M.E. Degree

in

POWER ELECTRONICS AND DRIVES

CURRICULUM & SYLLABUS (CBCS)

(For students admitted from the Academic Year 2022-2023)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

CHUNKANKADAI, NAGERCOIL – 629 003.

KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

Chunkankadai, Nagercoil – 629 003.

AUTONOMOUS COLLEGE AFFILIATED TO ANNA UNIVERSITY

ACADEMIC REGULATIONS 2022
M.E. POWER ELECTRONICS AND DRIVES CURRICULUM

CHOICE BASED CREDIT SYSTEM

Power Electronics and Drives is the most researched and futuristic course due to its wide variety of applications in the field of renewable energy, efficient power transmission and effective control of electrical drives. This curriculum aims to develop technically empowered professionals and researchers who can demonstrate a degree of mastery over the area.

I. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I	To design and test power electronic converters, drive systems and various controllers using advanced tools.
II	To analyse and design power electronic systems and special electrical machines for efficient extraction and utilization of various renewable energy sources
III	To develop smart products using cutting edge technologies to needs the societal needs and environmental aspects.
IV	To develop confidence and exhibit self-learning capability to demonstrate a pursuit in life-long learning through higher studies and research.

II. PROGRAMME OUTCOMES (POs)

PO#	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document.
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4	Apply the knowledge of basic science and engineering to control and test the power electronic systems and drives.
5	Analyse power electronics and drives related engineering problems and find innovative solutions to meet the requirement of social needs and environmental factors.
6	Design cost effective products using cutting edge technologies in power electronics and drives systems.

PEO's – PO's MAPPING:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	1	2	3	4	5	6
I	2	2	2	3	1	2
II	2	2	2	3	2	2
III	3	1	2	2	3	3
IV	3	3	2	2	2	1

PROGRAMME ARTICULATION MATRIX

Year	Semester	Course code	PO1	PO2	PO3	PO4	PO5	PO6
I	I	MA22106	2	-	-	2	1	-
		PE22102	1	-	1	3	2	1
		RM22101	3	2	3	-	-	2
		PE22101	2	-	2.75	2.6	2.6	2.5
		PE22103	2	2.2	2.2	1.4	1.6	2
		PE22104	3	3	3	-	-	-
	II	PE22201	1	1	1	3	2	1
		PE22203	1	3	2	2	1	1
		PE22204	1.6	-	3	2	1.33	2
		PE22202	2.4	3	2	3	1.4	1.33
		PE22205	1	2	3	1	1	1.2
		RM22201	2	2	-	-	2	2

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE – GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	MA22106	Advanced Mathematics for Power Electronics Engineers	FC	3	1	0	4	4
2	PE22102	Modelling and Design of	PCC	3	1	0	4	4

		SMPS						
3		Professional Elective I	PEC	3	0	0	3	3
4	RM22101	Research Methodology	RMC	2	0	0	2	2
THEORY COURSES WITH PRACTICAL COMPONENT								
5	PE22101	Analysis of Power Converters	PCC	3	0	2	5	4
PRACTICAL								
6	PE22103	Design Laboratory for Power Electronics and Drives	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
7	PE22104	Technical Seminar	EEC	0	0	2	2	1
MANDATORY COURSES								
8		Audit Course I	AC	2	0	0	2	0
TOTAL				**16**	**2**	**8**	**26**	**20**

SEMESTER II

SL. NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PERIODS PER WEEK**			**TOTAL CONTACT PERIODS**	**CREDITS**
				L	**T**	**P**		
THEORY								
1	PE22201	Analysis of Electrical Machines	PCC	3	1	0	4	4
2	PE22203	System Design Using Microcontroller	PCC	3	0	0	3	3
3	PE22204	Electric Vehicles and Power management	PCC	3	0	0	3	3
4		Professional Elective II	PEC	3	0	0	3	3
5		Professional Elective III	PEC	3	0	0	3	3

THEORY COURSES WITH PRACTICAL COMPONENT								
6	PE22202	Analysis of Electrical Drives	PCC	3	0	2	5	4
PRACTICAL								
7	PE22205	Analog and Digital Controllers for PE Converters Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
8	RM22201	Research Tool Laboratory	EEC	0	0	4	4	2
MANDATORY COURSES								
9		Audit Course II	AC	2	0	0	2	0
TOTAL				**20**	**1**	**14**	**34**	**24**

SEMESTER III

SL. NO.	**COURSE CODE**	**COURSE TITLE**	**CATE – GORY**	**PERIODS PER WEEK**			**TOTAL CONTACT PERIODS**	**CREDITS**
				L	**T**	**P**		
THEORY								
1		Professional Elective IV	PEC	3	0	0	3	3
2		Professional Elective V	PEC	3	0	0	3	3
3		Open Elective	OEC	3	0	0	3	3
EMPLOYABILITY ENHANCEMENT COURSES								
4	PE22301	Inplant / Industrial / Practical Training (4 weeks during summer vacation)	EEC	-	-	-	-	2
5	PE22302	Project Work I	EEC	0	0	6	6	3
TOTAL				**9**	**0**	**6**	**15**	**14**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE – GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
EMPLOYABILITY ENHANCEMENT COURSES								
1	PE22401	Project Work II	EEC	0	0	24	24	12
TOTAL				**0**	**0**	**24**	**24**	**12**

(Total Credit Range = 70 – 75)

Name of the Programme:Power Electronics and Drives						
S.No	**Subject Area**	**Credits per Semester**				**Total Credits**
		I	II	III	IV	
1	FC	4	-	-		**4**
2	PCC	10	16	-		**26**
3	PEC	3	6	6		**15**
4	OEC	-	-	3		**3**
5	EEC	1	2	5	12	**20**
6	RMC	2	-	-	-	**2**
7	Non-Credit AC	0	0	-	-	**0**
Total		**20**	**24**	**14**	**12**	**70**

PROFESSIONAL ELECTIVE I – SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PE22111	Power Semiconductor Devices	PEC	3	0	0	3	3
2	PE22112	Special Electrical Machines	PEC	3	0	0	3	3
3	PE22113	Soft Computing Techniques	PEC	3	0	0	3	3
4	PE22114	System Theory	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES II– SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PE22221	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3
2	PE22222	PWM Rectifiers and Resonant Converters	PEC	3	0	0	3	3
3	PE22223	Voltage Lift Converters	PEC	3	0	0	3	3
4	PE22224	Control of Power Electronic Circuits	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES III – SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
	PE22231	Power Quality	PEC	3	0	0	3	3
	PE22232	Machine Learning and Deep Learning	PEC	3	0	0	3	3
	PE22233	IoT for Smart Systems	PEC	3	0	0	3	3
	PE22234	MEMS Design of Sensors and Actuators	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES IV– SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PE22341	Renewable Energy Technology	PEC	3	0	0	3	3
2	PE22342	Wind Energy Conversion Technology	PEC	3	0	0	3	3
3	PE22343	Energy Management and Auditing	PEC	3	0	0	3	3
4	PE22344	HVDC and FACTS	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVES V – SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	PE22351	Energy Storage Technologies	PEC	3	0	0	3	3
2	PE22352	Battery management System	PEC	3	0	0	3	3
3	PE22353	Python programming for machine learning	PEC	3	0	0	3	3
4	PE22354	Smart Grid	PEC	3	0	0	3	3

AUDIT COURSES (AC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	AC22101	English for Research Paper Writing	AC	2	0	0	2	0
2	AC22102	Constitution of India	AC	2	0	0	2	0
3	AC22201	Disaster Management	AC	2	0	0	2	0
4	AC22202	நற்றமிழ் இலக்கியம்	AC	2	0	0	2	0

MA22106	ADVANCED MATHEMATICS FOR POWER ELECTRONICS ENGINEERS	L	T	P	C

		3	**1**	**0**	**4**

COURSE OBJECTIVES:

- To introduce the basic concepts of matrices, calculus, transforms and probability.
- To familiarize the students in the field of differential equations to solve boundary value problems associated with engineering applications
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems
- To develop the ability among the students to solve problems using Fourier series associated with engineering applications
- To understand the basic concepts of probability and to introduce some standard distributions applicable to engineering which can describe real life phenomenon

UNIT I	**MATRIX THEORY**	**12**

The Cholesky decomposition – Generalized Eigenvectors – Gram Schmidt orthogonalization process – QR factorization –Singular value decomposition – Pseudo inverses – Least square approximation.

UNIT II	**CALCULUS OF VARIATIONS**	**12**

Concept of variations and its properties – Euler's theorem – Functional dependent on first and higher order of derivatives – Functional dependent on functions of several independent variables – Isoperimetric problems – Rayleigh Ritz method.

UNIT III	**LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Definitions – Properties – Transform error function – Bessel's function – Dirac Delta function – Unit step function – Convolution theorem – Inverse Laplace transform – Complex inversion formula – Solutions to partial differential equations: Heat and Wave equations

UNIT IV	**FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS**	**12**

Fourier transforms: Definitions, properties – Transform of elementary functions, Dirac Delta functions – Convolution theorem, Parseval's identity – Solutions to partial differential equation: Heat equations, Wave equations, Laplace and Poisson's equations

UNIT V	**PROBABILITY AND RANDOM VARIABLES**	**12**

Probability – Axioms of probability – Conditional probability – Discrete random variable – Probability mass function– Continuous random variable – Probability density function – Properties - Mean, variance – Special distributions: Binomial, Poisson and Normal distributions (Derivations not included).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Define the basic concepts of matrices, calculus, transforms and probability
CO2:	Explain the decomposition techniques and the boundary value problems

CO3:	Demonstrate Laplace transform, Fourier transform and probability in electrical field
CO4:	Develop matrix theory and boundary value problems in electrical engineering
CO5:	Solve partial differential equations using transforms technique and distributions in engineering applications

REFERENCES:

1.	Richard Bronson, "Matrix Operation", Schaum's outline series, Second Edition, McGraw Hill, New Delhi, 2011.
2.	Elsgolc L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
3.	Kreyszig E, "Advanced Engineering Mathematics", 10th Edition, John Wiley, New Delhi, India, 2018.
4.	Sankara Rao K , "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd, New Delhi, 2013.
5.	Miller S.L. and Childers D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2012.

Mapping of Course Outcomes to Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	2	1	-
CO2	2	-	-	2	1	-
CO3	2	-	-	2	1	-
CO4	2	-	-	2	1	-
CO5	2	-	-	2	1	-
CO	2	-	-	2	1	-

Table of Specifications for End Semester Question Paper

MA22106 ADVANCED MATHEMATICS FOR POWER ELECTRONICS ENGINEERS

Unit No. and Title	Total 2 Marks Qns.	Total 16 Marks Qns.	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ap)	**Analyse** (An)
Unit-I:Matrix Theory	2	1 either or	1(2)-CO1	1(2)-CO2	1either or (16)-CO4	-
Unit-II: Calculus of Variations	2	1 either or	1(2)-CO1	1(2)-CO2	1either or (16)-CO4	-
Unit-III: Laplace Transform Techniques for Partial Differential Equations	2	1 either or	1(2)-CO1	1(2)-CO3	1either or (16)-CO5	-
Unit-IV: Fourier Transform Techniques for Partial Differential Equations	2	1 either or	1(2)-CO1	1(2)-CO3	1either or (16)-CO5	-
Unit-V: Probability and Random Variables	2	1 either or	1(2)-CO1	1(2)-CO3	1either or (16)-CO5	-
Total Qns.	10	5 either or	5(2)	5(2)	5 either or (16)	-
Total Marks	20	80	10	10	80	-
Weightage	20%	80%	10%	10%	80%	-

Weightage for Cos

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	10	4	6	32	48
Weightage	10%	4%	6%	32%	48%

PE22102	MODELLING AND DESIGN OF SMPS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To inculcate knowledge on steady state analysis of Non-Isolated DC-DC converter
- To perform steady state analysis of Isolated DC-DC converter
- To educate on different converter dynamics
- To impart knowledge on the design of controllers for DC-DC converters
- To familiarize the design magnetics for SMPS applications

UNIT I	ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS	12

Buck, Boost, Buck- Boost and Cuk converters: Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steadystate relationships – Introduction to discontinuous conduction .

UNIT II	ANALYSIS OF ISOLATED DC-DC CONVERTERS	12

Introduction – classification- forward- flyback- pushpull – half bridge – full bridge topologies design of SMPS – Applications

UNIT III	CONVERTER DYNAMICS	12

AC equivalent circuit analysis – State space averaging – Circuit averaging – Averaged switch 12nalyse1212 – Transfer function model for buck, boost, buck-boost and cuk converters – Input filters

UNIT IV	CONTROLLER DESIGN	12

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

UNIT V	DESIGN OF MAGNETICS	12

Basic magnetic theory revision – Inductor design – Design of mutual inductance – Design of transformer for isolated topologies – Ferrite core table and selection of area product – wire table – selection of wire gauge

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Analyze Non-Isolated DC-DC converter
CO2:	Analyze Isolated DC-DC converter
CO3:	Derive the transfer function of DC-DC converters
CO4:	Explain the design concepts for DC-DC converters
CO5:	Explain the magnetic concepts for the design of Inductors

REFERENCES:

1	John G. Kassakian, Martin F. Schlecht, George C. Verghese, “Principles of Power Electronics”, Pearson, India, New Delhi, 2010
2	Robert W. Erickson & Dragon Maksimovic, ” Fundamentals of Power Electronics”, Third

	Edition, 2020
3	2. Simon Ang and Alejandra Oliva, "Power-Switching Converters", CRC press, 3rd edition, 2011.
4	3. Philip T Krein, " Elements of Power Electronics", Oxford University Press, 2017.
5	4. Ned Mohan, "Power Electronics: A first course", Wiley,2011, 1st edition.
6	5. IssaBatarseh, Ahmad Harb, "Power Electronics- Circuit Analysis and Design, Second edition, 2018
7	6. V.Ramanarayanan, "Course material on Switched mode power conversion", 2007
8	7. Alex Van den Bossche and VencislavCekovValchev, "Inductors and Transformers for Power Electronics", CRC Press, 1st edition, 2005.
9	8. W. G. Hurley and W. H.Wolfle, "Transformers and Inductors for Power Electronics Theory, Design and Applications", 2013 Wiley, 1st Edition.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	1	3	2	1
CO2	1	-	1	3	2	1
CO3	1	-	1	3	2	1
CO4	1	-	1	3	2	1
CO5	1	-	1	3	2	1
CO	1	-	1	3	2	1

Table of Specification for End Semester Question Paper

PE22102 – MODELING AND DESIGN OF SMPS

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ay)	Analyse(An)
			No. of Qns. (marks) and CO			
Unit-I: Analysis Of Non-Isolated DC-DC Converters	2	1 either or	2(2) – CO1	-	-	1 either or (16) – CO1
Unit-II: Analysis of Isolated Dc-Dc Converters	2	1 either or	2(2) – CO2	-	-	1 either or (16) – CO2
Unit-III: Converter Dynamics	2	1 either or	2(2) — CO3	-	-	1 either or (16) – CO3
Unit-IV: Controller Design	2	1 either or	2(2) – CO4	1 either or (16) – CO4		-
Unit-V: Design of Magnetics	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	10(2)	2(2) 2 either or (16)	-	3(2) 3either or (16)
Total Marks	20	80	20	32	-	48
Weightage	20 %	80%	20%	32%	-	48%

Weightage for Cos					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

RM22101	RESEARCH METHODOLOGY	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

- To give an overview of the research methodology and IPR, and explain the techniques of data collection and analysis.

UNIT I	RESEARCH DESIGN	6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II	DATA COLLECTION AND SOURCES	6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data – Preparing, Exploring, examining and displaying

UNIT III	DATA ANALYSIS AND REPORTING	6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation

UNIT IV	INTELLECTUAL PROPERTY RIGHTS	6

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance

UNIT V	PATENTS	6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Outline the methodology of research.
CO2:	Explain the research problem, data collection methods, IPR and patent.
CO3:	Prepare a well-structured research paper, scientific presentations and patent application.
CO4:	Develop awareness on IPR, patent law and procedural mechanism in obtaining a patent.
CO5:	Analyse the data using appropriate tool.

REFERENCES:

1	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods",

	Tata McGraw Hill Education, 11e (2012).
2	Kothari C R, Gaurav Garg, "Research Methodology- Methods and Techniques" New Age International Publishers, 2019.
3	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
5	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	-
CO2	3	-	3	-	-	-
CO3	3	2	3	-	-	-
CO4	3	-	3	-	-	-
CO5	3	-	3	-	-	2
CO	3	2	3	-	-	2

Table of specification for end semester question paper

RM22101 RESEARCH METHODOLOGY

Unit No. and Title	Total 2 Marks Qns.	Total 16 Marks Qns.	Cognitive Level			
			Remember (Kn)	Understand (Un)	Apply (Ap)	Analyse (An)
			No. of Qns. (marks) and CO			
unit-I: Research Design	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
unit-II: Data Collection and Sources	2	1 either or	2(2) – CO2		1 either or (16) — CO2	-
unit-III: Data Analysis and Reporting	2	1 either or	1(2) — CO3	1(2) — CO3		1 either or (16) — CO3
unit-IV: Intellectual Property Rights	2	1 either or	2(2) – CO4		1 either or (16) — CO4	-
Unit-V: Patents	2	1 either or	1(2) – CO5	1(2) — CO5 1 either or (16) — CO5	-	
Total Qns.	10	5 either or	8(2)	2(2) 2 either or (16)	2 either or (16)	-
Total Marks	20	80	16	36	32	16
Weightage	20%	80%	16%	36%	32%	16%

Weightage for Cos

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22101	ANALYSIS OF POWER CONVERTERS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To provide the mathematical fundamentals necessary for deep understanding of power converter operating modes
- To introduce the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation
- To impart required skills to formulate and design inverters for generic load and for machine loads

- To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals
- To inculcate knowledge to perform analysis and comprehend the various operating modes of different configurations of power converters

UNIT I	**SINGLE PHASE AC-DC CONVERTER**	**9**

Half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation – inverter operation and its limit –performance parameters – effect of source impedance and overlap

UNIT II	**THREE PHASE AC-DC CONVERTER**	**9**

Half controlled and fully controlled converters with R, R-L, R-L-E loads and freewheeling diodes – inverter operation and its limit – performance parameters – effect of source impedance and overlap.

UNIT III	**SINGLE PHASE INVERTERS**	**9**

Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters– various harmonic elimination techniques.

UNIT IV	**THREE PHASE INVERTERS**	**9**

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques

UNIT V	**MULTILEVEL AND IMPEDANCE SOURCE INVERTERS**	**9**

Multilevel concept – diode clamped – flying capacitor – cascaded type multilevel inverters – Comparison of multilevel inverters – application of multilevel inverters – PWM techniques for MLI – Single phase &Three phase Impedance source inverters

LIST OF EXPERIMENTS:

1. Circuit Simulation of Three-phase semi-converter with R, RL& RLE load.
2. Circuit Simulation of Three-phase fully controlled converter with R, RL & RLE load.
3. Circuit Simulation of Three-phase Voltage Source Inverter in 180 and 120 degree mode of conduction.
4. Simulation of a five-level cascaded multilevel inverter with R load.
5. Circuit simulation of Three-phase PWM inverter.

TOTAL: (45+30)=75 PERIODS

COURSE OUTCOMES:

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

CO1:	Analyse various single phase controlled rectifiers for generic load and for machine load.
CO2:	Analyse and simulate three phase controlled rectifiers under different load conditions.
CO3:	Analyse the performance of single phase inverters.
CO4:	Explain and simulate various control techniques for three phase inverters.
CO5:	Describe multilevel inverters and Impedance Source inverters.

REFERENCES:

1.	P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003

2.	Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.
3.	Jai P. Agrawal, "Power Electronics System Theory and Design", Pearson Education, First Edition, 2015
4.	Bimal.K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003
5.	Ned Mohan, T.M.Undeland and W.P.Robbins, "Power Electronics: converters, Application and design", 3rd edition Wiley, 2007.
6.	Philip T. Krein, "Elements of Power Electronics" Indian edition Oxford University Press-2017
7.	P.C.Sen, "Modern Power Electronics", S.Chand Publishing 2005.
8.	Bin Wu, Mehdi Narimani, "High-Power Converters and AC Drives", Wiley, 2nd Edition, 2017

Mapping of Course Outcomes to Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	1	1	-
CO2	1	-	2	3	3	-
CO3	2	-	3	3	3	-
CO4	3	-	3	3	3	2
CO5	3	-	3	3	3	3
CO	2	-	2.75	2.6	2.6	2.5

Table of Specification for End Semester Question Paper

PE22101– ANALYSIS OF POWER CONVERTERS

UnitNo.andTitle	Total 2 Marks	Total 16Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No.ofQns.(marks) andCO			
Unit-I: Single Phase AC-DC Converter	2	1 either or	1(2) – CO1	1(2) — CO1 1 either or(16) – CO1	-	-
Unit-II: Three Phase AC-DC Converter	2	1 either or	1(2) – CO2	1(2) — CO2	1 either or(16) – CO2	-
Unit-III: Single Phase Inverters	2	1 either or	2(2) — CO3	-	1 either or(16) – CO3	-
Unit-IV: Three Phase Inverters	2	1 either or	2(2) – CO4	1 either or(16) – CO4	-	-
Unit-V: Multilevel and Impedance Source Inverters	2	1 either or	2(2) – CO5	1 either or(16) – CO5	-	-
Total Qns.	10	5 either or	8(2)	2(2) 2 either or (16)	3 either or (16)	-
Total Marks	20	80	16	52	32	-
Weightage	20 %	80%	16%	52%	32%	-

Weightagefor Cos					
	CO1	CO2	CO3	CO4	CO5
TotalMarks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22103	DESIGN LABORATORY FOR POWER ELECTRONICS AND DRIVES	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Design and test isolated and non-isolated power electronic converters
- Study the need for a power quality analyzer
- Demonstrate and develop a mini project of societal importance

LIST OF EXPERIMENTS

1.	Selection and Design of components (Inductor, Capacitor, transformers and devices) for power converters
2.	Design and testing of isolated converter.
3.	Design and testing of non-isolated converter.
4.	Analyzing the performance parameters of power electronic converters using power quality analyse.
5.	Mini Project Demonstration with applications.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Select suitable components for the design of power electronics circuits
CO2:	Design and test isolated power electronics converter circuits
CO3:	Design and test Non-isolated power electronics converter circuits
CO4:	Analyze the quality of power in power electronic circuits using power quality analyzer
CO5:	Develop a mini project of societal importance.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	1	2
CO2	2	2	2	1	1	2
CO3	2	2	2	1	1	2
CO4	2	2	3	1	2	1
CO5	3	3	3	3	3	3
CO	2	2.2	2.2	1.4	1.6	2

PE22104	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- · To work on a specific technical topic in Power Electronics and Drives in order to acquire the skills of oral presentation and to acquire technical writing abilities for seminars and conferences

COURSE OVERVIEW

1	The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Power Electronics and Drives and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Identify latest developments in the field of Power Electronics and Drives
CO2:	Develop technical writing abilities for seminars, conferences and journal publications
CO3:	Make use of modern tools to present the technical details

Mapping of Course Outcomes to Program Outcomes

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	-	3	3	-	-	-
CO3	-	-	-	-	-	-
CO	3	3	3	-	-	-

PE22201	ANALYSIS OF ELECTRICAL MACHINES	L	T	P	C

		3	**1**	**0**	**4**

COURSE OBJECTIVES:

- To understand the principles of electromechanical energy conversion in electrical machines and to know the dynamic characteristics of DC motors
- To study the concepts related with AC machines, magnetic noise and harmonics in rotating electrical machines
- To interpret the principles of reference frame theory
- To study the principles of three phase, doubly fed and 'n' phase induction machine in machine variables and reference variables
- To understand the principles of three phase, synchronous machine in machine variables and reference variables

UNIT I	**ELECTROMECHANICAL ENERGY CONVERSION and DC MACHINES**	**12**

Magnetic circuits, permanent magnet, Energy conservation – stored magnetic energy, co-energy – force and torque in singly and doubly excited systems – Elementary DC machine and analysis of steady state operation – Voltage and torque equations – dynamic characteristics – DC motors – Time domain block diagrams – solution of dynamic characteristic by Laplace transformation

UNIT II	**AC MACHINES –CONCEPTS**	**12**

Distributed Windings – Winding Functions – Air-Gap Magneto motive Force –Rotating MMF – Flux Linkage and Inductance –Resistance –Voltage and Flux Linkage Equations for Distributed Winding Machines–magnetic noise and harmonics in rotating electrical machines. Modeling of 'n' phase machine

UNIT III	**REFERENCE FRAME THEORY**	**12**

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame – transformation of balanced set-variables observed from several frames of reference

UNIT IV	**MODELLING OF INDUCTION MACHINES**	**12**

Three phase induction machine and doubly fed induction machine- equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque variations- Transformation theory for 'n' phase induction machine.

UNIT V	**MODELLING OF SYNCHRONOUS MACHINES**	**12**

Three phase synchronous machine and analysis of steady state operation – voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:	
CO1:	Analyze the principles of energy conversion and characteristics of DC motors
CO2:	Examine the modelling of AC machines
CO3:	Analyze the concepts of reference frame theory
CO4:	Develop induction machine model in both machine variable and reference variable forms
CO5:	Develop synchronous machine model in machine variables and reference variable form

REFERENCES:

1	Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition,2020.
2	Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
3	Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
4	R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015.
5	R.Ramanujam,Modeling and Analysis of Electrical Machines,I.k.International Publishing House Pvt.Ltd,2018

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	3	2	1
CO2	1	1	1	3	2	1
CO3	1	1	1	3	2	1
CO4	1	1	1	3	2	1
CO5	1	1	1	3	2	1
CO	1	1	1	3	2	1

Table of specification for end semester question paper

PE22201 ANALYSIS OF ELECTRICAL MACHINES

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Electromechanical Energy Conversion and Dc Machines	2	1 either or	2(2) – CO1	-	-	1 either or (16) – CO1
Unit-II: AC Machines – Concepts	2	1 either or	2(2) – CO2	-	1 either or (16) — CO2	-
Unit-III: Reference Frame Theory	2	1 either or	2(2) — CO3	-	-	1 either or (16) – CO3
Unit-IV: Modelling of Induction Machines	2	I either or	2(2) – CO4	-	-	1 either or (16) – CO4
Unit-V: Modelling of Synchronous Machines	2	I either or	2(2) – COS	-	-	1 either or (16) – CO5
Total Qns.	10	5 either or	10(2)	-	-	5 either or (16)
Total Marks	20	80	20	-	-	80
Weightage	20 %	80%	20%	-	-	80%

Weightage for Cos

	CO1	CO 2	CO 3	CO 4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22203	SYSTEM DESIGN USING MICROCONTROLLER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To recognize the basics of PIC and ARM microcontrollers.
- To understand the interfacing and peripherals of PIC Microcontroller.
- To realise the organization of ARM.
- To apply the concepts for programming in PIC and ARM microcontroller.
- To examine the various applications of PIC and ARM microcontroller.

UNIT I	INTRODUCTION TO PIC MICROCONTROLLER	9

PIC Architecture – Memory organization – Instruction set –Addressing modes- PIC programming in Assembly & C – Simple operations – I/O port – Timer programming.

UNIT II	INTERRUPTS AND INTERFACING	9

Interrupt Programming – LCD and keyboard Interfacing – ADC Characteristics – DAC Interfacing – Sensor Interfacing and Signal Conditioning.

UNIT III	APPLICATIONS	9

Relays and Optoisolators – Stepper Motor – DC Motor – PWM Motor Control with CCP – DC Motor Control with ECCP.

UNIT IV	INTRODUCTION TO ARM PROCESSOR	9

ARM Architecture – ARM programmer‘s model – ARM Development tools- Memory Hierarchy – ARM Assembly Language Programming – Simple Examples – Architectural Support for Operating systems.

UNIT V	ARM ORGANIZATION	9

3-Stage Pipeline ARM Organization – 5-Stage Pipeline ARM Organization –ARM Instruction Execution – ARM Implementation – ARM Instruction Set – Architectural support for High Level Languages – Embedded ARM Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Recognize the basics of PIC microcontroller.
CO2	Understand the interfacing and peripherals of PIC Microcontroller.
CO3	Examine the various applications of PIC microcontroller.
CO4	Recognize the basics of ARM microcontroller.
CO5	Realize the organization of ARM.

REFERENCES:	
1.	Muhammad Ali Mazidi, Rolin D.Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008.
2.	Steve Furber, ‘ARM system on chip architecture’, Addison Wesley,2010.
3.	Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield ‘ARM System Developer’s Guide Designing and Optimizing System Software’, Elsevier 2007.
4.	John Iovine, ‘PIC Microcontroller Project Book’, McGraw Hill, 2000.
5.	William Hohl, ARM Assembly Language‟ Fundamentals and Techniques, 2009.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	2	2	1	1
CO2	1	-	2	2	1	1
CO3	1	-	2	2	1	1
CO4	1	3	2	2	1	1
CO5	1	-	2	2	1	1
CO	1	3	2	2	1	1

Table of Specification for End Semester Question Paper

PE22203 SYSTEM DESIGN USING MICROCONTROLLER

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction to PIC Microcontroller	2	1 either or	1(2) – CO1	1(2) — CO1 1 either or (16) – CO1	-	-
Unit-II: Interrupts and Interfacing	2	1 either or	1(2) – CO2	1(2) — CO2 1 either or (16) – CO2	-	-
Unit-III: Applications	2	1 either or	1(2) — CO3	1(2) — CO3	1 either or (16) – CO3	-

Unit-IV: Introduction to ARM Processor	2	1 either or	2(2) – CO4	1 either or (16) – CO4	-	-
Unit-V: ARM Organization	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	7(2)	3(2) 4 either or (16)	1 either or (16) – CO5	-
Total Marks	20	80	14	70	16	-
Weightage	20 %	80%	14%	70%	16%	-

Weightage for Cos

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22204	**ELECTRIC VEHICLES AND POWER MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Understand the concept of electric vehicles and its operations
- Illustrate the architecture of Electric Vehicle (EV) and Hybrid Electric vehicle (HEV)
- Understand the need for energy storage in hybrid vehicles
- Understand various alternative energy storage technologies that can be used in electric vehicles

UNIT I	**INTRODUCTION TO ELECTRIC VEHICLES**	**9**

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Electric and Hybrid Vehicle Components, Vehicle mass and Performance, Electric Motor ratings, Comparison of EV with IC Engine vehicles, Power train components

UNIT II	**VEHICLE MECHANICS**	**9**

Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power, Velocity and Acceleration, Tire–Road Force Mechanics, Propulsion System Design.

UNIT III	**ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS**	**9**

Architecture of EV's and HEV's, Plug-in Hybrid Electric Vehicles (PHEV), Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT IV	**BATTERY ENERGY STORAGE SYSTEM**	**9**

Battery Basics, Different types of batteries, Battery Parameters, Electrochemical Cell Fundamentals, Battery modelling, Batteries for traction applications, Battery pack management.

UNIT V	**ALTERNATIVE ENERGY STORAGE SYSTEMS**	**9**

Fuel cells, Types of fuel cell, Fuel cell model, Hydrogen storage systems, Fuel cell electric vehicle, Ultracapacitors, Compressed air storage and flywheels for transportation applications.

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Understand and compare electric vehicle and IC engine driven vehicles
CO2:	Explain the mechanics of motion of a vehicle
CO3:	Illustrate the working and components of Electric Vehicle and Hybrid Electric Vehicle
CO4:	Illustrate the operation of battery storage system
CO5:	Understand the various alternative energy storage systems for EV applications
REFERENCES:	
1.	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).
2.	Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2010.
3	Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
4	C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001.
5	Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	3	-	-	-
CO2	-	-	3	-	2	-
CO3	2	-	3	-	1	2
CO4	-	-	3	2	1	-
CO5	2	-	3	-	-	-
CO	1.6	-	3	2	1.33	2

Table of Specification for End Semester Question Paper

PE22204 ELECTRIC VEHICLES AND POWER MANAGEMENT

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction to Electric Vehicles	2	1 either or	2(2) – CO1	-	-1 either or (16) – CO1	-
Unit-II: Vehicle Mechanics	2	1 either or	2(2) – CO2	-	1 either or (16) — CO2	-
Unit-III: Architecture of Ev's And Power Train Components	2	1 either or	2(2) — CO3	-	1 either or (16) – CO1	-
Unit-IV: Battery Energy Storage System	2	I either or	2(2) – CO4	-	1 either or (16) – CO1	-
Unit-V: Alternative Energy Storage Systems	2	I either or	2(2) – COS	-	1 either or (16) – CO1	-
Total Qns.	10	5 either or	10(2)	-	5 either or (16)	-
Total Marks	20	80	20	-	80	-
Weightage	20 %	80%	20%	-	80%	-

Weightage for Cos					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22202	ANALYSIS OF ELECTRICAL DRIVES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand steady state operation and transient dynamics of a motor load system
- To study and analyse the operation of the converter / chopper fed DC drive, both qualitatively and quantitatively
- To analyse and design the current and speed controllers for a closed loop solid state DC motor drive
- To understand the drive characteristics for different load torque profiles and quadrants of operation
- To understand the speed control of induction motor drive from stator and rotor sides
- To study and analyse the operation of VSI &CSI fed induction motor control and pulse width modulation techniques

UNIT I	DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS	9

DC motor- speed-torque relations, Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operation. Characteristics of mechanical system– dynamic equations, components of torque, types of load; Requirements of drives characteristics – stability of drives–multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating

UNIT II	CONVERTER AND CHOPPER CONTROL	9

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters –performance parameters, performance characteristics. Introduction to time ratio control and frequency modulation; chopper controlled DC motor – performance analysis, multi-quadrant control; Related problems

UNIT III	CLOSED LOOP CONTROL	9

Modelling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements – Closed loop speed control – current and speed loops.

UNIT IV	VSI AND CSI FED STATOR CONTROLLED INDUCTION MOTOR DRIVES	9

AC voltage controller – six step inverter voltage control-closed loop variable frequency PWM inverter fed induction motor (IM) with braking-CSI fed IM variable frequency motor drives.

UNIT V	ROTOR CONTROLLED INDUCTION MOTOR DRIVES	9

Static rotor resistance control – injection of voltage in the rotor circuit – static scherbius drives – static and modified Kramer drives – sub-synchronous and super-synchronous speed operation of induction machines

LIST OF EXPERIMENTS:

1. Simulation of closed loop control of Converter fed DC drive.
2. Simulation of Speed control of Converter fed DC motor.
3. Simulation of Speed control of Chopper fed DC motor.
4. Simulation of VSI fed three phase Induction motor drive.
5. Simulation of AC voltage Controller based speed control of induction motor.

TOTAL:(45+30)= 75PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:	
CO1:	Explain the converter/machine dynamics.
CO2:	Analyse and simulate direct current motor based adjustable speed drives.
CO3:	Design a closed loop motor drive system with controllers for the current and speed control operations.
CO4:	Analyse and simulate stator side control of Induction motor based adjustable speed drives.
CO5:	Analyse rotor side control of Induction motor based adjustable speed drives.
REFERENCES:	
1	Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Jersy, 1989
2	R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi,2010
3	Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia2002
4	Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, Second Edition, 2009.
5	Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw- Hill publishing company Ltd., New Delhi, 2002.
6	P.C Sen "Thyristor DC Drives", John wiely and sons, New York, 1981.
7	W.Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992.
8	Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press, Oxford, 1988.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	3	1	-
CO2	2	-	2	3	1	-
CO3	2	-	2	3	3	1
CO4	3	3	2	3	1	2
CO5	3	-	2	3	1	1
CO	2.4	3	2	3	1.4	1.33

Table of Specification for End Semester Question Paper

PE22202– Analysis of Electrical Drives

UnitNo.andTitle	Total 2 Marks	Total 16Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No.ofQns.(marks) andCO			
Unit-I: DCMotors Fundamentals and Mechanical Systems	2	1 either or	1(2) – CO1	1(2) — CO1 1 either or(16) - CO1	-	-
Unit-II: Converter and Chopper Control	2	1 either or	1(2) - CO2	1(2) — CO2	-	1 either or(16) - CO2
Unit-III: Closed Loop Control	2	1 either or	1(2) — CO3	1(2) — CO3	-	1 either or(16) - CO3
Unit-IV: VSI and CSI Fed Stator Controlled Induction Motor Drives	2	1 either or	2(2) - CO4	-		1 either or(16) - CO4
Unit-V: Rotor Controlled Induction Motor Drives	2	1 either or	2(2) – CO5	-	-	1 either or(16) - CO5
TotalQns.	10	5 either or	7(2)	3(2) 1 either or (16)	-	4 either or (16)
TotalMarks	20	80	14	22	-	64
Weightage	20 %	80%	14%	22%	-	64%

Weightagefor COs					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
TotalMarks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22205	ANALOG AND DIGITAL CONTROLLERS FOR PE CONVERTERS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Understand the concepts related with analog and digital controllers
- Design circuits for power electronics applications using op-amps and microcontrollers
- Design the driver circuits, sensing circuits for power converters
- Study the effect of digital controller for power converters

LIST OF EXPERIMENTS

1.	Analyze the switching characteristics of various power semiconductor devices.
2.	Design and verification of amplifier, buffer and filter for power electronic circuits.
3.	Design of driver circuits for power converters.
4.	Generation of PWM gate pulses with duty cycle control.
5.	Design closed loop P, I and PI controllers for power electronic circuits

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	Analyze the switching characteristics of power semiconductor devices.
CO2:	Design amplifier, buffer and filter circuits for power electronic applications
CO3:	Design driver circuit for power converter applications
CO4:	Implement PWM technique to generate firing pulses for converter circuits
CO5:	Design closed loop controllers for power electronic circuits

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	3	1	-	1
CO2	1	2	3	1	1	1
CO3	1	2	3	1	1	1
CO4	1	2	3	1	1	2
CO5	1	2	3	1	-	1
CO	1	2	3	1	1	1.2

RM22201	RESEARCH TOOL LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To familiarize the fundamental concepts/techniques for Project Management
- To familiarize the journal paper formatting using suitable Software
- To familiarise the software for literature review and Bibliography
- To find the plagiarism percentage of article contents
- To prepare a quality research report and the presentation

LIST OF EXPERIMENTS:

1.	Use of tools / Techniques for Research - Project management -Microsoft Project / Microsoft OneNote / Asana.
2.	Hands on Training related to Software for Paper Formatting like LaTeX / MS Office
3.	Design a Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process -Addressing Reviewer Comments.
4.	Introduction to Data Analysis Software - Origin SPSS, ANOVA etc.,
5.	Introduction to Software for detection of Plagiarism – Urkund, Turniton
6.	Preparing Bibliography / Different Reference Formats. – EndNote, Mently
7.	Format of Project Report - Use of Quotations - Method of Transcription- Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures
8.	Introduction to Microsoft Excel –for Research Analysis
9.	Presentation using PPTs.
10.	Data analysis using Matlab.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1:	List the various stages in research and develop systematic planning of project stages.
CO2:	Write a journal paper and formulate as per the standard journal format
CO3:	Develop a literature review and relevant references for a research problem using suitable software.
CO4:	Determine the plagiarism of the article / report content by using the Software
CO5:	Compile a research report and the presentation

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	2	-
CO2	2	3	-	-	-	-
CO3	-	2	-	-	-	-
CO4	-	2	-	-	-	-
CO5	-	3	-	-	-	2
CO	2	2	-	-	2	2

PE22111	**POWER SEMICONDUCTOR DEVICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the concepts related with power switches and its requirements
- To understand the working, steady state and switching characteristics of current controlled and voltage controlled silicon devices
- To study the working of driving circuits for power devices
- To understand the thermal characteristics of power devices and design heat sink for the power devices

UNIT I	**INTRODUCTION**	**9**

Characteristics and specifications of switches-Ideal characteristics, Practical characteristics, Specifications, Choice of devices, Power diodes – Basic Structure, static characteristics, Breakdown voltage considerations, Depletion layer boundary control, ON state losses, switching characteristics, Electromagnetic interference, New semiconductor materials for power devices.

UNIT II	**CURRENT CONTROLLED DEVICES**	**9**

Power BJT – Construction, static characteristics, Operation, switching characteristics, ON state losses, Second breakdown, Safe operating areas. SCR (Thyristor) – Construction, working, static and transient characteristics, two transistor model, Comparison of Power BJT and SCR, Basic structure and operation of GTO.

UNIT III	**VOLTAGE CONTROLLED DEVICES**	**9**

Principle of voltage controlled devices, Power MOSFET – Construction, Operation, static and switching characteristics, IGBT- Basic structure, Static and switching characteristics, Operation, Latch up, Safe operating areas, Basic structure and operation of field controlled thyristor. Basic Structure of Integrated gate commutated thyristor (IGCT).

UNIT IV	**ISOLATION AND DRIVER CIRCUITS**	**9**

Design considerations, DC coupled drive circuits for power BJT and power MOSFET, Necessity of isolation, Pulse transformer and optocoupler based electrically isolated circuits, Gate drive circuit for thyristor (SCR). Over voltage and current protection.

UNIT V	**THERMAL PROTECTION**	**9**

Control of semiconductor device temperature, Heat transfer by conduction, convection and radiation, Thermal resistance and impedance, Electrical analogy of thermal components, Heat sinks, Cooling – liquid cooling, vapour phase cooling	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Analyze the working and characteristics of power diodes.
CO2:	Analyze the working and characteristics of various current controlled devices.
CO3:	Analyze the working and characteristics of various voltage controlled devices.
CO4:	Employ suitable techniques and construct drive circuits for power semiconductor devices.
CO5:	Determine the electrical and mechanical parameters of a heat sink using equivalent circuits.
REFERENCES:	
1	Ned Mohan, T.M.Undeland and W.P.Robbins, "Power Electronics: converters, Application and design", 3rd edition Wiley, 2007
2	Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, 4th Edition, 10th Impression 2021
3	Tsunenobu Kimoto and James A. Cooper , Fundamentals of Silicon Carbide Technology: Growth, Characterization, Devices, and Applications, First Edition., 2014 John Wiley & Sons Singapore Pvt Ltd
4	Alex Lidow, Johan Strydom, Michael de Rooij, David Reusch, "GaN Transistors for Efficient Power Conversion", Second Edition, Wiley, 2015
5	Biswanath Paul, Power Electronics, Universities Press 2019.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	3	-	-	1
CO2	-	-	3	-	-	1
CO3	2	-	3	-	-	1
CO4	-	-	3	2	1	1
CO5	2	-	3	-	1	1
CO	1	-	3	2	1	1

Table of Specification for End Semester Question Paper

PE22111: POWER SEMICONDUCTOR DEVICES

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction	2	1either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Current Controlled Devices	2	1either or	2(2) - CO2	1 either or (16) — CO2	-	-
Unit-III: Voltage Controlled Devices	2	1either or	2(2) — CO3	1 either or (16) – CO3	-	-
Unit-IV: Isolation and Driver Circuits	2	1either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V: Thermal Protection	2	1either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	1either or	10(2)	5 (10)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22112	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the construction, working, characteristics and speed control methods of synchronous reluctance motors.
- To understand the working, characteristics and speed control principles of stepper motor.
- To study the construction, working, characteristics and speed control methods of switched reluctance motors.
- To know the principle of operation, construction, characteristics and speed control methods for the permanent magnet brushless DC motors
- To understand the concepts related with permanent magnet synchronous motors

UNIT I	SYNCHRONOUS RELUCTANCE MOTORS	9

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

UNIT II	STEPPER MOTORS	9

Constructional features – Rotary and Linear SRM - Principle of operation – Torque production – Steady state performance prediction- Analytical method -Power Converters and their controllers Methods of Rotor position sensing – Sensor less operation – Characteristics and Closed loop control Applications

UNIT III	SWITCHED RELUCTANCE MOTORS	9

Constructional features – Rotary and Linear SRM - Principle of operation – Torque production – Steady state performance prediction- Analytical method -Power Converters and their controllers Methods of Rotor position sensing – Sensor less operation – Characteristics and Closed loop control Applications.

UNIT IV	PERMANENT MAGNET BRUSHLESS D.C. MOTORS	9

Permanent Magnet materials – Minor hysteresis loop and recoil line-Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation - Power Converter Circuits and their controllers – Motor characteristics and control– Applications

UNIT V	PERMANENT MAGNET SYNCHRONOUS MOTORS	9

Principle of operation – Ideal PMSM – EMF and Torque equations – Armature MMF – Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements– Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the performance characteristics of synchronous reluctance motors
CO2:	Classify the excitation modes of stepping motor
CO3:	Construct the power converter circuits for Switched reluctance motor

CO4:	Analyze the magnetic characteristics of brushless D.C motor
CO5:	Compare the control methods of permanent magnet synchronous motor

REFERENCES:

1.	. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2.	T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.
3.	T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.
4	R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.
5	P.P. Acarnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus London, 1982.
6	T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press,London, 1988.
7	E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	2	1	1
CO2	1	-	-	2	1	1
CO3	1	-	-	2	1	1
CO4	1	-	-	2	1	1
CO5	1	-	-	2	1	1
CO	1	-	-	2	1	1

Table of Specification for End Semester Question Paper

PE22112 SPECIAL ELECTRICAL MACHINES

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Synchronous Reluctance Motors	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Stepper Motors	2	1 either or	2(2) - CO2	1 either or (16) — CO2	-	-
Unit-III: Switched Reluctance Motors	2	1 either or	2(2) — CO3	1 either or (16) – CO1	-	-
Unit-IV Permanent Magnet Brushless D.C. Motors	2	I either or	2(2) - CO4	1 either or (16) – CO1	-	-
Unit-V: Permanent Magnet Synchronous Motors	2	I either or	2(2) – CO5	1 either or (16) – CO1	-	-
Total Qns.	10	5 either or	10(2)	5 (10)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22113	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the different soft computing techniques
- To learn about the design of ANN and fuzzy set theory
- To analyze and implement the ANN and Fuzzy logic for modeling and control of Non-linear system and to get familiarized with the MATLAB toolbox
- To solve optimization problems using genetic algorithms
- To impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box

UNIT I	INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS	9

Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems – Single objective and multi-objective problems -Neuron- Nerve structure and synapse- Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- Mc Culloch Pitts neuron model- perceptron model- Adaline and Madaline- multilayer perception model- back propagation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training- applications

UNIT II	ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY	9

Counter propagation network- architecture- functioning & characteristics of counter Propagation network- Hopfield/ Recurrent network configuration - stability constraints associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications- Implementation and training - Associative Memory.

UNIT III	FUZZY LOGIC SYSTEM	9

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control- Fuzzification inferencing and defuzzification-Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system

UNIT IV	GENETIC ALGORITHM	9

Evolutionary programs – Genetic algorithms, genetic programming and evolutionary programming - Genetic Algorithm versus Conventional Optimization Techniques – Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators - Optimization problems using GA-discrete and continuous – Single objective and multi-objective problems - Procedures in evolutionary programming.

UNIT V	HYBRID CONTROL SCHEMES	9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm – Introduction to Support Vector Machine-Evolutionary Programming-Particle Swarm Optimization – Case study – Familiarization of NN, FLC and ANFIS Tool Box.

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Define the basic concepts of ANN and Fuzzy logic, genetic algorithm and hybrid control schemes
CO2:	Explain the architectures of ANN, learning methods, fuzzy sets and algorithms
CO3:	Develop ANN and fuzzy logic-based models and control schemes for non-linear Systems
CO4:	Examine the different operations on the fuzzy sets, artificial neural networks
CO5:	Analyze the optimization problems in genetic algorithm and hybrid control schemes

REFERENCES:

1.	Laurene V. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms And Applications", Pearson Education.
2.	Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India, 2008.
3.	Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4.	David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
5.	W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control" MIT Press", 1996.
6.	T. Ross, "Fuzzy Logic with Engineering Applications", Tata McGraw Hill, New Delhi, 1995.
7.	Ethem Alpaydin, "Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)", MIT Press, 2004.
8.	Corinna Cortes and V. Vapnik, " Support - Vector Networks, Machine Learning " 1995.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	2	-	-
CO2	-	-	-	2	-	-
CO3	2	-	-	-	3	-
CO4	1	-	-	-	3	-
CO5	2	-	-	-	3	-
CO	1.66	-	-	2	3	-

Table of Specification for End Semester Question Paper

PE22113 SOFT COMPUTING TECHNIQUES

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction and Artificial Neural Networks	2	1 either or	2(2) – CO1	1 either or (16) - CO1	-	-
Unit-II: Artificial Neural Networks and Associative Memory	2	1 either or	2(2) - CO2	1 either or (16) - CO2	-	-
Unit-III: Fuzzy Logic System	2	1 either or	2(2) — CO3	1 either or (16) - CO3	-	-
Unit-IV Genetic Algorithm	2	1 either or	2(2) - CO4	1 either or (16) - CO4	-	-
Unit-V: Hybrid Control Schemes	2	1 either or	2(2) – CO5	-	1 either or (16) - CO5	-
Total Qns.	10	5 either or	10(2)	4 either or (16)	1 either or (16)	-
Total Marks	20	80	20	64	16	-
Weightage	20 %	80%	20%	46%	16%	-

Weightage for COs

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22114	**SYSTEM THEORY**	**L**	**T**	**P**	**C**

		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To educate on modeling and representing systems in state variable form
- To train on solving linear and non-linear state equations
- To illustrate the properties of control system
- To classify non–linearities and examine stability of systems in the sense of Lyapunov's theory
- To educate on modal concepts, design of state, output feedback controllers and estimators

UNIT I	**STATE VARIABLE REPRESENTATION**	**9**

Introduction-Concept of State-Space equations for Dynamic Systems -Time invariance and linearity -Non uniqueness of state model- Physical Systems and State Assignment - free and forced responses- State Diagrams

UNIT II	**SOLUTION OF STATE EQUATIONS**	**9**

Existence and uniqueness of solutions to Continuous-time state equations - Solution of Nonlinear and Linear Time Varying State equations - State transition matrix and its properties – Evaluation of matrix exponential- System modes- Role of Eigen values and Eigen vectors

UNIT III	**PROPERTIES OF THE CONTROL SYSTEM**	**9**

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time SystemsTime varying and Time invariant case-Output Controllability-Reducibility-System Realizations

UNIT IV	**NON-LINEARITIES AND STABILITY ANALYSIS**	**9**

Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Types of nonlinearity – Phase plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Derivation of describing functions. Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems - Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems- Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems- Krasovskii and Variable-Gradiant Method

UNIT V	**MODAL ANALYSIS**	**9**

Controllable and Observable Companion Forms - SISO and MIMO Systems – Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Understand the concept of State-State representation for dynamic systems.
CO2:	Explain the solution techniques of state equations.
CO3:	Realize the properties of control systems in state space form.
CO4:	Identify non-linearities and evaluate the stability of the system.
CO5:	Perform Modal analysis and design controller and observer in state space form.

REFERENCES:	
1.	M. Gopal, “Modern Control System Theory”, New Age International, 2005.
2.	Z. Bubnicki, ”Modern Control Theory”, Springer, 2005
3.	K. Ogatta, “Modern Control Engineering”, PHI, 2002
4.	John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill, 1999
5.	D. Roy Choudhury, “Modern Control Systems”, New Age International, 2005
6.	John J. D’Azzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, 2003
7.	M. Vidyasagar, “Nonlinear Systems Analysis’, 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey, 2002.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	3	-	-
CO2	-	-	-	3	-	-
CO3	-	-	-	3	-	-
CO4	2	-	-	3	-	-
CO5	2	-	-	3	3	2
CO	2	-	-	3	3	2

Table of Specification for End Semester Question Paper

PE22114 SYSTEM THEORY

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Solution of State Equations	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Solution of State Equations	2	1 either or	2(2) - CO2	1 either or (16) — CO2	-	-
Unit-III: Properties of The Control System	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
Unit-IV Non-Linearities and Stability Analysis	2	1 either or	2(2) - CO4	-	1 either or (16) — CO4	
Unit-V: Modal Analysis	2	1 either or	2(2) – CO5	-	1 either or (16) — CO5	-
Total Qns.	10	5 either or	10(2)	3 either or (16)	2 either or (16)	-
Total Marks	20	80	20	48	32	-
Weightage	20 %	80%	20%	48%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22221	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge about the impacts of renewable energy power generation on environment and structure of renewable Energy conversion systems.
- To analyze and comprehend the mode of operation and the characteristics of solar energy and wind energy conversion systems.
- To equip with required skills to derive the criteria for the importance of solar and wind Maximum Power Point Tracking Techniques and hybrid systems.
- To develop the applications of solar and wind energy conversion systems.
- To design different power converters and apply suitable power converters for solar PV and wind energy conversion systems.

UNIT I	INTRODUCTION	9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) -Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems - operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II	ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEM	9

Principle of operation and analysis: Induction Generator, Permanent Magnet Synchronous Generator and Wound Field Synchronous Generator.

UNIT III	POWER ELECTRONICS FOR SOLAR PHOTO VOLTAIC SYSTEM	9

Block diagram of solar photo voltaic system : line commutated converters (inversion-mode) - Boost and buck-boost converters-selection of inverter, battery sizing, array sizing- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV	POWER ELECTRONICS FOR WIND ENERGY CONVERSION SYSTEM	9

Three phase AC voltage controllers-AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, matrix converters- Stand alone operation of fixed and variable speed wind energy conversion systems- Grid connection Issues -Grid integrated PMSG based WECS.

UNIT V	HYBRID RENEWABLE ENERGY SYSTEMS	9

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

	TOTAL: 45 PERIODS
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explain the impacts of renewable energy power generation on environment and the structure of renewable Energy conversion systems.
CO2:	Apply the mode of operation of machines and the characteristics of wind energy conversion systems.
CO3:	Explain the importance of power converters in solar photovoltaic systems.
CO4:	Explain the importance of power converters in wind energy conversion systems.
CO5:	Analyse Maximum Power Point Tracking method of hybrid wind energy conversion systems.

REFERENCES:

1.	S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
2.	B.H.Khan, "Non-conventional Energy sources", Tata McGraw-hill Publishing Company, New Delhi, 2009.
3.	M.Godoy Simoez, Felix A Farret, "Modeling and Analysis with Induction Generators", CRC Press, Taylor & Francis Group, 2015.
4.	Rashid .M. H "Power Electronics Hand book", Academic press, 2001.
5.	Rai. G.D," Solar energy utilization", Khanna publishers, 1993.
6.	R.Seyezhai and R.Ramaprabha, "Power Electronics for Renewable Energy Systems", Scitech Publication,2019.
7.	Gray, L. Johnson, "Wind energy system", PHI, 1995.
8.	P.S.Bimbhra,"Power Electronics",Khanna Publishers, 3rd Edition,2003.
9.	Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.
10.	Andrzej M. Trzynnadlowski, 'Introduction to Modern Power Electronics', Second edition, wiley

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	2	2	2
CO2	2	-	-	2	2	2
CO3	2	-	-	2	2	2
CO4	2	-	-	2	2	2
CO5	2	-	-	2	2	2
CO	2	-	-	2	2	2

Table of Specification for End Semester Question Paper

PE22221 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEM

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Electrical Machines for Wind Energy Conversion System	2	1 either or	2(2) - CO2	-	1 either or (16) – CO2	-
Unit-III: Power Electronics for Solar Photo Voltaic System	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
Unit IV- Power Electronics for Wind Energy Conversion System	2	1 either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V: Hybrid Renewable Energy Systems	2	1 either or	2(2) – CO5		-	1 either or (16) – CO5
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	48	16	16
Weightage	20 %	80%	20%	48%	16%	16%

Weightage for COs					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22222	PWM RECTIFIERS AND RESONANT CONVERTERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To inculcate knowledge on harmonics standards
- To impart knowledge on the design power factor correction rectifiers for UPS applications
- To familiarize the design resonant converters for SMPS applications
- To provide knowledge on dynamic analysis of DC to DC Converters
- To introduce the control techniques for control of resonant converters

UNIT I	POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS	9

Average power-RMS value of an AC waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Continuous Conduction Mode- Discontinuous Conduction Mode-Single phase Rectifier's behavior for large value of Capacitance -Minimizing THD for small value of Capacitance

UNIT II	PULSE WIDTH MODULATED RECTIFIERS	9

Properties of Ideal rectifiers-Realization of non-ideal rectifier-Single phase converter system

In corporating ideal rectifiers-Modelling losses and efficiency in CCM - high quality rectifiers-Boost rectifier-expression for controller duty cycle-expression for DC load current.

UNIT III	RESONANT CONVERTERS	9

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching - Zero Voltage Switching -Classification of Quasi resonant switches-Zero Current and Zero Voltage Switching of Quasi Resonant Buck converter- Zero Current and Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis.

UNIT IV	DYNAMIC ANALYSIS OF SWITCHING CONVERTERS	9

Review of linear system analysis-State Space Averaging-Basic State Space Average Model- State Space Averaged model for Buck Converter, Boost Converter, Buck Boost Converter and Cuk Converter.

UNIT V	CONTROL OF PWM RECTIFIERS	9

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme- Average current control-Current programmed Control- Hysteresis control- Nonlinear carrier control –Design of Controllers: PI Controller, Variable Structure Controller for source current shaping of PWM rectifiers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Understand the standards for supply current harmonics and its significance

CO2:	Design power factor correction rectifiers for UPS applications
CO3:	Analyze and design the resonant converters
CO4:	Derive the state space model of basic and derived DC-DC converters
CO5:	Design an appropriate controller for PWM rectifiers

REFERENCES:

1.	John G. Kassakian, Martin F. Schlecht, George C. Verghese, "Principles of Power Electronics",Pearson, India, New Delhi, 2010
2.	Philip T Krein, " Elements of Power Electronics", Oxford University Press,1998
3.	Ned Mohan, "Power Electronics: A first course", John Wiley,2011
4.	IssaBatarseh, Ahmad Harb, "Power Electronics- Circuit Analysis and Design, Second edition,2018
5.	Simon Ang and Alejandro Oliva, "Power Switching Converters", Taylor & Francis Group, 2010.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	2	-	-
CO2	-	-	-	2	-	-
CO3	-	-	-	2	-	1
CO4	1	-	-	2	1	1
CO5	1	-	-	2	1	-
CO	1	-	-	2	1	1

Table of Specification for End Semester Question Paper

PE22222 PWM RECTIFIERS AND RESONANT CONVERTERS

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Power System Harmonics & Line Commutated Rectifiers	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Pulse Width Modulated Rectifiers	2	1 either or	2(2) - CO2	1 either or (16) – CO2	-	-
Unit-III: Resonant Converters	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
Unit IV- Dynamic Analysis of Switching Converters	2	1 either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V: Control of PWM Rectifiers	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22223	VOLTAGE LIFT CONVERTERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the operation of voltage lift circuits
- To impart knowledge on the working of super lift circuits
- To learn the operation of ultra-lift converters and multiple quadrant converters
- To provide knowledge on the principle of bidirectional dual active bridge converters
- To educate on the working principle of Impedance source converter

UNIT I	VOLTAGE-LIFT CONVERTERS	9

Introduction- Self-lift and reverse self-lift circuits- Cuk converter, Luo converter and SEPIC converter- continuous and discontinuous conduction mode.-Applications

UNIT II	POSITIVE OUTPUT &NEGATIVE OUTPUT SUPER-LIFT LUOCONVERTERS	9

Main series, -Elementary Circuit, Re-Lift Circuit, Triple-Lift Circuit, Higher-Order Lift Circuit-. Continuous and discontinuous conduction modes- Applications

UNIT III	ULTRA LIFT CONVERTERS AND MULTIPLE-QUADRANT OPERATING LUO-CONVERTERS	9

Ultra-Lift Luo- Converter- Operation - Continuous and discontinuous conduction Modes of Ultra-Lift Luo-Converter-Instantaneous Values- Multiple quadrant operating Luo Converters- Circuit explanations- Modes of operation- Applications

UNIT IV	BIDIRECTIONAL DUAL ACTIVE BRIDGE DC–DC CONVERTERS	9

Application of Bidirectional DC–DC Converter-Classification of Bidirectional DC–DC Converter - Working Principle of Hybrid-Bridge-Based Dual active bridge (DAB) converter- Performance- Voltage mode control- Principle of Dual-Transformer based DAB converter- Three-Level bidirectional DC–DC converter- Applications

UNIT V	IMPEDANCE SOURCE CONVERTER	9

Voltage- Fed Z- source inverters -Topologies –Steady state and dynamic model- Current fed Zsource inverter -Topology -Modification and operational principles. Modulation Methods- Sine PWM- SVPWM and Pulse width Amplitude Modulation- Applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Understand the working of voltage lift circuits
CO2:	Design the super lift converters
CO3:	Understand the working and applications of ultra-lift converters
CO4:	Acquire knowledge on working and design of bi-directional DC-DC converters
CO5:	Understand the concepts related with impedance source converter

REFERENCES:

1.	Fang Lin Luo, Hong Ye "Advanced DC/DC Converters",Second Edition,CRC press,2018
2.	Yushan Liu , Haitham Abu- Rub , BaomingGe , Dr. FredeBlaabjerg , Omar Ellabban , Poh Chiang Loh, "Impedance source power electronic converters", Wiley IEEE Press, 2016
3.	DeshangSha,GuoXu, "High-Frequency Isolated Bidirectional Dual Active Bridge DC–DC Converters with Wide Voltage Gain", Springer 2019
4.	Fang Lin Luo, Hong Ye, "Essential DC/DC Converters", First Edition, CRC,2005
5.	Fang Lin Luo, Hong Ye, "Power Electronics Advanced Conversion Technologies", Second Edition, 2018 CRC press.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	3	2	1
CO2	1	1	1	3	2	1
CO3	1	1	1	3	2	1
CO4	1	1	1	3	2	1
CO5	1	1	1	3	2	1
CO	1	1	1	3	2	1

Table of Specification for End Semester Question Paper

PE22223 VOLTAGE LIFT CONVERTERS

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Voltage-Lift Converters	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Positive Output &Negative Output Super-Lift Luoconverters	2	1 either or	2(2) - CO2	1 either or (16) – CO2	-	-
Unit-III: Ultra Lift Converters and Multiple-Quadrant Operating Luo-Converters	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
UnitIV-Bidirectional Dual Active Bridge DC–DC Converters	2	1 either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V: Impedance Source Converter	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22224	CONTROL OF POWER ELECTRONIC CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To inculcate knowledge on the basics of control for power electronic circuits
- To illustrate the concepts of feedback controllers for DC-DC converters
- To learn about the controller design for AC-DC converter circuits
- To learn about the controller design for DC-AC converter circuits
- To impart knowledge on sliding mode control

UNIT I	INTRODUCTION TO CONTROLLER DESIGN	9

Introduction, Review of Linear Control Theory, Linearization of Various Transfer Function Blocks, Feedback Controller Design in Voltage-Mode Control, Peak-Current Mode Control, Feedback Controller Design in DCM

UNIT II	CONTROLLER DESIGN FOR DC-DC CONVERTERS	9

Introduction, Linear Feedback Control- Pole Placement by Full State Feedback, Pole Placement Based on Observer Design, Reduced Order Observers, Generalized Proportional Integral Controllers- Application to power converters

UNIT III	CONTROLLER DESIGN FOR AC-DC CONVERTER CIRCUITS	9

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

UNIT IV	CONTROLLER DESIGN FOR DC-AC CONVERTER CIRCUITS	9

Introduction, Synthesis of Low-Frequency AC, Single-Phase Inverters, Three-Phase Inverters, Multilevel Inverters, Converters for Bi-Directional Power Flow, Matrix Converters

UNIT V	SLIDING MODE CONTROL	9

Introduction, Variable Structure Systems, Control of Single Switch Regulated Systems, Sliding Surfaces, Equivalent Control and the Ideal Sliding Dynamics, Accessibility of the Sliding Surface - Application to power converters

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the basics of control for power electronic circuits
CO2:	Describe the concepts of feedback controllers for DC-DC converters
CO3:	Design controllers for front end power factor corrector circuits and AC-DC converters
CO4:	Design controllers for DC-AC converters
CO5:	Apply sliding mode control for power converters

REFERENCES:	
1.	Hebertt Sira-Ramírez and Ramón Silva-Ortigoza,"Control Design Techniques in Power Electronics Devices " Springer-Verlag London Limited 2006
2.	Ned Mohan,"Power Electronics: A First Course", Johnwiley, 2011
3.	Marian K. Kazimierczuk and Agasthya Ayachit,"Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters", Wiley 2016
4.	Farzin Asadi and Kei Eguchi, Morgan &Claypool", Dynamics and Control of DC-DC Converters", 2018
5	Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991
6	Azar, Ahmad Taher, Zhu, Quannmin," Advances and Applications in sliding mode control systems", Springer, 2015

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	-
CO2	3	-	2	2	2	-
CO3	3	-	2	2	2	2
CO4	3	-	2	2	2	2
CO5	3	-	2	2	2	2
CO	3	-	2	2	2	2

Table of Specification for End Semester Question Paper

PE22224 CONTROL OF POWER ELECTRONIC CIRCUITS

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction to Controller Design	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Controller Design for DC-DC Converters	2	1 either or	2(2) - CO2	1 either or (16) – CO2	-	-
Unit-III: Controller Design for AC-DC Converter Circuits	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
Unit IV- Controller Design For DC-AC Converter Circuits	2	1 either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V Sliding Mode Control	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22231	POWER QUALITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic terms and power quality issues.
- To analyse single phase and three phase systems .
- To understand the importance of conventional load compensation systems.
- To understand the load compensation problem using DSTATCOM.
- To understand the series compensation of power distribution systems.

UNIT I	INTRODUCTION	9

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

UNIT II	ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM	9

Single phase sinusoidal, non- sinusoidal source supplying linear and nonlinear loads – Three phase Balance system – Three phase unbalanced system – Three phase unbalanced and distorted source supplying non- linear loads – Concept of PF – Three phase three wire – Three phase four wire system

UNIT III	CONVENTIONAL LOADCOMPENSATION METHODS	9

Principle of Load compensation and Voltage regulation – Classical load balancing problem : Open loop balancing – Closed loop balancing, Current balancing – Harmonic reduction and voltage sag reduction – Analysis of unbalance – instantaneous real and reactive powers – Extraction of fundamental sequence component.

UNIT IV	LOAD COMPENSATION USING DSTATCOM	9

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

UNIT V	SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM	9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:	
CO1:	Understand the various basic terms and power quality issues.
CO2:	Analyze single phase and three phase systems.
CO3:	Explain the importance of conventional load compensation systems.
CO4:	Explain load compensation problem using DSTATCOM.
CO5:	Understand the series compensation of power distribution systems.

REFERENCES:

1.	Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
2.	R.C. Duggan, Mark.F.Mc Granaghan, Surya Santoas and H.Wayne Beaty, "Electrical Power System Quality", McGraw-Hill, 2004
3.	G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications,1994
4.	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad , "Power Quality: Problems and
5.	Mitigation Techniques", John Wiley &Sons,2015
6	Jos Arrillaga and Neville R. Watson ," Power systemharmonics",Wiley,2003.
7	Derek A. Paice , "Power Electronics Converter Harmonics :Multipulse Methods for Clean Power",Wiley,1999.
8	Ewald Fuchs, Mohammad A. S. Masoum Power Quality in Power Systems and Electrical Machines,Elseveir academic presspublications,2011.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	3	2	1
CO2	-	-	-	3	2	1
CO3	1	-	1	3	2	1
CO4	1	-	1	3	2	1
CO5	1	-	1	3	2	1
CO	1	-	1	3	2	1

Table of Specification for End Semester Question Paper

PE22231 POWER QUALITY

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Analysis of Single Phase And Three Phase System	2	1 either or	2(2) - CO2	1 either or (16) – CO2	-	-
Unit-III: Conventional Loadcompensation Methods	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
Unit-IV Load Compensation Using Dstatcom	2	1 either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V: Series Compensation of Power Distribution System	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22232	MACHINE LEARNING AND DEEP LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand about the learning problem and algorithms
- To Introduce the machine learning fundamentals and significance
- To enable the students to acquire knowledge about pattern recognition
- To motivate the students to apply deep learning algorithms for solving real life problems
- To provide insight about python for data science

UNIT I	LEARNING PROBLEMS AND ALGORITHMS	9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms.

UNIT II	MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS	9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, over fitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering

UNIT III	DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs

UNIT IV	DEEP LEARNING: RNNS, AUTOENCODERS AND GANS	9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

UNIT V	INTRODUCTION TO PYTHON FOR DATA SCIENCE	9

Data science- data outlook- tools for data science. Introduction to python, evolution of python , Variables and Data types; naming variables, naming conventions, assigning values to multiple variables, Data types, object data type, Operators-operators and operands, arithmetic operators, assignment operators-Relational or comparison operators, logical operators -bitwise operators-Sequence data types and associated operations-Python Pandas, Python Numpy, Python Scikit-learn

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Illustrate the categorization of machine learning algorithms.
CO2:	Construct different feature selection and classification techniques
CO3:	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO4:	Construct advanced neural network architectures such as RNN, Autoencoders, and GANs
CO5:	Apply python for machine learning applications.

REFERENCES:

1.	J. S. R. Jang, C. T. Sun, E. Mizutani, "Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence", PHI learning,2012.
2.	Ian Good fellow, YoshuaBengio and Aaron Courville "Deep Learning", , MIT Press, 2016
3.	Trevor Hastie, Robert Tibshirani and Jerome Friedman "The Elements of Statistical Learning", Second Edition. 2009.
4.	Christopher Bishop "Pattern Recognition and Machine Learning", Springer. 2006.
5.	Shai Shalev-Shwartz and Shai Ben-David "Understanding Machine Learning". Cambridge University Press. 2017.
6.	Samir Madhavan "Mastering python for data science" , PACKT Publishing, 2015.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2	1			3	1	
CO3	1			3	1	
CO4	2		2	3	1	2
CO5	1		1	1	1	1
CO	2		2	3	1	2

Table of Specification for End Semester Question Paper

PE22232 MACHINE LEARNING AND DEEP LEARNING

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Learning Problems and Algorithms	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Machine Learning – Fundamentals & Feature Selections & Classifications	2	1 either or	2(2) - CO2	1 either or (16) — CO2	-	-
Unit-III: Deep Learning: Convolutional Neural Networks	2	1 either or	2(2) — CO3		1 either or (16) — CO3	-
Unit IV- Deep Learning: Rnns, Autoencoders And Gans	2	1 either or	2(2) - CO4	-	1 either or (16) — CO4	
Unit-V: Introduction to Python for Data Science	2	1 either or	2(2) – CO5	-	1 either or (16) — CO5	-
Total Qns.	10	5 either or	10(2)	2 either or (16)	3 either or (16)	-
Total Marks	20	80	20	32	48	-
Weightage	20 %	80%	20%	48%	32%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22233	IOT FOR SMART SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study about Internet of Things technologies and its role in real time applications
- To introduce the infrastructure required for IOT
- To familiarize the accessories and communication techniques for IOT
- To provide insight about the embedded processor and sensors required for IOT
- To familiarize the different platforms and Attributes for IOT

UNIT I	INTRODUCTION TO INTERNET OF THINGS	9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IOT applications, Challenges in IOT implementation, Trends and implications.

UNIT II	IOT ARCHITECTURE	9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IOT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons

UNIT III	PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT	9

PROTOCOLS: NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell. Wireless technologies for IOT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends

UNIT IV	IOT PROCESSORS	9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability. Embedded processors for IOT: Introduction to Python programming -Building IOT with RASPERRY PI and Arduino

UNIT V	CASE STUDIES	9

Industrial IOT, Home Automation- Smart refrigerator, Smart Oven, Smart Washer and Dryer, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defence

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Analyze the concepts of IOT and its present developments
CO2:	Compare and contrast different platforms and infrastructures available for IOT
CO3:	Explain different protocols and communication technologies used in IOT
CO4:	Analyze the big data analytic and programming of IOT
CO5:	Implement IOT solutions for smart applications

REFERENCES:

1.	ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2.	Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.

3.	Samuel Greengard, "The Internet of Things", The MIT press, 2015.
4.	Adrian McEwen and Hakim Cassimally"Designing the Internet of Things "Wiley,2014
5.	Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010
6.	Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7.	Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	1	1	-	2
CO2	1	-	1	1	-	2
CO3	-	-	-	-	-	2
CO4	1	-	-	-	-	2
CO5	1	-	-	-	-	2
CO	1	-	1	1	-	2

Table of Specification for End Semester Question Paper

PE22233 IOT FOR SMART SYSTEMS

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction to Internet of Things	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Iot Architecture	2	1 either or	2(2) - CO2	1 either or (16) – CO2	-	-
Unit-III: Protocols and Wireless Technologies for Iot	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
Unit IV- Iot Processors	2	1 either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V: Case Studies	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22234	MEMS DESIGN OF SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the learning process to design micro sensors, embedded sensors & actuators
- To analyse the electrostatic sensors and actuators through MEMS and NEMS devices
- To examine the thermal sensors and actuators through MEMS and NEMS devices
- To examine the piezoelectric sensors and actuators through MEMS and NEMS
- To design piezoresistive sensors for biomedical and micro fluidic applications

UNIT I	MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS	9

Overview of micro fabrication – Silicon and other material based fabrication processes –Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain flexural beam bending analysis- torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II	ELECTROSTATIC SENSORS AND ACTUATION	9

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications.

UNIT III	THERMAL SENSING AND ACTUATION	9

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

UNIT IV	PIEZOELECTRIC SENSING AND ACTUATION	9

Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials Applications.

UNIT V	CASE STUDIES	9

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Explain the learning process to design micro sensors, embedded sensors & actuators
CO2:	Analyse the electrostatic sensors and actuators through MEMS and NEMS devices
CO3:	Examine the thermal sensors and actuators through MEMS and NEMS devices
CO4:	Examine the piezoelectric sensors and actuators through MEMS and NEMS
CO5:	Design piezoresistive sensors for biomedical and micro fluidic applications

REFERENCES:

1.	Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
2.	Marc Madou , “Fundamentals of microfabrication”,CRC Press, 1997.

3.	Boston , “Micromachined Transducers Source book”,WCB McGraw Hill, 1998.
4.	M.H.Bao “Micromechanical transducers: Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 2000.
5.	James J. Allen , “Micro Electro Mechanical System Design” CRC press 2005 .

Mapping of Course Outcomes to Program Outcomes

Course outcome	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	-	-	-	-
CO2	-	1	1	1	-	-
CO3	-	1	-	1	-	-
CO4	-	1	1	1	1	-
CO5	1	1	1	1	1	1
CO	1	1	1	1	1	1

Table of Specification for End Semester Question Paper

PE22234 MEMS DESIGN OF SENSORS AND ACTUATORS

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Micro-Fabrication, Materials and Electro-Mechanical Concepts	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Electrostatic Sensors and Actuation	2	1 either or	2(2) - CO2	1 either or (16) – CO2	-	-
Unit-III: Thermal Sensing and Actuation	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-

Unit IV- Piezoelectric Sensing and Actuation	2	1 either or	2(2) - CO4	1 either or (16) – CO4	-	-
Unit-V: Case Studies	2	1 either or	2(2) – CO5	1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22341	**RENEWABLE ENERGY TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To explain the Conventional and Non-Conventional energy resources, environmental impacts, national and international energy scenario.
- To develop the concept and techniques of electrical applications for solar photovoltaic systems.
- To construct solar heating applications used in conversion of energy through solar thermal systems.
- To explain the concept and techniques used in conversion of energy through Wind energy conversion systems.
- To understand the concept about biomass, geothermal, hydro power plant, tidal energy, ocean thermal energy conversion, fuel cell, energy storage and hybrid energy systems.

UNIT I	**INTRODUCTION OF ENERGY SOURCES**	**9**

Types of renewable energy sources, environmental impact of renewable energy sources, renewable energy resources in India, Current usage of renewable energy sources in India and international, future potential of renewable energy in power production and development of renewable energy technologies, literature review of solar and wind energy.

UNIT II	SOLAR PHOTOVOLTAIC ENERGY CONVERSION	9
Types of PV Systems- PV Module I-V Characteristics, configuration of PV system, maximum power point tracking. Application solar PV system in battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.		
UNIT III	**SOLAR THERMAL ENERGY CONVERSION**	**9**
Solar Thermal Energy Conversion from plate Solar Collectors, Concentrating Collectors and its Types, Applications of Solar Thermal Energy use of low and medium, high temperature and recent advances in industry and buildings. Solar Thermal Power Plant, Solar cookers, Solar hot water systems, Solar dryers, Solar Distillation, Solar greenhouses.		
UNIT IV	**WIND ENERGY**	**9**
Wind site and its resource assessment, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications.		
UNIT V	**OTHER TYPES OF ENERGY**	**9**
Bio-energy, biogas generation, thermal gasification of biomass, biomass gasifies, Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants. Tidal and wave energy: Potential and conversion techniques, mini- hydel power plants and their economics.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
CO1:	Explaining the Conventional and Non-Conventional energy resources, environmental impacts, national and international energy scenario.	
CO2:	Develop the concept and techniques of electrical applications for solar photovoltaic systems.	
CO3:	Construct solar heating applications used in conversion of energy through solar thermal systems.	
CO4:	Understand the concept and techniques used in conversion of energy through Wind energy conversion systems.	
CO5:	Demonstrate the concept about biomass, geothermal, hydro power plant, tidal energy, ocean thermal energy conversion, fuel cell, energy storage and hybrid energy systems	
REFERENCES:		
1	Twidell & Wier,'Renewable Energy Resources' CRC Press(Taylor & Francis).	

2	Chetan Singh Solanki, " Solar Photovoltaics : Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011
3	Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt.Ltd, New Delhi, 2011.
4	D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.
5	Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.

Course outcomes	PO					
	1	2	3	4	5	6
CO1	1	3	-	-	-	-
CO2	2	2	1	2	1	2
CO3	2	2	1	2	-	2
CO4	1	2	2	2	-	-
CO5	1	1	-	1	-	-
CO	1	2	1	2	1	2

Table of Specification for End Semester Question Paper

PE22341 RENEWABLE ENERGY TECHNOLOGY

Unit No. and Title	**Total 2 Marks**	**Total 16 Marks**	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction of Energy Sources	2	1either or	1(2)-CO1	1(2)-CO1 1 either or (16)-CO1	-	-
Unit-II: Solar Photovoltaic Energy Conversion	2	1either or	1(2)-CO2	1(2)-CO2	1either or (16)-CO2	-
Unit-III: Solar Thermal Energy Conversion	2	1either or	1(2)-CO3	1(2)-CO3	1 either or (16)-CO3	-

Unit IV- Wind Energy	2	1either or	1(2)-CO4	1(2)-CO4 1 either or (16)-CO4	-	-
Unit-V: Other Types Of Energy	2	1either or	1(2)-CO5	1(2)-CO5 1 either or (16)-CO5	-	-
Total Qns.	10	5either or	5(2)	5(2) 3 either or (16)	2 either or (16)	-
Total Marks	20	80	10	58	32	-
Weightage	20%	80%	10%	58%	32%	-

Weightage for COs

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22342	**WIND ENERGY CONVERSION TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To attain knowledge on the basic concepts of Wind energy and its conversion systems.
- To explaining the mathematical model of wind energy conversion system and its control.
- To demonstrate the fixed speed wind energy conversion system.
- To demonstrate the need of Variable speed system and its modeling.
- To illustrate the grid integration issues of wind power.

UNIT I	**INTRODUCTION OF WIND ENERGY**	**9**

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

UNIT II	**WIND TURBINES**	**9**
HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control, Pitch angle control- stall control-Schemes for maximum power extraction.		
UNIT III	**FIXED SPEED SYSTEMS**	**9**
Generating Systems- Constant speed constant frequency systems -Choice of Generators Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.		
UNIT IV	**VARIABLE SPEED SYSTEMS**	**9**
Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes. Tentative		
UNIT V	**GRID CONNECTED SYSTEMS**	**9**
Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.		
TOTAL: 45 PERIODS		
COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
CO1:	Outline the basic concepts of Wind energy and its conversion systems	
CO2:	Explaining the mathematical model of wind energy conversion system and its control.	
CO3:	Demonstrate the fixed speed wind energy conversion system.	
CO4:	Demonstrate the need of Variable speed system and its modeling.	
CO5:	Illustrate the grid integration issues of wind power.	
TEXT BOOKS:		
1	Twidell & Wier,'Renewable Energy Resources' CRC Press(Taylor & Francis).	
2	L.L.Freris "Wind Energy conversion Systems", Prentice Hall,1990	
3	S.N.Bhadra, D.Kastha,S.Banerjee, "Wind Electrical Systems", Oxford University Press,2010.	

4	Ion Boldea, "Variable speed generators", Taylor & Francis group,2006
5	E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,1976.
6	N. Jenkins," Wind Energy Technology" John Wiley &Sons,1997.
7	Power Conversion and Control Of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE
8	Wind Electrical Systems, S.N. Bhadra, 2005, Oxford
9	Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET

Course outcomes	PO					
	1	2	3	4	5	6
CO1	-	1	1	2	-	-
CO2	2	2	2	3	1	1
CO3	1	-	1	1	1	-
CO4	1	2	1	2	2	-
CO5	1	2	-	2	2	-
CO	1	2	1	2	2	1

Table of Specification for End Semester Question Paper

PE22342 WIND ENERGY CONVERSION TECHNOLOGY

Unit No. and Title	**Total 2 Marks**	**Total 16 Marks**	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: INTRODUCTION OF WIND ENERGY	2	1either or	1(2)-CO1	1(2)-CO1 1 either or (16)-CO1	-	-
Unit-II: WIND TURBINES	2	1either or	1(2)-CO2	1(2)-CO2 1either or (16)-CO2	-	-

Unit-III: FIXED SPEED SYSTEMS	2	1either or	1(2)-CO3	1(2)-CO3 1 either or (16)-CO3	-	-
Unit IV-VARIABLE SPEED SYSTEMS	2	1either or	1(2)-CO4	1(2)-CO4 1 either or (16)-CO4	-	-
Unit-V: GRID CONNECTED SYSTEMS	2	1either or	1(2)-CO5	1(2)-CO5 1 either or (16)-CO5	-	-
Total Qns.	10	5either or	5(2)	5(2) 5 either or (16)	-	-
Total Marks	20	80	10	90	-	-
Weightage	20%	80%	10%	90%	-	-

Weightage for COs

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22343	ENERGY MANAGEMENT AND AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the energy scenario and the concepts related to energy management
- To study the process behind energy audit.
- To study understand the energy action planning and financing.
- To emphasize the energy management of various electrical equipment.
- To illustrate the concept of energy efficient technologies

UNIT I	ENERGY SCENARIO	9

Basics of Energy and its various forms - Conventional and non-conventional sources – Energy intensity on PPP – Electricity pricing in India – Energy Security - Schemes under Energy conservation act 2001- Integrated energy policy - Electricity Act 2003 - NAPCC

UNIT II	ENERGY AUDITING	9

Definition – Need - Energy audit methodology: audit preparation, execution and reporting – Instruments for energy audit - Energy managers and energy auditors: Roles and responsibilities - Understanding energy costs – Benchmarking - Energy performance –BEE Regulations 2008

UNIT III	ENERGY ACTION PLANNING AND FINANCING	9

Top management commitment and support – Assessing energy profile and forming baseline – Energy policy and planning – Evaluating energy performance – Recognize achievements – Management tools for effective implementation - Financial analysis technique – cash flow – sensitivity and risk analysis – financing options.

UNIT IV	ENERGY MANAGEMENT IN ELECTRICAL SYSTEMS	9

Electricity billing – Electrical load management and Maximum demand control – Power factor improvement and benefits – Transformers – Distribution losses in industrial system – T & D losses in power systems – estimation of technical losses in distribution system – Commercial losses.

UNIT V	ENERGY EFFICIENT TECHNOLOGIES	9

Energy saving opportunities in electric motors - Energy efficient motors – Rewinding effects on energy efficiency - Energy saving opportunities fans, blowers, pumping system, cooling towers in electric furnaces, ovens and boilers - Lighting techniques: Natural, CFL, LED lighting sources.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:	
CO1:	Explain the present energy scenario and the energy policy.
CO2:	Summarize the energy audit methodology and the instruments used for audit.
CO3:	Describe the action plan involved in improving energy and finance profile.
CO4:	Explain the energy management in electrical systems.
CO5:	Categorize the different energy efficient technologies and energy saving opportunities.
REFERENCES:	
1	"General Aspects of Energy Management and Energy Audit", Guide book-1 for NCE examination or EA and EM.
2	"Energy Efficiency in electrical utilities", Guide book-3 for NCE examination or EA and EM.
3	Barney L. Capehart, Wayne C. Turner, William J. Kennedy, "Guide to Energy Management", CRC press, Taylor & Francis group, Eighth Edition, 2016.
4	Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.
5	Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.
6	Anil Kumar, Om Prakash, Prashant Singh Chauhan "Energy Management: Conservation and Audits, CRC Press, 2020.

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	-	2	-	-
CO2	2	1	-	2	-	-
CO3	2	1	-	2	-	-
CO4	2	1	-	2	-	-
CO5	2	1	-	2	-	-
CO	2	1	-	2	-	-

Table of Specification for End Semester Question Paper

PE22343 ENERGY MANAGEMENT AND AUDITING

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Energy Scenario	2	1 either or	1(2) – CO1	1(2) – CO1 1 either or (16) - CO1	-	-
Unit-II: Energy Auditing	2	1 either or	1(2) - CO2	1(2) - CO2 1 either or (16) - CO2		-
Unit-III: Energy Action Planning And Financing	2	1 either or	1(2) - CO3	1(2) - CO3 1 either or (16) - CO3	-	-
Unit IV: Energy Management In Electrical Systems	2	1 either or	1(2) - CO4	1(2) - CO4 1 either or (16) – CO4	-	-
Unit-V: Energy Efficient Technologies	2	1 either or	1(2) - CO5	1(2) – CO5 1 either or (16) – CO5	-	-
Total Qns.	10	5 either or	5(2)	5(2) 5 either or (16)	-	-
Total Marks	20	80	10	90	-	-
Weightage	20 %	80%	10%	90%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22344	HVDC AND FACTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To emphasis the need for FACTS controllers.
- To learn the characteristics, applications and modelling of series and shunt FACTS controllers.
- To analyse the interaction of different FACTS controller and perform control coordination.
- To impart knowledge on operation, modelling and control of HVDC link.
- To perform steady state analysis of AC/DC system.

UNIT I	INTRODUCTION	9

Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line- Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers-Need for HVDC system-MTDC system -Monopolar, Bipolar and Homopolar HVDC Scheme- Layout of HVDC system (LCC, VSC)

UNIT II	THYRISTOR BASED FACTS CONTROLLERS	9

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for power flow analysis- Concepts of Controlled Series Compensation – Operation of TCSC- Analysis of TCSC – Modelling of TCSC for power flow and stability studies.

UNIT III	ANALYSIS OF LCC HVDC CONVERTERS AND HVDC SYSTEM CONTROL	9

Choice of converter configuration – Simplified analysis of Graetz circuit - Converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters- principles of DC link control – Converter control characteristics – System control hierarchy - Firing angle control – Current and extinction angle control - power control – Higher level controllers– Generation of harmonics and filtering.

UNIT IV	VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS	9

Operation of STATCOM and SSSC- Modelling of STATCOM and SSSC for power flow and transient stability studies – Operation of Unified and Interline power flow controllers - Modelling of UPFC and IPFC for power flow and transient stability studies-Concepts of Power Oscillation Damping using FACTS controllers.

UNIT V	POWER FLOW ANALYSIS IN HVDC SYSTEM AND CONTROLS	9

Control and protection of MTDC systems-Converter model-converter control-Modelling of DC&AC network-Modelling of DC links-Solution of DC load flow-Solution of AC-DC power flow: Sequential and Simultaneous methods.	
TOTAL: 45 PERIODS	
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Explain the basics of power transmission networks and need for FACTS controllers.
CO2:	Design series and shunt compensating devices for power transfer enhancement.
CO3:	Explain AC/DC system coordinated control with FACTS and HVDC link.
CO4:	Understand the significance about different voltage source converter based FACTS controllers.
CO5:	Analyze the power flow in HVDC system.
REFERENCES:	
1	K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd., Publishers, New Delhi, Reprint 2008.
2	K.R.Padiyar, "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.
3	J.Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
4	V.K.Sood, "HVDC and FACTS controllers- Applications of Static Converters in Power System", Kluwer Academic Publishers 2004.
5	Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers For Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	1	1	2
CO2	3	-	1	1	1	2
CO3	3	-	1	1	1	2
CO4	3	-	1	1	1	2
CO5	3	-	1	1	1	2
CO	3	-	1	1	1	2

Table of Specification for End Semester Question Paper

PE22344 HVDC AND FACTS

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An) Evaluate(Ev)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction	2	1 either or	2(2) – CO1	1 either or (16) – CO1		-
Unit-II: Thyristor Based Facts Controllers	2	1 either or	1(2) - CO2	1(2) - CO2 1 either or (16) — CO2		-
Unit-III: Analysis Of LCC HVDC Converters and Hvdc System Control	2	1 either or	2(2) — CO3	1 either or (16) — CO3		-
Unit IV- Voltage Source Converter Based Facts Controllers	2	I either or	2(2) - CO4	1 either or (16) — CO4		-
Unit-V: Power Flow Analysis In Hvdc System And Controls	2	I either or	1(2) – CO5	1(2) — CO5 1 either or (16) — CO5		-
Total Qns.	10	5 either or	8(2)	2(2) 5 either or (16)	-	-
Total Marks	20	80	16	84	-	-
Weightage	20 %	80%	16%	84%	-	-

Weightage for COs

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22351	ENERGY STORAGE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the various types of energy storage Technologies
- To analyze thermal storage system
- To analyze different battery storage technologies
- To analyze the thermodynamics of Fuel Cell
- To study the various applications of energy storage systems

UNIT I	INTRODUCTION	9

Necessity of energy storage – types of energy storage –energy storage technologies – Applications.

UNIT II	THERMAL STORAGE SYSTEM	9

Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – Pressurized water storage system – Modelling of phase change storage system – Simple units, Packed bed storage units - Modelling using porous medium approach,

UNIT III	ELECTRICAL ENERGY STORAGE	9

Fundamental concept of batteries – Measuring of battery performance, charging and dis charging of a battery, storage density, energy density, and safety issues - Types of batteries: – Lead Acid, Lithium Ion, Nickel-Cadmium, Zinc-Manganese dioxide - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT IV	FUEL CELL	9

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types: Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, Alkaline fuel cell -Detailed analysis – Advantages and disadvantages –Fuel Cell Thermodynamics.

UNIT V	ALTERNATE ENERGY STORAGE TECHNOLOGIES	9

Flywheel, Super capacitors, Principles& Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:	Understand the physics of energy storage.
CO2:	Model the different energy technologies.
CO3:	Recognize the applications of various techniques.
CO4:	Design and analyze the energy storage technologies.
CO5:	Select and apply the appropriate technique based on the application.

REFERENCES:

1	James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 2003.
2	LunardiniV.J, "Heat Transfer in Cold Climates", John Wiley and Sons 1981.
3	Jiujun Zhang (Editor), Lei Zhang (Editor), Hansan Liu (Editor), Andy Sun (Editor), Ru-Shi Liu(Editor), "Electrochemical technologies for energy storage and conversion", Two Volume Set, Wiley publications, 2012.
4	Schmidt.F.W. and Willmott.A.J., "Thermal Storage and Regeneration", Hemisphere Publishing Corporation, 1981.
5	Luisa F. Cabeza (Editor), "Advances in Thermal Energy Storage Systems: Methods and Applications", Woodhead Publishers, 2020.
6	Ibrahim Dinçer and Marc A. Rosen, "Thermal Energy Storage Systems and Applications", Wiley Publishers, 2021.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	1	1	2
CO2	3	-	1	1	1	2
CO3	3	-	1	1	1	2
CO4	3	-	1	1	1	2
CO5	3	-	1	1	1	2
CO	3	-	1	1	1	2

Table of Specification for End Semester Question Paper

PE22351 ENERGY STORAGE TECHNOLOGIES

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An) Evaluate(Ev)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction	2	1 either or	I(2) – CO1	I(2) – CO1 1 either or (16) – CO1	-	-
Unit-II: Thermal Storage System	2	1 either or	2(2) - CO2	1 either or 1(16) — CO2	-	
Unit-III: Electrical Energy Storage	2	1 either or	I(2) — CO3	I(2) — CO3 1 either or (16) — CO3	-	-
Unit IV- Fuel Cell	2	I either or	2(2) - CO4	1 either or (16) — CO4	-	-
Unit-V: Alternate Energy Storage Technologies	2	I either or	2(2) – CO5	1 either or (16) — CO5	-	-
Total Qns.	10	5 either or	8(2)	2(2) 5 either or (16)	-	-
Total Marks	20	80	16	84	-	-
Weightage	20 %	80%	16%	84%	-	-

Weightage for COs

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22352	BATTERY MANAGEMENT SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the working and characteristics of different types of batteries
- To develop a battery pack
- To understand battery modelling
- To identify suitable state estimation algorithms
- To study the architecture of battery management system

UNIT I	ADVANCED BATTERIES	9

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics SOC, DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. NCR18650B specifications.

UNIT II	BATTERY PACK	9

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

UNIT III	BATTERY MODELLING	9

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

UNIT IV	BATTERY STATE ESTIMATION	9

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods-Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

UNIT V	BMS ARCHITECTURE AND REAL TIME COMPONENTS	9

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex RayCANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model Based Design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able to:	
CO1:	Explain different Li-ion Batteries performance.
CO2:	Develop a Battery Pack and make related calculations.
CO3:	Demonstrate a Battery Model or Simulation.
CO4:	Identify State-of-Charges in a Battery Pack.
CO5:	Illustrate different BMS architectures during real world usage.
REFERENCES:	
1.	Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles'', Wiley, 2015.
2.	Davide Andrea ,"Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.
3.	Panasonic NCR18650B- Data Sheet
4.	bq76PL536A-Q1- IC Data Sheet
5.	CC2662R-Q1- IC Data Sheet

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	3	-	-
CO2	-	-	2	3	2	1
CO3	-	-	-	3	-	-
CO4	-	-	2	3	2	1
CO5	-	-	-	3	-	-
CO	-	-	2	3	2	1

Table of Specification for End Semester Question Paper

PE22352 BATTERY MANAGEMENT SYSTEM

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An) Evaluate(Ev)**
			No. of Qns. (marks) and CO			
Unit-I: Advanced Batteries		1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Battery Pack	2	1 either or	2(2) - CO2	-	1 either or (16) — CO2-	-
Unit-III: Battery Modelling	2	1 either or	2(2) — CO3	1 either or (16) — CO3	-	-
Unit IV- Battery State Estimation	2	1 either or	2(2) - CO4	-	1 either or (16) — CO4	
Unit-V: BMS Architecture And Real Time Components	2	1 either or	2(2) – CO5	1 either or (16) — CO5	-	-
Total Qns.	10	5 either or	10(2)	3 either or (16)	2 either or (16)	-
Total Marks	20	80	20	48	32	-
Weightage	20 %	80%	20%	48%	32%	-

Weightage for COs					
	CO1	**CO2**	**CO3**	**CO4**	**CO5**
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22353	PYTHON PROGRAMMING FOR MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand and be able to use the basic programming principles such as data types, variable, conditionals, loops, recursion and function calls.
- To learn how to use basic data structures such as List, Dictionary and be able to manipulate text files and images.
- To make the students familiar with machine learning concepts & techniques.
- To understand the process and will acquire skills necessary to effectively attempt a machine learning problem and implement it using Python.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired for improved research/employability skills.

UNIT I	INTRODUCTION TO MACHINE LEARNING AND PYTHON	9

Introduction to Machine Learning: Significance, Advantage and Applications, Categories of Machine Learning, Basic Steps in Machine Learning: Raw Data Collection, Preprocessing, Training a Model, Evaluation of Model, Performance Improvement Introduction to Python and its significance , Difference between C, C++ and Python Languages; Compiler and Interpreters, Python3 Installation & Running, Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User, Arrays/List, Dictionary and Set Conditional Statements.

UNIT II	PYTHON FUNCTIONS AND PACKAGES	9

File Handling: Reading and Writing Data, Errors and Exceptions Handling, Functions & Modules, Package Handling in Python, Pip Installation & Exploring Functions in python package, Installing the Numpy Library and exploring various operations on Arrays: Indexing, Slicing, MultiDimensional Arrays, Joining Numpy Arrays, Array intersection and Difference, Saving and Loading Numpy Arrays, Introduction to Object Oriented Programming with Python.

UNIT III	IMPLEMENTATION OF MACHINE LEARNING USING PYTHON	9

Description of Standard Datasets: Coco, ImageNet, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset, Introducing the concepts of Regression, Linear, Polynomial & Logistic Regression with analytical understanding, Introduction to SciPy Package & its functions, Python Application of Linear Regression and Polynomial Regression using SciPy, Interpolation, Overfitting and Underfitting concepts & examples using SciPy

UNIT IV	CLASSIFICATION AND CLUSTERING CONCEPTS OF ML	9

Introduction to ML Concepts of Clustering and Classification, Types of Classification Algorithms , Support Vector Machines (SVM), Decision Tree, Random Forest, Introduction to ML using scikitlearn, Using scikitlearn, Loading a sample dataset, Learning & prediction, interpolation & fitting. Types of Clustering

Algorithms & Techniques, K-means Algorithm, Introduction to Python Visualization using Matplotlib: Plotting 2- dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph, Implementation of K-means Algorithm.		
UNIT V	**INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING**	**9**
Introduction to Neural Networks & Significance, Neural Network Architecture, Single Layer Perceptron & MultiLayer Perceptron (MLP), Commonly Used Activation Functions, Forward Propagation, Back Propagation, and Epochs, Gradient Descent, Introduction to Convolution Neural Networks, Implementation of Digit Classification using MNIST Dataset ML for Embedded Systems: Comparison with conventional ML, Challenges & Methods for Overcoming TinyML and Tensorflow Lite for Microcontrollers.		
	TOTAL: 45 PERIODS	

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1:	Develop skill in system administration and network programming by learning Python.
CO2:	Demonstrating understanding in concepts of python and its implementation using Python.
CO3:	Relate to use Python's highly powerful processing capabilities for primitives, modeling.
CO4:	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.
CO5:	Apply the concepts acquired over the advanced research/employability skills Tentative.

REFERENCES:

1	Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2	Zelle, John "M. Python Programming: An Introduction to Computer Science.", Franklin Beedle& Associates, 2003.
3	Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly,2016
4	Sebastian Raschka , VahidMirjalili, "Python Machine Learning - Third Edition", Packt, December 2019
5	Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.
6	Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6

CO1	-	-	1	2	-	-
CO2	-	-	-	-	-	-
CO3	-	-	1	-	-	-
CO4	-	-	-	1	-	-
CO5	-	-	-	1	-	-
	-	-	1	1	-	-

Table of Specification for End Semester Question Paper

PE22353 PYTHON PROGRAMMING FOR MACHINE LEARNING

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction to Machine Learning and Python	2	1 either or	2(2) – CO1	1 either or (16) – CO1		-
Unit-II: Python Functions and Packages	2	1 either or	2(2) - CO2	1 either or (16) — CO2		-
Unit-III: Implementation of Machine Learning Using Python	2	1 either or	2(2) — CO3	-	1 either or (16) — CO3	-
Unit IV-Classification and Clustering Concepts of Ml	2	I either or	I(2) - CO4	I(2) — CO4	1 either or (16) — CO4	-
Unit-V: Classification and Clustering Concepts of Ml	2	I either or	I(2) – CO5	I(2) — COC	1 either or (16) — CO5	-
Total Qns.	10	5 either or	8(2)	2(2) 2 either or (16)	3 either or (16)	-
Total Marks	20	80	16	36	48	-
Weightage	20 %	80%	16%	36%	48%	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

PE22354	SMART GRID	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the Challenges and benefits of smart grid
- To educate on the different smart grid technologies.
- To educate on smart meters and advanced metering infrastructure
- To explain the power quality issues in Smart Grid.
- To explain the communication networks for Smart Grid applications

UNIT I	INTRODUCTION TO SMART GRID	9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II	SMART GRID TECHNOLOGIES	9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Outage management, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

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) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

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

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

	TOTAL PERIODS:45
COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1	Explain the challenges and benefits of smart grid.
CO2	Illustrate the different smart grid technologies.
CO3	Explain the necessity of smart meter and AMI.
CO4	Demonstrate the power quality management in Smart Grid.
CO5	Illustrate the different communication networks for smart grid applications
REFERENCES:	
1	Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012.
3	Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press,2015.
4	Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5	Smart Grid Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

Course Outcomes	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	-	-	-	-
CO2	-	1	-	1	1	-
CO3	-	1	-	-	-	-
CO4	1	1	-	1	1	-
CO5	-	1	-	1	-	-
CO	1	1	-	1	1	-

Table of Specification for End Semester Question Paper

PE22354 SMART GRID

Unit No. and Title	Total 2 Marks	Total 16 Marks	Cognitive Level			
			Remember (Kn)	**Understand** (Un)	**Apply** (Ay)	**Analyse(An) Evaluate(Ev)**
			No. of Qns. (marks) and CO			
Unit-I: Introduction to Smart Grid	2	1 either or	2(2) – CO1	1 either or (16) – CO1	-	-
Unit-II: Smart Grid Technologies	2	1 either or	2(2) - CO2	1 either or (16) — CO2	-	-
Unit-III: Smart Meters and Advanced Metering Infrastructure	2	1 either or	2 (2) — CO3	1 either or (16) — CO3	-	-
Unit IV- Power Quality Management in Smart Grid	2	I either or	2(2) - CO4	1 either or (16) — CO4	-	-
Unit-V: High Performance Computing for Smart Grid Applications	2	I either or	2(2) – CO5	1 either or (16) — CO4	-	-
Total Qns.	10	5 either or	10(2)	5 either or (16)	-	-
Total Marks	20	80	20	80	-	-
Weightage	20 %	80%	20%	80%	-	-

Weightage for COs

	CO1	CO2	CO3	CO4	CO5
Total Marks	20	20	20	20	20
Weightage	20%	20%	20%	20%	20%

AC22101	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I	INTRODUCTION TO RESEARCH PAPER WRITING	6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II	PRESENTATION SKILLS	6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III	TITLE WRITING SKILLS	6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV	RESULT WRITING SKILLS	6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT V	VERIFICATION SKILLS	6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the firsttime submission.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Understand that how to improve your writing skills and level of readability.
CO2:	Learn about what to write in each section.
CO3:	Understand the skills needed when writing a title.
CO4:	Understand the skills needed when writing the conclusion.
CO5:	Ensure the good quality of paper at very first-time submission.

REFERENCES:

1.	Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.
2.	Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006.
3.	Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AC22102	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I	HISTORY OF MAKING OF THE INDIAN CONSTITUTION	5

History, Drafting Committee, (Composition & Working)

UNIT II	PHILOSOPHY OF THE INDIAN CONSTITUTION	5

Preamble, Salient Features

UNIT III	CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	5

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV	ORGANS OF GOVERNANCE	5

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

UNIT V	LOCAL ADMINISTRATION	5

District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI	ELECTION COMMISSION	5

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2:	Discuss the intellectual origins of the framework of argument that informed the

	conceptualization of social reforms leading to revolution in India.
CO3:	Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4:	Discuss the passage of the Hindu Code Bill of 1956.

REFERENCES:

1	The Constitution of India,1950(Bare Act),Government Publication.
2	Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3	M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4	D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AC22201	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

COURSEOBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
- Develop the strengths and weaknesses of disaster management approaches

UNITI	**INTRODUCTION**	**6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III	**DISASTER PRONE AREAS IN INDIA**	**6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V	**RISK ASSESSMENT**	**6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1:	Ability to summarize basics of disaster
CO2:	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response
CO3:	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
CO4:	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
CO5:	Ability to develop the strengths and weaknesses of disaster management approaches
REFERENCES:	
1.	Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2.	NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company, 2007.
3.	Sahni, PradeepEt.Al. ," Disaster Mitigation Experiences and Reflections", PrenticeHall of India, New Delhi, 2001.

AC22202	**நற்றமிழ்இலக்கியம்**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**
UNITI	**சங்க இலக்கியம்**				**6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   - எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II	**அறநெறித் தமிழ்**	**6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடமை, ஒப்பறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III	**இரட்டைக் காப்பியங்கள்**	**6**

1. கண்ணகி புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூக சேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV	அருள்நெறித் தமிழ்	6

1. சிறுபாணாற்றுப் படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்.
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V	நவீன தமிழ் இலக்கியம்	6

1. உரைநடைத் தமிழ்
   - தமிழின் முதல் புதினம்
   - தமிழின் முதல் சிறுகதை
   - கட்டுரை இலக்கியம்
   - பயண இலக்கியம்
   - நாடகம்
2. நாட்டு விடுதலை போராட்டமும், தமிழ் இலக்கியமும்
3. சமுதாய விடுதலையும், தமிழ் இலக்கியமும்
4. பெண் விடுதலையும், விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்
6. இணையத்தில் தமிழ்
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள்/புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
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