pubnub cloud using Raspberry pi. Real time data storage in cloud using Arduino, ESP8266 and Raspberry pi. IoT Protocol - Message Queing Telemetry Transport Protocol(MQTT) – Architecture, Machine to Machine Communication. Implementing MQTT Broker using Raspberry pi IoT Data Analytics – Data Analytics using Python, Introduction to Python Libraries – Matplotlib, Mayavi, NumPy, SciPy, Pandas, Scikit learn. Anaconda Installation and Data Analysis in Jupiter.

	LECTURE	TUTORIAL	TOTAL
	30	0	30

ENERGY AUDITING AND MANAGEMENT

COURSE CODE	COURSE NAME
VAC6	ENERGY AUDITING AND MANAGEMENT

Topics

Energy Scenario: energy needs of growing economy, energy pricing, energy sector reforms. Re-structuring of the energy supply sector, Energy Conservation Act-2010and its features. Need for energy audit - Energy management & audit approach. Understanding energy, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, energy audit instruments. Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques -energy consumption, production, cumulative sum of differences (CUSUM). Energy Efficiency in Electrical Utilities: electrical load management and maximum demand control, power factor improvement, energy saving opportunities with energy efficient motors

	LECTURE	TUTORIAL	TOTAL
	30	0	30

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ELECTIVE GROUP – I

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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COURSE CODE	COURSE NAME	L	T	P	C
XEE E11	PROTECTION AND SWITCHGEAR	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	To **Illustrate** and **recall** the principle, characteristics and working of different types of relay.	Cognitive	Understanding Remembering
CO2	To **choose** relevant protection systems for the Generator and Transformers.	Cognitive	Applying Evaluating
CO3	**To compare the** concepts of arc quenching techniques of different equipments	Cognitive	Analyzing
CO4	**To classify** the different type of Circuit breakers and its selection criteria.	Cognitive	Analyzing
CO5	**To select** of different type of equipments used for over voltage protection and Lightning arrestors.	Cognitive	Applying

UNIT - I: RELAYS	**9**
General classification, Principle of operation, types, characteristics, Torque equation, Relaying Schemes, Relay Co- ordination. Requirement of relays, Primary & backup protection, Desirable qualities of relays, Terminology used in protective relay, Over current relays directional, distance and differential, under frequency, negative sequence relays.	
UNIT - II: APPARATUS PROTECTION	**9**
Protection of Generator: Earth Fault, percentage, differential, Loss of excitation, Prime mover failure, over current, Negative phase sequence, heating, Reverse power protection schemes. Protection of Transformers: Internal and external fault protection, Differential, Earth fault, Over Current, Overheating. Transformer Protection - Incipient fault.	
UNIT - III: THEORY OF CIRCUIT INTERRUPTION	**9**
Physics of arc phenomena and interruption- rate of rise of recovery voltage. Elementary principle of arc quenching, Recovery and re-striking voltage, arc quenching devices, current chopping, capacitive current, resistance switching, interruption of capacitive current.	
UNIT - IV: CIRCUIT BREAKERS	**9**
Switchgear, fault clearing, description and operation of Bulk oil, Minimum oil, Air break, Air blast, SF6, Vacuum circuit breakers and DC circuit breakers, LT Switch gear, HRC fuses, current limiting reactor & influence of reactors in CB ratings, selection of circuit breakers, Testing of circuit breaker, Intelligent circuit breakers.	
UNIT - V: PROTECTION AGAINST OVERVOLTAGE	**9**
Switching surges, Phenomena of Lightning, over voltage due to lightning, Protection against lightning, Lightning arrestors, selection of lightning arrestors, Surge absorbers, and diverters, Rod gap, Horn gap expulsion type & valve type lightning arrestors, solid resistance and reactance earthing, Arc suppression coil, Earthing transformers, Earth wires, insulation co-ordination.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:

1. Badri Ram, Vishwakarma D N., **"**Power System Protection and Switchgear**"** Tata McGraw Hill

Publishing House Limited, New Delhi, 2005.
2. Soni, M.L., Gupta, P.V., Bhatnagar, U.S. and Chakrabarti, A., **"**A Text Book on Power Systems Engineering**"**, DhanpatRai& Sons Company Limited, New Delhi, 2008.
3. Sunil, S.Rao, **"**Switchgear Protection and Power Systems (Theory, Practice & Solved Problems**"**, Khanna Publishers Limited, New Delhi, 12th Edition, 2008.
4. B.Ravindranath, and N.Chander, **'**Power System Protection and Switchgear**'**,WileyEastern Ltd., 2000.

REFERENCE BOOKS:

1. Paithankar Y. G., Bhide S. R., **"**Fundamentals of Power System Protection**"** Prentice Hall of India Limited, New Delhi, 2nd Edition, 2010.
2. Wadhwa, C.L., **"**Electrical Power Systems**"**, New Age International Publishers Limited, 2006, New Delhi,6th Edition, 2010
3. Patra, S.P., Basu, S.K. and Chowduri, S., **'**Power systems Protection**'**, Oxford and International Book House Publishing Co, 2000.

E-RESOURCES:

1. NTPEL, Power System Generation, Transmission and Distribution, Prof. D. P. Kothari Center for Energy Studies, Indian Institute of Technology, Delhi.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	1	1	1	1	0	0	0	1	0	1	2	2
CO2	1	1	2	2	1	1	1	0	0	1	0	1	1	1
CO3	2	1	1	2	0	0	0	0	0	1	0	2	2	2
CO4	1	1	1	1	0	0	1	0	0	1	0	1	2	2
CO5	1	1	1	1	0	0	0	0	0	1	0	1	1	1
Total	**7**	**7**	**6**	**5**	**5**	**2**	**2**	**0**	**0**	**5**	**0**	**6**	**8**	**8**
Scaled	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**2**	**2**	**2**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

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COURSE CODE	COURSE NAME	L	T	P	C
XEE E12	ELECTRICAL MACHINE DESIGN	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Able to **define** and **recall** the different fundamental concepts of electrical and magnetic circuit parameters.	Cognitive	Remembering
CO2	Categorize different types of Transformer based on its design. **Understand** about single phase and three phase transformer parameters and its efficiency calculation.	Cognitive	Understanding Analyzing
CO3	**Compare** the main dimensions of different machines, and **relate** its impact on the **Analyze** various parts of induction machines.	Cognitive	Understanding Analyzing
CO4	**Classify** types of three phase Synchronous motor. **Analyze** the design procedure of each part of the motor	Cognitive	Understanding Analyzing
CO5	Use of software tools to do design calculations	Cognitive	Applying Analyzing

UNIT – I: INTRODUCTION	**9**
Major considerations in electrical machine design, electrical engineering materials, spacefactor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow,temperature rise, rating of machines.	
UNIT – II: TRANSFORMERS	**9**
Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.	
UNIT – III: INDUCTION MOTORS	**9**
Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.	
UNIT – IV: SYNCHRONOUS MACHINES	**9**
Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.	
UNIT – V: COMPUTER AIDED DESIGN (CAD)	**9**
Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines- PMSMs, BLDCs, SRM and claw-pole machines.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:
1. K. Sawhney, "A Course in Electrical Machine Design", DhanpatRai and Sons, 2016. 2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London. 3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
REFERENCE BOOKS:
1. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969. 2. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979. 3. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008. 4. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.
E-RESOURCES:
1. Web Content - http://www.library.dce.edu/e-resources/books/ee/ 2. Web Course - http://elearning.vtu.ac.in/

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	-	-	2	1	1	2	-	-	1	-	-	1	1
CO2	3	3	-	3	3	3	-	3	-	1	3	-	1	1
CO3	2	-	-	-	2	2	2	3	-	-	-	-	2	2
CO4	-	1	3	-	-	1	-	-	1	-	-	-	2	2
CO5	-	-	1	-	3	-	-	2	-	-	-	-	1	2
Total	**7**	**4**	**4**	**5**	**9**	**7**	**4**	**8**	**1**	**2**	**3**	**0**	**7**	**8**
Scaled	**2**	**1**	**1**	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**0**	**2**	**2**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE	COURSE NAME	L	T	P	C

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CODE					
XEE E13	EMBEDDED SYSTEMS	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Understand the structural units of Embedded Systems	Cognitive	Understanding
CO2	Explain and understand networking protocols and interfaces in Embedded Systems	Cognitive	Understanding
CO3	Understand and elaborate Embedded Firmware development	Cognitive	Understanding
CO4	Explain and understand the basic concepts of RTOS	Cognitive	Understanding
CO5	Understand how Embedded System Application Development is done	Cognitive	Understanding

UNIT – I: INTRODUCTION TO EMBEDDED SYSTEMS	**9**
Introduction to Embedded Systems – The build process for embedded systems-Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods-Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging	
UNIT - II: EMBEDDED NETWORKING	**9**
Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols – RS232 standard – RS422 – RS485 – CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) –need for device drivers.	
UNIT – III:EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT	**9**
Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object-oriented Model	
UNIT - IV: RTOS BASED EMBEDDED SYSTEM DESIGN	**9**
Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication shared memory, message passing, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Realtime Operating systems: Vx Works, C/OS-II, RT Linu0078	
UNIT - V: EMBEDDED SYSTEM APPLICATION DEVELOPMENT	**9**
Case Study of Washing Machine- Automotive Application- Smart card System Application, Mobile Embedded System.	

LECTURE	TUTORIAL	TOTAL
45	0	45

TEXT BOOKS:

1. Rajkamal, ‘Embedded System-Architecture, Programming, Design’, Mc Graw Hill, 2013.
2. Peckol, “Embedded system Design”, John Wiley & Sons,2010.
3. Lyla B Das,” Embedded Systems-An Integrated Approach”, Pearson, 2013

REFERENCE BOOKS:
1. Shibu. K.V, "Introduction to Embedded Systems", Tata McGraw Hill,2009. 2. Elicia White," Making Embedded Systems", O' Reilly Series,SPD,2011. 3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2006. 4. Han-Way Huang, "Embedded system Design Using C8051", Cengage Learning,2009. 5. Rajib Mall "Real-Time systems Theory and Practice" Pearson Education, 2007
E-RESOURCES:
1. https://nptel.ac.in/downloads/108105057/ 2. https://learnengineering.in/ee6602-embedded-systems/

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	0	0	0	1	0	0	0	1	1	1	1	1	1
CO2	2	0	0	0	1	0	0	0	1	1	1	1	1	1
CO3	2	0	0	0	1	0	0	0	1	1	1	1	1	1
CO4	2	0	0	0	1	0	0	0	1	1	1	1	1	1
CO5	2	0	0	0	1	0	0	0	1	1	1	1	1	1
Total	**10**	**0**	**0**	**0**	**5**	**0**	**0**	**0**	**5**	**5**	**5**	**5**	**5**	**5**
Scaled	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**

1-5 → 1, 6-10 → 2, 11-15 → 3

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COURSE CODE	COURSE NAME	L	T	P	C
XEE E14	ELECTRICAL ENERGY CONSERVATION AND AUDITING	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Understand** the energy and environment, energy security and energy conservation.	Cognitive	Understanding
CO2	**Understand** the various form of energy.	Cognitive	Remembering
CO3	**Understand** energy auditing and planning.	Cognitive	Understanding
CO4	**Understand** the various energy saving opportunities with energy efficient equipments.	Cognitive	Remembering
CO5	**Understand** about industrial energy management systems.	Cognitive	Understanding

UNIT - I: ENERGY SCENARIO	**9**
Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2012 and its features.	
UNIT - II: BASICS OF ENERGY AND ITS VARIOUS FORMS	**9**
Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.	
UNIT - III: ENERGY MANAGEMENT & AUDIT	**9**
Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	
UNIT - IV: ENERGY EFFICIENCY IN ELECTRICAL SYSTEMS	**9**
Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and 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.	
UNIT - V: ENERGY EFFICIENCY IN INDUSTRIAL SYSTEMS	**9**
Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and	

Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Guide books for National Certification Examination for Energy Manager / EnergyAuditors Book-1, General Aspects.
2. Guide books for National Certification Examination for Energy Manager / EnergyAuditors Book-3, Electrical Utilities.

REFERENCE BOOKS:

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
2. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

Mapping of COs with POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	0	2	1	0	2	0	1	0	1	0	0	0	0	3
CO2	0	0	0	1	2	0	1	0	0	0	0	0	3	1
CO3	1	2	3	1	2	0	0	1	1	0	0	0	1	2
CO4	0	2	0	1	3	0	1	0	0	0	0	0	2	1
CO5	2	0	1	0	0	1	1	1	1	0	0	1	1	2
Total	**3**	**6**	**5**	**3**	**9**	**1**	**4**	**2**	**3**	**0**	**0**	**1**	**7**	**9**
Scaled	**1**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**2**	**3**

1-5 → 1, 6-10 → 2, 11-15 → 3

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ELECTIVE GROUP – II

COURSE	COURSE NAME	L	T	P	C

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CODE					
XEE E21	SIGNALS AND SYSTEMS	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Understand the concepts of continuous time and discrete time systems.	Cognitive	Understand
CO2	Analyse systems in complex frequency domain.	Cognitive	Analyse
CO3	Learn about Fourier transformation techniques.	Cognitive	Remembering
CO4	Learn about Laplace transformation techniques.	Cognitive	Remembering
CO5	Learn about Z- transformation techniques.	Cognitive	Remembering

UNIT - I: INTRODUCTION TO SIGNALS AND SYSTEMS	9
Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, reliability. Examples.	
UNIT - II: BEHAVIOUR OF CONTINUOUS AND DISCRETE-TIME LTI SYSTEMS	**9**
Impulse response and step response, convolution, input-output behavior with a periodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its Relation to the impulse response.	
UNIT - III: FOURIER TRANSFORMS	**9**
Fourier series representation of periodic signals, Waveform Symmetries, Fourier Coefficients, harmonic spectrum and THD. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete- Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Application to simple circuits.	
UNIT - IV: LAPLACE TRANSFORMS	**6**
Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behaviour. Application to simple circuits.	
UNIT - V: Z - TRANSFORMS AND SAMPLING RECONSTRUCTION	**12**
The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis. The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.	

	LECTURE	TUTORIAL	TOTAL

	45	**0**	**45**

TEXT BOOKS:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 2006.
3. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons, 2007.

REFERENCE BOOKS:

1. A. V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing", Prentice Hall, 2009.
2. M. J. Robert "Fundamentals of Signals and Systems", McGraw Hill Education, 2007.
3. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2009.

Mapping of COs with POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	2	2	1	0	0	0	1	0	0	1	1	0
CO2	3	3	2	1	0	3	0	1	0	0	0	2	0	1
CO3	3	0	0	1	0	3	0	1	0	0	1	0	0	1
CO4	3	2	2	2	1	0	1	0	0	2	0	2	0	1
CO5	3	0	0	1	0	0	0	0	0	2	0	0	0	1
Total	**15**	**7**	**6**	**7**	**2**	**6**	**1**	**2**	**1**	**4**	**1**	**5**	**1**	**4**
Scaled	**3**	**2**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE	**COURSE NAME**	**L**	**T**	**P**	**C**

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CODE					
XEE E22	SPECIAL ELECTRICAL MACHINES	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Able** to know the construction and working of synchronous motor.	Cognitive	Understand
CO2	**Describe** the construction and working of stepping motor and **Analyze** the control and performance of stepping motor.	Cognitive	Analyse
CO3	**Understand** the construction, working and performance of switched reluctance motor. **Illustrate** the different types of power controllers of switched reluctance motor.	Cognitive	Remembering
CO4	**Explain** the construction and working of permanent magnet dc and synchronous motor.	Cognitive	Remembering
CO5	**Handle** the microprocessors based control using Permanent magnet synchronous motor.	Cognitive	Remembering

UNIT – I: SYNCHRONOUSRELUCTANCEMOTORS	**9**
Constructional features – types – axial and radial air gap motors – operating principle –reluctance– phasor diagram-characteristics– Vernier motor.	
UNIT – II: STEPPINGMOTORS	**9**
Constructional features – principle of operation – variable reluctance motor – Hybrid motor–single and Multi stack configurations –theory of torque predictions –linear and non-linear analysis–characteristics– closed loop control –drive circuits.	
UNIT – III: SWITCHEDRELUCTANCEMOTORS	**9**
Constructional features – principle of operation – torque prediction – power controllers –Non-linear analysis – Microprocessor based control – closed loop control-characteristics.	
UNIT – IV: PERMANENTMAGNETBRUSHLESSDCMOTORS	**9**
Principle of operation –EMF and Torque equations – Types of Power Controllers –Torque peed characteristics–Commutation logic-Control.	
UNIT – V: PERMANENTMAGNETSYNCHRONOUSMOTORS	**9**
Principle of operation – EMF and torque equations – reactance – phasor diagram – power controllers - converter - volt-ampere requirements – torque speed characteristics –microprocessor based control.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:

1. Miller,T.J.E.,'BrushlessPermanentMagnetandReluctanceMotorDrives',Clarendon Press, Oxford,1989.
2. Aearnley, P.P.,'Stepping Motors –A Guide to Motor Theory and Practice', Peter Perengrinus, London,1982.
3. P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus,

London,1982.
4. R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, NewYork,2001.

REFERENCE BOOKS:

1. Kenjo,T.,' Stepping Motors and their Microprocessor Controls', Clarendon Press London,1984.
2. Kenjo,T.,and Nagamori,S.,'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
3. K.Dhayalini,'Special Electrical Machines', Anuradha Publications.
4. S.Albert Alexander,J.Gnanavadivel, "Special Electrical Machines", Anuradha Publications.

COURSE CODE	COURSE NAME	L	T	P	C
XEE E23	ELECTRICAL POWER QUALITY	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Understand** the fundamentals and working principle of power quality.	Cognitive	Understand
CO2	**Use** the measuring instruments to **measure** the electrical parameters **Record** the harmonics value in harmonics.	Cognitive	Analyse
CO3	**Indentify** the various types of filters.	Cognitive	Remembering
CO4	**Compare** the power quality strategy.	Cognitive	Remembering
CO5	Gain the knowledge in the measuring instruments and **analyze** the various power quality Monitoring systems. **Analysis** power line disturbance.	Cognitive	Remembering

UNIT – I: INTRODUCTION	9
Definition of Electric Power Quality- Description of poor power quality events. Power Quality phenomena – Basic terminologies – various events in Power Quality – Causes for reduction in Power Quality—Power Quality Standards and power quality strategy.	
UNIT – II: VOLTAGESAG	**9**
Sources of sags – estimating voltage sag performance, sag severities – voltage sag due to induction motor starting - mitigation of voltage sags - effect on adjustable AC Drives, DC drives, computers and consumer electronics.	
UNIT – III: HARMONICS	**9**

Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics Vs transients. Effect of harmonics –evaluation of Harmonic distortion-devices for controlling harmonic distortion.	
UNIT – IV: FILTERING AND POWER FACTOR IMPROVEMENT	**9**
Power factor improvement – Passive Compensation. Passive Filtering Active Harmonic Filtering Shunt Injection Filter for single phase, three – phase three – wire and three – phase four-wire systems static VAR compensators - SVC and STATCOM.	
UNIT – V: POWER QUALITY MONITORING	**9**
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 /flicker meters - disturbance analyzer. Applications of expert systems for power quality monitoring.	

	LECTURE	TUTORIAL	TOTAL
	45	**0**	**45**

TEXT BOOKS:

1. Roger.C.Dugan,Mark.F.McGranagham,SuryaSantoso,H.WayneBeaty,“Electrical Power Systems Quality” McGrawHill, 2003.
2. C.Sankaran,“Power Quality” CRC Press.
3. AlexanderKusko“Power Quality in Electrical Systems” The McGraw-HillCompanies,Inc.
4. EwaldF.Fuchsand MohammadA.S.Masoum “Power Quality in Power Systems and Electrical Machines”.

REFERENCE BOOKS:

1. SilvesterandFerrari,“Finite for Electrical Engineers”,CambridgeUniversityPress,1983.
2. S.R.H.Hoole,Computer–Aided, Analysis and Design of Electromagnetic Devices, Elsevier, NewYork, Amsterdam, London, 1989.
3. D.A.LowtherandP.PSilvester,“Computer Aided Designin Magnetics”,Springer Verlag, New York, 1956.
4. S.J.Salon,“Finite Element Analysis of Electrical Machines”,Kluwer Academic Publishers, London,1995.

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COURSE CODE	COURSE NAME	L	T	P	C
XEE E24	SUSTAINABLE ENERGY UTILIZATION	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Understand** and explain the physics that govern an indoor climate, and assess the changes needed to improve the indoor climate in existing buildings.	Cognitive	Understand
CO2	**Perform** heating /cooling load calculations for a single family residence.	Cognitive	Analyse
CO3	**Understand** and describe different types of heating systems, and assess their applicability.	Cognitive	Remembering
CO4	**Understand** and describe the function of passive systems and **discuss** about alternative cooling processes.	Cognitive	Remembering
CO5	**Recognize** need of energy in building and various conservation techniques to use energy in sustainable manner.	Cognitive	Remembering

UNIT – I: HEAT FLOW CALCULATIONS IN BUILDINGS	**9**
Unsteady heat flows through walls, roof, windows etc. Direct heat gains through windows. Convective gains / losses, air exchange rates. Gains from people, appliances etc. Air conditioning load calculations	
UNIT – II: NEED OF ENERGY IN BUILDINGS	**9**
Role of building design and building services to evaluate the energy performance in buildings. Study of Climate and its influence in building design for energy requirement –Environmental science of buildings- Study of Thermal environment and visual environment -Heat gain and heal loss phenomenon of buildings -Role of building enclosures, openings and materials in thermal environment -Energy efficient light design of buildings- Design for visual Environment. Energy rating of buildings.	
UNIT – III: PASSIVE COOLING / HEATING CONCEPTS	**9**
Building form and orientation, internal and external shading devices, ventilation, passive concepts for composite climates, evaporative and nocturnal cooling, earth–air tunnel, sky-thermal system, and solar chimney-based hybrid system. Introduction and use of different building simulations software such as TRNSYS, ECOTECT etc.-Case studies of non-air conditioned buildings-Case studies of air conditioned buildings.	
UNIT – IV: ENERGYEFFICIENTBUILDINGS	**9**
Introduction - Definition and concepts, Energy and Water as a resource, - Criticality of resources and needs of modern living Envelop heat loss and heat gain and its evaluation, Thermal Comportimprovementmethods,Optimumperformance,otherbuildingcomports,IAQrequirements.	
UNIT – V: ELECTRICALENERYCONVERSION	**9**
Opportunities and Techniques for energy conservation in Buildings-Adoption to sustainable resources, process and Technologies. Green Buildings, Intelligent Buildings, Rating of Buildings, Efficient Use of Buildings, Solar Passive Architecture, Eco-housing concepts and National and International norms.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:
1. Koenigs berger, et.al Manual of Tropical housing and Building Long man Group Ltd London(now published by Orient Longman Ltd, Madras, India),1974. 2. Oliver and Daniel, DChiras Natural Resource Conservation Management for a sustainable future, Prentice Hall International Ltd, London, 1992. 3. USAID International resource book, Energy Conservation Building design Tip Sheet-Building Lighting Design. 4. MS Sodha, NK Bansal, PK Bansal, A Kumar and MAS Malik, Solar Passive Building, Science and Design,PergamonPress,1986. 5. JR Williams, Passive Solar Heating, Ann Arbar Science,1983.
REFERENCE BOOKS:
1. RW Jones, JD Balcomb ,CE Kosiewiez, GS Lazarus, RDMc Farlandand WO Wray, Passive Solar Design Handbook,Vol3, Report of US Department of Energy (DOE/CS-0127/3), 1982. 2. J Krieder and A Rabi, Heating and Cooling of Buildings: Design for Efficiency, McGraw-Hill,1994. 3. RD Brown, TJ Gillespie, Micro climatic Landscape Design, JohnWileyandSons,NewYork,1990. 4. TA Markus, EN Morris, Building, Climate and Energy, Spott woode Ballan type Ltd,London,1980.

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ELECTIVE GROUP – III

COURSE CODE	COURSE NAME	L	T	P	C
XEE E31	SOLID STATE DRIVES	3	0	0	3
C : P : A		L	T	P	H

3 : 0 : 0		3	0	0	3

Course Outcomes:		**Domain**	**Level**
CO1	**Understand** the fundamentals of Electric Drives and their ratings.	Cognitive	Understanding
CO2	**Express** the various control techniques of DC Drives.	Cognitive	Remembering
CO3	**Analyze** the different speed control methods of Induction motor at stator.	Cognitive	Understanding
CO4	**Formulate** the closed loop control of Induction motor drive.	Cognitive	Remembering
CO5	**Devise** the assorted control strategies of synchronous motor control operation.	Cognitive	Understanding

UNIT – I: DRIVE CHARACTERISTICS	**9**
Fundamentals of Electric Drives – Advantage of Electric Drives – selection of Motor power rating- Thermal model of motor for heating and cooling – Classes of duty cycle. Determination of motor rating – Control of Electric drives – modes of operation – speed control and drive classifications.	
UNIT – II: SOLID STATE CONTROL OF DC DRIVES	**9**
DC motor and their performance - Transient analysis -Ward Leonard drives – Steady state analysis of the single and three phase fully controlled converter fed separately excited DC motor drive – continuous and discontinuous mode Chopper controlled DC drives-Time ratio control and current limit control.	
UNIT – III: STATOR CONTROLLED INDUCTION MOTOR DRIVES	**9**
Induction Motor Drives-Stator control – Stator voltage and frequency control – VSI, CSI and cycloconverter fed induction motor drives–open loop and closed VVVF control.	
UNIT – IV: ROTOR CONTROLLED INDUCTION MOTOR DRIVES	**9**
Rotor resistance control – Slip power recovery schemes–Sub synchronous and super synchronous operations– Power factor improvement– Closed loop control.	
UNIT – V: SYNCHRONOUS MOTOR DRIVES	**9**
Separate controlled mode – Self controlled mode of synchronous motor –Constant marginal angle control and motor power factor control – Cycloconverter fed synchronous motors - Digital Control and Drive Applications.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Dubey. G.K."Fundamentals of Electrical drives", Narora publications,1995.
2. R. Krishnan,“Electric motor & Drives; Modelling, Analysis and Control”, Prentice Hall of India,2001.
3. Gopal K. Dubey, Fundamentals of Electrical Drives, New Delhi, 2nd Edition, Narosa Publishing House, 2001.
4. B.K.Bose,‘Power Electronics and AC Drives’, Prentice Hall Ongle woodcliffs,NewJersey,1986.

REFERENCE BOOKS:

1. Murphy, J.M.D and Turnbull. F.G., ‘Thyristor control of AC Motors’,PergamonPress,1988.
2. Sen. P.C., 'Thyristor D.C. Drives', John Wiley and Sons,1981.
3. Vedam Subrahmaniyam, ‘Electric Drives Concepts and Applications’, Tata McGraw Hill Publishing company Ltd.,1994.
4. Gaekward,“Analog and Digital control systems”, Wiley Eastern Ltd,1989.

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COURSE CODE	COURSE NAME	L	T	P	C
XEE E32	HIGH VOLTAGE ENGINEERING	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Explain** the different causes of overvoltage and **Illustrate** overvoltage control due to switching. **Classify** the various methods for protection of lightning overvoltage.	Cognitive	Understanding
CO2	**Explain** and **Classify** breakdown mechanisms in solid, liquid and gases dielectrics and list out the application of insulating materials.	Cognitive	Understanding
CO3	**Able** to define **and Classify** the different methods to generate the various types of high voltages and high currents.	Cognitive	Understanding
CO4	**Classify** and **analyze** the different techniques used to measure the various types of high voltages and high currents.	Cognitive	Understanding Analyzing
CO5	**Recall and Illustrate the** different testing methods to test the various high voltage components of power System and **define** the International, Indian standards and insulation co-ordination.	Cognitive	Remembering Understanding

UNIT - I: OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS	**9**
Natural Causes of overvoltage-Lightning phenomena and its effects on power system – Over voltage due to switching surge-power frequency overvoltage-control of overvoltage due to switching – protection of transmission lines against overvoltage –Becoleys lattice diagram.	
UNIT - II: ELECTRICAL BREAKDOWN IN GASES, SOLIDS AND LIQUIDS	**9**
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.	
UNIT – III: GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS	**9**
Generation of High DC, AC, impulse voltages and currents. Tripping and control of impulse generators.	
UNIT – IV: MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS	**9**
Measurement of High direct current voltages– measurement of voltages: alternating and impulse voltages and measurement of currents: direct, alternating and impulse currents. Digital techniques in high voltage measurement	

UNIT – V: HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS	**9**
International and Indian standards-Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment. - Insulation co-ordination.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. E. Kuffel and M. Abdullah, 'High Voltage Engineering', Pergamon press, Oxford,2010.
2. M.S. Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill,4th Edition, 2004.
3. E. Kuffel and W.S. Zaengl, 'High Voltage Engineering Fundamentals', Pergamon Press, Oxford, London, 2012 August
4. F.Metraux. "Some problems and actual limits of test techniques at extra high voltages",Haefely publications EIS 14.

REFERENCE BOOKS:

1. C.L.Wadhwa, 'High Voltage Engineering', New Age International (P) Ltd, 2nd Edition, 2006.
2. RavindraArora, Wolfgang Mosch, "High Voltage Insulation Engineering", New Age International (P) Limited, 2011.
3. Chinnappa ,K.M., Need for next higher voltage level in India", National seminar on high voltage AC and DC Transmission, New Delhi.

E-RESOURCES:

1. Web Content - http://www.library.dce.edu/e-resources/books/ee/
2. NPTEL-High Voltage Engineering, C.L. Wadhwa -IIT Madras.

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2	0	0	1	0	1	0	0	0	2	2	2
CO2	3	2	0	0	0	0	0	0	0	0	0	1	1	2
CO3	2	2	0	0	1	1	0	1	0	0	0	1	1	1
CO4	2	2	0	0	0	0	1	0	0	0	0	1	2	2
CO5	2	2	0	2	0	1	0	0	0	0	0	2	2	2
Total	**12**	**10**	**2**	**2**	**1**	**3**	**1**	**2**	**0**	**0**	**0**	**7**	**8**	**9**
Scaled	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**0**	**0**	**0**	**2**	**2**	**2**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	COURSE NAME	L	T	P	C
XEE E33	**POWER QUALITY AND FACTS**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	**Inference** of series and shunt reactive power compensation in ac transmission line.	Cognitive	Remembering Understanding
CO2	**Explain** the working principles of thyristor-based flexible AC transmission controllers.	Cognitive	Understanding Applying
CO3	**Describe** the various voltage source converter-based controllers in transmission line.	Cognitive	Understanding Applying
CO4	**Infer** the electrical power quality terms, power quality events and causes of reduction of power and analyse the voltage sag performance, mitigation of sag.	Cognitive	Remembering Understanding
CO5	**Construct a** circuit for harmonics and power factor improvement techniques.	Cognitive	Understanding Applying

UNIT – I: TRANSMISSION LINES AND SERIES/SHUNT REACTIVE POWER COMPENSATION	**9**
Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.	
UNIT – II: THYRISTOR-BASED FLEXIBLE AC TRANSMISSION CONTROLLERS	**9**
Description and Characteristics of Thyristor-based FACTS devices - Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.	
UNIT - III: VOLTAGE SOURCE CONVERTER BASED CONTROLLERS	**9**
Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.	
UNIT - IV: POWER QUALITY PROBLEMS IN DISTRIBUTION SYSTEMS	**9**
Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.	
UNIT - V: DSTATCOM	**9**
Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Current Control Techniques in for DSTATCOM. Dynamic Voltage Restorer-Unified Power Quality Conditioner (UPQC).	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press, 1999.
2. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007.

3. T. J. E. Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, NewYork, 1983.
4. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
5. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991.

REFERENCE BOOKS:

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.WayneBeaty, **"**Electrical Power Systems Quality**"** McGraw Hill,2003.
2. C. Sankaran, **"**Power Quality**"** CRC Press, 2002.
3. Alexander Kusko**"**Power Quality in Electrical Systems**"** The McGraw-Hill Companies, Inc, 2007.
4. Ewald F. Fuchs and Mohammad A.S. Masoum**"** Power Quality in Power Systems and Electrical Machines**"**, 2011.

E-RESOURCES:

1. http://www.copper.org/applications/electrical/pq/issues.html

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	1	3	1	1	0	1	0	1	1	0	1	3	2
CO2	3	3	1	2	1	0	1	0	0	1	0	1	1	0
CO3	3	2	1	1	1	0	1	0	1	0	0	1	2	1
CO4	3	2	1	2	1	0	1	0	1	0	0	1	1	1
CO5	2	1	1	0	1	0	1	0	0	0	0	1	2	1
Total	**14**	**9**	**7**	**6**	**5**	**0**	**5**	**0**	**3**	**2**	**0**	**5**	**9**	**5**
Scaled	**3**	**2**	**2**	**2**	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**1**	**2**	**1**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	COURSE NAME	L	T	P	C
XEE E34	**SMART GRIDS**	**3**	**0**	**0**	**3**

C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Describe** the paradigm shift between traditional power transmission and distribution and smart power grids verbally and in writing.	Cognitive	Remembering Understanding
CO2	**Understand and describe** drivers, challenges and benefits to the integration of renewable and distributed generation into large power grids.	Cognitive	Understanding Applying
CO3	Describe and **assess** smart grid technologies that enhance transmission and distribution systems.	Cognitive	Understanding Applying
CO4	**Study** current implementations of smart grid technologies and / or policies using regional data sources.	Cognitive	Remembering Understanding
CO5	**Work effectively** in project teams using appropriate communication skills in order to present information about smart grid industry practices and community engagement.	Cognitive	Understanding Applying

UNIT – I: INTRODUCTION TO SMART GRID	**9**
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart. Grid initiatives.	
UNIT – II: SMART GRID TECHNOLOGIES	**9**
Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug-in Hybrid Electric Vehicles (PHEV).	
UNIT – III: SMART METERS AND ADVANCED METERING INFRASTRUCTURE	**9**
Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.	
UNIT – IV: POWER QUALITY MANAGEMENT IN SMART GRID	**9**
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.	
UNIT – V: HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS	**9**
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid:

Technology and Applications", Wiley.
2. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions",CRCPress2012.
3. Yang Xiao, "Communication and Networking in Smart Grids", CRC press, 2012.

REFERENCE BOOKS:

1. Nouredine Hadjsaïd and Jean-Claude Sabonnadière Smart, Smar tGrids, ISTE Ltd..2012.
2. Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella,CarloCecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November2011.
3. XiFang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid The New and Improved Power Grid: A Survey ,IEEE Transaction on Smart Grids.

ELECTIVE GROUP – IV

COURSE CODE	COURSE NAME	L	T	P	C
XEE E41	ELECTRICAL AND HYBRID VEHICLES	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	To understand the working and performance of conventional vehicles.	Cognitive	Understanding
CO2	To understand Hybrid Electric Vehicles and Drive-trains.	Cognitive	Understanding
CO3	To explain basic concepts of Electric Drive Trains.	Cognitive	Understanding
CO4	To explain the various types of Energy Storage Systems.	Cognitive	Understanding
CO5	To understand different types of Energy management strategies.	Cognitive	Understanding

UNIT - I: INTRODUCTION	9
Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.	
UNIT – II: HYBRID ELECTRIC VEHICLES	**9**
Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	
UNIT – III: ELECTRIC DRIVE TRAINS	**9**
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-Train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration	

and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switched Reluctance Motor drives, drive system efficiency.	
UNIT – IV: ENERGY STORAGE	**9**
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subject systems.	
UNIT – V: ENERGY MANAGEMENT STRATEGIES	**9**
Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Charging Stations. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:

1. C. Mi, M.A. MasrurandD. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G.Rizzoni,"HybridElectricVehicles:EnergyManagementStrategies",Springer, 2015.

REFERENCE BOOKS:

1. M.Ehsani, Y.Gao, S.E.Gay and A.Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRCPress, 2004.
2. T. Denton, "Electric and HybridVehicles", Routledge, 2016.

E-RESOURCES:

1. www.nptel.ac.in

Mapping of COs with POs

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	0	0	0	0	0	0	0	0	1	0	1	0	2
CO2	3	0	0	0	0	0	0	0	0	1	0	1	0	2
CO3	3	2	0	0	0	0	0	0	0	1	1	2	0	2
CO4	3	2	0	0	1	0	0	0	0	1	1	1	0	3
CO5	3	2	0	0	1	0	0	0	0	1	1	1	0	3

Total	**15**	**6**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**5**	**3**	**6**	**0**	**12**
Scaled	**3**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**3**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE E42	**WIND AND SOLAR SYSTEMS**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	Understand the basic physics of wind and solar power generation.	Cognitive	Understanding
CO2	Understand the various types of wind generators.	Cognitive	Understanding
CO3	Understand the power electronic interfaces for wind and solar generation.	Cognitive	Understanding
CO4	Understand the issues related to the grid- integration of solar and wind Energy systems.	Cognitive	Understanding
CO5	Understand the issues related to the grid-integration of solar and wind Energy systems.	Cognitive	Understanding

UNIT - I: PHYSICS OF WIND POWER	**9**
History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Power from Wind, Parts of Wind Turbine, Characteristics of Wind Turbines, Wind speed statistics- probability distributions, Wind speed and power-cumulative distribution functions. Review of modern wind turbine technologies, Fixed and Variable speed wind turbines.	
UNIT - II: WIND GENERATOR TOPOLOGIES	**9**
Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control..	
UNIT – III: THE SOLAR RESOURCE	**9**

Introduction, solar radiation spectra, solar geometry, solar constant, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.	
UNIT - IV: SOLAR PHOTOVOLTAIC	**9**
Technologies- Amorphous, mono crystalline, polycrystalline V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum PowerPoint Tracking (MPPT) algorithms. Converter Control. Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, Solar chimney, elementary analysis.	
UNIT - V: NETWORK INTEGRATION ISSUES	**9**
Overview of grid code technical requirements. Fault ride-through for wind farms-real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.	

LECTURE	**TUTORIAL**	**TOTAL**
45	**0**	**45**

TEXT BOOKS:

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.
2. G.M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.
3. S.P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 17th June 2008.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.

REFERENCE BOOKS:

1. G.N. Tiwari and M.K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.
2. J.A. Duffie and W.A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 17th May 2013.

E-RESOURCES:

1. www.nptel.ac.in

Mapping of COs with POs

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	0	0	0	1	0	0	0	0	1	0	1	1	3
CO2	3	0	0	0	1	0	0	0	0	1	0	1	1	3
CO3	3	2	0	0	1	0	0	0	0	1	1	2	1	3
CO4	3	2	0	0	1	0	0	0	0	1	1	1	1	3
CO5	3	2	0	0	1	0	0	0	0	1	1	1	1	3

Total	**15**	**6**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**5**	**3**	**6**	**5**	**15**
Scaled	**3**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**2**	**1**	**3**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE E43	**POLLUTION PERFORMANCE OF POWER APPARATUS AND SYSTEMS**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	**Understand** the structure of Electrical power system.	Cognitive	Understanding
CO2	**Summarize** the different pollution testing mechanism.	Cognitive	Understanding
CO3	**Design** of shed profile in AC and DC insulators.	Cognitive	Understanding
CO4	**Model** a surge arrester to prevent a power system from high voltages.	Cognitive	Understanding
CO5	**Estimate** the effect of pollution on the protective characteristics of gap and gapless arresters.	Cognitive	Understanding

UNIT – I: INTRODUCTION	**10**
Fundamental process of pollution flashover – Causes of failure in insulators – development and effect of contamination layer – creep age distance – pollution conductivity –mechanism of pollution flashover – analytical determination of flashover voltage.	
UNIT – II: POLLUTION TESTING	**8**
Artificial pollution testing – salt-fog method – solid layer method – monitoring of parameters – measurement of layer conductivity – field testing methods.	
UNIT – III: POLLUTION PERFORMANCE OF INSULATORS	**9**
Ceramic and non-ceramic insulators – mitigation of pollution induced flash over – design of shed profiles – rib factor effect in AC and DC insulators – modeling.	

UNIT – IV: POLLUTION PERFORMANCE OF SURGE DIVERTERS	**9**
External insulation – effect of pollution on the protective characteristics of gap and gapless arresters – modeling of surge diverters under polluted conditions.	
UNIT – V: POLLUTION PERFORMANCE OF INDOOR EQUIPMENT	**9**
Condensation and contamination of indoor switch gear – performance of organic insulator under polluted conditions– accelerated testing techniques.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Kind and Karner, "High Voltage Insulation", Translated from German by Y. Narayana Rao, Frider. Vieweg, & Sohn, Braunschweig, Weishaden, 1985.
2. Kuffel, E., Zaengl, W.S. and KuffelJ., "High Voltage Engineering Fundamentals", Elsvier India Pvt. Ltd, 2005.
3. KlausRagaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980.
4. Looms, J.S.T., "Insulators for High Voltages", Peter Peregrinus Ltd., London,1988.

REFERENCE BOOKS:

1. Dieter Kind and Kurt Feser, "High Voltage Test Techniques", Second Edition, SBA Electrical Engineering Series, New Delhi, 1999.
2. Ravi S. Gorur, "Outdoor Insulators", Inc. Phoenix, Arizona 85044, USA,1999.

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE E44	**BIO-MEDICAL INSTRUMENTATION**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	**Describe** the principles of biomedical measurement systems and apply the signal amplification and processing that is common to many medical Instruments.	Cognitive	Understanding
CO2	**Identify** the origin of bio-potentials and various bioelectric signals that are recorded routinely in modern clinical practice. **Understand** the basic mechanisms involved in the transduction process of bio-potential electrodes and be able to discuss electrical characteristics of electrodes.	Cognitive	Understanding
CO3	**Handle** the various techniques of measuring blood flow, pressure & volume. **Summarize** the concepts and mechanisms of various clinical laboratory instrumentation.	Cognitive	Understanding
CO4	**Describe** and apply the safety issues, safe design, and safe use	Cognitive	Understanding

	of medical instrumentation, specifically electrical safety, and learn how to incorporate safety features into the design.		
CO5	**Design** an instrument that can be used to analyze heart rate with exercise using appropriate Bio-amplification and filters, bio-potential sensors, and data acquisition programs.	Cognitive	Understanding

UNIT – I: HUMAN SYSTEM AND BIOPOTENTIAL ELECTRODES	**9**
Different types of human system, origin of bio-potential and its propagation. Electrode-electrolyte interface, electrode – skin interface, half cell potential, Types of electrode, PH electrode, Recording problems, measurement with two electrodes – human cell structure.	
UNIT – II: ELECTRODE CONFIGURATION	**9**
Bio-signals characteristics – frequency & amplitude ranges. ECG –Enthoven's triangle, standard12 load system, PQPs waveform. EEG – 10-20 electrode system, brainwaves, recording setup of EEG, EMG, ERG, and EOG – unipolar and bipolar mode.	
UNIT – III: BIOAMPLIFIER AND TRANSDUCER	**9**
Need for Bio-amplifier, power amplifier, isolation amplifier, feedback amplifier. Resistive, Inductive, Capacitive transducer and application, Fibre optic, photo electric transducer – description, features applicable for biomedical instrumentation.	
UNIT – IV: CARDIAC MEASUREMENTS	**9**
Blood pressure measurement – blood flow measurement – phonocardiography – vector cardiography. Heart lung machine –ventilator – Anesthetic machine – cardiac pacemaker –defibrillator patient safety-electrical shock hazards.	
UNIT – V: MEDICAL DIAGNOSTICS INSTRUMENTS AND SYSTEMS	**9**
CTscanner–MRIScanandUltrasonicscanner–XRay–LaserEquipmentandapplication- bio-telemetry Kidney dialysis machine – electron microscope – blood cell counter-Endoscopy.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Khandpur, R.S., 'Handbook of Biomedical Instrumentation',TataMcGrawHill,1989.
2. Arumugam M., 'Bio-Medical Instrumentation', Anuradha Agencies Pub.,2002.
3. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India) Ltd, Orient Longman ltd, 2000.
4. J. Webster, 'Medical Instrumentation', John Wiley & Sons,1995.

REFERENCE BOOKS:

1. Geddes L.A., and Baker, L.E., 'Principles of Applied Bio-medical Instrumentation', 3rd Edition, John Wiley and Sons, 1995.
2. Cromwell, Weibell and Pfeiffer, 'Biomedical Instrumentation and Measurements', 2nd Edition, Prentice Hall of India,1999.
3. Tompkins W.J., Biomedical Digital Signal Processing, Prentice Hall of India, 1998.
4. J. Wilson, J.F.B. Hawkes, 'Laser Principles and Applications', .Prentice-Hall, NewYork, 1987.

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COURSE CODE	COURSE NAME	L	T	P	C
XEE OE1	INDUSTRIAL AUTOMATION	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	Able to **define** and **Explain** the fundamentals of Pneumatics, hydraulics and electrical drives. **List** out the advantages, disadvantages and its application.	Cognitive	Understanding
CO2	**Apply** the knowledge of electrical ladder hydraulic and pneumatic system and able to **define** pressure, proximity switches and intelligent Relays.	Cognitive	Applying
CO3	**Explain** and **Categorize** different types of Sensors and their application. **List** out timer, counter and their application.	Cognitive	Analyzing
CO4	**Illustrate** the knowledge in the PLC logic, Architecture and design the industrial automated system applications and **Apply** the knowledge of PLC programming to interface pneumatics.	Cognitive	Applying
CO5	**Outline** the overview of robotics and their application. **Apply** the knowledge of robotics programming.	Cognitive	Applying

UNIT - I: INTRODUCTION TO PNEUMATICS AUTOMATION	9
Introduction to Pneumatics- Overall structure- Electro pneumatic –hydraulics- Overall structure – Advantages and disadvantages – Application-Electrical drives.	
UNIT – II: APPLICATIONS OF RELAYS	**9**
Essential qualities of relays - NO & NC contacts - Electrical signal storage – Electrical Ladder diagram- Pneumatic system - Hydraulic system - pressure and proximity switches - Intelligent Relays.	
UNIT – III: SMART SENSORS AND TIMERS IN CONTROLLERS	**9**
Introduction to sensors – characteristics - types of sensors-resistive – inductive – capacitive – magnetic - ultrasonic - photoelectric- Nano sensors- timers-counters-types-applications.	

UNIT – IV: PROGRAMMABLE LOGIC CONTROLLERS	**9**
Evolution of PLC – Sequential and Programmable controllers – Architecture – Programming of PLC – Relay logic and Ladder logic – Functional blocks – PLC interface to pneumatics**.**	
UNIT – V: ROBOTICS	**9**
Introduction and overviews of Robotics **–** Terms and Definition, Historical development of robotics, classification and configuration of robots, Basic components - Drives, controller gripper, application-programming in Robotics.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. "Programmable Logic Controllers" by W. Bolton, Newnes; 6th edition, March 17th, 2015.
2. "Programmable Logic Controllers and Industrial Automation: An Introduction" by Madhuchhanda Mitra, Samarjit Sen Gupta Penram International Publishing (India) Pvt. Ltd, Second edition, 2017.

REFERENCE BOOKS:

1. "Programmable Logic Controllers: Programming Methods and Applications" by Hackworth, Prentice Hall, April 21st, 2003.

E-RESOURCES:

1. https://www.automation.com/library/education/reference-guides

Mapping of COs with GAs

	GA 1	**GA 2**	**GA 3**	**GA 4**	**GA 5**	**GA 6**	**GA 7**	**GA 8**	**GA 9**	**GA 10**	**GA 11**	**GA 12**
CO 1	3	2	0	2	1	1	1	0	0	1	1	0
CO 2	3	2	0	0	1	1	0	1	0	1	3	2
CO 3	2	3	0	0	1	1	1	0	0	0	0	1
CO 4	2	1	3	0	0	1	0	1	1	0	0	1
CO 5	2	2	0	0	1	0	0	2	0	0	0	1
Total	**12**	**10**	**3**	**2**	**4**	**4**	**2**	**4**	**1**	**2**	**4**	**5**
Scaled	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	COURSE NAME	L	T	P	C
XEE OE2	ENERGY MANAGEMENT AND AUDITING	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Explain** the stages and process of energy management Programme.	Cognitive	Understanding
CO2	**Analyze** economic models of load management systems. **Explain** monitoring and control of energy management systems.	Cognitive	Analyzing
CO3	**Compare** different energy management techniques for Electric loads and drives.	Cognitive	Understanding
CO4	**Explain** the different metering arrangement and their performance in an electrical system.	Cognitive	Understanding
CO5	**Define** the lighting scheme and Standards for energy conservation. **Explain** the methods of improving the power quality.	Cognitive	Understanding

UNIT - I: INTRODUCTION	**9**
Need for energy management - energy basics- designing and starting an energy management program – energy accounting -energy monitoring, targeting and reporting-energy audit process.	
UNIT – II: ENERGY COST AND LOAD MANAGEMENT	**9**
Important concepts in an economic analysis - Economic models-Time value of money-Utility rate structures- cost of electricity-Loss evaluation Load management: Demand control techniques-Utility monitoring and control system- HVAC and energy management.	
UNIT – III: ENERGY MANAGEMENT FOR MOTORS, SYSTEMS AND ELECTRICAL EQUIPMENT	**9**
Systems and equipment- Electric Motors-Transformers and reactors-Capacitors and synchronous machines-Energy management in industrial drive.	
UNIT – IV: METERING FOR ENERGY MANAGEMENT	**9**

Relationships between parameters-Units of measure-Typical cost factors- Utility meters - Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters - Metering location vs. requirements.		
UNIT – V: LIGHTING SYSTEMS & COGENERATION		**9**
Concept of lighting systems - The task and the working space -Light sources - Ballasts - Luminaries - Lighting Controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality - Cost analysis techniques-Lighting and energy standards-BEE standards.		
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**
TEXT BOOKS:		
1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, **"**Guide to Energy Management**"**, Fifth Edition, The Fairmont Press, Inc., 2006. 2. Eastop T.D. & Croft D.R., "Energy Efficiency for Engineers and Technologists", Longman Scientific & Technical, ISBN -0-582-03184, 1990.		
REFERENCE BOOKS:		
1. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 2011. 2. Amit K. Tyagi, 'Handbook on Energy Audits and Management', TERI, 2003.		
E-RESOURCES:		
1. E-learning course on Energy audit and management, Dr. K. Shanti Swarup, Indian Institute of Technology, Chennai.		

Mapping of COs with GAs

	GA 1	**GA 2**	**GA 3**	**GA 4**	**GA 5**	**GA 6**	**GA 7**	**GA 8**	**GA 9**	**GA 10**	**GA 11**	**GA 12**
CO 1	1	3	0	0	0	0	0	0	2	1	0	0
CO 2	1	0	0	0	0	1	0	0	0	0	2	0
CO 3	1	0	0	1	1	0	0	1	0	1	0	0
CO 4	1	2	2	0	0	0	0	0	0	0	3	1
CO 5	0	2	0	0	0	0	2	0	0	0	0	1
Total	**4**	**7**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**5**	**2**
Scaled	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

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COURSE CODE	COURSE NAME	L	T	P	C
XEE OE3	RENEWABLE ENERGY TECHNOLOGY	3	0	0	3
C : P : A		L	T	P	H
3 : 0 : 0		3	0	0	3

Course Outcomes:		Domain	Level
CO1	**Infer** Power Demand and **Identify** the various renewable energy systems to meet out the demand.	Cognitive	Applying
CO2	**Explain** about the Performance of various solar collectors and **Apply** the recent advancement in PV systems to improve the efficiency.	Cognitive	Applying
CO3	**Explain** about the performance characteristics of wind energy and its application in hybrid systems.	Cognitive	Understanding
CO4	**Apply** the Bio-energy in various conversion technologies and processes, for sustainable development.	Cognitive	Applying
CO5	**Compare** the role-play of various energy resources.	Cognitive	Understanding

UNIT - I: INTRODUCTION	**9**
Primary energy sources, Renewable Vs non-renewable primary e n e r g y sources, Renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.	
UNIT – II: SOLAR ENERGY	**9**
Solar Radiation and its measurements, Solar Thermal Energy Conversion from Flat-plate Solar Concentrating Collectors and its Types, Efficiency and performance of collectors, Direct Solar Electricity Conversion from Photovoltaics - types of solar cells and its application of battery charger, Recent Advances in PV Applications- Building Integrated Grid Connected PV Systems.	
UNIT – III: WIND ENERGY	**9**
Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, Hybrid systems - safety and environmental aspects, economic aspects.	
UNIT – IV: BIO-ENERGY	**9**

Energy from biomass, Principle of biomass conversion technologies process and their classification, Bio-gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, biomass gasifier, Application of biomass and biogas plants and their economics.	
UNIT – V: OTHER TYPES OF ENERGY	**9**
Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, Potential in India. Tidal and wave energy.	

	LECTURE	TUTORIAL	TOTAL
	45	0	45

TEXT BOOKS:

1. G.D. Rai, "Non-Conventional Energy Sources"- Khanna Publishers,2004.
2. Twidell and Wier, "Renewable Energy Resources" –CRC Press (Taylor & Francis), Third Edition 2015.
3. D.P.Kothari, K.C.Singhal and Rakesh Ranjan, "Renewable energy sources and emerging technologies" - P.H.I., 2nd Edition, 2011.
4. Mukund R.Patel ,"Wind And Solar Power Systems",Copyright 1999.- CRC Press.

REFERENCE BOOKS:

1. G.N. Tiwari and M.K.Ghosal,"Renewable Energy Resources: Basic Principles and Applications", Narosa Publishing House (1 August 2004).
2. K Mittal, "Non-Conventional Energy Systems",A H Wheeler Publishing Co Ltd (January 31, 1999).
3. Volker Quaschning, "Understanding the Renewable Energy Systems", 2nd Edition, 2016 Earth Scan, London, UK.

E-RESOURCES:

1. http://www.nptelvideos.in/2012/11/energy-resources-and-technology.html
2. NPTEL, Lecture Series on Energy Resources and Technology, Prof. S. Banerjee, Department of Electrical Engineering, IIT Kharagpur.
3. http://freevideolectures.com/Course/2352/Power-System-Generation-Transmission-and-Distribution/6 NPTEL, Renewable Energy Technology, Prof. D.P.Kothari IIT Delhi Course.
4. http://textofvideo.nptel.iitm.ac.in/112105051/lec43.pdfNPTEL, Renewable Energy Technology, Prof. V. V. Satyamurty Department of Mechanical Engineering Indian Institute of Technology, Kharagpur.

Mapping of COs with GAs

	GA 1	GA 2	GA 3	GA 4	GA 5	GA 6	GA 7	GA 8	GA 9	GA 10	GA 11	GA 12
CO 1	2	2	0	0	1	0	3	1	1	1	0	1
CO 2	2	2	2	2	0	0	2	1	1	1	2	1
CO 3	3	3	0	0	0	0	0	0	0	0	0	0
CO 4	3	2	2	0	3	0	3	1	1	1	0	1
CO 5	0	2	0	0	0	0	0	0	0	0	0	0

Total	**10**	**11**	**4**	**2**	**4**	**0**	**8**	**3**	**3**	**3**	**2**	**3**
Scaled	**2**	**3**	**1**	**1**	**1**	**0**	**2**	**1**	**1**	**1**	**1**	**1**

1-5 → 1, 6-10 → 2, 11-15 → 3

0 – No Relation, 1 – Low Relation, 2 – Medium Relation, 3 – High Relation

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE OE4	**SOLAR AND ENERGY STORAGE SYSTEM**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	**Recognize and reproduce** Basic knowledge of semiconductors, cell properties and their interconnection.	Cognitive	Understanding
CO2	Gain the knowledge in the solar modules & system and **design** the standalone PV system for specific applications.	Cognitive	Understanding
CO3	**Classify** the various PV systems in buildings and manage the issues for central power stations.	Cognitive	Understanding
CO4	**Define** the various types of energy storage systems.	Cognitive	Understanding
CO5	**Employ** different applications of PV systems and its storage systems.	Cognitive	Understanding

UNIT – I: INTRODUCTION	**9**
Characteristics of sunlight – Semiconductors and PN junctions – Behaviour of solar cells – Cell properties – PV cell interconnection.	
UNIT – II: STANDALONE PV SYSTEM	**9**
Solar modules – Storage systems – Power conditioning and regulation – Protection – Standalone PV systems design – Sizing.	
UNIT – III: GRID CONNECTED PV SYSTEMS	**9**
PV Systems in buildings – Design issues for central power stations – Safety – Economic aspect – Efficiency and performance - International PV programs.	
UNIT – IV: ENERGY STORAGE SYSTEMS	**9**
Impact of intermittent generation – Battery energy storage – Solar thermal energy storage - Pumped hydro electric energy storage.	
UNIT – V: APPLICATIONS	**9**

Water pumping – Battery chargers – Solar car – Direct-drive applications – Space – Telecommunications.			
	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Eduardo Lorenzo G. Araujo, 1994. Solar Electricity Engineering of Photo voltaic Systems, Progensa.
2. Stuart R. Wenham, Martin A. Green, Murie lE. Wattand Richard Corkish, 2007. Applied Photovoltaics, Earthscan, UK.

REFERENCE BOOKS:

1. Frank S. Barnes and Jonah G. Levine, 2011. Large Energy Storage Systems Handbook, CRCPress.
2. McNeils, Frenkeland Desai,1990. Solar & Wind Energy Technologies, Wiley Eastern.
3. Sukhatme, S.P., 1987. Solar Energy, New Delhi: Tata McGraw-Hill.

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
XEE OE5	**ELECTRIC VEHICLES AND POWER MANAGEMENT**	**3**	**0**	**0**	**3**
C : P : A		**L**	**T**	**P**	**H**
3 : 0 : 0		**3**	**0**	**0**	**3**

Course Outcomes:		**Domain**	**Level**
CO1	**Specify** the key components of a vehicle propulsion system and their functions.	Cognitive	Understanding
CO2	**Select** appropriate hybrid electric power-train architecture.	Cognitive	Understanding
CO3	**Determine** appropriate type and size of hybrid electric power-train components and ESS.	Cognitive	Understanding
CO4	**Design** hybrid electric power train system by combining appropriate power-train architecture, key power-train components, and energy storage system.	Cognitive	Understanding
CO5	Perform vehicle operation performance and energy efficiency **evaluation** for given driving cycle, power-train design, and vehicle data through computer simulation.	Cognitive	Understanding

UNIT – I: ELECTRIC VEHICLES AND VEHICLE MECHANICS	**9**
Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings, Comparisons of EV with internal combustion Engine vehicles, Fundamentals of vehicle mechanics.	
UNIT – II: ARCHITECTURE OF EV's ANDPOWER-TRAIN COMPONENTS	**9**

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV) – Power train components and sizing, Gears, Clutches, Transmission and Brakes.	
UNIT – III: CONTROL OF DC AND AC DRIVES	**9**
DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (motoring and braking) of induction motor drive system – Induction motor and permanent motor based vector control operation – Switched reluctance motor (SRM) drives.	
UNIT – IV: BATTERY ENERGY STORAGE SYSTEM	**9**
Battery Basics, Different types, Battery Parameters, Battery modeling, Traction Batteries.	
UNIT – V: ALTERNATIVE ENERGY STORAGE SYSTEMS	**9**
Fuel cell – Characteristics – Types – hydrogen Storage Systems and Fuel cell EV – Ultra capacitors.	

	LECTURE	**TUTORIAL**	**TOTAL**
	45	**0**	**45**

TEXT BOOKS:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press,2003.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, AliEmadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press,2004.
3. ChrisMi,M. Abul Masrur and David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley and Sons,2011.

REFERENCE BOOKS:

1. Ali Emadi, Mehrdad Ehsani, John M. Miller Vehicular Electric Power Systems, Marceldekker, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. L.E. Carmichael, Hybrid and Electric Vehicles, ABDO Publishing Company, 2013.