ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.E. ENERGY ENGINEERING

THE VISION OF THE DEPARTMENT OF MECHANICAL ENGINEERING

We, at the Department of Mechanical Engineering, Anna University shall strive hard to impart knowledge and state-of-the-art training to our students and expose them to broad areas of Mechanical Engineering, namely Design, Manufacturing, Energy, Thermal Sciences and currently related interdisciplinary areas, so that they can later practice their profession at home or abroad keeping in mind the needs and concern of the society they represent, safeguarding values, ethics and be instrumental in bringing about an overall technological development.

THE MISSION OF THE DEPARTMENT OF MECHANICAL ENGINEERING

1. To deliver knowledge in Mechanical Engineering and Materials Science and Engineering with high educational standards so that the outgoing students are employable and globally competitive.
2. To produce graduate and post graduate engineers with core competency as well as relevant software skills and social responsibility.
3. To be dynamic in imparting knowledge to students depending upon the changing national and International needs

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M.E. ENERGY ENGINEERING (FULL –TIME AND PART -TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

The Energy Engineering program seeks to prepare PG students for productive and rewarding careers in the energy arena. The PEOs are listed below

I. Acquire knowledge and accomplish a decent employment in energy sector and advance quickly to significant positions of leadership in their Profession.
II. Inclination towards advanced research for mitigating the shortcomings in energy systems.
III. Ascending as an energy consultant for providing solutions towards improving the efficacy of energy systems.
IV. Become a successful entrepreneur and be a part of a supply chain or manufacture or market energy products for sustainable development.
V. Lead an ethical life by engaging in lifelong learning experiences for developing environmentally benign and economically affordable energy products for societal upliftment

PROGRAMME OUTCOMES (POs):

After studying Energy Engineering, our students will exhibit ability to:

PO #	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply knowledge of mathematics, basic science and engineering science.
2	Problem analysis	Identify, formulate and solve engineering problems.
3	Design/development of solutions	Design a system or process to improve its performance, satisfying its constraints.
4	Conduct investigations of complex problems	Conduct experiments & collect, analyze and interpret the data.
5	Modern tool usage	Apply various tools and techniques to improve the efficiency of the system.
6	The Engineer and society	Conduct themselves to uphold the professional and social obligations.
7	Environment and sustainability	Design the system with environment consciousness and sustainable development.
8	Ethics	Interact in industry, business and society in a professional and ethical manner.
9	Individual and team work	Function in a multidisciplinary team.
10	Communication	Proficiency in oral and written Communication.
11	Project management and finance	Implement cost effective and improved system.
12	Life-long learning	Continue professional development and learning as a life-long activity.

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PROGRAM SPECIFIC OUTCOMES (PSOs):

1. To create awareness on the energy sourcing, generation, distribution, consumption, and emission patterns of India Vs Globe, apart from computation of plant load factor, efficiency, quantification of emissions along with cost of power generation from various energy sources
2. To carry out energy audit in Industries by accounting its energy consumption pattern, determining its specific energy consumption, diagnosing the causes for deviation from the industry benchmarks and suggestions for improving the performance of the plant
3. To instill ability to use knowledge in various domains to identify research gaps and ideate innovations by simulation of energy systems using softwares such as MATLAB, ANSY- CFX, Fluent, TRNSYS, PV-SYST

PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
II	✓	✓	✓	✓	✓				✓		✓	✓
III	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
IV	✓	✓	✓		✓		✓	✓	✓	✓	✓	
V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		Energy Management and Environmental Benefits	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
Year I	Semester 1	Fluid Mechanics and Heat Transfer	✓	✓	✓	✓	✓		✓					✓
		Instrumentation for Energy Systems	✓	✓	✓	✓			✓					✓
		Renewable Energy Systems	✓	✓	✓	✓		✓	✓	✓				✓
		Thermodynamic Analysis of Energy Systems	✓	✓	✓	✓	✓		✓					✓
		Research Methodology and IPR	✓	✓										✓
		Audit Course – I												
		Renewable Energy Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
		Applied Thermal Engineering Laboratory	✓	✓	✓	✓	✓		✓		✓	✓		✓
	Semester 2	Energy Conservation in Industrial Utilities	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
		Computational Fluid Dynamics for Energy Systems	✓	✓	✓	✓	✓		✓					✓
		Program Elective I												
		Program Elective II												
		Program Elective III												
		Audit Course – II												
		Energy Conservation Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
		Analysis and Simulation Laboratory for Energy Engineering	✓	✓	✓	✓	✓		✓		✓	✓		✓
		Mini Project with Seminar	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year II	Semester 3	Program Elective IV												
		Program Elective V												
		Open Elective												
		Dissertation-I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Semester 4	Dissertation-II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

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CHOICE BASED CREDIT SYSTEM
M.E. ENERGY ENGINEERING (FULL -TIME)
SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EY5151	Energy Management and Environmental Benefits	PCC	3	0	0	3	3
2.	EY5152	Fluid Mechanics and Heat Transfer	PCC	3	1	0	4	4
3.	EY5153	Instrumentation for Energy Systems	PCC	3	0	0	3	3
4.	EY5154	Renewable Energy Systems	PCC	3	0	0	3	3
5.	EY5155	Thermodynamic Analysis of Energy Systems	PCC	3	1	0	4	4
6.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
8.	EY5111	Renewable Energy Laboratory	PCC	0	0	4	4	2
9.	RA5161	Applied Thermal Engineering Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**2**	**8**	**29**	**23**

* Audit Course is optional.

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EY5201	Energy Conservation in Industrial Utilities	PCC	3	0	0	3	3
2.	EY5251	Computational Fluid Dynamics for Energy Systems	PCC	3	1	0	4	4
3.		Program Elective I	PEC	3	0	0	3	3
4.		Program Elective II	PEC	3	0	0	3	3
5.		Program Elective III	PEC	3	0	0	3	3
6.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
7.	EY5211	Energy Conservation Laboratory	PCC	0	0	4	4	2
8.	EY5212	Analysis and Simulation Laboratory for Energy Engineering	PCC	0	0	4	4	2
9.	EY5213	Mini Project with Seminar	EEC	0	0	4	4	2
			TOTAL	**17**	**1**	**12**	**30**	**22**

* Audit Course is optional.

SEMESTER III

SL. 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	OEC	3	0	0	3	3
PRACTICAL								
4.	EY5311	Dissertation - I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	EY5411	Dissertation - II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

Total credits for the programme = 23 + 22 + 15 +12 = 72

ANNA UNIVERSITY, CHENNAI

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REGULATIONS - 2019

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SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EY5155	Thermodynamic Analysis of Energy Systems	PCC	3	1	0	4	4
2.	EY5152	Fluid Mechanics and Heat Transfer	PCC	3	1	0	4	4
3.	EY5154	Renewable Energy Systems	PCC	3	0	0	3	3
PRACTICAL								
4.	EY5111	Renewable Energy Laboratory	PCC	0	0	4	4	2
			TOTAL	**9**	**2**	**4**	**15**	**13**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EY5151	Energy Management and Environmental Benefits	PCC	3	0	0	3	3
2.	EY5153	Instrumentation for Energy Systems	PCC	3	0	0	3	3
3.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
4.		Audit Course – I*	AC	2	0	0	2	0
PRACTICAL								
5.	RA5161	Applied Thermal Engineering Laboratory	PCC	0	0	4	4	2
			TOTAL	**10**	**0**	**4**	**14**	**10**

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SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EY5201	Energy Conservation in Industrial Utilities	PCC	3	0	0	3	3
2.	EY5251	Computational Fluid Dynamics for Energy Systems	PCC	3	1	0	4	4
3.		Program Elective I	PEC	3	0	0	3	3
PRACTICALS								
4.	EY5211	Energy Conservation Laboratory	PCC	0	0	4	4	2
			TOTAL	**9**	**1**	**4**	**14**	**12**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective II	PEC	3	0	0	3	3
2.		Program Elective III	PEC	3	0	0	3	3
3.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
4.	EY5212	Analysis and Simulation Laboratory for Energy Engineering	PCC	0	0	4	4	2
5.	EY5213	Mini Project with Seminar	EEC	0	0	4	4	2
			TOTAL	**8**	**0**	**8**	**16**	**10**

* Audit Course is optional.

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SEMESTER V

SL. 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	OEC	3	0	0	3	3
PRACTICAL								
4.	EY5311	Dissertation - I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	EY5411	Dissertation - II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

Total credits for the programme =13+10+12+10+15+12 = 72

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PROGRAM CORE COURSES (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	EY5151	Energy Management and Environmental Benefits	3	0	0	3	1
2.	EY5152	Fluid Mechanics and Heat Transfer	3	1	0	4	1
3.	EY5153	Instrumentation for Energy Systems	3	0	0	3	1
4.	EY5154	Renewable Energy Systems	3	0	0	3	1
5.	EY5155	Thermodynamic Analysis of Energy Systems	3	1	0	4	1
6.	EY5111	Renewable Energy Laboratory	0	0	4	2	1
7.	RA5161	Applied Thermal Engineering Laboratory	0	0	4	2	1
8.	EY5201	Energy Conservation in Industrial Utilities	3	0	0	3	2
9.	EY5211	Energy Conservation Laboratory	0	0	4	2	2
10.	EY5212	Analysis and Simulation Laboratory for Energy Engineering	0	0	4	2	2
11.	EY5251	Computational Fluid Dynamics for Energy Systems	3	1	0	4	2

PROGRAM ELECTIVE COURSES

SEMESTER II, ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY5001	Design and Analysis of Turbo Machines	PEC	3	0	0	3	3
2.	EY5002	Fluidized Bed Systems	PEC	3	0	0	3	3
3.	EY5072	Bio Energy Technologies	PEC	3	0	0	3	3
4.	EY5003	Power Generation, Transmission and Distribution	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY5075	Energy Forecasting, Modeling and Project Management	PEC	3	0	0	3	3
2.	EY5078	Modeling and Analysis of Energy Systems	PEC	3	0	0	3	3
3.	EY5004	Nuclear Engineering	PEC	3	0	0	3	3
4.	EY5081	Solar Energy Technologies	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY5071	Advanced Energy Storage Technologies	PEC	3	0	0	3	3
2.	EY5074	Energy Efficient Buildings Design	PEC	3	0	0	3	3
3.	EY5005	Design of Heat Exchangers	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY5073	Electrical Drives and Controls	PEC	3	0	0	3	3
2.	EY5079	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3
3.	EY5006	Wind Energy systems	PEC	3	0	0	3	3
4.	EY5007	Advanced Power Plant Engineering	PEC	3	0	0	3	3

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SEMESTER III, ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EY5077	Hydrogen and Fuel Cells	PEC	3	0	0	3	3
2.	EY5080	Smart Grid	PEC	3	0	0	3	3
3.	EY5076	Environmental Engineering and Pollution Control	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2

OPEN ELECTIVE COURSES [OEC]

(Out of 6 Courses one Course must be selected)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX5091	English for Research Paper Writing	2	0	0	0
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

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1	EY5213	Mini Project with Seminar	0	0	4	2	2
2	EY5311	Dissertation I	0	0	12	6	3
3	EY5411	Dissertation II	0	0	24	12	4

SUMMARY

	M.E. (Energy Engineering) (Full Time)					
	Subject Area	Credits per Semester				Credits Total
		I	II	III	IV	
1.	PCC	21	11	0	0	32
2.	PEC	0	9	6	0	15
3.	RMC	2	0	0	0	2
4.	OEC	0	0	3	0	3
5.	EEC	0	2	6	12	20
6.	Non Credit / Audit Courses	✓	✓	0	0	0
	Total Credit	**23**	**22**	**15**	**12**	**72**

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EY5151	ENERGY MANAGEMENT AND ENVIRONMENTAL BENEFITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To create awareness on the energy scenario of India with respect to world
2. To learn the methodology adopted for an energy audit
3. To appreciate the concepts adopted in project management
4. To study the different techniques adopted for financial appraisal of a project
5. To Comprehend the impact of energy on environment

UNIT – I ENERGY SCENARIO 9

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – energy security - energy conservation and its importance - Energy Conservation Act 2001

UNIT – II ENERGY MANAGEMENT 9

Energy audit - need – types – methodology – barriers - analysis on energy costing and sharing - bench marking - fuel and energy substitution – billing parameters in TANGEDCO – demand side management - instruments for energy audit – energy monitoring and targeting – CUSUM - energy labelling

UNIT – III PROJECT MANAGEMENT 9

Four Basic Elements of Project Management - Project Management Life Cycle - Steps in Project Management - Project Definition and Scope, Technical Design, Financing, Contracting, Implementation Techniques (Gantt Chart, CPM and PERT) and Performance Monitoring

UNIT – IV FINANCIAL MANAGEMENT 9

Investment appraisal for energy conservation projects - Financial analysis techniques -Simple pay back period, Return on investment, Net present value, Internal rate of return - Cash flows - Risk and sensitivity analysis : micro and macro factors - Financing options - energy performance contracts - ESCOs.

UNIT – V ENERGY AND ENVIRONMENT 9

Greenhouse effect and the carbon cycle - current evidence and future effects of climate change - Global Environmental Concerns - United Nations Framework Convention on Climate Change (UNFCC), Kyoto Protocol, Conference of Parties (COP), Emissions trading (ET), Joint implementation (JI), Clean Development Mechanism (CDM), Prototype Carbon Fund (PCF), Sustainable Development

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Recognize the importance of energy conservation and suggest measures for improving per capita energy consumption
2. Analyse the energy sharing and cost sharing pattern of fuels used in industries
3. Apply Gantt Chart, CPM and PERT in energy conservation projects
4. Evaluate the techno-economics of a project adopting discounting and non-discounting cash flow techniqes
5. Assess the sources of additional revenue generation for energy conservation projects adopting UNFCC

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REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004.
2. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
3. W.C. turner, "Energy Management Hand book" Wiley, New York, 1982
4. W.R. Murphy and G. McKay "Energy Management" Butterworths, London 1987
5. Eastop.T.D& Croft D.R, Energy Efficiency for Engineers and Technologists,.Logman Scientific & Technical, ISBN-0-582-03184, 1990.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9						0.6					0.3	0.9	0.6	0.3
2	0.9	0.6	0.6	0.6	0.3	0.3	0.6				0.6	0.6	0.6	0.9	
3	0.3	0.3	0.3	0.3	0.6			0.3	0.6		0.9				0.9
4	0.3	0.3		0.3	0.3			0.3	0.3		0.9	0.6		0.6	
5	0.3					0.6	0.9	0.3			0.6	0.3	0.9		

EY5152 FLUID MECHANICS AND HEAT TRANSFER

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. To make students familiarize with the application of conservation equations
2. To explain the incompressible and compressible fluid flow concepts
3. To inculcate the analysis of conduction and gas radiation heat transfer
4. To provide the details of turbulent forced convective heat transfer
5. To impart the knowledge of design of single phase and multi-phase heat exchangers

UNIT – I BASIC EQUATION, POTENTIAL FLOW AND BOUNDARY LAYER THEORY **12**

Three dimensional forms of governing equations – Mass, Momentum and Energy equations and their engineering applications. Rotational and irrotational flows – vorticity – stream and potential functions. Boundary Layer – displacement, momentum and energy thickness – laminar and turbulent boundary layers in flat plates and circular pipes.

UNIT – II INCOMPRESSIBLE AND COMPRESSIBLE FLOWS **12**

Laminar flow between parallel plates – flow through circular pipe – friction factor – smooth and rough pipes – Moody diagram – losses during flow through pipes. Pipes in series and parallel – transmission of power through pipes. One dimensional compressible flow analysis – flow through variable area passage – nozzles and diffusers.

UNIT – III CONDUCTION AND RADIATION HEAT TRANSFER **12**

Governing Equation and Boundary conditions, Extended surface heat transfer, Transient conduction – Use of Heisler-Grober charts, Conduction with moving boundaries, Stefan and Neumann problem - Gas Radiation.

UNIT – IV TURBULENT FORCED CONVECTIVE HEAT TRANSFER **12**

Turbulence theory – mixing length concept – turbulence model – k Є model – analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube – high speed flows.

UNIT – V PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 12

Condensation on bank of tubes – boiling – pool and flow boiling, Heat exchanger – Є – NTU approach and design procedure – compact heat exchanger.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

1. Identify, formulate and analyze the governing equations for various engineering applications
2. Learn the flow concepts of incompressible and compressible flow.
3. Solve the conduction and gas radiation heat transfer problems.
4. Understand the turbulent forced convective heat transfer
5. Design a heat exchanger as per the industrial needs.

REFERENCES:

1. **Yunus A Cengel and John M Cimbala**, "Fluid Mechanics Fundamentals and Ap-plications," TMH Ltd., Second Edition, 2006.
2. **Shiv Kumar**, "Fluid Mechanics Basic Concepts & Principles " Ane Books Pvt. Ltd, Second Edition 2011
3. **Venkateshan S P.**, "Heat Transfer " Ane Books Pvt. Ltd, 2011
4. **Holman J P,** "Heat Transfer", TMH Ltd., Ninth Edition, 2010.
5. **Ozisik M N.,** "Heat Transfer – A Basic Approach", McGraw Hill Co, 1985.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.9	0.9	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.9
2	0.9	0.9	0.9	0.9	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.9
3	0.9	0.9	0.9	0.9	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.9
4	0.9	0.9	0.9	0.9	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.9
5	0.9	0.9	0.9	0.9	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.9

EY5153 INSTRUMENTATION FOR ENERGY SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To impart knowledge about characteristics of measurement system and statistical analysis of measured data.
2. To make students conversant with the electrical measurements and signal conditioning circuits.
3. To provide insight into the digital measuring techniques of physical quantities and Solar instruments.
4. To make the students get acquainted with the measurement of thermo-physical properties and air pollutants.
5. To inculcate skills in the design and development of measurement and control systems.

UNIT – I MEASUREMENT SYSTEM: CHARACTERISTICS AND STATISTICAL ANALYSIS 9

Introduction to measurement system, Errors in Measurement, Static and Dynamic characteristics of transducers, Statistical analysis of experimental data – Uncertainty analysis, Regression analysis, Design of experiments – Full and Half factorial design.

UNIT – II ELECTRICAL MEASUREMENTS AND SIGNAL CONDITIONING 9

Voltage, Current, Power, Energy, Time and Frequency measurement, Frequency Counter, Signal conditioning Circuits: Wheatstone bridge – Differential Amplifier – V to I Converter, I to V Converter, Integrator, Differentiator, Instrumentation Amplifier, Attenuators and Filters, DAC, ADC, PID Controller.

UNIT – III DIGITAL MEASUREMENT OF PHYSICAL QUANTITIES 9

Digital measuring techniques of Displacement, Temperature, Pressure, Force, Torque, Vibration, Acceleration, Velocity, Level, Flow, Thermal and Nuclear Radiation. Solar instruments:Pyrheliometers – Pyranometers– Pyrheliometers – Albedometers – Pyrradiometers – Pyrgeometers – Net Pyrradiometers – Sunphotometers.

UNIT – IV MEASUREMENT OF THERMO-PHYSICAL PROPERTIES AND AIR POLLUTANTS 9

Measurement of Thermal Conductivity – Solids, Liquids and Gas, Viscosity, Gas Diffusion. Calorimetry – Bomb Calorimeter – Continuous flow Calorimeter. Measurement of Heat Transfer, Humidity, Heat flux, pH, Air pollution Sampling and Measurement – Particulate Sampling techniques – Measurement of Sulphur Dioxide, Combustion products, Opacity and Odour.

UNIT – V CONTROL SYSTEMS 9

Introduction to Arduino and Raspberry Pi – Interfacing with I/O devices of system: Sensors, Display devices, Stepper and Servo motors. Measurement by Data Acquisition System. Introduction to Internet of Things (IoT) – Application of IoT with Raspberry Pi for Process monitoring and control – Energy management. Application of PID controller in PV and Energy systems. Application of Smart Sensors and Intelligent instrumentation and Control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Analyze and evaluate the uncertainties in measurement data.
2. Identify appropriate sensors for measuring electrical quantities and signal conditioning circuits.
3. Explain the digital measurement techniques of physical quantities.
4. Implement the measurement of thermo-physical properties and air pollutants.
5. Design and develop the appropriate measurement and control system for an application.

REFERENCES:

1. Barney G.C., “Intelligent instrumentation: microprocessor applications in measurement and control”, Prentice Hall, 1988.
2. Bell C., “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013.
3. Doebelin E. and ManikD.N., “Doebelin's Measurement Systems”, Tata McGraw Hill, 2011.
4. George, B., Roy, J.K., Kumar, V.J., Mukhopadhyay, S.C., “Advanced Interfacing Techniques for Sensors”, Springer, 2017.
5. Holman J.P., “Experimental methods for Engineers”, Tata McGraw Hill, 2007.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9		0.9										0.9	
2	0.9		0.6						0.9					0.9	
3	0.9		0.9											0.9	
4	0.9		0.9				0.6							0.9	
5	0.9		0.9	0.9	0.9				0.9			0.9			0.9

EY5154	RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To know the Indian and global energy scenario
2. To learn the various solar energy technologies and its applications.
3. To educate the various wind energy technologies.
4. To explore the various bio-energy technologies.
5. To study the ocean and geothermal technologies.

UNIT – I ENERGY SCENARIO 9

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

UNIT – II SOLAR ENERGY 9

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

UNIT – III WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT – IV BIO-ENERGY 9

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

UNIT – V OCEAN AND GEOTHERMAL ENERGY 9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Know the Indian and global energy scenario
2. Learn the various solar energy technologies and its applications.
3. Have knowledge in the various wind energy technologies.
4. Explore the various bio-energy technologies.
5. Learn the ocean and geothermal technologies.

REFERENCES:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.3	0.3	0.3	0.3	0.3	0.6	0.9	0.6	0.6	0.3	0.3	0.9	0.6	0.3	0.3
2	0.9	0.6	0.6	0.3	0.3	0.3	0.9	0.3	0.3	0.3	0.6	0.9	0.6	0.3	0.6
3	0.9	0.6	0.9	0.6	0.6	0.3	0.9	0.3	0.3	0.3	0.3	0.9	0.3	0.3	0.3
4	0.6	0.6	0.6	0.3	0.6	0.3	0.9	0.3	0.3	0.3	0.6	0.9	0.6	0.6	0.3
5	0.6	0.3	0.6	0.3	0.6	0.3	0.9	0.3	0.3	0.3	0.3	0.9	0.6	0.3	0.3

EY5155 THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. To understand and apply the concept of availability and thermodynamic relations
2. To understand and calculate the behaviour of real gases and gas mixtures
3. To understand the applications of first and second law to chemically reacting systems
4. To learn various aspects of combustion chemistry
5. To use the concepts of advanced thermodynamics to combustion systems

UNIT – I AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS **12**

Reversible work – availability – irreversibility. Second law efficiency for a closed system and steady – state, control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwell relations. Generalized relations for changes in entropy – internal energy and enthalpy – C_p and C_V. Clausius Clayperon equation, Joule – Thomson coefficient. Bridgeman tables for thermodynamic relations.

UNIT – II PROPERTIES OF REAL GAS AND GAS MIXTURES **12**

Different equations of state – fugacity – compressibility. Principle of corresponding States – Use of generalized charts for enthalpy and entropy departure. Fugacity coefficient, Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition. Partial molar properties. Ideal and real gas mixtures.

UNIT – III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM **12**

First and second law analysis of reacting systems - Adiabatic flame temperature - entropy change of reacting systems. Criterion for reaction equilibrium. Equilibrium constant for gaseous mixtures and evaluation of equilibrium composition.

UNIT – IV COMBUSTION CHEMISTRY **12**

Combustion of Hydrocarbon Fuels. Heat of reaction, combustion and formation. Stoichiometric, fuel rich and oxygen rich reactions. Heating value of fuels. Explosion limits, flames and flammability limits. Diffusion and premixed flames.

UNIT – V COMBUSTION PROCESSES AND COMBUSTION CHAMBERS **12**

Combustion in IC Engines and Gas turbines. Knocking and Detonation and control. Design principles of combustion chambers for IC Engines and Gas turbine. Arrangements of gas turbine combustion – comparative analysis.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

1. Calculate the availability of the systems and cycles, and apply various thermodynamic relations
2. Predict the behavior of real gas and calculate the properties of gas mixtures
3. Apply first and second law to chemically reacting systems
4. Calculate the air fuel ratio, composition of combustion products and combustion limits
5. Apply the thermodynamic knowledge for analyzing the combustion process and combustion chamber design

REFERENCES:

1. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 1988.
2. Kalyan Annamalai, Ishwar K. Puri, Milind A. Jog., Advanced thermodynamics engineering, CRC press, 2011
3. Natarajan, E., Engineering Thermodynamics – Fundamentals and Applications, Anuragam Publications, 2014.
4. Kuo, K.K., Principles of Combustion, John Wiley and Sons, 2005
5. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw – Hill Inc., 1995.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.9	0.6	0.3	0.6	0.3	0.6	0.9	0.3	0.6	0.9	0.9	0.6	0.6
2	0.6	0.9	0.6	0.9	0.3	0.6	0.6	0.3	0.3	0.6	0.3	0.6	0.6	0.3	0.3
3	0.3	0.6	0.3	0.9	0.9	0.6	0.3	0.3	0.3	0.3	0.3	0.9	0.6	0.3	0.6
4	0.3	0.6	0.6	0.3	0.9	0.3	0.9	0.6	0.3	0.3	0.3	0.3	0.6	0.3	0.3
5	0.3	0.3	0.9	0.3	0.3	0.3	0.3	0.3	0.6	0.3	0.3	0.3	0.3	0.3	0.3

RM5151 RESEARCH METHODOLOGY AND IPR L T 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

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

EY5111 RENEWABLE ENERGY LABORATORY L T P C

0 0 4 2

COURSE OBJECTIVES:

1. To learn the working of different renewable energy gadgets
2. To understand the methodology adopted for performance evaluation of various renewable energy systems

LIST OF EXPERIMENTS

1. Study on solar radiation measurement devices
2. Performance testing of solar water heater
3. Determining the characteristics of solar photovoltaic materials and estimation of MPP (I-V curve)
4. Performance evaluation of solar cookers (box type and concentrating type)
5. Evaluating and comparing the efficiency of conventional stove and improved (energy efficient) cook stoves
6. Testing of biomass Gasifier in updraught/downdraught mode
7. Study of biogas plant – fixed dome and floating drum model
8. Proximate analysis of a given biofuel
9. Estimation of calorific value of any solid fuels using bomb calorimeter
10. Computation of calorific value of liquid fuels using Junkers gas calorimeter
11. Synthesis of biodiesel – energy and mass balancing
12. Performance evaluation of engine on biodiesel
13. Comparison of combustion and emissions of B0 and B100

Attested

TOTAL: 60 PERIODS

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COURSE OUTCOMES:

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

1. Evaluate the performance of renewable energy gadgets
2. Analyse the factors influencing the efficiency and suggest methods for improving the adaptability and efficiency of renewable energy gadgets

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.6	0.6	0.6				0.6			0.6	0.9	0.6	
2	0.9	0.9	0.6	0.6	0.6				0.6			0.6	0.9	0.6	

RA5161 APPLIED THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES

1. To educate the students on the realities of thermal engineering.
2. To educate the students about calibration and its essentiality in thermal systems.

LIST OF EXPERIMENTS

1. Experimental Studies on Thermal Boundary Layer for different geometries.
2. Calibration of Temperature Transducers (Thermocouple, RTD & Thermistors).
3. Calibration of Pressure Transducers.
4. Experimental Analysis of Organic Rankine Cycle.
5. Fluid and Thermal Transfer Properties of Liquid Fuels / Heat Transfer Fluids.
6. Experimental Studies on Pool Boiling of Water using Flow Visualization Technique.
7. Flow Characteristic occurrence between Bodies in Wind Tunnel.
8. Experimental Studies on Fluidization of Solid Fuels.
9. Studies on Absorption Refrigeration System.
10. Experimental Studies on Drying of Agro Products.
11. Determining the Actual p-v Diagram of an IC Engine.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

1. Plot the error curve and correction curve for different measuring instruments.
2. Analyze the critical/influential properties of thermal systems.

PO & PSO Mapping:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.6	0.6	0.6	-	-	-	0.6	-	-	0.6	0.9	0.6	-
2	0.9	0.9	0.6	0.6	0.6	-	-	-	0.6	-	-	0.6	0.9	0.6	-

Attested

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EY5201 ENERGY CONSERVATION IN INDUSTRIAL UTILITIES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the types of fuels used in Industries and their characteristics
2. To Know the techniques adopted for performance evaluation of thermal utilities
3. To Learn and appreciate the working principle employed in VCRS and VAM systems
4. To list the parameters considered in electricity billing and the losses associated with a motor
5. To Comprehend the techniques available for energy conservation in electrical utilities

UNIT – I BOILERS **9**

Types - Performances evaluation via direct and indirect method – energy conservation avenues. Properties of steam - Assessment of steam distribution losses - Steam trapping - Condensate and flash steam recovery system - Opportunities for energy saving in steam consumption systems

UNIT – II FURNACES AND THERMIC FLUID HEATERS **9**

Furnaces and Thermic Fluid Heaters: Types - Performances evaluation via direct and indirect method – energy conservation avenues.
Insulation and Refractory : types and application

UNIT – III HVAC AND WASTE HEAT RECOVERY **9**

VCRS – performance assessment – energy savings opportunities – VAM: working, types, benefits, comparison with vapor compression system.
WHR systems: Classification – Benefits - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, thermocompressor. CHP – Polygeneration

UNIT – IV ELECTRICAL SYSTEMS AND INDUCTION MOTORS **9**

Electricity billing - Demand side management - Power factor improvement transformer losses – Harmonics induction Motors : Types – Losses – performance assessment adopting direct and indirect method - Factors affecting motor performance - energy efficient motors

UNIT – V ENERGY CONSERVATION IN ELECTRICAL UTILITIES **9**

Performance assessment and energy conservation avenues in : fans - blowers – pumps – air compressors - illumination systems - cooling towers

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Compute stoichiometric air for any given fuel and suggest measures for efficient combustion
2. Diagnose the cause for under performance of thermal utilities and suggest suitable remedial measures thereof
3. Analyse the factors affecting the COP of a VCR and VAR system
4. Evaluate the performance of induction motors and transformers
5. Perform energy audit in an Industry

REFERENCES:

1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004.
2. L.C. Witte, P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.
3. W.C. turner, “Energy Management Hand book” Wiley, New York, 1982

Attested

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4. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987
5. Eastop.T.D& Croft D.R, Energy Efficiency for Engineers and Technologists,.Logman Scientific & Technical, ISBN-0-582-03184, 1990.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.6	0.6	0.6		0.3		0.3		0.6	0.6	0.6	0.9	
2	0.9	0.6	0.6	0.6	0.6		0.3		0.3		0.6	0.6	0.6	0.9	
3	0.9	0.6	0.6	0.6	0.6		0.3		0.3		0.6	0.6	0.6	0.9	
4	0.9	0.6	0.6	0.6	0.6		0.3		0.3		0.6	0.6	0.6	0.9	
5	0.9	0.6	0.6	0.6	0.6		0.3		0.3		0.6	0.6	0.6	0.9	

EY5251 COMPUTATIONAL FLUID DYNAMICS FOR ENERGY SYSTEMS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. To make students familiarize with the computational analysis
2. To explain the numerical analysis of solving of steady and unsteady diffusion heat transfer
3. To explain the numerical analysis of solving of convection-diffusion heat transfer
4. To provide the details of discretization of incompressible flow governing equations
5. To impart the knowledge of turbulence modelling

UNIT – I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES **12**

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretization techniques using finite difference methods – Taylor’s Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT – II DIFFUSION PROCESSES : FINITE VOLUME METHOD **12**

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretization of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson’s schemes, Stability of schemes.

UNIT – III CONVECTION - DIFFUSION PROCESSES : FINITE VOLUME METHOD **12**

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme. – Assessment of discretization scheme properties.

UNIT – IV INCOMPRESSIBLE FLOW PROCESSES : FINITE VOLUME METHOD **12**

Discretization of incompressible flow equations – Stream Function – Vorticity methods - Pressure based algorithms, SIMPLE, SIMPLER, SIMPLEC & PISO algorithms.

UNIT – V TURBULENCE MODELLING **12**

Kolmogorov’s Theory - Turbulence - Algebraic Models, One equation model & k – ε, k – ω models - Standard and High and Low Reynolds number models.

TOTAL: 60 PERIODS

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COURSE OUTCOMES:

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

1. Know the differences between various discretization techniques.
2. Learn the finite volume based numerical method for solving diffusion heat transfer problems.
3. Learn the finite volume based numerical method for solving convection-diffusion heat transfer problems.
4. Understand the discretization of incompressible flow governing equations
5. Recognize the impact of various turbulence modelling

REFERENCES:

1. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.
2. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer " Hemisphere Publishing Corporation, New York, USA,1984
3. Subas, V.Patankar, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Tapan K. Sengupta, "Fundamentals of Computational Fluid Dynamics" Universities Press, 2011.
5. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.3									0.6	0.9	0.6	
2	0.9	0.6	0.3									0.6	0.9	0.6	
3	0.9	0.6	0.3									0.6	0.9	0.6	
4	0.9	0.6	0.3									0.6	0.9	0.6	
5	0.9	0.6	0.3									0.6	0.6	0.6	

EY5211 ENERGY CONSERVATION LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

The students will be able to

1. Understand the instruments employed in energy audits
2. Learn the methodology adopted for performance evaluation of industrial gadgets

LIST OF EXPERIMENTS

1. Study of energy audit instruments (flue gas analyser, calorimeter, pitot tube, digital pressure indicator, differential manometer, anemometer – vane type and thermal type, digital tachometer - contact/non-contact, stroboscope, hygrometer, temperature indicator - contact type and non-contact type, ultrasonic leak detector, ultrasonic flow meter, lux meter, energy manager, harmonic analyzer, KVA demand analyser)
2. Performance evaluation of boiler adopting direct and indirect method
3. Determining the efficiency of a simple impulse steam turbine
4. Assessment of performance of steam condensers
5. Performance evaluation of air compressors and computing its specific energy consumption and cost of compressed air
6. Determining the characteristics of an induction motor and computing its efficiency adopting direct and indirect method
7. Determination of pump & pumping system characteristics (pump curve, system curve and BEP)

8. Comparison on the effect of different discharge control techniques in pumps (VFD, throttling and bypass mode) with respect to specific energy consumption
9. Analysis of various luminaries and evaluation of their efficacy
10. Determination of characteristic curves of blowers and comparison of its characteristics upon subjecting it to damper control at inlet and discharge.
11. Performance evaluation of cooling tower
12. Comparison on the performance of shell and tube, pipe-in-pipe and plate heat exchangers

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

1. Evaluate the specific energy consumption of industrial utilities
2. Estimate the cost of energy for process essentials like steam, compressed air

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.6	0.6					0.6			0.3	0.9	0.9	0.3
2	0.9	0.9	0.6	0.6					0.6			0.3	0.9	0.9	0.3

EY5212 ANALYSIS AND SIMULATION LABORATORY FOR ENERGY ENGINEERING

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

1. To provide a platform to learn and get familiar with computational analysis
2. To learn the simulation and analysis software for solving of flow with heat transfer related problems

LIST OF EXPERIMENTS

1. Heat exchanger analysis – NTU method
2. Heat exchanger analysis – LMTD method
3. Convection heat transfer analysis – Velocity boundary layer
4. Convection heat transfer analysis – Internal flow
5. Radiation heat transfer analysis – Emissivity
6. Critical radius of insulation
7. Lumped heat transfer analysis
8. Conduction heat transfer analysis
9. Condensation heat transfer analysis
10. Analysis on flow through pipe
11. Nozzle/Diffuser Analysis
12. Boiling heat transfer analysis

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

1. Use modern engineering software tools to analyze the flow with heat transfer related problems
2. Analyse the various parameters influencing the performance of thermodynamic systems

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6			0.9							0.6	0.6	0.9	0.9
2	0.9	0.6			0.9							0.6	0.6	0.9	0.9

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EY5001 DESIGN AND ANALYSIS OF TURBO MACHINES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the energy transfer process in turbo machines and to derive governing equations
2. To understand the functional aspects and performance of turbo machines
3. To learn about the components of combustion chamber and their functions
4. To understand the working and performance of turbines
5. To calculate the performance of gas turbines and jet engines

UNIT – I INTRODUCTION **9**

Basics of isentropic flow – static and stagnation properties – diffuser and nozzle configurations – area ratio – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles for a generalized turbo machines – velocity diagrams. Euler's equation for turbo machines and its different forms. Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, overall and polytropic.

UNIT – II CENTRIFUGAL AND AXIAL FLOW COMPRESSORS **9**

Centrifugal compressor – configuration and working – slip factor – work input factor – ideal and actual work – pressure coefficient - pressure ratio. Axial flow compressor – geometry and working – velocity diagrams – ideal and actual work – stage pressure ratio – free vortex theory – performance curves and losses.

UNIT – III COMBUSTION CHAMBER **9**

Basics of combustion. Structure and working of combustion chamber – combustion chamber arrangements – flame stability – fuel injection nozzles. Flame stabilization – cooling of combustion chamber.

UNIT – IV AXIAL AND RADIAL FLOW TURBINES **9**

Elementary theory of axial flow turbines – stage parameters – multi-staging – stage loading and flow coefficients. Degree of reaction – stage temperature and pressure ratios – single and twin spool arrangements – performance. Matching of components. Blade Cooling. Radial flow turbines.

UNIT – V GAS TURBINE AND JET ENGINE CYCLES **9**

Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scramjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, specific fuel consumption, thermal and propulsive efficiencies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Analyze the energy transfer process in thermodynamic systems
2. Calculate the performance of centrifugal flow and axial flow combustion systems
3. Design and analyze the combustion chamber for turbomachines
4. Compute and analyze the performance of axial and radial flow turbines
5. Predict the performance of gas turbines and thermodynamic energy systems

REFERENCES:

1. Ganesan, V., Gas Turbines, Tata McGraw Hill, 2011.
2. Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, John Wiley, 5th Edition 2001.
3. KhajuriaP.R and DubeyS.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003
4. Hill P G and Peterson C R, Mechanics and Thermodynamics of Propulsion, Addition-Wesley, 1970.
5. Mattingly J D, Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition. 1997

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.3	0.3	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.3	0.3
2	0.3	0.9	0.9	0.3	0.3	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
3	0.6	0.3	0.3	0.6	0.6	0.3	0.9	0.6	0.6	0.3	0.6	0.6	0.3	0.6	0.3
4	0.3	0.6	0.3	0.9	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.6	0.3	0.3	0.3
5	0.3	0.3	0.3	0.3	0.9	0.3	0.3	0.3	0.6	0.3	0.6	0.3	0.3	0.3	0.6

EY5002 FLUIDIZED BED SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the behavior of fluidized beds
2. To learn about the heat transfer process
3. To differentiate the combustion and gasification, and appreciate the relative merits
4. To design components of fluidized bed systems
5. To understand the industrial applications of fluidized bed systems

UNIT – I FLUIDIZED BED BEHAVIOUR 9

Characterization of bed particles – comparison of different methods of gas – solid contacts. Fluidization phenomena – regimes of fluidization – bed pressure drop curve. Two phase and well-mixed theory of fluidization. Particle entrainment and elutriation – unique features of circulating fluidized beds.

UNIT – II HEAT TRANSFER 9

Different modes of heat transfer in fluidized bed – bed to wall heat transfer – gas to solid heat transfer – radiant heat transfer – heat transfer to immersed surfaces. Methods for improvement – external heat exchangers – heat transfer and part load operations.

UNIT – III COMBUSTION AND GASIFICATION 9

Fluidized bed combustion and gasification – stages of combustion of particles – performance – start – up methods. Pressurized fluidized beds.

UNIT – IV DESIGN CONSIDERATIONS 9

Design of distributors – stoichiometric calculations – heat and mass balance – furnace design – design of heating surfaces – gas solid separators.

UNIT – V INDUSTRIAL APPLICATIONS 9

Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing. Cracking and reforming of hydrocarbons, carbonization, combustion and gasification. Sulphur retention and oxides of nitrogen emission Control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Calculate the behavior of fluidized beds
2. Analyze the heat transfer process in fluidized beds
3. Apply concepts of combustion and gasification in fluidized beds
4. Design fluidized beds for given applications
5. Apply fluidized bed systems for various industrial applications

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REFERENCES:

1. Howard,J.R., Fluidized Bed Technology: Principles and Applications, Adam Hilger, New York, 1983.
2. Geldart, D., Gas Fluidization Technology, John Willey and Sons, 1986.
3. Kunii, D and Levespiel, O., Fluidization Engineering, John Wiley and Son Inc, New York,1969.
4. Howard, J.R. (Ed), Fluidized Beds: Combustion and Applications, Applied Science Publishers, New York, 1983.
5. Botteril, J.S.M., Fluid Bed Heat Transfer, Academic Press, London, 1975.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.3	0.3	0.3	0.3	0.3
2	0.3	0.3	0.3	0.3	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.6
3	0.3	0.6	0.3	0.6	0.6	0.9	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3
4	0.6	0.9	0.9	0.6	0.9	0.3	0.3	0.3	0.6	0.3	0.6	0.3	0.3	0.3	0.6
5	0.6	0.6	0.6	0.9	0.6	0.3	0.3	0.3	0.9	0.3	0.9	0.9	0.6	0.6	0.6

EY5072 BIO ENERGY TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To detail on the types of biomass, its surplus availability and characteristics.
2. To create awareness on the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.
3. To impart knowledge on stoichiometry and combustion of bio fuels
4. To elucidate on the influence of equivalence ratio on thermochemical conversion of biomass
5. To provide insight to the possibilities of producing liquid fuels form biomass

UNIT I INTRODUCTION 9

Biomass: types – advantages and drawbacks – Indian scenario – characteristics – carbon neutrality – conversion mechanisms – fuel assessment studies – densification technologies Comparison with coal – Proximate & Ultimate Analysis - Thermo Gravimetric Analysis –Differential Thermal Analysis – Differential Scanning Calorimetry

UNIT II BIOMETHANATION 9

Microbial systems – phases in biogas production – parameters affecting gas production – effect of additives on biogas yield – possible feed stocks. Biogas plants – types – design –constructional details and comparison – biogas appliances – burner, luminaries and power generation – effect on engine performance.

UNIT III COMBUSTION 9

Perfect, complete and incomplete combustion - stoichiometric air requirement for biofuels-equivalence ratio – fixed Bed and fluid Bed combustion – fuel and ash handling systems –steam cost comparison with conventional fuels

UNIT IV GASIFICATION, PYROLYSIS AND CARBONISATION 9

Chemistry of gasification - types – comparison – application – performance evaluation –economics – dual fuelling in IC engines – 100 % Gas Engines – engine characteristics on gas mode – gas cooling and cleaning systems - Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization Techniques – merits of carbonized fuels

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UNIT V LIQUIFIED BIOFUELS 9

History of usage of Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel health effects / emissions /performance. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Estimate the surplus biomass availability of any given area
2. Design a biogas plant for a variety of biofuels
3. Determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels
4. Analyse the influence of process governing parameters in thermochemical conversion of biomass
5. Synthesize liquid biofuels for power generation from biomass

REFERENCES

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester,1984.
2. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
4. Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication,1997
5. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6				0.6		0.9		0.3			0.6	0.9		
2	0.6	0.6	0.9			0.6	0.6				0.3	0.6	0.9		
3	0.6	0.6	0.9	0.6			0.3				0.6	0.6	0.9	0.6	
4	0.6	0.6	0.9	0.6			0.3				0.6	0.6	0.9	0.3	
5	0.6	0.6	0.9	0.6			0.3				0.6	0.6	0.9	0.3	

EY5003 POWER GENERATION, TRANSMISSION AND DISTRIBUTION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on Conventional Power Plants (Steam, Hydro, Nuclear and
- Gas Turbine plants)
- To impart knowledge on Non - Conventional Power Plants (Renewable Energy Power generation)
- To understand various components and factors affecting power transmission
- To impart knowledge on major electrical energy components
- To understand the Economics of Power generation and Utilization of Electrical
- Energy for Various applications.

UNIT I CONVENTIONAL POWER GENERATION 9

Steam power plant - Selection of site - Generated Layout - coal and Ash Handling -Steam Generating Plants - Feed Make Circuit - Cooling Towers - Turbine Governing -Hydro Power Plant- Selection of Site - Classification Layout Governing of Turbines -Nuclear Power Plants - Selection of Site - Classification Layout Governing of Turbines - Nuclear Power Plants - Gas Turbine Plants.

UNIT II NON CONVENTIONAL POWER GENERATION 9

Wind power generation - characteristics of wind power-design of windmills - Tidal power generation - Single and two-basin systems -Turbines for tidal power - Solar power generation - Energy from biomass, biogas and waste

UNIT III ELECTRICAL POWER TRANSMISSION 9

Online diagram of transmission - substation and distribution systems - comparison of systems (DC and AC) - EHVAC and HVDC transmission - layout of substations and bus bar arrangements - Equivalents circuit of short, medium and long lines -Transmission efficiency regulation-reactive power - compensation-transmission - loss minimization.

UNIT IV UTILISATION OF ELECTRICAL ENERGY 9

Selection of Electrical Drives - Electrical characteristics and mechanical considerations -size, rating and cost, Transformer characteristics – illumination - laws of illumination-polar curve – incandescent - fluorescent and vapour lamps - Design of OLTC lighting Scheme of industry-electrical welding - energy efficient aspects of devices

UNIT V ECONOMICS OF POWER GENERATION & TRANSMISSION 9

Daily load curves - load factor - diversity factor - load deviation curve - load management - number and size of generating unit, distribution losses, cost of electrical energy – tariff – power factor improvement

TOTAL: 45 PERIODS

COURSE OUTCOMES

The student will be able to understand

1. The Operation of Conventional Power Plants (Steam, Hydro, Nuclear and Gas Turbine plants) and concepts of Renewable Energy Power generation.
2. The Operation of Non - Conventional Power Plants (Renewable Energy Power generation)
3. Explain about the functioning of major electrical energy component
4. Explain about power transmission and various factors involved affecting it
5. The Economics of Power generation and Utilization of Electrical Energy for Various applications.

REFERENCES

1. Singh.S.N., Electrical Power generation, Transmission and Distribution 2nd Edition, PHI Learning Private Limited, 2010
2. Wadhwa.C.L., Generation Distribution and utilization of Electrical Energy, New Age International, 2012
3. Twidell.J.W. and Weir.A.D., Renewable Energy Sources, Taylor and Francis, 2006.
4. Mohammed E. El Hawary, Introduction to Electrical Power Systems, John Wiley & Sons, 2008.
5. R. Krishnan, Electric Motor Drives, Prentice hall, 2001.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.6	0.3		0.6	0.3						0.9	0.9	0.6
2	0.9	0.9	0.6	0.3		0.6	0.9					0.6	0.9	0.9	0.9
3	0.6	0.6	0.3	0.3	0.3	0.6	0.3						0.9	0.9	0.3
4	0.6	0.6	0.3	0.3	0.6	0.6	0.3						0.6	0.6	0.3
5	0.6	0.6	0.3	0.6	0.3	0.3					0.9		0.3	0.3	

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EY5075	ENERGY FORECASTING, MODELING AND PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand about National energy scenario.
2. To predict the energy demand using various forecasting models.
3. To develop an optimization model for the effective utilisation of energy sources.
4. To know the procedure to the write the project proposal.
5. To know the energy policies in the country.

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.

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)-Costing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Have knowledge in the National energy scenario.
2. Do Energy prediction using various forecasting techniques.
3. Develop optimization model for energy planning.
4. Capable of writing project proposals.
5. Understand the National and state energy policies.

REFERENCES:

1. Armstrong J.Scott (ed.), Principles of forecasting: a hand book for researchers and practitioners, Norwell, Massachusetts: Kluwer Academic Publishers.2001.
2. DhandapaniAlagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
3. Fred Luthans, Brett C. Luthan, Kyle W. Luthans, Organisational Behaviour: An Evidence-Based Approach, Information Age Publishing; 13 edition, 2015
4. Spyros G. Makridakis, Steven C. Wheelwright, Rob J. Hyndman, Forecasting: Methods and Applications, 4th Edition, ISBN: 978-0-471-53233-0,2003
5. Yang X.S., Introduction to mathematical optimization: From linear programming to Metaheuristics, Cambridge, Int. Science Publishing, 2008.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.3	0.3	0.6	0.3	0.3	0.3	0.9	0.3	0.3	0.6	0.3	0.9	0.9	0.6	0.3
2	0.9	0.6	0.9	0.9	0.9	0.6	0.6				0.3	0.6	0.9	0.6	0.6
3	0.6	0.9	0.9	0.9	0.9			0.6			0.3	0.3	0.6	0.6	0.9
4	0.6	0.3	0.3	0.6		0.6		0.6	0.6	0.9	0.9	0.6	0.6	0.9	0.6
5	0.3	0.3				0.6	0.9	0.6	0.6	0.9	0.9	0.6	0.6	0.9	0.3

EY5078 **MODELING AND ANALYSIS OF ENERGY SYSTEMS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To learn to apply mass and energy balances for the energy systems
2. To learn the modeling and simulation techniques for energy systems.
3. To learn the optimization techniques to optimize the energy system.
4. To learn to use the energy-economy models.
5. To understand the application of case studies.

UNIT – I INTRODUCTION **9**

Primary energy analysis - energy balance for closed and control volume systems - applications of energy analysis for selected energy system design - modeling overview - levels and steps in model development - Examples of models – curve fitting and regression analysis

UNIT – II MODELLING AND SYSTEMS SIMULATION **9**

Modeling of energy systems – heat exchanger - solar collectors – distillation -rectification turbo machinery components - refrigeration systems - information flow diagram - solution of set of non-linear algebraic equations - successive substitution - Newton Raphson method- examples of energy systems simulation

UNIT – III OPTIMISATION TECHNIQUES **9**

Objectives - constraints, problem formulation - unconstrained problems - necessary and sufficiency conditions. Constrained optimization - Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis - New generation optimization techniques – Genetic algorithm and simulated annealing – examples.

UNIT – IV ENERGY- ECONOMY MODELS **9**

Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation – Econometric Energy Demand Modeling - Overview of Econometric Methods - Dynamic programming- Search Techniques - Univariate / Multivariate

UNIT – V APPLICATIONS AND CASE STUDIES **9**

Case studies of optimization in Energy systems problems- Dealing with uncertainty- probabilistic techniques – Trade-offs between capital and energy using Pinch analysis

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply mass and energy balances for the energy systems
2. Do Simulation and Modeling of typical energy system
3. Use the optimization techniques to optimize the energy system.
4. Perform Energy-Economic Analysis for the typical applications
5. Have knowledge in optimization of Energy systems problems

REFERENCES:

1. Bejan, A, Tsatsaronis, G and Moran, M., Thermal Design and Optimization, John Wiley & Sons, 1996
2. Balaji C., Essentials of Thermal System Design and Optimization, Aue Books, 2011
3. Chang, Ni-Bin, Systems analysis for sustainable engineering: theory and applications, New York : McGraw-Hill, c2011.
4. Stoecker W.F., Design of Thermal Systems, McGraw Hill, 2011
5. Yogesh Jaluria, Design and Optimization of Thermal Systems, CRC Press INC, 2008

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.6	0.9	0.6							0.6		0.6	0.9
2	0.9	0.6	0.9	0.9	0.6							0.3	0.3	0.6	0.6
3	0.6	0.9	0.6	0.6	0.3	0.6	0.3								0.9
4	0.6	0.3	0.6	0.6	0.9	0.3	0.3				0.9				0.6
5	0.3	0.6	0.6	0.9	0.6	0.3					0.6	0.6		0.6	0.3

EY5004 NUCLEAR ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To describe the fundamental study of nuclear reactions
2. To understand the characteristics of nuclear fuels.
3. To understand the reprocessing of nuclear fuels.
4. To learn the separation of reactor products.
5. To learn about the waste disposal and radiation protection.

UNIT – I NUCLEAR REACTIONS **9**

Mechanism of nuclear fission - nuclides - radioactivity – decay chains - neutron reactions - the fission process - reactors - types of fast breeding reactor - design and construction of nuclear reactors - heat transfer techniques in nuclear reactors - reactor shielding

UNIT – II REACTOR MATERIALS **9**

Nuclear Fuel Cycles - characteristics of nuclear fuels - Uranium - production and purification of Uranium - conversion to UF4 and UF6 - other fuels like Zirconium, Thorium – Beryllium

UNIT – III REPROCESSING **9**

Nuclear fuel cycles - spent fuel characteristics - role of solvent extraction in reprocessing - solvent extraction equipment

UNIT – IV SEPARATION OF REACTOR PRODUCTS **9**

Processes to be considered - 'Fuel Element' dissolution - precipitation process – ion exchange – redox - purex - TTA - chelation -U235 - Hexone - TBP and thorax Processes - oxidative slagging and electro - refining - Isotopes - principles of Isotope separation

UNIT – V WASTE DISPOSAL AND RADIATION PROTECTION **9**

Types of nuclear wastes - safety control and pollution control and abatement - international convention on safety aspects - radiation hazards prevention

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

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

1. Understand fundamentals of nuclear reactions
2. Have knowledge in nuclear fission chain reaction and fusion
3. Aware about reprocessing of spent fuel and waste disposal
4. Have knowledge about separation of reactor products
5. Aware about radiation protection methods

REFERENCES:

1. Cacuci, Dan Gabriel, Nuclear Engineering Fundamentals, Springer, 2010
2. Kenneth Shultis J., Richard E. Faw, Fundamentals of Nuclear Science and Engineering, CRC Press; 3 edition, 2016
3. Kenneth D. Kok, Nuclear Engineering, CRC Press, 2009
4. Lamarsh, J.R., Introduction to Nuclear Reactor Theory, Wesley, 2002
5. Tatjana Tevremovic, Nuclear Principles in Engineering, Springer, 2008

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.3	0.3			0.9	0.6	0.6			0.3	0.6		0.3	
2	0.9	0.3	0.3			0.3	0.3	0.3				0.6		0.6	
3	0.6	0.6	0.3			0.6	0.6	0.3				0.3		0.3	
4	0.6	0.3	0.6			0.6	0.9	0.6			0.6	0.3		0.3	
5	0.9	0.6	0.6			0.6	0.9	0.9				0.6	0.6	0.3	

EY5081 SOLAR ENERGY TECHNOLOGIES

L	T	P	C
3	0	0	3

OBJECTIVES:

1. To learn and study the solar radiation and various solar collectors
2. To study the various solar thermal energy technologies and their applications
3. To learn about various solar PV cell materials and conversion techniques
4. To learn various Solar SPV systems designs and their applications
5. To know about various solar passive building techniques for cooling and heating applications

UNIT – I SOLAR RADIATION AND COLLECTORS 9

Solar angles – Sun path diagrams – Radiation - extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces - flat plate collector thermal analysis - testing methods- evacuated tubular collectors - concentrator collectors – classification - design and performance parameters - tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors

UNIT – II SOLAR THERMAL TECHNOLOGIES 9

Principle of working, types, design and operation of - Solar heating and cooling systems - Thermal Energy storage systems – Solar Desalination – Solar cooker : domestic, community – Solar pond – Solar drying-solar chimney-solar thermal electricity conversion

UNIT – III SOLAR PV FUNDAMENTALS 9

Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetro junctions - metal-semiconductor interface - dark and illumination characteristics - figure of merits of solar cell - efficiency limits - variation of efficiency with band-gap and temperature - efficiency measurements - high efficiency cells – Solar thermo-photovoltaics

UNIT – IV SPV SYSTEM DESIGN AND APPLICATIONS 9

Solar cell array system analysis and performance prediction- Shadow analysis: reliability - solar cell array design concepts - PV system design - design process and optimization - detailed array design - storage autonomy - voltage regulation - maximum tracking - centralized and decentralized SPV systems - standalone - hybrid and grid connected system - System installation - operation and maintenances - field experience - PV market analysis and economics of SPV systems

UNIT – V SOLAR PASSIVE ARCHITECTURE 9

Thermal comfort - bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - Radiative cooling- application of wind, water and earth for cooling; shading - paints and cavity walls for cooling – roof radiation traps - earth air-tunnel – energy efficient landscape design - thermal comfort

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Learn and study the solar radiation and various solar collectors
2. Know the various solar thermal energy technologies and their applications
3. Aware about various solar PV cell materials and conversion techniques
4. Learn various Solar SPV systems designs and their applications
5. Know about various solar passive building techniques for cooling and heating applications

REFERENCES:

1. Chetan Singh Solanki, Solar Photovoltatics – Fundamentals, Technologies and Applications, PHI Learning Private limited, 2011
2. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2013
3. Lovegrove K., Stein W., Concentrating Solar Power Technology, Woodhead Publishing Series in Energy, Elsevier, 1st Edition, 2012
4. Solar Energy International, Photovoltaic – Design and Installation Manual, New Society Publishers, 2006
5. Sukhatme S P, Nayak J K, Solar Energy – Principle of Thermal Storage and collection, Tata McGraw Hill, 2008

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.3		0.3		0.9	0.6				0.9	0.6	0.3	
2	0.9	0.6	0.6		0.6	0.3	0.9	0.6				0.9			0.6
3	0.9	0.6	0.3		0.6		0.9	0.6				0.9		0.3	
4	0.9	0.9	0.6			0.6	0.9	0.6				0.9	0.3		0.6
5	0.6	0.3	0.9		0.6	0.6	0.9	0.9				0.9	0.3	0.3	0.6

EY5071 ADVANCED ENERGY STORAGE TECHNOLOGIES L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the various types of energy storage technologies and its applications.
2. To study the various modelling techniques of energy storage systems using TRNSYS.
3. To learn the concepts and types of batteries.
4. To make the students to get understand the concepts of Hydrogen and Biogas storage.
5. To provide the insights on Flywheel and compressed energy storage systems.

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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 – Modelling 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 discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide and modern batteries for example (i) zinc-Air (ii) Nickel Hydride, (iii) Lithium Battery.

UNIT – IV HYDROGEN AND BIOGAS STORAGE 9

Hydrogen storage options – compressed gas – liquid hydrogen – Metal Hydrides, chemical Storage, Biogas storage - comparisons. Safety and management of hydrogen and Biogas storage - Applications.

UNIT – V ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Identify the energy storage technologies for suitable applications.
2. Analyze the energy storage systems using TRNSYS.
3. Recognize the concepts and types of batteries.
4. Diagnose the principle operations of Hydrogen and Biogas storage.
5. Analyze the concepts of Flywheel and compressed energy storage systems

REFERENCES:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
2. James Larminie and Andrew Dicks, Fuel cell systems Explained, Wiley publications, 2003.
3. Luisa F. Cabeza, Advances in Thermal Energy Storage Systems: Methods and Applications, Elsevier Woodhead Publishing, 2015
4. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
5. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, , Wiley publications, 2012.

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1	0.9	0.3	0.9	0.3	0.3	0.6	0.9	0.3	0.3	0.3	0.6	0.3	0.9	0.6	0.6
2	0.9	0.3	0.9	0.3	0.3	0.6	0.9	0.3	0.3	0.3	0.6	0.3	0.9	0.6	0.6
3	0.9	0.3	0.9	0.3	0.3	0.6	0.9	0.3	0.3	0.3	0.6	0.3	0.9	0.6	0.6
4	0.9	0.3	0.9	0.3	0.3	0.6	0.9	0.3	0.3	0.3	0.6	0.3	0.9	0.6	0.6
5	0.9	0.3	0.9	0.3	0.3	0.6	0.9	0.3	0.3	0.3	0.6	0.3	0.9	0.6	0.6

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EY5074 ENERGY EFFICIENT BUILDINGS DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To learn the green buildings concepts applicable to alternate design
2. To be familiar with basic terminologies related to buildings
3. To learn the building (air) conditioning techniques
4. To know the methods to evaluate the performance of buildings
5. To incorporate Renewable energy systems in buildings

UNIT I INTRODUCTION 9
Climate and Building, Historical perspective, Aspects of green building design – Sustainable Site, Water, Energy, Materials and IAQ, ECBC Standards

UNIT II LANDSCAPE AND BUILDING ENVELOPES 9
Energy efficient Landscape design – Microclimate, Shading, Arbors, Windbreaks, Xeriscaping, Building envelope – Thermal comfort, Psychrometry, Comfort indices, Thermal Properties of Building Materials – Thermal Resistance, Thermal Time Constant (TTC), Diurnal Heat Capacity (DHC), Thermal Lag, Decrement Factor, Effect of Solar Radiation – Sol-air Temperature, Processes of heat exchange of building with environment, Insulation

UNIT III PASSIVE HEATING AND COOLING 9
HVAC introduction, Passive Heating – Solar radiation basics, Sun Path Diagram, Direct Heating, Indirect Heating and Isolated heating, Concept of Daylighting, Passive Cooling – Natural Ventilation (Stack and Wind), Evaporative Cooling and Radiative Cooling.

UNIT IV THERMAL PERFORMANCE OF BUILDINGS 9
Heat transfer due to fenestration/infiltration, Calculation of Overall Thermal Transmittance, Estimation of building loads: Steady state method, network method, numerical method, correlations, Thermal Storage integration in buildings

UNIT V RENEWABLE ENERGY IN BUILDINGS 9
Introduction of renewable sources in buildings, BIPV, Solar water heating, small wind turbines, stand-alone PV systems, Hybrid system – Economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students:
1. Will be familiar with climate responsive building design and basic concepts
2. Will Know the basic terminologies related to buildings
3. Will Know the passive (air) conditioning techniques
4. Will be able to evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

REFERENCES:

1. ASHRAE Handbook -2009 - Fundamentals.
2. Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons, 15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
5. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.3	0.3	0.6	0.6	0.9	0.3	0.6	0.3			0.9	0.3	
2	0.9	0.9	0.9	0.3	0.3		0.9					0.3	0.3		
3	0.9	0.3	0.9		0.3	0.6	0.9		0.3			0.6	0.6	0.3	
4	0.9	0.9	0.9	0.6	0.6	0.6	0.9				0.6	0.6	0.3	0.3	0.9
5	0.9	0.6	0.9		0.9	0.3	0.9		0.6		0.6	0.6	0.6	0.3	0.9

EY5005 DESIGN OF HEAT EXCHANGERS

L	T	P	C
3	0	0	3

COURSE OUTCOMES :

1 To make students familiarize with the various types of heat exchangers
2 To explain the importance of thermal and stress analysis of heat exchangers
3 To inculcate the thermal design aspects of tubular heat exchangers
4 To provide the details of design aspects of compact heat exchangers
5 To explain the function and design aspects of condensers and cooling towers

UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9

Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method

UNIT II STRESS ANALYSIS 9

Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures.

UNIT III DESIGN ASPECTS 10

Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe - finned tube - shell and tube heat exchangers - simulation of heat exchangers

UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 8

Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters – limitations

UNIT V CONDENSERS AND COOLING TOWERS 9

Design of surface and evaporative condensers – cooling tower – performance characteristics

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

1. Know the types and applications of various types of heat exchangers
2. Understand the significance of stress analysis of heat exchangers
3. Understand the design of tubular heat exchangers for various applications
4. Recognize the design of compact heat exchangers for industrial requirements
5. Know the performance calculation of condensers and cooling towers

REFERENCES:

1. SadikKakac, Hongtan Liu, AnchasaPramuanjaroenkij, “Heat Exchangers Selection, Rating and Thermal Design”, CRC Press, Third Edition, 2012.
2. Ramesh K. Shah, Dušan P. Sekulić,” Fundamentals of heat exchanger design”, John Wiley & Sons, 2003.
3. Robert W. Serth, “Process heat transfer principles and applications”, Academic press, Elesevier, 2010.
4. T. Kuppan, “Heat exchanger design hand book”, New York: Marcel Dekker, 2009.
5. Arthur. P Frass, “Heat Exchanger Design”, John Wiley & Sons, 1989.

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.6				0.3						0.6	0.6	
2	0.9	0.9	0.6				0.3						0.6	0.6	
3	0.9	0.9	0.6				0.3						0.6	0.6	
4	0.9	0.9	0.6				0.3						0.6	0.6	
5	0.9	0.9	0.6				0.3						0.6	0.6	

EY5073 ELECTRICAL DRIVES AND CONTROLS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To impart the knowledge on the principle of conventional motor drives, various starting and speed control methods of motors.
2. To understand the concepts of various losses and harmonics effects in motors.
3. To study the Power Electronics components and controllers.
4. To provide insights of Superconductivity theory and super conducting magnetic energy storage.
5. To understand the concept of Solid State motor controllers and their applications

UNIT I CONVENTIONAL MOTOR DRIVES 9

Characteristics of DC and AC motor for various applications - starting and speed control - methods of breaking

UNIT II PHYSICAL PHENOMENA IN ELECTRICAL MACHINES 9

Various losses in motors-Saturation and Eddy current effects - MMF harmonics and their influence of leakage-stray losses - vibration and noise.

UNIT III SOLID STATE POWER CONTROLLERS 9

Power devices: Triggering Circuits, Rectifiers – Single Phase and Three Phase with R, RL and Freewheeling Diode, Choppers - Type-A, Type-B, Type C and Type D, Inverters - Single Phase and Three Phase with R, RL and Freewheeling Diode, AC Voltage Controllers

UNIT IV SUPERCONDUCTIVITY 9

Principle of Super conductivity, Super conducting generators-motors and magnets - Super conducting magnetic energy storage (SMES).

UNIT V SOLID STATE MOTOR CONTROLLERS 9

Single and Three Phase fed DC motor drives - AC motor drives - Voltage Control - Rotor resistance control - Frequency control - Slip Power Recovery scheme

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. Diagnose the operations of conventional motor drives, various starting and speed control methods of motors.
2. Analyze the different losses and harmonic effects in motors.
3. Recognize the Power electronics components and design the controllers.
4. Apply the Superconductivity theory and analyze the super conducting magnetic energy storage.
5. Analyse the concept of Solid State motor controllers and their applications

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REFERENCES

1. Subrahmanyam, Electric Drives : Concepts & Applications 2/E, Tata McGraw Hill Education,2011
2. Robert A. Huggins, Energy Storage , Springer(2010)
3. Rene Husson, Modelling and Control of Electrical machines, Elsevier Science Ltd, 2009
4. D.Singh, K.B.Khanchandani, Power Electronics, Tata McGraw Hill Education Ltd, s2006
5. Austin Hughes, Electric Motor & Drives, Newnes, 2006.

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.3	0.3		0.3							0.6	0.3	0.3
2	0.9	0.6	0.3	0.3		0.3							0.6	0.3	0.3
3	0.9	0.6	0.9	0.6		0.9							0.6	0.3	0.6
4	0.9	0.3	0.3	0.3		0.3							0.6	0.3	0.6
5	0.9	0.3	0.3	0.3		0.3							0.3	0.6	0.3

EY5079 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES

1. To impart knowledge on conversion techniques and renewable energy technologies.
2. To study the mechanisms of machines for the conversion of renewable energy sources.
3. To learn the power converters and its applications in renewable energy systems.
4. To understand the different conversion mechanisms of wind and solar systems.
5. To understand the various hybrid systems of renewable energy conversion techniques.

UNIT I INTRODUCTION 9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG

UNIT III POWER CONVERTERS 9

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. Power Quality Measurements.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS 9

Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system- Grid connection Issues -Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

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

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TOTAL: 45 PERIODS

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COURSE OUTCOMES:

1. Analyze the various conversion techniques in renewable energy technologies.
2. Apply the various mechanisms for the conversion of renewable energy sources.
3. Identify the appropriate power converters for renewable energy systems.
4. Implement the different conversion mechanisms for wind and solar systems.
5. Recognize the importance of various hybrid renewable energy systems.

REFERENCES

1. Leon Freris, David Infield, “Renewable energy in power systems”, John Wiley & Sons, 2008.
2. Rashid .M. H “power electronics Hand book”, Academic press, 2007.
3. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 2010.
4. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, John Wiley & Sons, 2011.
5. Wind Electric Systems: S.N. Bhadra, D. Kastha, OXFORD university press, 2005.

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1	0.9	0.9	0.3	0.3	0.6	0.3	0.6					0.3	0.6	0.3	0.3
2	0.6	0.9	0.3	0.3	0.6	0.3	0.6					0.3	0.6	0.3	0.3
3	0.9	0.9	0.9	0.6	0.9	0.3	0.9					0.3	0.6	0.3	0.3
4	0.3	0.6	0.3	0.3	0.6	0.3	0.6						0.6	0.3	0.3
5	0.3	0.3	0.3	0.3		0.3	0.3						0.3	0.6	0.3

EY5006 WIND ENERGY SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understand the fundamentals of wind energy and its conversion system
2. To impart knowledge on airfoil design and braking system
3. To learn gear coupled generator wind turbine components
4. To brief on the working of different generators and power conditioning system used in grid tied wind systems
5. To impart knowledge on modern wind turbine control & monitoring

UNIT I WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS 9

Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence. Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz’s Limit, Turbulence Analysis

UNIT II AERODYNAMICS THEORY & WIND TURBINE TYPES 9

Airfoil terminology, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator

UNIT III GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION 9

Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronisation System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : ACDrives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor / Lightning Arrestors, Oscillation & Vibration sensing

UNIT IV DIRECT ROTOR COUPLED GENERATOR (MULTIPOLE) [VARIABLE SPEED VARIABLE FREQ.] 9

Excited Rotor Synch. Generator / PMG Generator, Control Rectifier, Capacitor Banks, Step Up /Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits

UNIT V MODERN WIND TURBINE CONTROL & MONITORING SYSTEM 9

Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA& Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, FACTS control &LVRT& New trends for new Grid Codes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. Analyse the energy in conversion techniques of wind energy
2. Analyse the performance of wind turbine aerodynamics and breaking system
3. Explain about various gear coupled generators with its construction
4. Explain about different types of generators and power condition used in wind systems
5. Analyse the concept of modern wind turbine control & monitoring

REFERENCES

1. C-WET : Wind Energy Resources Survey in India.
2. John D Sorensen and Jens N Sorensen, Wind Energy Systems, Woodhead Publishing Ltd, 2011
3. Kaldellis.J.K, Stand – alone and Hybrid Wind Energy Systems, CRC Press, 2010
4. Mario Garcia –Sanz, Constantine H. Houpis, Wind Energy Systems, CRC Press 2012
5. Spera, D.A., Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press, 1994.

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6		0.3									0.9		0.3
2	0.6	0.6	0.3	0.3									0.9		0.3
3	0.6	0.3	0.3	0.3									0.9		0.3
4	0.9	0.3	0.6	0.3									0.9		0.3
5	0.6	0.3	0.3	0.6	0.6								0.9		0.6

EY5007 ADVANCED POWER PLANT ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

The students will be able to

1. Understand the thermodynamics associated with power plants
2. Detail on the role of various utilities in coal based thermal power plants
3. Acquire know-how on the working of gas turbine and diesel power plants
4. Appreciate the concept of Polygeneration for total energy recovery from a system
5. Brief on the working of hydroelectric and nuclear power plants

UNIT – I INTRODUCTION 9

Energy scenario : India Vs. World - Load curves and – Thermodynamic analysis of Conventional Power Plants (Coal, Gas Turbine and Diesel) - Advanced Power Cycles - Kalina Cycle, IGCC

UNIT – II COAL BASED THERMAL POWER PLANTS 9

Basics of typical power plant utilities – Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system – steam rate and heat rate – mean temperature of heat addition - Rankine cycle improvements – Superheat, Reheat, Regeneration, Super critical, AFBC/PFBC – computation of per unit cost of power generation from coal/biomass

UNIT – III GAS TURBINE AND DIESEL POWER PLANTS 9

Brayton cycle – Open and Closed – Improvements - Intercooler, Reheating and Regeneration. Diesel power plant – Layout - Performance analysis and improvement – Techniques for starting, cooling and lubrication of diesel engines - computation of per unit cost of power generation

UNIT – IV CHP AND MHD POWER PLANTS 9

Cogeneration systems – types - heat to power ratio - Thermodynamic performance of steam turbine, gas turbine and IC engine based cogeneration systems – Polygeneration - Binary Cycle - Combined cycle. MHD – Open cycle and closed cycle- Hybrid MHD& steam power plants

UNIT – V HYDROELECTRIC & NUCLEAR POWER PLANTS 9

Hydroelectric Power plants – classifications - essential elements – pumped storage systems – micro and mini hydel power plants. General aspects of Nuclear Engineering – Components of nuclear power plants - Nuclear reactors & types – PWR, BWR, CANDU, Gas Cooled, Liquid Metal Cooled and Breeder reactor - nuclear safety – Environmental issues - Computation of per unit cost of power generation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Suggest appropriate power generation technologies for mitigating the energy gap
2. Compute the steam rate, heat rate and cost for generating electricity from coal based thermal power plants
3. Analyse and suggest measures for improving the performance of gas turbine and diesel power plants
4. Assess the applicability and performance of a cogeneration system
5. Identify a suitable type of hydroelectric/nuclear power plant commensurate with the prevailing conditions

REFERENCES:

1. Nag, P.K., Power Plant Engineering, Tata McGraw Hill Publishing Co Ltd, New Delhi, 1998.
2. Haywood, R.W., Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.
3. Wood, A.J., Wollenberg, B.F., Power Generation, operation and control, John Wiley, New York,1984.
4. Gill, A.B., Power Plant Performance, Butterworths, 1984.
5. Lamarsh, J.R., Introduction to Nuclear Engg.2nd edition, Addison-Wesley, 1983.

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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.6	0.6							0.3	0.6	0.9	0.6	
2	0.6	0.9	0.6	0.6	0.6	0.3	0.3				0.3	0.6	0.9	0.6	
3	0.6	0.9	0.6	0.6	0.6	0.3	0.3				0.3	0.6	0.9	0.6	
4	0.6	0.9	0.6	0.6	0.6	0.3	0.3				0.3	0.6	0.9	0.6	
5	0.9	0.6	0.6	0.3	0.3		0.3				0.3	0.6	0.9	0.6	

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EY5077 **HYDROGEN AND FUEL CELLS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To study the basic production techniques of Hydrogen.
2. To understand the concepts of various storage methods of Hydrogen.
3. To study the thermodynamics and kinetics of fuel cell process.
4. To understand the classifications, construction and working of fuel cells.
5. To provide insights into fuel cell applications and its economics.

UNIT I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES 9

Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

UNIT II HYDROGEN STORAGE AND APPLICATIONS 9

Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons. Safety and management of hydrogen. Applications of Hydrogen.

UNIT III INTRODUCTION TO FUEL CELLS 9

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell.

UNIT IV CLASSIFICATION OF FUEL CELLS 9

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, MFC – principle, construction and working – relative merits and demerits.

UNIT V FUEL CELL APPLICATIONS AND ECONOMICS 9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

1. Analyze the techniques of Hydrogen generation.
2. Apply the various options for Hydrogen storage.
3. Recognize the principle operations of fuel cell, types, its thermodynamics and kinetics.
4. Comprehend the different types of fuel cells.
5. Apply the fuel cells for domestic, automotive, space craft power generations and evaluate the techno-economics of a fuel cells.

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2. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK 2005.
3. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
4. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA 2002.
5. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany 1996.
6. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
7. Viswanathan B. and Aulice Scibioh.M, Fuel Cells – Principles and Applications, Universities Press, 2006.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.6	0.9	0.9	0.3	0.6	0.3					0.3	0.6	0.3	0.3
2	0.9	0.6	0.9	0.6	0.3	0.6	0.3					0.3	0.6		
3	0.6	0.3	0.6	0.6	0.6	0.3							0.3		
4	0.6	0.3	0.6	0.3	0.3	0.3							0.3		
5	0.6	0.3	0.9	0.6	0.3	0.6	0.9					0.3	0.6		

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EY5080 **SMART GRID** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To Study about Smart Grid technologies with its benefits and challenges
2. To study about smart grid transmission technologies
3. To study about smart grid distribution technologies
4. To familiarize about smart metering and need for Advanced metering infrastructure
5. 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/VArcontrol, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, 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, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

1. Students will develop more understanding on the concepts of Smart Grid and its present developments.
2. Students will study about different Smart Grid technologies.
3. Students will acquire knowledge about different smart meters and advanced metering infrastructure.
4. Students will have knowledge on power quality management in Smart Grids
5. Students will develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

REFERENCES:

1. Vehbi C. Güngör, DilanSahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
2. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grids.
3. Stuart Borlase “Smart Grid :Infrastructure, Technology and Solutions”,CRC Press, 2012.
4. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley, 2012
5. Fabio Toledo “Smart Metering Handbook”, PennWell Corporation, 2013

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CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.3	0.3	0.3	0.3	0.3	0.3						0.3		
2	0.6	0.3	0.3	0.3	0.3		0.3						0.3		0.3
3	0.9	0.3	0.6	0.3	0.3		0.6						0.3	0.9	0.3
4	0.6	0.3	0.3	0.3	0.3		0.6						0.3	0.3	0.3
5	0.3	0.3	0.6	0.6	0.9										0.9

EY5076 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To impart knowledge on the atmosphere and its present condition and, global warming.
2. To detail on the sources of water pollution and possible solutions for mitigating their degradation.
3. To detail on the sources of air pollution and possible solutions for mitigating their degradation.
4. To detail on the sources of solid waste and possible ways to dispose them safely.
5. To impart knowledge on hazardous waste management.

UNIT – I INTRODUCTION **9**

Man & Environment – Types of Pollution – Global Environmental issues – Environmental Impact Assessment – Global Warming Issues – CO_2 Mitigation – Basic definition of Pollution Indicators – Noise Pollution

UNIT – II WATER POLLUTION **9**

Pollutants in Water & Wastewater – Physical and Chemical Treatment Methods – (An Overview) Neutralization – Aeration –Colour / Odour Removal - Sludge dewatering – Biological Treatment including Aerobic & Anaerobic Treatment

UNIT – III AIR POLLUTION **9**

Sources – Ambient Air Quality Standards – Emission Limits – Equipment for Ambient Air & Stack Monitoring – Principles of operation of Particulate Control Equipments -ESPs, Bag Filters, Cyclone Separators– Vehicular Pollution and its Control – BS standards

UNIT – IV SOLID WASTE MANAGEMENT **9**

Types & Sources – Types– Waste Generation – Composition – Physical, Chemical and Biological Properties – Transformation Technologies for Waste Treatment – Landfill Management – Layout, Closure & Post Closure Operation – Reclamation Leachate Generation – e Waste Disposal

UNIT – V HAZARDOUS WASTE MANAGEMENT **9**

Sources – Classification – Characterization of waste - health effects - Incineration– Radioactive Waste from nuclear power plants and disposal options - RDF- Mass Firing – Material Recycling

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Types and effects of each type of pollution on man – earth will be made known.
2. Technical aspects of Global Warming will make them understand the impact they have on climate
3. Technologies that are available for reduction of pollutants dumped into the atmosphere
4. Cursory / superficial formation - the students – had in Hazardous waste, waste disposal hitherto will be deep & sensible enough after studying this subject
5. Comprehend the different techniques available for safe disposal of hazardous waste

REFERENCES:

1. Peavy, H.S. and D.R. Rowe, G.Tchobanoglous: Environmental Engineering - McGraw-Hill Book Company, NewYork, 1985.
2. Ludwig, H. W.Evans: Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J, 1991.
3. Arcadio P Sincero and G. A. Sincero, Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002.
4. G. Masters: Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2003.
5. Richard J. Watts, Hazardous Wastes - Sources,Pathways, Receptors John Wiley and Sons, New York,1997

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.3	0.3	0.3	0.3	0.3	0.3						0.3		
2	0.6	0.3	0.3	0.3	0.3		0.3						0.3		0.3
3	0.9	0.3	0.6	0.3	0.3		0.6						0.3	0.9	0.3
4	0.6	0.3	0.3	0.3	0.3		0.6						0.3	0.3	0.3
5	0.3	0.3	0.6	0.6	0.9										0.9

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OPEN ELECTIVE COURSES (OEC)

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

COURSE 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.

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

COURSE 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.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
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** **L T P C**
3 0 0 3

COURSE 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**

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

COURSE 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, McGraw 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 L T P C
3 0 0 3

COURSE 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

COURSE 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	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
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 MANAGEMENT OF 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

COURSE 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
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
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

COURSE 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.

TOTAL: 45 PERIODS

COURSE 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, West Germany.
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

UNIT I 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

UNIT II BIOMASS PYROLYSIS 9

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

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UNIT III 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.

UNIT IV 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

COURSE 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:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
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.

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AUDIT COURSES (AC)

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

COURSE OBJECTIVES

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

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

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

UNIT II PRESENTATION SKILLS 6

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

UNIT III TITLE WRITING SKILLS 6

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

UNIT IV RESULT WRITING SKILLS 6

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

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

COURSE 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										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
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
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

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AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

COURSE 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

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

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

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

COURSE 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

COURSE 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.

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AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

COURSE 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

COURSE 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

COURSE 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

COURSE 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.
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.

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

COURSE 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

COURSE 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?

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

COURSE 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

COURSE 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

COURSE 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

COURSE 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 mankind 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.

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