DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ANNA UNIVERSITY, CHENNAI – 25

VISION OF THE DEPARTMENT

The vision of Anna University is to be a world class institution by producing professionals with high technical knowledge, professional skills and ethical values, and remain as a preferred partner to the industry and community for their economic and social development through excellence in teaching, research and consultancy. Anna University shall be recognized as a point of reference, a catalyst, a facilitator, a trend setter and a leader in technical education.

MISSION OF THE DEPARTMENT

To produce full fledged Electrical and Electronics Engineers to cater to the needs of the modern industries and be useful for building the nation.

Attested

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Centre for Academic Courses
Anna University, Chennai-600 025

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UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.E. POWER ENGINEERING AND MANAGEMENT

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare the students to have career in the electrical power industry/research organization/teaching.
II. To provide good foundation in mathematics, management and computational technology to analyze and solve problems encountered in electrical power industry.
III. Pursue lifelong learning and continuous improvement of their knowledge in the electrical power industry.
IV. To understand the national and global issues related to the electrical power industry and to be considerate of the impact of these issues on the environment and within different cultures.
V. To apply engineering and management principles to assess and evaluate renewable energy based power generation for maximum utilization and develop the skills of the students into power industry business.
VI. To provide the students with knowledge to be involved with the technology advancements and future developments in power generation, and management as well as with alternate and new energy resources.

2. PROGRAMME OUTCOMES (POs):

After going through the two years of study, our Power Engineering and Management graduates will exhibit ability to:

PO#	Graduate Attribute	Programme Outcome
1	Engineering knowledge	impart the knowledge about the principles of energy conservation and management, power trading, power business and power management.
2	Problem analysis	Be able to apply the knowledge gained for the efficient power and energy management.
3	Design/development of solutions	Be able to provide all the possible solutions for the design and development of power management project.
4	Conduct investigations of complex problems	Be able to handle and analyse the problems of the power industry.
5	Modern tool usage	Hands on experience to work on real time software packages for the design and analysis of power engineering and management.
6	The Engineer and society	Conduct themselves to uphold the professional and social obligations.
7	Environment and sustainability	Design the system with environment consciousness, better reliability and sustainable development.
8	Ethics	Interaction among the industry and society in a professional and ethical manner.
9	Individual and team work	Functions as a multi-disciplinary team.
10	Communication	Proficiency in oral and written Communication.
11	Project management and finance	Implement cost effective and improved financial and business model meeting the requirement of power

		industry.
12	Life-long learning	Helps in the professional development and learning as a life-long activity to meet the fast growing power industry.

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

After the completion of Power Engineering and Management program the student will have the following Program specific outcomes.

1. Students will have strong core knowledge of energy conservation and management, power trading and power business.
2. Students will be able to derive mathematical models of the various electrical power apparatus to analyze their feasibility for the real time implementation.
3. Students will acquire ability to design and develop various indigenous high power controllers for the power management project.
4. By gaining in-depth knowledge of various electricity market models students will be able to participate as market players in pricing and emerge as entrepreneurs.
5. Students will be capable of integrating the green building concepts into the field of energy efficient buildings and energy recovery from the waste.
6. Students will be able to design solutions to mitigate the technical problems and challenges related to power industry.

4. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAM OUTCOMES											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	P9 O	PO10	PO11	PO12
I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
II	✓	✓	✓	✓	✓				✓	✓	✓	
III									✓			✓
IV						✓	✓					✓
V	✓					✓			✓		✓	
VI	✓	✓	✓	✓				✓			✓	✓

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Mapping of Course
Outcome and Programme Outcome

		Course Name	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
YEAR 1	Semester 1	Advanced Power Converters	✓	✓	✓									
		Climate Change and Energy Environment	✓						✓					
		Energy Conservation in Electrical Systems	✓	✓		✓			✓					
		Modern Power System Engineering	✓	✓	✓	✓								
		Program Elective I												
		Research Methodology and IPR						✓						✓
		Audit Course I						✓		✓				
		Power Engineering Laboratory	✓	✓	✓	✓	✓				✓			
		Power Converters Laboratory	✓	✓	✓	✓	✓				✓			
	Semester 2	Energy Management and Audit	✓	✓	✓		✓		✓					
		Optimization Techniques for Energy Management	✓	✓	✓	✓	✓							
		Program Elective II												
		Program Elective III												
		Audit Course II						✓		✓				✓
		Energy Audit Laboratory	✓	✓	✓	✓	✓		✓		✓			
		Renewable Energy Laboratory	✓	✓	✓	✓	✓				✓			
		Mini Project with Seminar	✓	✓	✓	✓	✓				✓	✓	✓	
A	Semester 3	Program Elective IV												
		Program Elective V												

		Open Elective						✓		✓				✓
		Project Phase I	✓	✓	✓	✓	✓				✓	✓	✓	
	Semester 4	Project Phase II	✓	✓	✓	✓	✓				✓	✓	✓	

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CURRICULUM AND SYLLABUS I TO IV SEMESTERS

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	PERIOD PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PW5101	Advanced Power Converters	PCC	3	0	0	3	3
2.	PW5151	Climate Change and Energy Environment	PCC	3	0	0	3	3
3.	PW5152	Energy Conservation in Electrical Systems	PCC	3	0	0	3	3
4.	PW5153	Modern Power System Engineering	PCC	3	1	0	4	4
5.		Program Elective I	PEC	3	0	0	3	3
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course I (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
8.	PW5111	Power Engineering Laboratory	PCC	0	0	4	4	2
9.	PE5161	Power Converters Laboratory	PCC	0	0	4	4	2
		TOTAL		**19**	**1**	**8**	**28**	**22**

*Audit Course is optional

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PW5251	Energy Management and Audit	PCC	3	1	0	4	4
	PW5252	Optimization Techniques for Energy Management	PCC	3	1	0	4	4
3.		Program Elective II	PEC	3	0	0	3	3
4.		Program Elective III	PEC	3	0	0	3	3
5.		Audit Course II (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
6.	PW5211	Energy Audit Laboratory	PCC	0	0	4	4	2
7.	PW5261	Renewable Energy Laboratory	PCC	0	0	4	4	2
8.	PW5212	Mini Project with Seminar	EEC	0	0	6	6	3
		TOTAL		**14**	**2**	**14**	**30**	**21**

*Audit Course is optional

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SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective IV	PEC	3	0	0	3	3
2.		Program Elective V	PEC	3	0	0	3	3
3.		Open Elective (one from list of 6 courses)	OEC	3	0	0	3	3
PRACTICALS								
4.	PW5311	Project Phase I	EEC	0	0	12	12	6
		TOTAL		**9**	**0**	**12**	**21**	**15**

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	PW5411	Project Phase II	EEC	0	0	24	24	12
		TOTAL		**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 70

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PROGRAM CORE COURSES (PCC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CREDITS	SEMESTER
				L	T	P		
1	PW5101	Advanced Power Converters	PCC	3	0	0	3	1
	PW5151	Climate Change and Energy Environment	PCC	3	0	0	3	1
	PW5152	Energy Conservation in Electrical Systems	PCC	3	0	0	3	1
2	PW5153	Modern Power System Engineering	PCC	3	1	0	4	1
3	PW5111	Power Engineering Laboratory	PCC	0	0	4	2	1
4	PE5161	Power Converters Laboratory	PCC	0	0	4	2	1
5	PW5251	Energy Management and Audit	PCC	3	1	0	4	2
6	PW5252	Optimization Techniques for Energy Management	PCC	3	1	0	4	2
9	PW5211	Energy Audit Laboratory	PCC	0	0	4	2	2
10	PW5261	Renewable Energy Laboratory	PCC	0	0	4	2	2

PROGRAM ELECTIVE COURSES (PEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1	PW5001	Distribution System and Automation	PEC	3	0	0	3	3
2	PW5002	Power Business Management	PEC	3	0	0	3	3
3	PW5071	Electric Vehicles and Power Management	PEC	3	0	0	3	3
4	PW5072	Energy Efficient Buildings	PEC	3	0	0	3	3
5	PW5073	Energy Forecasting, Modelling and Project Management	PEC	3	0	0	3	3
6	PW5074	Energy Storage Technologies	PEC	3	0	0	3	3
7	PW5075	Grid Integration of Renewable Energy Sources	PEC	3	0	0	3	3
8	PW5076	Micro-grid Operation and Control	PEC	3	0	0	3	3
9	PW5077	Renewable Energy Technology	PEC	3	0	0	3	3
10	PW5078	SCADA System and Applications Management	PEC	3	0	0	3	3
11	PW5079	Waste Management and Energy Recovery Techniques	PEC	3	0	0	3	3
12	PS5252	Restructured Power System	PEC	3	0	0	3	
13	PS5151	Analysis and Computation of Electromagnetic Transients in Power Systems	PEC	3	1	0	4	3
14	PS5251	HVDC and FACTS	PEC	3	1	0	4	4
15	PS5075	Smart Grid	PEC	3	0	0	3	4
16	PS5076	Wind Energy Conversion System	PEC	3	0	0	3	3
17	PE5074	Power Quality	PEC	3	0	0	3	3
18	PE5073	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3
19	PE5151	Analysis of Electrical Machines	PEC	3	1	0	4	3
20	PE5251	Special Electrical Machines	PEC	3	0	0	3	4
21	CO5152	Intelligent Controllers	PEC	3	0	0	3	3
22	CO5072	Control of Electrical Drives	PEC	3	0	0	3	3

23	CO5153	MEMS Design: Sensors and Actuators	PEC	3	0	0	3	3
24	CO5151	Control System Design	PEC	4	0	0	4	4
25	HV5074	Pollution Performance of Power Apparatus and Systems	PEC	3	0	0	3	3
26	HV5075	Principles of Electric Power Transmission	PEC	3	0	0	3	3
27	HV5071	Applications of High Electric Fields	PEC	3	0	0	3	3
28	ET5072	Automotive Embedded System	PEC	3	0	0	3	3
29	ET5076	MEMS Technology	PEC	3	0	0	3	3
30	ET5078	Robotics and Automation	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL.NO	COURSE CODE	COURSETITLE	PERIODSPERWEEK			CREDITS	SEMESTER
			L	T	P		
1.	RM5151	Research Methodology and IPR	2	0	0	2	1
					Total Credits	2	

OPEN ELECTIVE COURSES [OEC]

*(Out of 6 Courses one Course must be selected)

S.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSETITLE	PERIODSPERWEEK			CREDITS	SEMESTER
			Lectur	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	
					Total Credits	**0**	

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1	PW5212	Mini Project with Seminar	0	0	6	3	2
2	PW5311	Project Phase I	0	0	12	6	3
3	PW5411	Project Phase II	0	0	24	12	4
					Total Credits:	**21**	

SUMMARY

	Programme : M.E. Power Engineering and Management					
	Subject Area	Credits per Semester				Credits Total
		I	II	III	IV	
1.	FC	00	00	00	00	00
2.	PCC	17	12	00	00	29
3.	PEC	03	06	06	00	15
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	03	06	12	21
7.	Non Credit/Audit Course	✓	✓	00	00	
	Total Credit	22	21	15	12	**70**

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PW5101 **ADVANCED POWER CONVERTERS** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To equip with required skills to derive the criteria for the design of power converters for power engineering industry.
- To analyze the converter performance in wind energy systems.
- To understand the operation of UPS system.
- To know the working of converters with motor drive system.

UNIT I ADVANCED SOLID STATE DEVICES **9**

MOSFETs, IGBT, GTO, IGCT etc., Power modules, intelligent power modules, gating circuits, Thermal design, protection, Digital signal processors used in their control.

UNIT II CONVERTERS IN POWER GRID **9**

Compensation : shunt, series, shunt – series, series – series – HVDC:12-pulse converter based HVDC systems - HVDC light - HVDC PLUS (Power universal link) - Multipulse and multilevel VSC based flexible HVDC systems – low frequency high voltage AC transmission – solid state transformer.

UNIT III CONVERTERS FOR WIND ENERGY SYSTEM **9**

Overview – power electronic interface for variable speed wind turbines - control algorithms – MPPT – FOC and DTC based WTs – direct power control – control for stand-alone mode of operation.

UNIT IV CONVERERS FOR UPS SYSTEM **9**

Line interactive UPS – delta conversion UPS – hybrid static and rotary UPS – flywheels – DC UPS for pulse load with power levelling – controls for UPS system – converters for PC, data centres and medical equipments.

UNIT V CONVERTERS FOR MOTOR DRIVES **9**

Vector control and direct torque control of induction, synchronous, permanent magnet sine fed, synchronous reluctance motors - Permanent magnet brushless dc (PMLDC) and switched reluctance motors - LCI (load commutated inverter) fed large rating synchronous motor drives. Energy conservation and power quality improvements in these drives – shipboard propulsion system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand the characteristics of solid state devices.
CO2: Learned the concept of converters in power grid.
CO3: Able to select the converters for various wind energy conversion systems.
CO4: Able to design the UPS system.
CO5: The students acquire the capability to analyze the performance of the converter with motor drive system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓								
CO2	✓	✓		✓	✓							
CO3	✓		✓	✓	✓		✓					
CO4	✓	✓	✓									
CO5	✓	✓	✓		✓							

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REFERENCES:

1. R. S. Ramshaw, 'Power Electronics Semiconductor Switches', Champman&Hall, 1993.
2. N. Mohan, T. M. Undeland and W. P. Robbins, 'Power Electronics, Converter, Application and Design', Third Edition, John Willey & Sons, 2004.
3. K. Billings, 'Switch Mode Power Supply Handbook', McGraw-Hill, 2010.
4. N. G. Hingorani and L. Gyugyi, 'Understanding FACTS: Concepts and Technology of flexible AC transmission system', IEEE Press, Delhi, 2000.
5. B. K. Bose, 'Power Electronics and Motor Drives: Advances and Trends', Elsevier, 2006.

PW5151 CLIMATE CHANGE AND ENERGY ENVIRONMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge about climate change and its environmental impact
- To give exposure about technology and policy options for GHG emission
- To provide knowledge about international climate change conventions, protocols and perspectives.
- To know the environmental problems related to energy use.
- To know the various options to improve the energy use.

UNIT I CLIMATE CHANGE 9

Energy use and Global Warming, Climate Change Concerns, Climate Change in India, the Greenhouse Effect, Earth's Radiation balance, Greenhouse Gases (GHG) types and Sources, Climate Change Impacts.

UNIT II TECHNOLOGY AND POLICY OPTIONS FOR GHG EMISSION MITIGATION 9

Renewable Energy, Energy Efficient Technologies by Sector and End-Use, Cleaner Production, Barriers to GHG Mitigation Technologies, Carbon tax and Tradable Emission Permits, Other Policy Options.

UNIT III INTERNATIONAL CLIMATE CHANGE CONVENTIONS, PROTOCOLSAND PERSPECTIVES 9

Climate Change in India and mitigation measures on Indian perspectives, United Nations Framework Convention on Climate Change (UNFCCC), Clean Development Mechanism (CDM) as per the Kyoto Protocol and Flexible Mechanisms, comparison on India vs developed countries perspectives on GHG mitigations.

UNIT IV ENVIRONMENTAL PROBLEMS RELATED TO ENERGY USE 9

Energy use and its air pollution, acid rain, Technological and policy options for control of SO_2 and NOx emissions, the problem of Atmospheric Brown Cloud (ABC) and possible mitigation options.

UNIT V URBAN ENERGY USE AND THE ENVIRONMENT 9

Efficient/cleaner transport options of electric vehicles and their effects on energy use, environment and GHG emissions, other options to improve energy use and environment in urban areas.

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TOTAL: 45 PERIODS

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COURSE OUTCOMES:

CO1: Able to understand the climate change and its environmental impact.
CO2: Acquired knowledge about technology and policy options for GHG emission.
CO3: Ability to understand the international climate change conventions, protocols and perspectives.
CO4: Learned the environmental problems related to energy use.
CO5: Ability to identify the various options to improve the energy use.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓			✓	✓				
CO2	✓		✓					✓				
CO3	✓	✓	✓									
CO4	✓	✓					✓				✓	
CO5	✓	✓					✓					✓

REFERENCES:

1. R. T. Watson, M. C. Zinyowera, and R. H. Moss (eds.),'Technologies, Policies, and Measures for Mitigating Climate Change', IPCC Technical Paper No. 1, Intergovernmental Panel on Climate Change, 1996.
2. L. D. D. Harvey,'Climate and Global Environmental Change', Prentice Hall, 2000.
3. C.S.Pearson, 'Economics and the Global Environment', Cambridge University Press, Cambridge, UK, 2000.
4. 'United Nations Framework Convention on Climate Change' (UNFCCC), Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1998.
5. 'Intergovernmental Panel on Climate Change' (IPCC), Special Report on Emission Scenarios, Cambridge University Press, Cambridge, 2000.
6. UNEP and C4, The Asian Brown Cloud,'Climate and Other Environmental Impacts', UNEP, Nairobi, 2002

PW5152 ENERGY CONSERVATION IN ELECTRICAL SYSTEMS LT P C
3 0 0 3

COURSE OBJECTIVES:

- To study the concepts of power factor, load management.
- To study the various measures for energy conservation in electrical devices both static & rotating machineries.
- To understand the energy conservation in pump and compressor systems.
- To study the performance of lighting systems.
- To understand the concept of PAT systems and cost factor.

UNIT I ELECTRICAL ENERGY USAGE : BASICS 9

Cascade Efficiency – Electricity Billing : components and Costs – kVA – need and Control – Determination of kVA and Consumption – Tariff – power factor – poor power factor impact and penalty – power factor correction methods – demand side management.

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UNIT II TRANSFORMERS AND MOTORS **9**

Transformer : Basics - types – specification and selection of Transformers - AVR and OLTC concepts – performance prediction – efficiency improvement in transformers - Motors: specification and selection – efficiency / load curve – load estimation – assessment of Motor performance under different operating conditions – factors affecting performance – over sizing - effects of rewinding energy efficient motors - ENCON Scope.

UNIT III FANS, PUMPS AND COMPRESSORS **9**

Operation – selection – performance evaluation – cause for inefficient operation – possibility for energy conservation – methods adopted for effecting ENCON – economics of ENCON adoption in all the utilities.

UNIT IV ILLUMINATION AND ENERGY EFFICIENCY DEVICES **9**

Specification of Luminaries – types – efficacy – selection and application – ENCON avenues and economic proposition - new generation luminaries (LED / Induction Lighting) - soft starters - auto star – delta starters - variable speed and frequency drives – time sensors –occupancy sensors.

UNIT V CASE STUDIES & CO_2 MITIGATION **9**

Case Study Evaluation for 3/4 Typical Sectors – introduction to PAT Scheme – CO2 Mitigation, Energy Conservation & Cost Factor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to know the importance of power factor improvement.
CO2: Learned the various measures for energy conservation in electrical devices.
CO3: Able to improve the energy efficiency in pump and compressor systems.
CO4: Able to design effective lighting systems.
CO5: The students acquire the concept of PAT systems and cost factor.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								
CO2	✓						✓				✓	
CO3	✓	✓		✓	✓							
CO4	✓		✓		✓							
CO5	✓									✓		✓

REFERENCES

1. Marguerite A.H. Ruffner, 'Energy Auditing and Conservation: Methods Measurements, management and Case Study', Hemisphere Publishing Corporation,1980.
2. Jack J. Kraushaar and Robert A. Ristenen, 'Energy and Problems of a Technical Society', Wiley, 1993.
3. Detlef Stolten, Viktor Scherer, 'Transition to Renewable Energy Systems', Wiley, 2013.
4. Charles M. Gottschalk, 'Industrial Energy Conservation', Wiley, 1996.
5. 'Energy Managers and Energy Auditors Guide book', Bureau of Energy Efficiency, 2006.

PW5153 MODERN POWER SYSTEM ENGINEERING L T P C
3 1 0 4

COURSE OBJECTIVES:

- To apply iterative techniques for power flow analysis
- To provide knowledge about state estimation
- To analyse the power system security under different contingency events
- To gain knowledge about power system protection.
- To provide basic knowledge on voltage stability

UNIT I POWER FLOW ANALYSIS 12

Problem Formulation: Review of NR method, Fast Decoupled Load Flow– Distribution Load Flow: Ladder Iterative Technique, Three phase load flow solutions.

UNIT II STATE ESTIMATION 12

Introduction–Maximum Likelihood Weighted Least Squares Estimation–State Estimation of an AC Network– State Estimation by Orthogonal Decomposition – Use of Phasor Measurement Units – Applications of Power Systems State Estimation

UNIT III POWER SYSTEM SECURITY 12

Introduction–Factors Affecting Power System Security – Contingency Analysis: Generation outages, Transmission outages – Linear Sensitivity Factors – Voltage Collapse

UNIT IV POWER SYSTEM PROTECTION 12

Introduction to Power System Protection– Operating principles and Relay Construction – Overcurrent Protection– Microprocessor based Overcurrent Relays

UNIT V VOLTAGE STABILITY 12

Single-Load Infinite-Bus System– Maximum Deliverable Power– Power-Voltage Relationships– Generator Reactive Power Requirement– Instability Mechanisms– Effect of Compensation– VQ Curves.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Ability to carry out power flow analysis for transmission and distribution network.
CO2: Able to Compute the state of the power system.
CO3: Ability to carry out contingency analysis to analyse power system security.
CO4: Able to understand over current protection for system security.
CO5: Analyse the concept of voltage stability.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								
CO2	✓	✓	✓	✓								
CO3	✓	✓	✓	✓								
CO4	✓			✓								
CO5	✓	✓	✓	✓								

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REFERENCES:

1. J. J. Grainger and W. D. Stevenson, 'Power System Analysis', McGraw-Hill, 1994.
2. Badri Ram and D. N. Vishwakarma, 'Power System Protection and Switchgear', McGraw-Hill, 1995.
3. T. V. Cutsem and C. Vournas, 'Voltage Stability of Electric Power Systems', Springer, 1998.
4. A. J. Wood, B. F. Wollenberg and G. B. Sheblé, 'Power Generation Operation and Control', John Wiley and sons, New York, 2013.

RM5151 RESEARCH METHODOLOGY AND IPR LT P C
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.

Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

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COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

PW5111 POWER ENGINEERING LABORATORY LT P C
0 0 4 2

COURSE OBJECTIVES:

- To have hands on experience on various system studies and different techniques used for system planning, software packages.
- To apply iterative techniques for power flow analysis
- To analyse power system security using shift factors.
- To analyse the over current relay settings and their coordination
- To study the characteristics of PV cell, Wind Energy Conversion System and Fuel Cell.

LIST OF EXPERIMENTS:

1. Power flow analysis by Newton Raphson method
2. Power flow analysis by Fast decoupled method
3. Distribution Load Flow Analysis: Ladder Iterative Technique
4. Contingency analysis: Generator shift factors and line outage distribution factors
5. State Estimation by Weighted Least Square Method
6. Digital Over Current Relay Setting and Relay Coordination
7. Voltage stability: PV and VQ curves
8. Characteristics of Solar PV System
9. Characteristics of Wind Energy Conversion System
10. Characteristics of Fuel Cell Based Energy Source
11. Power Management in hybrid power system

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TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Ability to analyze the power flow using Newton-Raphson method, Fast decoupled method and Ladder Iterative Technique.
CO2: Able to perform contingency analysis & state estimation
CO3: Ability to select and coordinate over current relay
CO4: Acquired knowledge in steady state voltage stability.
CO5: Able to analyze the characteristics of PV system, Wind Energy Conversion System & hybrid power system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓				✓			
CO2	✓	✓	✓	✓	✓				✓			
CO3	✓	✓	✓	✓	✓				✓			
CO4	✓	✓	✓	✓	✓				✓			
CO5	✓	✓	✓	✓	✓				✓			

PE5161 POWER CONVERTERS LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

- To provide the requisite knowledge necessary to appreciate the dynamical equations involved in the analysis of different PED configurations.
- To understand the dynamics and different operating modes of power converters studied in the core courses on power converters.
- To analyze, design and simulate different rectifier circuits for generic load and for machine loads
- To simulate different inverter topologies.
- To formulate, design, simulate power supplies for generic load and for machine loads.

LIST OF EXPERIMENTS:

1. Simulation of single phase half wave controlled converter fed RLE load.
2. Simulation of single phase fully controlled converter fed RLE load.
3. Simulation of three phase half controlled converter fed RL load.
4. Simulation of three phase fully controlled converter fed RL load.
5. Study of single phase Fully Controlled Rectifier, Half Controlled Rectifier with different Loads.
6. Study of Three phase Fully Controlled Rectifier, Half Controlled Rectifier with different Loads.
7. Simulation of single phase VSI fed RL/RC load.
8. Design of UPS.
9. Design of SMPS.
10. Simulation of multilevel inverter topologies.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1:Ability to solve dynamic equations involved in power electronics.
CO2:Ability to acquire and apply knowledge of mathematics and converter/machine dynamics in Electrical engineering.
CO3:Ability to model and analyze different rectifier circuits using computational software and

to understand their various operating modes.

CO4:Ability to model and analyze different rectifier circuits using computational software and to understand their various operating modes.

CO5:Ability to formulate, design, simulate power supplies for generic load and for machine loads.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓				✓			
CO2	✓	✓			✓				✓			
CO3	✓	✓			✓				✓			
CO4	✓	✓			✓				✓			
CO5	✓	✓			✓				✓			

REFERENCES:

1. Ned Mohan, T.M.Undeland and W.P Robbin, “Power Electronics: converters, Application and design” John Wiley and sons. Wiley India edition, 2006.
2. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hal India, New Delhi, 1995.

PW5251 ENERGY MANAGEMENT AND AUDIT L T P C
3 1 0 4

COURSE OBJECTIVES:

- To study the concepts behind economic analysis and Load management.
- To understand the basics of materials and energy balance.
- To analyze the energy efficiency in thermal utilities.
- To know the concept of compressed air system.
- To illustrate the concept of lighting systems and cogeneration.

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT 12

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

UNIT II MATERIAL AND ENERGY BALANCE 12

Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager – employees training and planning- Financial Management:financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return – Case Study.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 12

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

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM 12

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

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UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES 12

Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient motors - soft starters with energy saver - variable speed drives – Fans and blowers: Types - efficient system operation - flow control strategies -Pumps and Pumping System: Types - system operation - flow control methods - Lighting System: Light source, choice of lighting, luminance requirements – ballast - occupancy sensors - energy efficient lighting controls - energy conservation avenues - Case Study.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓								
CO2	✓						✓		✓		✓	
CO3	✓		✓	✓	✓							
CO4	✓	✓							✓			
CO5	✓		✓	✓							✓	

REFERENCES:

1. Moncef Krati, 'Energy Audit of Building Systems: An Engineering Approach', Second Edition, CRC Press, 2016.
2. Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.
3. Michael P.Deru, Jim Kelsey, 'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011.
4. Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990.
5. 'Energy Managers and Energy Auditors Guide book',Bureau of Energy Efficiency, 2006.
6. Larry C. Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.

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PW5252 OPTIMIZATION TECHNIQUES FOR ENERGY MANAGEMENT L T P C
3 1 0 4

COURSE OBJECTIVES:

- To understand the probability concepts.
- To provide knowledge on the demand analysis and forecasting techniques
- To emphasis the optimization for energy management.
- To provide knowledge about the selection of optimization techniques for real time problems and to analyze the solutions.
- To analyze and comprehend the various operating modes of different configurations at different applications.

UNIT I PROBABILITY THEORY 12

The nature of random variables: populations and samples, parameters and statistics. Probability concepts; properties of random variables, probability distribution functions.

UNIT II DEMAND ANALYSIS AND FORECASTING 12

Drivers of energy demand, Sectoral energy demand: domestic, commercial, industrial, agricultural. Projections for future demands.

UNIT III INTRODUCTION TO OPTIMIZATION 12

Problem formulation: decision variables, objective function, maxima, minima, constraints. Analysis techniques: simulation, optimization, stochastic optimization. Multiobjective optimization - non-inferior solutions, trade off analysis, weighted and constraints method.

UNIT IV LINEAR PROGRAMMING AND APPLICATION 12

Assumptions, problems formulation and solutions, graphical methods, simplex algorithm, duality concept, sensitivity analysis. Power system planning using optimization techniques, case study.

UNIT V DYNAMIC PROGRAMMING AND APPLICATION 12

Introduction, multi stage decision problems, recursive equations, principle of optimality, discrete dynamic programming. Optimal energy resource, technology mix in micro and macro level energy planning exercises. Power generation expansion planning, case study.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Ability to define and use optimization techniques and concepts.
CO2: Understand the concept of optimization methods for energy system planning
CO3: Able to define an optimization problem and exploring the solution by applying optimization methods and interpreting results.
CO4: Excel the selection of optimization techniques for real time problems and to analyze the solutions.
CO5: Analyze the various operating modes of different configurations in different applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓	✓	✓		✓							
CO3	✓	✓	✓		✓							
CO4	✓	✓	✓	✓	✓							
CO5	✓	✓	✓	✓	✓							

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REFERENCES

1. Taha, H. A.,'Operations Research—An Introduction', Prentice Hall of India, New Delhi,2007.
2. Vohra, N. D.,'Quantitative Techniques in Management, III Edition', Tata McGraw-Hill Education, 2006.
3. Rardin, R. L.,'Optimization in operations research: Upper Saddle River', NJ: Prentice Hall, 1998.
4. Dhillon, J. S., and Kothari, D. P,'Power system optimization',Prentice Hall of India Private Limited, 2010.

PW5211	ENERGY AUDIT LABORATORY	L T P C 0 0 4 2

COURSE OBJECTIVES:

- To understand the energy audit procedures.
- To analyze the performance of electric motor systems.
- To know the cost benefit analysis in electrical systems.
- To understand the concept of waste minimization and resource conservation.
- To know the working of alternate energy sources.

List of Experiment:

1. Study of energy conservation and audit
2. Performance study of Electric Motors.
3. Analysis on fan characteristic curves at different operating points
4. Case study of illumination system
5. Power factor improvement and cost benefit analysis
6. Computation of pump & pumping system characteristics (pump curve, system curve)
7. Performance analysis of Compressors
8. Performance analysis 0of boiler
9. Energy performance assessment of diesel engine based generators
10. Performance study in a solar water heater.
11. Study of Cogeneration
12. Waste minimization and resource conservation
13. Performing Financial Analysis for residential/industry.

COURSE OUTCOMES:

CO1: Acquired knowledge in the field of the energy audit.
CO2: Able to analyze the performance of electric motor systems.
CO3: Ability to perform cost benefit analysis.

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CO4: Learned various waste minimization and resource conservation techniques.
CO5: Ability to develop a system with alternate energy resources.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓									
CO2	✓		✓				✓					
CO3		✓	✓								✓	
CO4		✓	✓				✓					
CO5	✓		✓									

TOTOTAL: 60 PERIODS

PW5261 **RENEWABLE ENERGY LABORATORY** **LT P C**
0 0 4 2

COURSE OBJECTIVES

Students will be able to:

- Study the performance of various renewable energy sources.
- Obtain hands-on experience on various wind turbine operation.
- Analyze the grid integration issues of renewable energy sources.
- To analyze the performance characteristics of DFIG and PMSG.
- To design and model PV system integration with grid.

1. Performance characteristics of solar PV panel.
2. Performance of PV panel in series and parallel combination.
3. VI characteristics of fuel cell.
4. Performance characteristics of self- excited Induction Generator.
5. Performance characteristics of DFIG.
6. Performance characteristics of PMSG.
7. MPPT tracking of DFIG based WT.
8. MPPT tracking of PMSG based WT.
9. Grid integration of RES.

TOTAL 60 PERIODS

COURSE OUTCOMES

CO1: Students will understand the characteristics of various renewable energy sources.
CO2: Students will be able to program different MPPT algorithm and understand their merits and demerits
CO3: Students will learn control of DFIG .
CO4: Students will learn control of PMSG .
CO5: Students will design and model PV system integration with grid.

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MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓	✓	✓	✓	✓	✓	
CO2	✓				✓	✓	✓	✓	✓	✓	✓	
CO3	✓				✓	✓	✓	✓	✓	✓	✓	
CO4	✓				✓	✓	✓	✓	✓	✓	✓	
CO5	✓				✓	✓	✓	✓	✓	✓	✓	✓

PW5001 DISTRIBUTION SYSTEM AND AUTOMATION LT P C
3 0 0 3

COURSE OBJECTIVES:

- To Provide knowledge about management of distribution system and distribution automation
- To gain knowledge about planning of distribution system
- To gain knowledge about design of distribution system
- To analyse power quality issues in distribution system
- To provide knowledge about distribution system automation

UNIT I INTRODUCTION 9

Overview of distribution system, Importance of Distribution Systems, the Differences of Power Supply between Urban and Rural Areas, Distribution system Consumer Classification.

UNIT II OVERVIEW OF DISTRIBUTION SYSTEM 9

Factors affecting planning, techniques, planning models (Short term planning, long term planning and dynamic planning), planning for the future, Load forecast, Load characteristics and Load models.

UNIT III DISTRIBUTION SYSTEM DESIGN 9

Types of sub- transmission, Distribution substation, bus schemes, substation location, rating of substation, calculation of voltage drops with primary feeders and secondary feeders, uniformly distributed load and Non uniformly distributed load.

UNIT IV POWER QUALITY AND DISTRIBUTION SYSTEM PERFORMANCE ANALYSIS 9

Power quality problems in distribution systems, Power quality study as per IEEE and IECStandards, Distribution Feeder Analysis – the ladder Iterative technique, Power loss calculations and control measures. Distribution system voltage regulation: voltage control, Application of capacitors in Distribution system. Case study on TNEB distribution system.

UNIT V DISTRIBUTION AUTOMATION 9

Definitions, Distribution automation planning, communication-Wireless and wired Communications - DA Communication Protocols, Architectures and user interface, sensors, Supervisory Control and Data Acquisition Systems (SCADA) - Case Studies.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

CO1: Students gained knowledge about distribution system management
CO2: Students gained knowledge about distribution system operation and planning
CO3: Understand the design concept of a distribution system
CO4: Acquired knowledge about Power quality issues in distribution system
CO5: Gained ability to understand the distribution system automation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2		✓	✓									
CO3		✓	✓									
CO4			✓									
CO5	✓											

REFERENCES:

1. James Northcote – Green, Robert Wilson, 'Control and Automation of Electrical Power Distribution Systems', CRC Press, New York, 2007.
2. Turan Gonen, 'Electric Power Distribution System Engineering', McGraw Hill Company, 1986.
3. IEEE Press:'IEEE Recommended practice for Electric Power Distribution for IndustrialPlants', published by IEEE, Inc., 1993.
4. Pansini, 'Electrical Distribution Engineering', The Fairmont Press, Inc., 2007
5. G.T.Heydt, 'Electric Power Quality', stars in a circle publication, 1991.

PW5002 POWER BUSINESS MANGEMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the power scenario in India.
- To understand the electricity acts and regulatory commission policies
- To provide knowledge about distribution utility, metering and billing.
- To give exposure about tariff policy and tariff regulations.
- To introduce the procedure for power purchase and its management.

UNIT I POWER MANAGEMENT IN INDIA 9

Growth of Power Industry in India, Organizational Structure of central and state companies and its major roles and regulations, Power scenario in India, Load management in power sector, Grid Management, Development of power projects in India vs. demand study, Management of Electricity Demand Scenario in state and overall India, Energy Management System, Energy conservation & Efficiency measures. **Case Study**: Power demand study in state, Load management study in state.

UNIT II ACT AND REGULATORY COMMISSIONS 9

Introduction to the Power Scenario, Overview of the Indian Electricity Act 1910, Electricity Supply Act1948, Electricity Regulatory Commissions Act 1998, Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, The Electricity Act 2003, Electricity Grid Code, State Electricity Regulatory commission(SERC),Central Electricity Regulatory commission (CERC), Tribunal, Electricity regulatory and Industry Structure in India.

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UNIT III STATE UTILITY SERVICES **9**

Distribution System, Commercial Operations of a Distribution Utility, Metering & Billing, Revenue Collection, Emerging Trends in Metering Technology, Available Transfer Capability losses and remedial measures.

UNIT IV TARIFF POLICY AND DETERMINATION OF TARIFF **9**

Tariff policy, Tariff regulations, Tariff structure, fixed tariff, availability based tariff, time of the day tariff, Multi Year Tariff, Assessment of tariff levels, Determination of tariff for Generation, transmission and distribution levels, Comparison of year wise tariff/ state wise. **Case Study**: Present tariff Scenario in Tamilnadu and compare with other states.

UNIT V POWER PURCHASE MANAGEMENT **9**

Scope of the power purchase management, Definition and interpretation of terms of a model power purchase agreement (PPA), Desirable Principles of power purchase agreements, Requirements of PPA, Risks and responsibilities in a power purchase agreement, Negotiating Power purchase agreements, PPA - Financial and legal issues, Drafting of a model PPA.

Case Study: Study and Analysis of a sample PPA between a Generation and Distribution Utility,Financial Statement Analysis of a State Power Sector Organization, Power Project Appraisal, Returns of a large Power Project etc.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Acquired knowledge about power scenario in India.
CO2: Understand the electricity acts and regulatory commission policies.
CO3: Able to identify elements in distribution utility and the concept of billing.
CO4: Able to evaluate the tariff policy and its regulations.
CO5: Able to understand and create awareness about power purchase and its management.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓									✓	✓	
CO2	✓		✓			✓			✓			
CO3	✓	✓		✓	✓							
CO4	✓			✓	✓							
CO5			✓		✓				✓	✓		✓

REFERENCES:

1. Turan Goneu, 'Electric Power Distribution System Engg' , McGraw Hill company.
2. Leon K. Kirchmayer, 'Economic Operation of Power Systems' Publisher by Wiley Eastern Ltd.
3. 'Terms and Conditions of Tariff' –CERC Regulations.
4. Herry Sarkar and Gopal K. Kadekod, 'Energy Pricing in India', United National Development Program & Economic Commission for Asia & Pacific
5. 'Electricity Act', 2003.
6. 'Central Regulatory Commission Act', 1998.
7. 'Energy Conservation Act', 2001, Energy Conservation (Amendment) Act, 2010.

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PW5071 ELECTRIC VEHICLES AND POWER MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge about electric vehicle architecture and power train components.
- To know the concepts of dynamics of electrical vehicles
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)
- To understand the concept of energy storage systems.
- To provide knowledge about different energy sources and energy management in HEVs.

UNIT I HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT II MECHANICS OF HYBRID ELECTRIC VEHICLES 9

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity.

UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

UNIT IV ENERGY STORAGE SYSTEMS 9

Battery: Principle of operation, types, models, estimation of parameters, battery modeling, SOC of battery, Traction Batteries and their capacity for standard drive cycles, Vehicle to Grid operation of EV's. **Alternate sources:** Fuel cells, Ultra capacitors, Fly wheels.

UNIT V HYBRID VEHICLE CONTROL STRATEGY AND ENERGY MANAGEMENT 9

HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode - energy management of HEV's.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Learned the electric vehicle architecture and power train components.
CO2: Acquired the concepts of dynamics of electrical vehicles
CO3: Able to understand the vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs).
CO4: Ability to design and select energy storage systems.
CO5: Acquired the knowledge of different energy sources and energy management in HEVs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓							
CO2	✓	✓	✓						✓			
CO3	✓			✓		✓	✓					
CO4	✓	✓	✓		✓							
CO5	✓		✓								✓	

Attested

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REFERENCES:

1. Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2011.
2. Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017.
3. James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Second Edition, 2012.

PW5072	ENERGY EFFICIENT BUILDINGS	LT P C 3 0 0 3

COURSE OBJECTIVES:

- To understand the different climate zones and modelling methods
- To understand about the principle of energy conscious building design.
- To understand about the concept of passive solar heating and efficient technologies in electrical system.
- To provide knowledge about the energy conservation techniques in buildings.
- To provide knowledge about energy efficient technologies.

UNIT I CLIMATE AND SHELTER 9

Historic buildings – Modern architecture – Examples from different climate zones –Thermal comfort – Solar geometry and shading – Energy modeling techniques– Integrative Modeling methods and building simulation.

UNIT II PRINCIPLES OF ENERGY CONSCIOUS BUILDING DESIGN 9

Energy conservation in buildings – Day lighting – Solar based Water heating - Advances in thermal insulation – Heat gain/loss through building components - Solar architecture.

UNIT III PASSIVE SOLAR HEATING 9

Basics of Passive solar – Mechanical Systems – South Facing Glass – Thermal mass – Orientation – site planning for solar access - Direct gain – thermal storage wall – Sunspace – Passive cooling – Ventilation - Radiation – Evaporation and Dehumidification – Design guidelines and natural cooling guidelines.

UNIT IV ENERGY CONSERVATION IN BUILDING 9

Air conditioning – HVAC equipments – Computer packages for thermal design of buildings and performance prediction – Monitoring and instrumentation of passive buildings – Control systems for energy efficient buildings – Illustrative passive buildings – Integration of emerging technologies –Intelligent building design principles – ECBC applicability – Building Envelope – Comfort system and controls – Lighting – Electrical Power and Renewable Energy.

UNIT V EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS 9

Maximum demand controllers, automatic power factor controllers, energy efficient motors, and soft starters – Energy efficient Lighting and Transformers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand the different climate zones and modelling methods
CO2: Able to design energy conscious building design.
CO3: Able to understand about the concept of passive solar heating and efficient technologies in electrical system.

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CO4: Able to gain knowledge about the energy conservation techniques in buildings.
CO5: Know about different energy efficient technologies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2			✓									
CO3			✓	✓								
CO4			✓									
CO5			✓	✓								

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1. Joseph Clarke, 'Energy Simulation in Building Design', II Edition, Butterworth, 2001.
2. J. K. Nayak and J. A. Prajapati, 'Handbook on Energy Conscious Buildings', Solar Energy Centre, MNES, May 2006.
3. 'Energy conservation Building Codes – 2017', Bureau of Energy Efficiency.
4. 'Passive Solar Building - Design Strategies', Guidelines for home passive solar industries council, National Renewable Energy Laboratory and Charles Elay Associates.
5. J. Douglas Batcomb, 'Passive Solar Building',The MIT Press, 1992.
6. Thomas H.Kuehn, James W. Ramsey and J. L. Threlkeld, 'Thermal Environmental Engineering', 3rd Edition Prentice Hall, 1970.

PW5073 ENERGY FORECASTING, MODELLING AND PROJECT MANAGEMENT **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To analyze the energy availability & changing pattern
- To analyze different forecasting models.
- To learn different optimization techniques for energy planning.
- To equip the students in writing project proposals and making project cost estimation.
- To learn about the different energy policy.

UNIT I ENERGY SCENARIO **9**

Role of energy in economic development and social transformation: Energy & GDP,GNP and its dynamics - Energy Sources and Overall Energy demand and Availability - Energy Consumption in various sectors and its changing pattern - Status of Nuclear and Renewable Energy: Present Status and future promise.

UNIT II FORECASTING MODEL **9**

Forecasting Techniques - Regression Analysis - Double Moving Average - Double Experimental Smoothing - Triple Exponential Smoothing – ARIMA model - Validation techniques – Qualitative forecasting – Delphi technique - Concept of Neural Net Works.

UNIT III OPTIMIZATION MODEL **9**

Principles of Optimization - Formulation of Objective Function - Constraints - Multi Objective Optimization – Mathematical Optimization Software – Development of Energy Optimization Model - Development of Scenarios – Sensitivity Analysis - Concept of Fuzzy Logic.

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UNIT IV PROJECT MANAGEMENT **9**

Project Preparation – Feasibility Study – Detailed Project Report - Project Appraisal – Social-cost benefit Analysis - Project Cost Estimation – Project Risk Analysis - Project Financing – Financial Evaluation.

UNIT V ENERGY POLICY **9**

National & State Level Energy Issues - National & State Energy Policy - Energy Security – National solar mission - state solar energy policy - Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs).

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Knowledge in Energy pattern and availability.
CO2: Ability to apply forecasting techniques.
CO3: Able to develop optimization model for energy planning
CO4: Equipped to write project proposal and cost estimation.
CO5: Acquired knowledge of national and state energy policies

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2		✓			✓							
CO3		✓			✓							
CO4											✓	
CO5		✓				✓						

REFERENCES

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2. Austin H. Church, 'Centrifugal pumps and blowers', John Wiley and sons, 1980.
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5. S. Makridakis, 'Forecasting Methods and applications', Wiley, 1983.
6. Sukhvinder Kaur Multani, 'Energy Security in Asia Current Scenario', The ICFAI UniversityPress, 2008.
7. Yang X.S., 'Introduction to mathematical optimization: From linear programming to Metaheuristics', Cambridge, Int. Science Publishing, 2008.

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PW5074 **ENERGY STORAGE TECHNOLOGIES** **LT 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 – comparison of 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, Use of TRNSYS.

UNIT III ELECTRICAL ENERGY STORAGE **9**

Fundamental concept of batteries – measuring of battery performance, charging and is charging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, ickel – 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:

CO1: Gained knowledge of various storage technologies.
CO2: Able to design a thermal storage system.
CO3: Ability to model battery storage system.
CO4: Learned to analyze the thermodynamics of fuel cell.
CO5: Gained Knowledge of various applications of storage technologies and perform the selection based on techno-economic view point.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2			✓									
CO3			✓									
CO4			✓									
CO5	✓		✓									

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REFERENCES

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', JohnWiley & Sons 2002.
2. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 2003.
3. Lunardini.V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981.
4. Ru-shiliu, Leizhang and Xueliang sun, 'Electrochemical technologies for energy storage and conversion', Wiley publications, 2012.
5. Schmidt.F.W. and Willmott.A.J., 'Thermal Storage and Regeneration', Hemisphere Publishing Corporation, 1981.

PW5075 GRID INTEGRATION OF RENEWABLE ENERGY SOURCES LT P C
3 0 0 3

COURSE OBJECTIVES:

- To study about the integration of various renewable energy sources into the grid.
- To analyse various grid issues due to renewable energy sources.
- To analyse the dynamics of network due to wind farm
- To provide knowledge about power system stabilizers.
- To provide knowledge about grid connected and standalone PV system

UNIT I INTRODUCTION 9

Introduction to renewable energy grid integration - Concept of mini/micro grids and Smart grids - Different types of grid interfaces - Issues related to grid integration of small and large scale of synchronous generator based - induction generator based and converter based sources together - Network voltage management - Power quality management (voltage dips, harmonics, flickers, and reactive power control) - Frequency management - Influence of WECS on system transient response - Interconnection standards and grid code requirements for integration.

UNIT II NETWORK INFLUENCE OF GENERATION TYPE 9

starting – Network voltage management – Thermal/Active power management – Network power quality management – Transient system performance – Fault level issues – Protection.

UNIT III INFLUENCE OF WIND FARMS ON NETWORK DYNAMIC PERFORMANCE 9

Dynamic Stability and its Assessment – Dynamic characteristics of Synchronous Generation - A Synchronizing power and Damping power model of a Synchronous Generator – Influence of Automatic Voltage Regulator on Damping – Influence on Damping of Generator Operating Conditions – Influence of Turbine Governor on Generator Operation – Transient Stability – Voltage Stability – Influence of Generation Type on Network Dynamic Stability – Dynamic Interaction of Wind Farms with the Network – influence of Wind Generation on Network Transient Performance.

UNIT IV POWER SYSTEM STABILIZERS AND NETWORK DAMPING CAPABILITY OF WIND9

A Power System Stabilizer for a Synchronous Generator - A Power System Stabilizer for a DFIG - A Power System Stabilizer for a FRC Wind Farm.

UNIT V STAND ALONE AND GRID CONNECTED PV SYSTEM 9

Solar modules – storage systems – Basics of batteries – Batteries for PV Systems – Charge Controllers – MPPT and Inverters – Power Conditioning and Regulation – protection – Types of Solar PV systems - standalone PV systems design – sizing – PV systems in buildings – design

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issues for central power stations – safety – Economic aspect – efficiency and performance – International PV programs

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Know about the integration of various renewable energy sources into the grid.
CO2: Able to analyze various grid issues due to renewable energy sources.
CO3: Able to analyze the dynamics of network due to windfarm
CO4: Know about power system stabilizers.
CO5: Able to design the grid connected and standalone PV system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2		✓										
CO3		✓										
CO4		✓										
CO5			✓									

REFERENCES

1. Stuart R.Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, 'Applied Photovoltaics', Earthscan, UK, 2007.
2. Joshua Earnest, 'Wind power technology', II Edition, PHI, 2015.
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4. Brenden Fox, Damian Flynn and Leslie Bryans, 'Wind Power Integration Connection and system operational aspects', Published by The Institute of Engineering and Technology, London, United Kingdom, 2007.
5. Frank S. Barnes & Jonah G.Levine, 'Large Energy Storage Systems Handbook', CRC Press, 2011.
6. S.P. Sukhatme, 'Solar Energy', Tata McGraw Hill, 1987.
7. Chetan Singh Solanki, 'Solar Photovoltaic Technology and Systems' – A Manual for Technicians, Trainees and Engineers, PHI, 2014.

PW5076 MICRO-GRID OPERATION AND CONTROL LT P C
3 0 0 3

COURSE OBJECTIVES:

- To illustrate the concept of micro sources and storage.
- To study concept of AC microgrid and its controllers.
- To study concept of DC microgrid and its controllers.
- To study concept of hybrid microgrid and its controllers.
- To study concept of islanding and impact on protection.

UNIT I MICRO SOURCES AND STORAGE 9

Microgrid Structure and Operating Modes – Solar PV – Wind Energy – Fuel Cell –Battery – Super capacitor

UNIT II AC MICROGRID 9

Hierarchical Control: Primary, Secondary and Tertiary Control– Primary Control: Droop Control, Virtual Synchronous Generator Control for VSC – Secondary Control – Simulation Studies

UNIT III DC MICROGRID 9

Hierarchical Control: Primary, Secondary and Tertiary Control – Primary Control: Droop Control, Virtual Inertia Control – Secondary Control: Centralized and Decentralized Control – Simulation Studies

UNIT IV HYBRID MICROGRID 9

Hybrid AC/DC Microgrid Structure: AC Coupled, DC Coupled, AC-DC Coupled –Control Strategies: different modes of operation, during transition – Simulation Studies

UNIT V MICROGRID PROTECTION 9

Protection: Effect on Relay Protection of distribution network, Differential Relay Protection, Directional Impedance Relay Protection– Islanding: Active and Passive Techniques– Earthing: Requirements, Earthing mode of DG in TN/TT Earthing System, Earthing mode of DG in IT

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to analyze micro-sources and storage systems.
CO2: Able to analyse the configurations and control aspects of AC microgrid.
CO3: Understand and analyse the configurations and control aspects of DC microgrid.
CO4: Acquired knowledge about configurations and control aspects of Hybrid microgrid.
CO5: Learned the protection aspects of microgrid.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓						✓					
CO2	✓	✓	✓	✓	✓		✓					
CO3	✓	✓	✓	✓	✓		✓					
CO4	✓	✓	✓	✓	✓		✓					
CO5	✓		✓	✓								

REFERENCES:

1. H. Bevrani, Bruno Francois and ToshifumiIse, 'Microgrid Dynamics and Control', Wiley, 2017.
2. Li Fusheng, Li Ruisheng and Zhou Fengquan, 'Microgrid Technology and Engineering Application', Elsevier, 2016.
3. M.S. Mahmoud, 'Microgrid - Advanced Control Methods and Renewable Energy System Integration', Elsevier, 2017.
4. FarzamNejabatkhah and Yun Wei Li, 'Overview of Power Management Strategies of Hybrid AC/DC Microgrid', IEEE Transactions on Power Electronics, 2014.

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PW5077 **RENEWABLE ENERGY TECHNOLOGY** **LT P C**
3 0 0 3

COURSE OBJECTIVES

- To Provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To Provide knowledge about various possible hybrid energy systems
- To gain knowledge about application of various renewable energy technologies

UNIT I INTRODUCTION **9**

Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.

UNITII SOLAR ENERGY **9**

Solar Radiation and its measurements, Solar Thermal Energy Conversion from plate Solar Collectors, Concentrating Collectors and its Types , Efficiency and performance of collectors, Applications of Solar Thermal Energy use of low and medium, high temperature and recent advances in industry and buildings. Direct Solar Electricity Conversion from Photovoltaic, types of solar cells and its application of battery charger, domestic lighting, street lighting, and water pumping, power generation schemes. Recent Advances in PV Applications: Building Integrated PV, Grid Connected PV Systems, Hybrid Systems and Solar Cars, Solar Energy Storage system and their economic aspects.

UNIT III WIND ENERGY **9**

Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications. Hybrid systems - safety and environmental aspects, economic aspects.

UNIT IV BIO-ENERGY **9**

Energy from biomass, Principle of biomass conversion technologies/process and their classification, Bio gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, thermal gasification of biomass, biomass gasifies, Application of biomass and biogas plants and their economics.

UNIT V OTHER TYPES OF ENERGY **9**

Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants and their economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Attained knowledge about various renewable energy technologies
CO2: Ability to understand and design a PV system.
CO3: Understand the concept of various wind energy system.
CO4: Gained knowledge about various possible hybrid energy systems
CO5: Attained knowledge about various application of renewable energy technologies

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓		✓									
CO3	✓		✓									
CO4	✓		✓									
CO5			✓									

REFERENCES

1. Twidell & Wier,**'**Renewable Energy Resources' CRC Press(Taylor & Francis).
2. Tiwari and Ghosal/ Narosa,'Renewable energy resources'.
3. D.P.Kothari,K.C.Singhal,'Renewable energy sources and emerging technologies', P.H.I.
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PW5078 SCADA SYSTEM AND APPLICATIONS MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts and components of SCADA
- To introduce the SCADA communication protocols
- To apply the SCADA technology to power systems for automation
- To provide knowledge about SCADA based energy management centre.
- To emphasis the role of SCADA monitoring and control concepts.

UNIT I INTRODUCTION TO SCADA 9

SCADA overview, general features, SCADA architecture, SCADA Applications, Benefits, Remote Terminal Unit (RTU), Human- Machine Interface Units (HMI), Display Monitors/Data Logger Systems, Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA Control systems and Control panels

UNIT II SCADA COMMUNICATION 9

SCADA Communication requirements, Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Comparison of various communication protocols, IEC61850 based communication architecture, Communication media like Fiber optic, PLCC etc. Interface provisions and communication extensions, synchronization with NCC, DCC, IOT, Cyber cell, Redundancy of Network.

UNIT III SCADA IN POWER SYSTEM AUTOMATION 9

Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, System selection such as Substation configuration, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning,

CASE STUDIES:SCADA Design for 66/11KV and 132/66/11KV or 132/66 KV any utility Substation and IEC 61850 based SCADA Implementation issues in utility Substations

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UNIT IV ENERGY MANAGEMENT CENTRE **9**

Functions, production control and load management, economic despatch, distributed centres and power pool management, energy management system and its role.

UNIT V SCADA MONITORING AND CONTROL **9**

Online monitoring the event and alarm system, trends and reports, Blocking list, Event disturbance recording. Control function: Station control, bay control, breaker control and disconnector control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Students will learn the SCADA system components and its significance.
CO2: Students will understand the need and advantages of communication protocols for SCADA
CO3: Students will get implementation knowledge about the application of SCADA to Power System.
CO4: Students will get exposure to the best operating mechanism for Energy centre based on SCADA concepts
CO5: Students will understand the need and importance of monitoring and control logic for SCADA based power systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓							✓
CO2			✓		✓							
CO3		✓	✓		✓				✓			✓
CO4		✓	✓		✓				✓			✓
CO5	✓		✓									

REFERENCES:

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2. Gordon Clarke, Deon Reynders, 'Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems', Newnes Publications, Oxford, UK,2004.
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PW5079 WASTE MANAGEMENT AND ENERGY RECOVERY TECHNIQUES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide information on various methods of waste management.
- To Impart Knowledge about separation techniques & Transformation Technologies.
- To detail on the recent technologies of waste disposal
- To familiarize students with recent energy generation techniques.
- To make student realize on the importance of healthy environment.

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UNIT I CHARACTERISTICS AND PERSPECTIVES 9

Sources – Types – Composition – Generation – Estimation Techniques – Characterization –Types of Collection System – Transfer Stations – Transfer Operations – Material Recycle/ Recovery Facilities.

UNIT II UNIT OPERATIONS & TRANSFORMATION TECHNOLOGIES 9

Separation & Processing: Size Reduction – Separation through Density Variation, Magnetic / Electric Field: Densification - Physical, Chemical and Biological Properties and Transformation Technologies – Selection of Proper Mix of Technologies.

UNIT III WASTE DISPOSAL 9

Disposal Option & Selection Criteria - Landfill Classification – Types – Siting Considerations – Landfill Gas (Generation, Extraction, Gas Usage Techniques) – Leachates Formation, Movement, Control Techniques – Environmental Quality Monitoring – Layout, Closure & Post Closure Operation – Reclamation - Waste Disposal: A Case Study of Bangalore

UNIT IV TRANSFORMATION TECHNOLOGIES AND VALUE ADDITION 9

Physical Transformation: Component Separation & Volume Reduction: Chemical Transformation– Combustion/Gasification/ Pyrolysi: Energy Recovery - Biological Transformation – Aerobic Composting – Anaerobic Digestion.

UNIT V HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING 9

Definition – Sources – Classification – Incineration Technology - Incineration vs Combustion Technology – RDF / Mass Firing – Material Recycling: Paper / Glass / Plastics etc., - Disposal of White Goods & E-Wastes.

Hazardous Waste Management: Generation, Storage & Collection, Transfer & Transport, Processing, Disposal-Hazardous Waste Treatment: Physical & Chemical Treatment, Thermal Treatment, Biological Treatment - Pollution Prevention and Waste Minimization- Hazardous Wastes Management in India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Acquired basic knowledge about the Methods of Waste Management.
CO2: Understand the concept of Segregation & Transformation Techniques.
CO3: Learned the technologies that are available for effective waste disposal along with pros / cons.
CO4: Ability to develop various Energy generation Techniques.
CO5: Able to predict the waste related problems (Hazardous Waste, Pharma Waste, Biomedical Waste etc).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2		✓										
CO3								✓				
CO4												
CO5		✓		✓		✓	✓					✓

REFERENCES

1. George Polimveros, 'Energy Cogeneration Hand book', Industrial Press Inc, New York 1982.
2. Howard S. Peavy etal, 'Environmental Engineering', McGraw Hill International Edition,

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1985.
3. LaGrega, M., et al., 'Hazardous Waste Management', McGraw-Hill, c. 1200 pp., 2nd edition.,2001.
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PS5252 RESTRUCTURED POWER SYSTEM

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

Students will be able to:

- describe various types of deregulated markets in power system.
- describe the technical and non-technical issues in deregulated power industry.
- classify different market mechanisms and summarize the role of various entities in the market.
- analyze the energy and ancillary services management in deregulated power industry.
- understand the restructuring framework US and Indian power sector

UNIT I INTRODUCTION 9

Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models**:** Market models based on contractual arrangements - Market architecture - .

UNIT II TRANSMISSION CONGESTION MANAGEMENT 9

Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - Non-market methods - Market based methods - Nodal pricing - Inter-zonal Intra-zonal congestion management - Price area congestion management - Capacity alleviation method.

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

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

UNIT IV ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK **9**

Types of ancillary services - Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services - International comparison. Pricing of transmission network**:** wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - loss allocation methods

UNIT V MARKET EVOLUTION **9**

US markets: PJM market - The Nordic power market **-** Reforms in Indian power sector**:** Framework of Indian power sector - Reform initiatives - availability based tariff (ABT) - The Electricity Act 2012 - Open Access issues - Power exchange

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: describe the requirement for deregulation of the electricity market and the philosophy of various market models
CO2: analyze the various methods of congestion management in deregulated power system
CO3: analyze the locational marginal pricing and financial transmission rights
CO4: analyze the ancillary service management
CO5: understand the framework of Indian power sector

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓	✓					
CO2	✓	✓	✓			✓						
CO3	✓	✓	✓			✓						
CO4	✓	✓	✓			✓						
CO5	✓					✓	✓	✓				

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PS5151 ANALYSIS AND COMPUTATION OF ELECTROMAGNETIC TRANSIENTS IN POWER SYSTEMS

L T P C
3 1 0 4

COURSE OBJECTIVES

- To impart in depth knowledge aboutvarious power system transientsand analyze the travelling wave phenomena.
- To impart knowledge on the EMTP Type modelling of overhead lines and underground cables.
- To impart knowledge on the EMTP Type modelling of transformers.
- To coordinate the insulation of power system and protective devices.
- To describe the methodology for computing the transients in power systems.

UNITI REVIEW OF TRAVELLINGWAVE PHENOMENA 12

Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behavior of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion-switching overvoltage: Short line or kilometric fault, energizing transients - closing and re-closing of lines, methods of control; temporary over voltages: line dropping, load rejection; voltage induced byfault; very fast transient overvoltage(VFTO).

UNIT II PARAMETERS AND MODELLING OFOVERHEADLINES AND UNDERGROUNDCABLES 12

Review of line parameters for simple configurations: series resistance, inductance and shunt capacitance; bundle conductors : equivalent GMR and equivalent radius; modal propagation in transmission lines: modes on multi-phase transposed transmission lines, α-β-0 transformation and symmetrical components transformation, modal impedances; analysis of modes on un-transposed lines; effect of ground return and skin effect; transposition schemes; introduction to frequency-dependent line modelling. Distinguishing features of underground cables: technical features, electrical parameters, overhead lines versus underground cables; cable types; series impedance and shunt admittance of single- core self-contained cables, impedance and admittance matrices for three phase system formed by three single-core self-contained cables; approximate formulas for cable parameters

UNIT III PARAMETERS AND MODELLING OF TRANSFORMER 12

Transformer modelling guidelines for transient phenomena – Generalization of [R]-[ωL] model single phase N-coil transformer-Generalization of [R]-[ωL]-1 model single phase N-coil transformer- Inverse Inductance Matrix representation of three-phase N-coil transformers-inclusion of exciting current.

UNIT IV INSULATION CO-ORDINATION 12

Insulation co-ordination –volt –time characteristics , Insulation strength and their selection-Evaluation of insulation strength standard BILs-Characteristics of protective devices, applications, location of arresters – insulation co-ordination in AIS and GIS

UNIT V COMPUTATION OF POWER SYSTEM TRANSIENTS 12

Digital computation of line parameters: why line parameter evaluation programs? salient features of a typical line parameter evaluation program; constructional features of that affect transmission line parameters; line parameters for physical and equivalent phase conductors elimination of

ground wires bundling of conductors; principle of digital computation of transients: features and capabilities of electromagnetic transients program; steady state and time step solution modules: basic solution methods; case studies on simulation of various types of transients and insulation co-ordination.

TOTAL: 60 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: Understand and analyse the different types of transients.
CO2: Model overhead lines and cables and for transient studies.
CO3: Model transformers for transient studies.
CO4: Design a reliable power system with appropriate insulation coordination.
CO5: Compute different types of transients in power systems.

MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2	✓	✓	✓	✓	✓							
CO3	✓	✓	✓	✓	✓							
CO4	✓	✓	✓	✓	✓							
CO5	✓	✓	✓	✓	✓							

REFERENCES

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991.
2. R. Ramanujam, Computational Electromagnetic Transients: Modelling, Solution Methods and Simulation, I.K. International Publishing House Pvt. Ltd, New Delhi -110 016, ISBN 978-93- 82332-74-9, 2014; email: info@ikinternational.com
3. Pritindra Chowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., Second Edition, 2009.
4. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, (Second edition) Newage International (P) Ltd., New Delhi,1990.
5. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi,2004.
6. Andrew R. Hileman, “Insulation Coordination for Power Systems”, CRC press, Taylor &Francis Group, New York, 1999.

Attested

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PS5251 **HVDC AND FACTS** **L T P C**
3 1 0 4

COURSE OBJECTIVES

- To impart knowledge on the need for HVDC and FACTS.
- To impart in depth knowledge the operation, modelling and control of thyristor based FACTS controllers.
- To have an in-depth knowledge on the operation, modelling and control of LCC basedHVDC link.
- To have an in-depth knowledge on the operation, modelling and control of VSC basedHVDC link and FACTS controllers.
- To analyze the interaction of AC- DC systems through Power flow analysis.

UNIT I INTRODUCTION **12**

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-Review of basics of LCC and VSC HVDC system.

UNIT II THYRISTOR BASED FACTS **12**

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for power flow analysis- Stability studies- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line-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 **12**

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

UNIT IV VOLTAGE SOURCE CONVERTER BASED FACTS AND HVDC CONTROLLERS 12

Static synchronous compensator (STATCOM) - Static synchronous series compensator (SSSC) Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers (UPFC) - Modelling of UPFC and IPFC for power flow and transient stability studies- ApplicationsVSC based HVDC: Operation, Modelling for steady state and dynamic studies.

UNIT V POWER FLOW ANALYSIS OF AC/DC SYSTEMS **12**

Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow-Solution of AC-DC power flow: Sequential and Simultaneous methods.

TOTAL: 60 PERIODS

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COURSE OUTCOMES

Students will be able to:

CO1: Understand the basics of power transmission networks and need for HVDC and FACTS controllers.
CO2: Analyze the operation, control and application of thyristor based FACTS controllers.
CO3: Analyze the operation, control and application of LCC based HVDC link .
CO4: Analyze the operation, control and application of VSC based HVDC link .
CO5: Model HVDC and FACTS for Power Flow studies.

MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2	✓	✓	✓	✓	✓							
CO3	✓	✓	✓	✓	✓			✓				
CO4	✓	✓	✓	✓	✓							
CO5	✓	✓	✓	✓	✓	✓						✓

REFERENCES

1. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 2006.
2. K.R.Padiyar, “HVDC Power Transmission Systems”, New Age International (P)Ltd., New Delhi, 2002.
3. Mohan Mathur, R., Rajiv. K. Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley& Sons, Inc.
4. K.R.Padiyar,” FACTS Controllers in Power Transmission and Distribution”, New Age International(P) Ltd., Publishers, New Delhi, Reprint 2008.
5. J.Arrillaga, , “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983.
6. Erich Uhlmann, “ Power Transmission by Direct Current”, BS Publications,2004.
7. V.K.Sood, HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers.
8. A.T.John, “Flexible AC Transmission System”, Institution of Electrical and Electronic Engineers (IEEE), 1999.
9. Narain G.Hingorani, Laszio. Gyugyl, “Understanding FACTS Concepts and Technology of Flexible AC Transmission System”, Standard Publishers, Delhi 2001.

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PS5075 **SMART GRID**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

Students will be able to:

- Understand concept of smart grid and its advantages over conventional grid
- Know smart metering techniques
- Learn wide area measurement techniques
- Understanding the problems associated with integration of distributed generation & its solution through smart grid.
- To familiarize the high performance computing for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, Functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES (Transmission) 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT III SMART GRID TECHNOLOGIES (Distribution) 9

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, and Plug in Hybrid Electric Vehicles (PHEV).

UNIT IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits,AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing algorithms for Smart grid, IOT, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1:Understand on the concepts of Smart Grid and its present developments.

CO2:Analyze about different Smart Grid transmission technologies.

CO3:Analyze about different Smart Grid distribution technologies.

CO4:Acquire knowledge about different smart meters and advancedmetering infrastructure.

CO5:Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓	✓					
CO2	✓				✓	✓	✓					
CO3	✓				✓	✓	✓					
CO4	✓				✓	✓	✓					
CO5	✓				✓	✓	✓			✓		

REFERENCES

1. Stuart Borlase "Smart Grid :Infrastructure, Technology and Solutions",CRC Press 2016.
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications",Wiley.
3. Vehbi C. Gungor, DilanSahin, TaskinKocak, Salih Ergut, Concettina Buccella, Carlo Cecati ,and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies andStandards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
4. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey" , IEEE Transaction on Smart Grid

PS5076 WIND ENERGY CONVERSION SYSTEM LT P C
3 0 0 3

COURSE OBJECTIVES

- To learn about the basic concepts of wind energy conversion system
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed wind energy conversion systems.
- To understand the concepts of Variable speed wind energy conversion systems.
- To analyze the grid integration issues.

UNITI INTRODUCTION 9

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

UNIT II WINDTURBINES 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 powerextraction.

UNIT III FIXEDSPEEDSYSTEMS 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 VARIABLESPEED 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.

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UNIT V GRIDCONNECTED 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 modellingissue.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: Attain knowledge on the basic concepts of Wind energy conversion system.
CO2: Attain the knowledge of the mathematical modelling and control of the Wind turbine
CO3: Develop more understanding on the design of Fixed speed system
CO4: Study about the need of Variable speed system and its modelling.
CO5: Learn about Grid integration issues and current practices of wind interconnections with power system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓		✓		✓							
CO3	✓		✓									
CO4	✓		✓		✓							
CO5	✓	✓	✓	✓								

REFERENCES

1. L.L.Freris “Wind Energy conversion Systems”, Prentice Hall,1990
2. S.N.Bhadra, D.Kastha,S.Banerjee,”Wind Electrical Sytems”,Oxford University Press,2010.
3. Ion Boldea, “Variable speed generators”, Taylor & Francis group,2006.
4. E.W.Golding “The generation of Electricity by wind power”, Redwood burn Ltd., Trowbridge,1976.
5. N. Jenkins,” Wind Energy Technology” John Wiley &Sons,1997
6. S.Heir “Grid Integration of WECS”, Wiley1998.

PE5074 POWER QUALITY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge about various power quality issues.
- To understand the concept of power and power factor in single phase and three phase systems supplying nonlinear loads.
- To equip with required skills to design conventional compensation techniquesfor power factor correction and load voltage regulation.
- To introduce the control techniques for the active compensation.
- To understand mitigation techniques using custom power devices such as DVR & UPQC

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 linear and non linear loads –single phase sinusoidal, non sinusoidal source – supplying linear and nonlinear load – 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 LOAD COMPENSATION 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 of real and reactive powers – Extraction of fundamental sequence component from measured.

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 DVR – Dc Capacitor supported DVR – DVR Structure – voltage Restoration – Series Active Filter – Unified power quality conditioner.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to understand consequences of Power quality issues.
CO2 Ability to conduct harmonic analysis of single phase and three phase systems supplying nonlinear loads.
CO3 Ability to design passive filter for load compensation.
CO4 Ability to design active filters for load compensation.
CO5 Ability to understand the mitigation techniques using custom power devices such as distribution static compensator (DSTATCOM), dynamic voltage restorer (DVR)& UPQC.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓					✓					
CO3	✓	✓					✓					
CO4	✓	✓					✓					
CO5	✓	✓					✓					

TEXTBOOKS:

1. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers,2002
2. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1994(2ndedition)

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REFERENCES:

1. Power Quality - R.C.Duggan
2. Power system harmonics –A.J.Arrillga
3. Power Electronic Converter Harmonics –Derek A.Paice

PE5073	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION 9

Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy generation on environment, GHG Effect, Qualitative study of different renewable energy resources Ocean, Biomass, Hydrogen energy systems and Fuel cells.

UNIT II POWER ELECTRONIC CONVERTERS FOR RENEWABLE ENERGY 9

Solar: Block diagram of solar photo voltaic system: line commutated converters (inversion mode) - Boost and buck-boost converters.
Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT III PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS 9

Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Stand-alone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve and Operating area, Types of wind generators system based on Electrical machines-Induction Generator and Permanent Magnet Synchronous Generator(PMSG), Grid Connected-Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS AND MPPT 9

Energy Storage systems, Need for Hybrid Systems, Features of Hybrid Systems, Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV), Case studies of PV-

Maximum Power Point Tracking (MPPT) and Wind Energy system

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to understand different renewable energy systems
CO2 Ability to design and simulate power electronics converters used for interfacing Renewable energy systems
CO3 Ability to design standalone renewable energy system employing embedded energy storage and MPPT strategy.
CO4 Ability to design grid connected renewable energy system.
CO5 Ability to extract maximum power using different MPPT algorithms

TEXTBOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
2. Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", IEEE Press and John Wiley & Sons Ltd Press, 2014.

REFERENCES:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.
2. Rai. G.D, "Non-conventional energy sources", Khanna publishes, 1993.
3. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
4. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
5. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						✓	✓	✓			✓	
CO2	✓	✓	✓	✓								
CO3	✓	✓	✓	✓					✓			
CO4	✓	✓	✓	✓								
CO5	✓	✓	✓	✓								

PE5151 ANALYSIS OF ELECTRICAL MACHINES

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.
- To analyze the steady state and dynamic state operation of DC machine through mathematical modeling and simulation in digital computer.
- To provide the knowledge of theory of transformation of three phase variables to two phase variables.
- To analyze the steady state and dynamic state operation of three-phase induction

machines using transformation theory based mathematical modeling and digital computer simulation.

- To analyze the steady state and dynamic state operation of three-phase synchronous machines using transformation theory based mathematical modeling and digital computer simulation.

UNIT I PRINCIPLES OF ELECTRO MAGNETIC ENERGY CONVERSION 12

Magnetic circuits, permanent magnet, stored magnetic energy, co-energy - force and torque in singly and doubly excited systems – machine windings and air gap mmf– determination of winding resistances and inductances of machine windings – determination of friction coefficient and moment of inertia of electrical machines.

UNIT II DC MACHINES 12

Elementary DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics of permanent magnet and shunt DC motors – electrical and mechanical time constants - Time domain block diagrams –transfer function of DC motor-responses – digital computer simulation of permanent magnet and shunt DC machines.

UNIT III REFERENCE FRAME THEORY 12

Historical background of Clarke and Park transformations – power invariance and phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame - variables observed from several frames of reference.

UNIT IV INDUCTION MACHINES 12

Three phase 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 – modeling of multiphase machines - digital computer simulation of three phase induction machines.

UNIT V 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 – digital computer simulation of synchronous machines.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1 Ability to optimally design magnetics required in power supplies and drive systems.
CO2 Ability to acquire and apply knowledge of mathematics of machine dynamics in Electrical engineering.
CO3 Ability to model, simulate and analyze the dynamic performance of electrical machines using computational software.
CO4 Ability to formulate, design, simulate power supplies and loads for complete electrical machine performance
CO5 Ability to verify the results of the dynamic operation of electrical machine systems

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

TEXT BOOKS:

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley, Second Edition, 2010.
2. R Ramanujam,"Modelling and Analysis of Electrical Machines", I.K International Publishing Pvt. Ltd., New Delhi, 2018

REFERENCES:

1. P S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.
2. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition,199

PE5251 SPECIAL ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
- To introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
- To develop the control methods and operating principles of switched reluctance motors.
- To introduce the concepts of stepper motors and its applications.
- To understand the basic concepts of other special machines.

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS 9

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

UNIT II PERMANENT MAGNET SYNCHRONOUS MOTORS 9

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

UNIT III SWITCHED RELUCTANCE MOTORS 9

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

UNIT IV STEPPER MOTORS 9

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications.

UNIT V OTHER SPECIAL MACHINES 9

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

Applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to model and analyze power electronic systems and equipment using computational software.

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

CO3 Ability to analyse the dynamic performance of special electrical machines

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

CO5 Ability to design and conduct experiments towards research.

TEXT BOOKS:

1. T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Claredon press, London,1989.
2. R.Krishnan, 'Switched Reluctance motor drives', CRC press,2001.
3. T.Kenjo, 'Stepping motors and their microprocessor controls', Oxford University press, New Delhi,2000.

REFERENCES:

1. T.Kenjo and S.Nagamori, 'Permanent magnet and Brushless DC motors', Clarendon press, London,1988.
2. R.Krishnan, 'Electric motor drives', Prentice hall of India,2002.
3. D.P.Kothari and I.J.Nagrath, ' Electric machines', Tata McGraw hill publishing company, New Delhi, Third Edition,2004.
4. Irving L.Kosow, "Electric Machinery and Transformers" Pearson Education, Second Edition,2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓					✓				
CO2	✓	✓	✓	✓				✓				
CO3	✓	✓	✓	✓				✓				
CO4	✓	✓	✓	✓				✓				
CO5	✓	✓										

CO5152 INTELLIGENT CONTROLLERS L T P C
3 0 0 3

COURSE OBJECTIVES

To educate the students on

- Design of ANN and fuzzy set theory.
- Analysis and implementation of ANN and Fuzzy logic for modeling and control of Non-linear system and to get familiarized with the Matlab toolbox.
- Impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC 9

Review of fundamentals - Biological neuron, Artificial neuron, Activation function, Single Layer Perceptron – Limitations – Multi Layer Perceptron – Back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets - Scalar cardinality, fuzzy cardinality, union

and intersection, complement (yager and sugeno), equilibrium points, aggregation, projection, composition, fuzzy relation – Fuzzy membership functions.

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL 9

Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller –Case study - Familiarization of Neural Network Control Tool Box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL 9

Modeling of nonlinear systems using fuzzy models(Mamdani and Sugeno) –TSK model - Fuzzy Logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification- Adaptive fuzz y systems-Case study-Familiarization of Fuzzy Logic Tool Box.

UNIT IV GENETIC ALGORITHM 9

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search, Ant-colony search and Particle Swarm Optimization.

UNIT V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS –Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization - Case study– Familiarization of ANFIS Tool Box.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Ability to

CO1:Understand the basic architectures of NN and Fuzzy sets
CO2:Design and implement ANN architectures, algorithms and know their limitations.
CO3:Identify and work with different operations on the fuzzy sets.
CO4:Develop ANN and fuzzy logic based models and control schemes for non-linear systems.
CO5:Understand and explore hybrid control schemes and PSO

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓						✓
CO2	✓	✓	✓			✓						
CO3	✓	✓	✓			✓						✓
CO4	✓	✓	✓			✓						✓
CO5	✓	✓	✓			✓						✓

REFERENCES:

1. LaureneV.Fausett, “Fundamentals of Neural Networks, Architecture, Algorithms, and Applications”, Pearson Education, 2008.
2. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, Wiley, Third Edition, 2010.
3. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
4. W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.

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5. George J.Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic: Theory and Applications”, Prentice HalI, First Edition, 1995.

CO5072 CONTROL OF ELECTRICAL DRIVES LT P C
3 0 0 3

COURSE OBJECTIVES

- To introduce the PWM converters and their analysis.
- To educate on modeling of dc motor, drives and control techniques
- To educate on dynamic modeling of Induction motor drive.
- To educate on the V/f and vector control of Induction motor.
- To educate on generation of firing pulses and control algorithms in embedded platforms.

UNIT I POWER ELECTRONIC CONVERTERS FOR DRIVES 9

Power electronic switches-state space representation of switching converters-Fixed frequency PWM-variable frequency PWM- space vector PWM- Hysteresis current control-dynamic analysis of switching converters-PWM modulator model.

UNIT II CONTROL OF DC DRIVES 9

Modelling of DC machines-block diagram/transfer function-phase control-1phase/3phase converter fed DC drives- Chopper fed DC drives-four quadrant chopper circuit-closed loop control-speed control-current control-cascade control –constant torque/power operation-comparison of chopper/converter fed drives- techniques-merits/demits.

UNIT III ANALYSIS AND MODELLING OF INDUCTION MOTOR DRIVE 9

Basics of induction motor drive-classification – equivalent circuit- torque Vs slip characteristics-steady state performance- Dynamic modeling of induction motor, Three phase to two phase transformation-stator, rotor, synchronously rotating reference frame model.

UNIT IV CONTROL OF INDUCTION MOTOR DRIVE 9

VSI fed induction motor drives- waveforms for 1-phase, 3-phase Non-PWM and PWM VSI fed induction motor drives -principles of V/F control- principle of vector control-direct vector control-space vector modulation- indirect vector control .

UNIT V EMBEDDED CONTROL OF DRIVES 9

Generation of firing pulses- generation of PWM pulses using embedded processors-IC control of DC drives- fixed frequency/variable frequency/current control- V/F control using PIC microcontroller- vector control using embedded processors.

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1:understand Power Electronic Converter Switches and different PWM approach.
CO2:design and analyze converter and chopper driven dc drives.
CO3:analyze converter and chopper driven dc drives.
CO4:understand conventional control techniques of Induction motor drive.
CO5:understand V/f Control using PIC Micro Controller and Vector control using Embedded processor.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓					
CO2	✓	✓	✓			✓	✓					
CO3	✓	✓	✓	✓		✓	✓					
CO4	✓	✓	✓	✓		✓	✓					
CO5	✓	✓	✓	✓	✓	✓	✓					

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1. R.Krishnan, "Electric Motor Drives, Modeling, Analysis and Control" Prentice Hall of India, 2002.
2. Thyristor control of Electric drives, Vedam Subrahmanyam, Tata McGraw Hill, 1988
3. Ion Boldea & S.A.Nasar "ELECTRIC DRIVES", CRC Press, 2006
4. Simon Ang, Alejandro Oliva "POWER SWITCHING CONVERTERS", CRC Press, 2005
5. Buxbaum, A. Schierau, and K.Staughen, "A design of control systems for DC Drives", Springer- Verlag, Berlin,1990.

CO5153 MEMS DESIGN:SENSORS AND ACTUATORS LT P C
3 0 0 3

COURSE OBJECTIVES

- To analyse the properties of materials, microstructure and fabrication methods.
- To design and modeling of Electrostatic sensors and actuators.
- To teach the characterizing thermal sensors and actuators through design and modeling.
- To understand the fundamentals of piezoelectric sensors and actuators through exposure to different MEMS and NEMS devices

UNIT I MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONEPTS 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.

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UNIT V CASE STUDIES **9**

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

TOTAL : 45 PERIODS

COURSEOUTCOMES:

At the end of this course, the students will demonstrate the ability

CO1:To analyse the learning process to design of micro sensors, embedded sensors & actuators

CO2:To analyse the electrostatic sensors and actuators through MEMS and NEMS devices

CO3:To analyse the thermal sensors and actuators through MEMS and NEMS devices

CO4:To analyse the piezoelectric sensors and actuators through MEMS and NEMS

CO5:Design of piezoresistive sensors for biomedical and micro fluidic applications

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓						✓			✓
CO2	✓	✓	✓						✓			✓
CO3	✓	✓	✓						✓			✓
CO4	✓	✓		✓		✓						✓
CO5	✓	✓		✓			✓					

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.

CO5151 CONTROL SYSTEM DESIGN **L T P C**

4 0 0 4

COURSE OBJECTIVES

To educate the students on

- Analysis and design of controllers for linear systems defined in transfer function and state space from.
- Application of optimal control and filtering concepts for linear systems continuous and discrete domain.

UNIT I ANALYSIS OF LINEAR SYSTEMS **12**

Review of system models –Transfer function and state space form– Time and Frequency Response – stability- Discretization –Need for Discretization –Sample and Hold devices – Effect of sampling on transfer function and state models – Analysis – Test for controllability and Observability.

UNIT II DESIGN OF SISO SYSTEM **12**

Design Specifications –In continuous domain – Limitations – Controller Structure – Multiple degrees of freedom – PID controllers and Lag-lead compensators- Design – Discretization and direct discrete design - Design in continuous and discrete domain

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UNIT III STATE SPACE DESIGN 12

Pole assignment design – State and Output Feedback – observers – Estimated State Feedback – Design Examples (Continuous and Discrete).

UNIT IV OPTIMAL CONTROL 12

Introduction: Classical control and optimization, formulation of optimal control problem, Typical performance measures – Linear quadratic regulator problem – solution – Application examples.

UNIT V OPTIMAL FILTERING 12

Filtering – Linear system and estimation – System noise smoothing and prediction – Kalman Filter –Recursive estimation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Ability to

CO1:Analyse controllers for linear systems defined in transfer function and state space forms.

CO2:Design controllers for linear systems defined in transfer function and state space forms.

CO3:Apply state space forms to continuous and discrete systems.

CO4:Apply optimal control to linear systems in continuous and discrete systems

CO5:Apply filtering concepts to linear systems in continuous and discrete systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓								
CO2	✓	✓	✓	✓								
CO3	✓	✓	✓	✓								
CO4	✓	✓	✓	✓								
CO5	✓	✓	✓	✓								

TEXT BOOKS:

1. M.Gopal, “Digital Control and State Variable Methods”, 4th edition, McGraw Hill India, 2012
2. K. Ogata, ‘Modern Control Engineering’, 5th Edition, Pearson, 2012.
3. K. P. Mohandas, “Modern Control Engineering”, Sanguine Technical Publishers, 2006.
4. Kirk D.E., ‘Optimal Control Theory – An introduction’,Prentice hall, N.J., 1970.
5. Sage, A.P., ‘Optimum System Control’, Prentice Hall N.H., 1968.
6. Anderson, BD.O. and Moore J.B., ‘Optimal Filtering’, Prentice hall Inc., N.J., 1979.

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1. M.Gopal, Modern Control System Theory, 3rd edition, New Age International Publishers, 2014.
2. William S Levine, “Control System Fundamentals,” The Control Handbook, CRC Press, Taylor and Francis Group, 2011.

3. AshishTewari, ‘Modern Control Design with Matlab and Simulink’, John Wiley, New Delhi, 2002.
4. T. Glad and L. Ljung, “Control Theory –Multivariable and Non-Linear Methods”, Taylor & Francis, 2002.

HV5074 POLLUTION PERFORMANCE OF POWER APPARATUS AND SYSTEMS **L T P C 3 0 0 3**

COURSE OBJECTIVES:

To provide in-depth knowledge on

- the mechanism and effect of pollution
- Artificial and field pollution test methods

To the pollution performance of

- High voltage insulators
- surge diverters
- indoor equipment.

UNIT I INTRODUCTION **9**

Fundamental process of pollution flashover – development and effect of contamination layer – creepage distance – pollution conductivity – mechanism of pollution flashover – analytical determination of flashover voltage.

UNIT II POLLUTION TESTING **9**

Artificial pollution testing – salt-fog method – solid layer method – monitoring of parameters – measurement of layer conductivity – field testing methods., IS/IEC/IEEE Standard

UNIT III POLLUTION PERFORMANCE OF INSULATORS **9**

Ceramic and non-ceramic insulators – design of shed profiles – rib factor effect in AC and DC insulators – modelling

UNIT IV POLLUTION PERFORMANCE OF SURGE ARRESTERS **9**

External insulation – effect of pollution on the protective characteristics of gap and gapless arresters – modeling of surge diverters under polluted conditions.

UNIT V POLLUTION PERFORMANCE OF INDOOR EQUIPMENT **9**

Condensation and contamination of indoor switch gear – performance of organic insulator under polluted conditions – accelerated testing techniques.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to understand the mechanism and factors affecting the pollution performance
CO2 Ability to design and conduct pollution tests
CO3 Ability to design insulator profile based on pollution
CO4 Ability to understand the external insulation based on pollution
CO5 Ability to design indoor equipment

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2			✓	✓		✓						
CO3			✓	✓								
CO4			✓	✓								
CO5			✓	✓								

REFERENCES

1. Kind and Karner, “High Voltage Insulation”, Translated from German by Y.Narayana Rao, Frider. Vieweg, &Sohn, Braunschweig, Weishaden, 1985.
2. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India Pvt. Ltd, 2005.
3. Klaus Ragaller, “Surges in High Voltage Networks”, Plenum Press, New York, 1980.
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5. Dieter Kind and Kurt Feser, “High Voltage Test Techniques”, Second Edition, SBA Electrical

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Engineering Series, New Delhi, 1999.
6. Ravi S. Gorur, “Outdoor Insulators”, Inc. Phoenix, Arizona 85044, USA, 1999
7. Working Group D1.44, “Pollution test of naturally and artificially contaminated insulators” Cigre 2017

HV5075 **PRINCIPLES OF ELECTRIC POWER TRANSMISSION** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand power system structure and line configurations
- To compute line parameters and understand effect of ground return
- To understand voltage gradients of transmission line conductors.
- To compute electrostatic field and design of EHV AC
- To design and know basic concepts of HVDC lines.

UNIT I INTRODUCTION **9**

Standard transmission voltages-AC and DC – different line configurations– average values of line parameters – power handling capacity and line loss – costs of transmission lines and equipment – mechanical considerations in line performance

UNIT II CALCULATION OF LINE PARAMETERS **9**

Calculation of resistance, inductance and capacitance for multi-conductor lines – calculation of sequence inductances and capacitances – line parameters for different modes of propagation – effect of ground return

UNIT III VOLTAGE GRADIENTS OF CONDUCTORS **9**

Charge-potential relations for multi-conductor lines – surface voltage gradient on conductors – gradient factors and their use – distribution of voltage gradient on sub conductors of bundle - voltage gradients on conductors in the presence of ground wires on towers-I^2R loss and corona loss-RIV

UNIT IV ELECTROSTATIC FIELD AND DESIGN OF EHV LINES **9**

Effect of EHV line on heavy vehicles - calculation of electrostatic field of AC lines- effect of high field on humans, animals, and plants - measurement of electrostatic fields - electrostatic Induction in unenergised circuit of a D/C line - induced voltages in insulated ground wires - electromagnetic interference, Design of EHV lines

UNIT V HVDC LINES **9**

Introduction- Reliability and failure issues-Design-tower, ROW, clearances, insulators, electrical and mechanical protection-Maintenance-Control and protection-D.C Electric field and Magnetic field -Regulations and guide lines-under ground line design.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to identify voltage level and line configurations
CO2: Ability to model EHV AC and HVDC lines
CO3: Ability to compute voltage gradients of transmission line conductors
CO4: Ability to understand effects of electrostatic field on living and nonliving organisms
CO5: Ability to coordinate the insulation level of the power system

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓	✓					
CO2	✓	✓			✓							
CO3	✓			✓	✓	✓	✓					
CO4						✓	✓					
CO5		✓	✓		✓	✓	✓					

REFERENCES

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, Second Edition, New Age International Pvt. Ltd., 2006.
2. Pritindra Chowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., 2009.
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8. J.C Molburg, J.A. Kavicky, and K.C. Picel ,”A report on The design, Construction and operation of Long-distance High-Voltage Electricity Transmission Technologies” , Argonne (National Laboratory)
9. P.Kundur,“Power system stability and control”,McGraw-Hill,Inc.,1993
10. K.R.Padiyar, “HVDC Power Transmission Systems”, New Age International (P) Ltd.,New Delhi, 2002.

HV5071 APPLICATIONS OF HIGH ELECTRIC FIELDS LT P C
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on,

- industrial applications of High electric fields
- in-activation of microbes by High electric fields
- food preservation by High electric fields
- High electric fields applications in cancer treatment
- the awareness on electro-static hazards and safety measures

UNIT I APPLICATION IN INDUSTRY 9

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

UNIT II APPLICATION IN MICROBIAL INACTIVATION 9

Introduction-definitions, descriptions and applications-mechanisms of microbial in-activationselectrical breakdown-electroporation-inactivation models -Critical factors-analysis of process, product and microbial factors-pulse generators and treatment chamber design-Research needs

UNIT III APPLICATION IN FOOD PRESERVATION 9

Processing of juices, milk, egg, meat and fish products- Processing of water and waste – Industrial feasibility, cost and efficiency analysis

UNIT IV APPLICATION IN CANCER TREATMENT 9

Different types of cancer – Different types of treatments, anti-cancer drugs – Electrochemotherapy – Electric fields in cancer tissues – Modeling, analysis of cancer tissues

UNIT V SAFETY AND ELECTROSTATIC HAZARDS 9

Introduction – Nature of static electricity – Triboelectric series – Basic laws of Electrostatic electricity– materials and static electricity – Electrostatic discharges (ESD) – Static electricity problems – Hazards of Electrostatic electricity in industry – Hazards from electrical equipment and installations – Static eliminators and charge neutralizers – Lightning protection- safety measures and standards

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to apply high electric fields in day-to-day life problems
CO2: Ability to apply high electric fields in microbial inactivation
CO3: Ability to preserve food by high electric fields
CO4: Ability to work in multidisciplinary projects like cancertreatment with high electric fields
CO5: Ability to provide safety measures against electrostatic hazards

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							✓				✓	
CO2				✓					✓			
CO3				✓				✓	✓			
CO4				✓					✓			
CO5							✓				✓	

REFERENCES

1. N.H.Malik, A.A.Ai-Arainy, M.I.Qureshi, “Electrical Insulation in power systems”, Marcel Dekker, inc., 1998.
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6. H L M Lelieveld and Notermans.S,et.al., “Food preservation by pulsed electric fields: From research to application”, Woodhead Publishing Ltd. October 2007.
7. Indian Electricity Rules; IS-5216; Electrical Safety Handbook by John Cadick

ET5072 **AUTOMOTIVE EMBEDDED SYSTEM** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals and building of Electronic Engine Control systems**.**
- To teach on functional components and circuits for vehicles
- To discuss on programmable controllers for vehicles management systems
- To teach logics of automation & commercial techniques for vehicle communication
- To introduce the embedded systems concepts for E-vehicle system development.

UNIT I BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS 9

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications – open source ECU- RTOS - Concept for Engine management-Standards; Introduction to AUTOSAR and Introduction to Society SAE- Functional safety ISO 26262- Simulation and modeling of automotive system components.

UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES 9

Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

UNIT III VEHICLE MANAGEMENT SYSTEMS 9

Electronic Engine Control-engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition- Adaptive cruise control - speed control-anti-locking braking system-electronic suspension - electronic steering , Automatic wiper control- body control system ; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- Battery management system , power management system-electrically assisted power steering system- Adaptive lighting system- Safety and Collision Avoidance.

UNIT IV ONBOARD DIAGONSTICS AND TELEMATICS 9

On board diagnosis of vehicles -System diagnostic standards and regulation requirements Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST, KWP2000 and recent trends in vehicle communications- Navigation- Connected Cars technology – Tracking- Security for data communication- dashboard display and Virtual Instrumentation, multimedia electronics- Role of IOT in Automotive systems

UNIT V ELECTRIC VEHICLES 9

Electric vehicles –Components- Plug in Electrical vehicle- Charging station – Aggregators- Fuel cells/Solar powered vehicles- Autonomous vehicles.

NOTE: Miniproject/Discussions/Practice on Workbench/AUTOSAR/ Vehicle simulators / modeling packages on the basics of interfacing sensors, actuators specific to automobile-microcontrollers/ special automobile-microcontrollers for i/o port communication applicable to vehicles

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The learning process delivers insight into the significance of the role of embedded system for automotive applications.
CO2: Understanding the need, selection of sensors and actuators and interfacing with ECU
CO3: Applying the Embedded concepts for vehicle management and control systems.

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CO4: Understanding the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							
CO2	✓	✓		✓	✓							
CO3	✓	✓	✓	✓	✓							
CO4		✓	✓									
CO5	✓	✓	✓			✓		✓	✓			

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2. Ali Emedi, Mehrded ehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004.
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4. Jack Erjavec,Jeff Arias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles",Cengage ,2012
5. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford
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ET5076 MEMS TECHNOLOGY LT P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the diverse technological and functional approaches of MEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro sensors, actuators.
- To emphasis the need and role of MEMS process techniques.
- To update the ongoing trends and real time applications of MEMS technology.

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UNIT I INTRODUCTION TO 9

Overview of Micro electro mechanical systems (MEMS), devices and technologies, Laws of scaling- multi disciplinary nature of MEMS- Survey of materials- Smart Sensors-Applications of MEMS.

UNIT II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES 9

Photolithography- Film deposition, Etching Processes- wafer bonding- Bulk micro machining, silicon surface micro machining- LIGA process.

UNIT III MICRO SENSORS AND MICRO ACTUATORS 9

Transduction mechanisms in different energy domain- Micromachined capacitive, Piezoelectric , piezoresistive and Electromechanical and thermal sensors/actuators and applications

UNIT IV MEMS PROCESS TECHNIQUES 9

Simulation and modeling of MEMS components - Computer- aided design for MEMS layout, SOI, Metal and Poly MUMPs- Microsystem Design and Packaging -Rapid product development.

UNIT V MEMS APPLICATION AND RECENT TRENDS 9

Introduction to Micro/Nano Fluids- Micro pump- Bio MEMS- Optical MEMS- Micro motor- Accelerator- Applications of SMA- Recent trends in MEMS- Introduction to NEMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understanding the material properties and the significance of MEMS for industrial automation.

CO2: Knowledge delivery on micromachining and micro fabrication.

CO3: Applying the fabrication mechanism for MEMS sensor and actuators.

CO4: Applying the concepts of MEMS to models ,simulate and process the sensors and actuators.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS technology.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓						✓
CO2	✓			✓	✓			✓				
CO3	✓		✓	✓	✓							
CO4	✓		✓									
CO5	✓	✓	✓			✓		✓	✓			

REFERENCES:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
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ET5078	ROBOTICS AND AUTOMATION	LT P C 3 0 0 3

COURSE OBJECTIVES:

- To teach the need of embedded system technology for robot building
- To Study The Various Parts Of Robots And Fields Of Robotics.
- To Study The Various Kinematics And Inverse Kinematics Of Robots.
- To Study The Trajectory Planning For Robot.
- To Study The Control Of Robots For Some Specific Applications.

UNIT I INTRODUCTION TO ROBOTICS 9

Overview of Robotics & Automation – Different Types of Robotics – Various Generations of Robots- Asimov"S Laws Of Robotics –Selection of Robots-Role and design of embedded system for robotics and automation –Recent trends.

UNIT II POWER SOURCES AND SENSORS 9

Hydraulic, Pneumatic And Electric Drives – Determination Of HP Of Motor And Gearing Ratio – Variable Speed Arrangements – Path Determination – Micro Machines In Robotics – Machine Vision – Ranging – Laser – Acoustic – Magnetic, Fiber Optic And Tactile Sensors-smart sensors.

UNIT III MANIPULATORS, ACTUATORS AND GRIPPERS 9

Construction Of Manipulators – Manipulator Dynamics And Force Control – Electronic And Pneumatic Manipulator Control Circuits – End Effectors – Various Types Of Grippers – Design Considerations.

UNIT IV KINEMATICS AND PATH PLANNING 9

Solution Of Inverse Kinematics Problem – Multiple Solution Jacobian Work Envelop – Hill Climbing Techniques –path planning algorithms- Robot Programming Languages- Simulation and modeling of simple

UNIT V CASE STUDIES 9

Robot Cell Design -Intelligent Robot- Humanoid Robot -Mutiple Robots –Robots in healthcare applications- Machine Interface – Robots in Manufacturing and Non- Manufacturing Applications- Self balancing robots- Micro/nano robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Selection of suitable embedded boards for robots

CO2: Understanding the concepts of robotics & automation and Working Of Robot

CO3: Analyze the Function of Sensors and actuators In the Robot

CO4: Write Program to Use a Robot For a Typical Application

CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge up gradation on Embedded system based robot development

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							
CO2	✓		✓		✓							
CO3	✓		✓	✓	✓							
CO4	✓		✓	✓	✓							
CO5	✓		✓		✓	✓		✓	✓			

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2. Ghosh, Control In Robotics And Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
3. Deb. S.R.,“Robotics Technology And Flexible Automation”, John Wiley, USA 1992.
4. Klafter R.D., Chimielewski T.A., Negin M., “Robotic Engineering – An Integrated Approach”, Prentice Hall Of India, New Delhi, 1994.
5. Mc Kerrow P.J. “Introduction To Robotics”, Addison Wesley, USA, 1991.
6. Issac Asimov “Robot”, Ballantine Books, New York, 1986.
7. Barry Leatham – Jones, “Elements Of Industrial Robotics” PITMAN Publishing, 1987.
8. Mikell P.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, “Industrial Robotics Technology, Programming And Applications “, McGraw Hill Book Company 1986.
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OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

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Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

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1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.

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6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 INDUSTRIAL SAFETY LT P C
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

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Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook, Eighth Edition,2008

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

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2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENTOF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution

- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING *CONCEPTS* 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
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5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

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TOTAL: 45 PERIODS

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OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, WestGermany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITII BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNITIII BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNITIV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY **9**

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

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2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING **L T P C**
2 0 0 0

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 first- time submission

TOTAL: 30 PERIODS

OUTCOMES

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

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2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
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AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- 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

UNIT I 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

OUTCOMES

CO1: Ability to summarize basics of disaster

CO2: Ability to explaina critical understanding of key concepts in disaster riskreduction and humanitarian response.

CO3: Ability to illustratedisaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describean 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

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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 "'NewRoyal book Company,2007.
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AX5093 **SANSKRIT FOR TECHNICAL KNOWLEDGE** **L T P C**
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

Attested

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AX5094	VALUE EDUCATION	L T P C
		2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

Suggested reading

1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University, Press, New Delhi

AX5095 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to:

- 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:

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

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:

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:

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:

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

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- 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.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading

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.

Attested

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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.

AX5096 **PEDAGOGY STUDIES** **L T P C**
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

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Suggested reading

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do's and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.