St. XAVIER'S CATHOLIC COLLEGE OF ENGINEERING

Chunkankadai, Nagercoil – 629 003.

AUTONOMOUS COLLEGE AFFILIATED TO ANNA UNIVERSITY

M.E. ENERGY ENGINEERING CURRICULUM

ACADEMIC REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

The curriculum incorporates the necessary mechanical engineering fundamentals, advanced technologies, communication and management skills required to solve local, global needs with ethical and society concern. The curriculum shows a close alignment with the program outcome and the program specific outcome. In which, the various courses impart in the curriculum shall inculcate deep knowledge and skills required for a mechanical engineer. The curriculum learning outcomes result successful mechanical engineering professionals with excellent skills as that focused by the program outcome and program specific outcome. The pupil transformation through the curriculum will show a good degree of coherence with the college mission and vision, creating young vibrant technocrats for global society with ethical values.

I. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I	Able to identify, design, analyse and solve complex and evolving problems in energy related sectors.
II	Accomplish through Employment, Entrepreneur and perform advanced research in the fields of energy manufacturing and management.
III	Exhibit excellent communication, leadership qualities, lifelong learning ability with professional ethics and human values in profession/career.

II. PROGRAM OUTCOMES (POs)

PO#	Programme Outcomes
1	An ability to independently carry out research/investigation and development work to solve practical problems
2	An ability to write and present a substantial technical report/document.

3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4	Students should be able to exhibit skill to use modern tools, softwares and techniques to analyse and improve the efficiency of energy systems and management in an organization.
5	Students should be able to work autonomously and also with team towards designing energy products and multidisciplinary task with environment concern and sustainable development.
6	Students should be able to divulge energy solution for business conglomerates and society in ethical manner and develop competence through life-long learning.

III. PROGRAM SPECIFIC OUTCOMES (PSOs) - (3 to 4 statements)

1	Develop necessary skills to design, develop and analyse energy systems using modern tools and technologies.
2	Design and critically analyse the efficient production of energy from bio-mass and other renewable sources.
3	Engage in research process embracing lifelong learning independently with the zeal to start-up their own businesses for the welfare of the society.

PEO's – PO's & PSO's MAPPING:

PROGRAMME EDUCATIONAL OBJECTIVES	**PROGRAMME OUTCOMES**						**PROGRAM SPECIFIC OUTCOMES**		
	1	2	3	4	5	6	1	2	3
I	3	2	2	-	3	1	3	2	3
II	3	1	3	2	2	-	3	1	2
III	3	1	3	2	2	2	3	2	3

PROGRAM ARTICULATION MATRIX

Year	Semester	Course Name	PO						PSO		
			1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
I	I	Fluid Mechanics and Heat Transfer	2	-	1	-	-	1	1	-	-
		Renewable Energy Systems	3	2	2	1	2	1	1	2	1
		Thermodynamic analysis of energy systems	2	-	1	-	-	1	-	1	-
		Research Methodology	3	1	-	1	-	2	1	1	-
		Applied Thermal Engineering Laboratory	2	2	-	1	1	1	1	-	1
		Technical Seminar	2	3	1	-	-	1	1	2	-
I	II	Computational Fluid Dynamics for Energy Systems	2	-	1	-	-	1	1	-	-
		Energy Conservation in Industrial Utilities	3	2	1	-	1	2	1	2	1
		Waste to Energy	2	-	2	-	-	1	-	3	1
		Instrumentation for Energy Systems	3	-	1	1	-	1	1	-	1
		Simulation and Analysis Laboratory for Energy Systems	3	2	1	3	-	1	3	-	-
		Research Tools in Engineering	3	2	2	2	-	-	3	-	1
II	III	Inplant / Industrial / Practical Training	1	3	1	-	3	1	-	2	2
		Project Work I	3	3	2	1	-	3	1	2	2
II	IV	Project Work II	3	3	2	1	-	3	1	2	2

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	EY22101	Fluid Mechanics and Heat Transfer	FC	3	1	0	4	4
2	EY22102	Renewable Energy Systems	PCC	3	0	2	5	4
3	EY22103	Thermodynamic analysis of energy systems	PCC	3	1	0	4	4
4		Professional Elective I	PEC	3	0	0	3	3
5	RM22101	Research Methodology	RMC	2	0	0	2	2
6		Audit Course I	AC	2	0	0	2	0
PRACTICAL								
7	EY22104	Simulation and Analysis Laboratory for Energy Systems	PCC	0	0	4	4	2
8	EY22105	Technical Seminar	EEC	0	0	2	2	1
TOTAL				16	2	8	26	20

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	EY22201	Computational Fluid Dynamics for Energy Systems	PCC	3	1	0	4	4
2	EY22202	Energy Conservation in Industrial Utilities	PCC	3	0	0	3	3
3	EY22203	Waste to Energy	PCC	3	0	0	3	3
4	EY22204	Instrumentation for Energy Systems	PCC	3	1	0	3	4
5		Professional Elective II	PEC	3	0	0	3	3
6		Professional Elective III	PEC	3	0	0	3	3
7		Audit Course II	AC	2	0	0	2	0
PRACTICAL								
8	EY22205	Analysis and Simulation Laboratory	PCC	0	0	4	4	2
9	RM22201	Research Tools in Engineering	EEC	0	0	4	4	2
TOTAL				20	1	10	31	24

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Professional Elective IV	PEC	3	0	0	3	3
2		Professional Elective V	PEC	3	0	0	3	3
3		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4	EY22301	Inplant / Industrial / Practical Training (4 weeks during summer vacation)	EEC	-	-	-	-	2
5	EY22302	Project Work I	EEC	-	-	6	6	3
TOTAL				15	-	-	15	14

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1	EY22401	Project Work II	EEC	-	-	-	-	12
TOTAL								12

(Total Credit Range = 70)

AUDIT COURSES (AC)

Semester I								
SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AC22101	English for Research Paper Writing	AC	2	0	0	2	0
2.	AC22102	Constitution of India	AC	2	0	0	2	0

Semester II								
SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	AC22201	Disaster Management	AC	2	0	0	2	0
2.	AC22202	நற்றமிழ் இலக்கியம	AC	2	0	0	2	0

SUMMARY

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

PROGRAM ELECTIVE COURSES

SEMESTER I (PROGRAM ELECTIVE I)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	EY22111	Power Generation, Transmission and Distribution	PEC	3	0	0	3	3
2	EY22112	Energy Forecasting, Modeling and Project Management	PEC	3	0	0	3	3
3	EY22113	Modeling and Analysis of Energy Systems	PEC	3	0	0	3	3
4	EY22114	Energy Management and Environmental Benefits	PEC	3	0	0	3	3

SEMESTER II (PROGRAM ELECTIVE II)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	EY22211	Solar Energy Technologies	PEC	3	0	0	3	3
2	EY22212	Bioenergy Technologies	PEC	3	0	0	3	3
3	EY22213	Green Buildings	PEC	3	0	0	3	3
4	EY22214	Wind Energy systems	PEC	3	0	0	3	3

SEMESTER II (PROGRAM ELECTIVE III)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	EY22221	Design of Heat Exchangers	PEC	3	0	0	3	3
2	EY22222	Advanced Energy Storage Technologies	PEC	3	0	0	3	3
3	EY22223	Energy Efficient Buildings Design	PEC	3	0	0	3	3
4	EY22224	Environmental Engineering and Pollution Control	PEC	3	0	0	3	3

SEMESTER III (PROGRAM ELECTIVE IV)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	EY22311	Climate change and CO_2 emission assessment	PEC	3	0	0	3	3
2	EY22312	Materials for Energy Applications	PEC	3	0	0	3	3
3	EY22313	Hydrogen and fuel cells	PEC	3	0	0	3	3
4	EY22314	Alternative fuels	PEC	3	0	0	3	3

SEMESTER III (PROGRAM ELECTIVE V)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	EY22321	Power Plant Engineering and Carbon Capture	PEC	3	0	0	3	3
2	EY22322	Fluidized Bed Systems	PEC	3	0	0	3	3
3	EY22323	Nuclear Engineering	PEC	3	0	0	3	3
4	EY22324	Design and Analysis of Turbo Machines	PEC	3	0	0	3	3

SEMESTER I

		L	T	P	C
EY22101	**FLUID MECHANICS AND HEAT TRANSFER**	**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

COURSE OUTCOMES: At the end of the course the students would be able to

1 Understand the basic knowledge of fluid mechanics and heat transfer concepts.

2 Learn the flow concepts of incompressible and compressible flow.

3 Solve the conduction and gas radiation heat transfer problems.

4 Calculate the turbulent forced convective heat transfer for the given flow

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	1	2	3
1	2		1			1	1		
2	2		2			1	1		
3	1		1			1	1		
4	2		1			2	1		
5	3		1			1	1		

EY22102 RENEWABLE ENERGY SYSTEMS

L	T	P	C
3	0	2	4

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 60

List of Experiments

1. Estimation of solar radiation using measurement devices
2. Determining the characteristics of solar photovoltaic materials and estimation of MPP(I-V curve)
3. Performance evaluation of solar cookers (box type and concentrating type)
4. Evaluating and comparing the efficiency of conventional stove and improved (energy efficient) cook stoves.
5. Testing of biomass Gasifier in down draught mode.
6. Estimation of properties (Flash & Fire point, Viscosity, density and Calorific Value) of biofuel.
7. Synthesis of biodiesel –energy and mass balancing
8. Performance evaluation of engine on biodiesel

COURSE OUTCOMES: At the end of the course the students would be able to

1 Identify the present energy status of Indian and global energy scenario.

2 Describe the basic principles of renewable energy systems.

3 Examine the components, working and technologies involved in solar, wind and bioenergy systems.

4 Distinguishing the different types of solar, wind, ocean and bioenergy systems.

5 Review the technologies, advantages and applications of renewable energy systems.

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**	**1**	**2**	**3**
1	2	1	1	1	2	1	1	2	1
2	2	2	2	1	2	1	1	1	2
3	3	3	2	1	2	1	1	2	1
4	3	2	2		1	2	1	1	1
5	3	2	1	1	2	1	1	2	1

EY22103 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 – Cp and CV. 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

COURSE OUTCOMES: At the end of the course the students would be able to

1 Calculate the availability of the thermodynamic systems and cycles.

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.

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	1	2	3
1	2		1			1		2	
2	2		1			1		1	
3	3		1			1		2	
4	2		2			2		1	
5	2		1			1		2	

RM22101 RESEARCH METHODOLOGY

L	T	P	C
2	0	0	2

Course Objectives

1 understand some basic concepts of research and its methodologies

2 Identify appropriate research topics

3 select and define appropriate research problem and parameters

4 organize and conduct research (advanced project) in a more appropriate manner

5 write a research report and thesis

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

OUTCOMES: At the end of the course the students would be able to

1 Demonstrate the ability to choose methods appropriate to research aims and objectives

2 Describe the limitations of particular research methods

3 Develop skills in qualitative and quantitative data analysis and presentation

4 Develop advanced critical thinking skills

5 Demonstrate enhanced writing skills

References:

1 Douglas C. Montgomery, 'Design and Analysis of Experiments', Wiley, 10th Edition 2019.

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.

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1	2	1		1		1	1	1	
2	2	1		1		1	1	1	
3	3	1		1		2	1	2	
4	3	1		1		2	1	1	
5	3	1		1		2	1	1	

EY22104 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 Lessons on Thermal Boundary Layer for different geometries.

2 Calibration of Temperature Transducers (Thermocouple, RTD & Thermistors).

3 Calibration of Pressure Transducers.

4 Fluid and Thermal Transfer Properties of Heat Transfer Fluids.

5 Flow Characteristic occurrence between Bodies in Wind Tunnel.

6 Experimental Studies on Fluidization of Solid Fuels.

7 Performance test on Absorption Refrigeration System.

8 Experimental Studies on Drying of Agro Products.

9 Determining the Actual p-v Diagram of an IC Engine.

10 Experimental Studies on Thermal Boundary Layer for different geometries.

Total 60

OUTCOMES: At the end of the course the students would be able to

1 Apply the skill learnt in theory subjects to do hands on experiments.

2 Identify the various fuel characterizations through experimental testing.

3 Evaluate the performance parameters of refrigeration systems

4 Analyse different thermal equipment's.

5 Analyse and do necessary calculations on thermos-fluid related problems.

CO	PO						PSO		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	2	1		1	1	1	1		1
2	2	1		1	1	1	1		1
3	3	2		1	1	2	1		2
4	2	2		1	1	1	1		1
5	2	2		2	1	2	1		1

EY22105	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

Course Objectives

1 To Enhance the ability of self-study
2 To Improve the presentation and communication skills
3 To Increase the breadth of knowledge.

GUIDELINES

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic	You are requested to select an area of interest, topic and state an objective	2nd week	5 % Based on clarity of thought, current relevance Stating an and clarity in writing
Collecting Information about your area & topic	1. List 2 journals 2. List 2 conferences, symposia or workshops 3. List 3 web presences (mailing lists, forums, news sites) 4. List 3 authors who publish regularly in your area.	3rd Week	5 % (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective collect 10	Students have to provide a complete list of references you will be using Based on your objective Search various digital libraries and Google Scholar When picking papers to read - try to Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them. Favour more recent papers.	4th Week	10 % (the list of standard papers and reason for selection)
Draft outline and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	6th week	10% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	7th week	10% (Clarity, purpose and conclusion)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	9th week	10% (this component will be evaluated based on the linking and classification among the papers)
Final Draft	Complete the final draft of your paper 13th week 10% (formatting, English, Clarity and linking)	11th Week	10% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	12th to 14th Week	40% (based on presentation and Viva-voce)

Total	**30**

OUTCOMES: At the end of the course the students would be able to

1	Identify and choose appropriate topic of relevance.

2	Assimilate literature on technical articles of specified topic and develop comprehension.
3	Prepare technical report for the given task.
4	Design, develop and deliver presentation on specified technical topic

CO	**PO**						**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
1	2	1		1	1	1	1		1
2	2	1		1	1	1	1		1
3	3	2		1	1	2	1		2
4	2	2		1	1	1	1		1

SEMESTER II

		L	T	P	C
EY22201	**COMPUTATIONAL FLUID DYNAMICS FOR ENERGY SYSTEMS**	**3**	**1**	**0**	**4**

Course Objectives

1 To make students familiarize with the computational analysis.

2 To understand, apply and analyze to numerically solve the steady and unsteady diffusion problems by various schemes.

3 To understand, apply and analyze to numerically solve the convection-diffusion Tentative 23 problems by various discretization techniques

4 To study and understand the discretization of incompressible flow governing equations by various pressure velocity decoupling algorithms.

5 To impart and make students familiarize with the knowledge of various turbulence models

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: FINITEV OLUME 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 –models, Standard and High and Low Reynolds number models.

Total **60**

OUTCOMES: At the end of the course the students would be able to

1 Infer the fundamental governing equations and apply the boundary conditions to arrive at the unknown variables.

2 Solve the diffusion heat transfer problems by finite volume method

3 Formulate the convection-diffusion heat transfer problems by finite volume method.

4 Interpret the incompressible flow governing equations by applying various pressure velocity decoupling algorithms.

5 Construct various turbulence models available.

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, NewYork, USA, 4th Edition, 2020.

3 Suhas, V. Patankar, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, Special Indian Edition, 2017.

4 Tapan K. Sengupta, "Fundamentals of Computational Fluid Dynamics "UniversitiesPress, 2011.

5 Muralidhar,K., and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi,1995.

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5	2		2			2	1		

EY22202 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

OUTCOMES: At the end of the course the students would 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

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.

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1	2	2	1		1	2	1	2	2
2	3	2	1		1	1	1	2	1
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4	2	2	1		1	2	1	2	1
5	3	2	1		2	2	1	2	1

EY22203 **WASTE TO ENERGY**

L	T	P	C
3	0	0	3

Course Objectives

1 Interpret the various types of wastes from which energy can be generated.

2 Develop knowledge on biomass pyrolysis process and its applications.

3 Develop knowledge on various types of biomass gasifiers and their operations.

4 Invent knowledge on biomass combustors and its applications on generating energy.

5 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.

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.

UNIT – V 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

OUTCOMES: At the end of the course the students would be able to

1 Identify different sources of solid waste from which energy can be generated.

2 Apply the knowledge about the operations of Waste to Energy Plants

3 Develop knowledge on various types of biomass gasifiers and their operations

4 Apply the knowledge of biomass combustion and select a suitable plant for the given aoolication.

5 Illustrate sources of thermo chemical energy generation and understand Biochemical conversion of biomass for energy application

References:

1 Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 2012.

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., 2008.

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4	2		2			1		3	1
5	2		2			1		2	1

EY22204	INSTRUMENTATION FOR ENERGY SYSTEMS	L	T	P	C
		3	1	0	4

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.

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– Sunshine recorder.

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.

Total **45**

OUTCOMES: At the end of the course the students would be able to

1 Interpret the characteristics of measurement systems, instruments for measuring various electrical parameters and circuits for signal conditioning.

2 Classify the standard devices and galvanometers for the measurement of voltage and current.

3 Explain the digital measurement techniques for Displacement, Temperature, Pressure, Force, Torque, Vibration, Acceleration, Velocity, Level, Flow, Thermal ,Nuclear and Solar. Radiation.

4 Measure the thermo-physical properties and air pollutants.

5 Develop a specific technical expertise in the analysis and design of feedback control systems

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.

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4	2		1	1		1	1		1
5	3		1	2		2	1		1

EY22205	SIMULATION AND ANALYSIS LABORATORY FOR ENERGY SYSTEMS	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 transfer analysis of Heat exchanger using LMTD method

2 Analysis of Heat exchanger effectiveness using NTU method

3 Convective heat transfer analysis based on Velocity boundary layer concept

4 Analysis of thermal radiation between two concentric cylinders.

5 Thermal analysis of steel casting process.

6 Transient heat transfer analysis through fins.

7 Heat transfer analysis through two walls in steady state Conduction

8 Transient thermal analysis of a pipe support bracket

9 Analysis of a laminar flow through a circular pipe.

10 Analysis of a turbulent fluid flow through a flat plate

11 Conjugate heat transfer analysis of a counter flow heat exchanger.

12 Thermal analysis of Internal forced convection in a pipe.

Total 60

OUTCOMES: At the end of the course the students would 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

3 Solve the diffusion heat transfer problems by finite volume method

4 Formulate the convection-diffusion heat transfer problems by finite volume method.

5 Interpret the incompressible flow governing equations by applying various pressure velocity decoupling algorithms.

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RM22201 RESEARCH TOOLS IN ENGINEERING

L	T	P	C
0	0	4	2

Course Objectives

1 To familiarize the fundamental concepts/techniques for Project Management

2 To familiarize the journal paper formatting using suitable Software

3 To familiarise the software for literature review and Bibliography

4 To find the plagiarism percentage of article contents

5 To prepare a quality research report and the presentation

LIST OF EXPERIMENTS: **9**

1 Use of tools / Techniques for Research - Project management -Microsoft Project / Microsoft OneNote / Asana.

2 Hands on Training related to Software for Paper Formatting like LaTeX / MS Office

3 Design a Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process -Addressing Reviewer Comments.

4 Introduction to Data Analysis Software - Origin SPSS, ANOVA.

5 Introduction to Software for detection of Plagiarism – Urkund, Turniton

6 Preparing Bibliography / Different Reference Formats. – EndNote, Mently

7 Format of Project Report - Use of Quotations - Method of Transcription- Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures

8 Introduction to Microsoft Excel –for Research Analysis

9 Presentation using PPTs.

Total 60

OUTCOMES: At the end of the course the students would be able to

1 List the various stages in research and develop systematic planning of project stages. (Analysing)

2 Write a journal paper and formulate as per the standard journal format. (Applying)

3 Develop a literature review and relevant references for a research problem using suitable software. (Applying)

4 Determine the plagiarism of the article / report content by using the Software. (Applying)

5 Compile a research report and the presentation. (Applying)

AUDIT COURSES (AC)

Semester I

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

Course Objectives

1 Teach how to improve writing skills and level of readability

2 Tell about what to write in each section

3 Summarize the skills needed when writing a Title

4 Infer the skills needed when writing the Conclusion

5 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**

OUTCOMES: At the end of the course the students would be able to

1 Understand that how to improve your writing skills and level of readability

2 Learn about what to write in each section

3 Understand the skills needed when writing a Title

4 Understand the skills needed when writing the Conclusion

5 Ensure the good quality of paper at very first-time submission

References:

1 Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht

2 Heidelberg London, 2011

3 Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006

4 Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006

5 Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's

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

Course Objectives

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

UNIT – I HISTORY OF MAKING OF THE INDIAN CONSTITUTION **5**

History, Drafting Committee, (Composition & Working)

UNIT – II PHILOSOPHY OF THE INDIAN CONSTITUTION **5**

Preamble, Salient Features

UNIT – III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES **5**

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

UNIT – IV ORGANS OF GOVERNANCE **5**

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

UNIT – V LOCAL ADMINISTRATION **5**

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

UNIT VI ELECTION COMMISSION **5**

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

Total **30**

OUTCOMES: At the end of the course the students would be able to

1 Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

2 Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

3 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.

4 Discuss the passage of the Hindu Code Bill of 1956.

References:

1 The Constitution of India,1950 (Bare Act),Government Publication.

2 Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.

3 M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.

4 D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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Semester II

		L	T	P	C
AC22201	**DISASTER MANAGEMENT**	**3**	**0**	**0**	**0**

Course Objectives

1 Summarize basics of disaster

2 Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

3	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4	Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5	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**

OUTCOMES: At the end of the course the students would be able to

1	Ability to summarize basics of disaster
2	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5	Ability to develop the strengths and weaknesses of disaster management approaches

References:

1 Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2019.
2 NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2017.
3 Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

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AC22202 **நற்றமிழ் இலக்கியம்**

L	T	P	C
2	0	0	0

UNIT – I சங்க இலக்கியம் **5**

1. தமிழின் துவக்க நூல் ததொல்கொப்பியம் – எழுத்து, த ொல், தபொருள்
2. அகநொனூறு (82) - இயற்கக இன்னிக அரங்கம்
3. குறிஞ்சிப் பொட்டின் மலர்க்கொட்சி
4. புறநொனூறு (95,195) - பபொகர நிறுத்திய ஔகவவயொர

UNIT – II அறநநறித்தமிழ் **5**

1. அறதநறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன் புகடகம, ஒப்புரவறிதல், ஈகக, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து – ஏலொதி, சிறுபஞ் மூலம், திரிகடுகம், ஆ ொரக்பகொகவ (தூய்கமகய வலியுறுத்தும் நூல்)

UNIT – III இரட்டடக்காப்பியங்கள் **5**

1. கண்ணகியின் புரட்சி

- சிலப்பதிகொர வழக்குகர கொகத மூகப கவ இலக்கியம் மணிபமகல -

சிகறக்பகொட்டம் அறக்பகொட்டமொகிய கொகத

UNIT – IV அருள்நநறித்தமிழ் **5**

1. சிறுபொணொற்றுப்பகட - பொரி முல்கலக்குத்பதர்தகொடுத்தது, பபகன் மயிலுக்குத்பபொர்கவ தகொடுத்தது, அதியமொன் ஔகவக்கு தநல்லிக்கனி தகொடுத்தது, அர ர் பண் புகள் 2. நற்றிகண - அன்கனக்குரிய புன்கன சிறப்பு

3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள் 4. தர்ம ் ொகலகய நிறுவிய வள்ளலொர்

5. புறநொனூறு - சிறுவபன வள்ளலொனொன

UNIT – V நவீன தமிழ் இலக்கியம **5**

1. உகரநகடத்தமிழ், - தமிழின் முதல் புதினம், - தமிழின் முதல் சிறுககத, - கட்டுகர இலக்கியம், - பயணஇலக்கியம், - நொடகம், 2. நொட்டு விடுதகல பபொரொட்டமும் தமிழ் இலக்கியமும், 3. முதொய விடுதகலயும் தமிழ் இலக்கியமும், 4. தபண் விடுதகலயும் விளிம்பு நிகலயினரின் பமம்பொட்டில் தமிழ் இலக்கியமும், 5. அறிவியல் தமிழ், 6. இகணயத்தில் தமிழ், 7. சுற்று ்சூழல் பமம்பொட்டில் தமிழ் இலக்கியம்.

References:

1. தமிழ் இலக்கிய நெளியீடுகள் / புத்தகங்கள் தமிழ் இகணய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org Tentative 59
2. தமிழ் விக்கிப்பீடியொ (Tamil Wikipedia) -https://ta.wikipedia.org
3. தர்மபுர ஆதீன தவளியீடு
4. ழ்வியல் களஞ்சியம் - தமிழ்ப் பல்ககலக்கழகம், தஞ் ொவூர்
5. தமிழ்ககலக் களஞ்சியம் - தமிழ் வளர் ்சித்துகற (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்ககலக்கழகம், தஞ் ொவூர

PROGRAM CORE ELECTIVES

PROGRAM ELECTIVE I

SEMESTER I

		L	T	P	C
EY22111	**POWER GENERATION, TRANSMISSION AND DISTRIBUTION**	**3**	**0**	**0**	**3**

Course Objectives

1. To impart knowledge on Conventional Power Plants (Steam, Hydro, Nuclear and Gas Turbine plants)
2. To impart knowledge on Non - Conventional Power Plants (Renewable Energy Power generation)
3. To understand various components and factors affecting power transmission
4. To impart knowledge on major electrical energy components
5. 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

OUTCOMES: At the end of the course the students would be able to

1 Describe the operations and economics of conventional and non-conventional power plants.

2 Classify the different types of energy generating components.

3 Relate the concepts of power generation, transmission and distribution for different power plants.

4 Categorized the power generating procedures and economic analysis

5 Review the economics of power generation and utilization of conventional and non-conventional 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. EI Hawary, Introduction to Electrical Power Systems, John Wiley & Sons, 2008.

5 R. Krishnan, Electric Motor Drives, Prentice hall, 2011.

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	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
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		L	T	P	C
EY22112	**ENERGY FORECASTING, MODELING AND PROJECT MANAGEMENT**	**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 utilization 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

OUTCOMES: At the end of the course the students would be able to

1 Describe the details of energy forecasting, modeling and project management.

2 Infer knowledge of energy scenarios, energy forecasting, modeling, project management and energy policy.

3 Manipulate the techniques of the energy model, energy management and energy policies.

4 Categorize the different energy model and energy policies.

5 Validate the energy forecasting, modeling, project management and energy policy.

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.

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EY22113 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

OUTCOMES: At the end of the course the students would be able to

1 Describe the modelling and analysing techniques for energy system

2 Solve the energy systems problems using modelling and analysing techniques

3 Identify the optimization techniques to optimize the energy system.

4 Illustrate the energy-economic analysis methods for the typical applications

5 Apply mass and energy balances for the energy systems

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

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EY22114 **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

OUTCOMES: At the end of the course the students would be able to

1 Identify the importance of energy conservation, energy consumption in environmental concerns.

2 Understand the fundamentals of energy sources and its management system.

3 Report the parameters used in energy management and financial management to analyse the climatic change and risk.

4 Predict the techno-economics of any project adopting cash flow techniques and analyse the emission parameters.

5 Schedule the sources of additional revenue generation for energy conservation projects adopting UNFCC

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, NewYork,1982

4 W.R.Murphy and G.McKay "Energy Management" Butter worths, London 1987

5 Eastop.T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.

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SEMESTER II (PROGRAM ELECTIVE II)

SEMESTER II

		L	T	P	C
EY22211	**SOLAR ENERGY TECHNOLOGIES**	**3**	**0**	**0**	**3**

Course 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**

OUTCOMES: At the end of the course the students would be able to

1 Define the fundamental technologies of solar energy system.

2 Describe the characteristics of solar radiation, PV and SPV systems.

3 Calculate the output of solar collectors, Solar cooker, PV and PSV along with passive cooling systems.

4 Compare the performance of solar collectors, Solar cooker, PV and PSV along with passive cooling systems.

5 Manage the applications and advantages of various solar energy systems including passive building techniques.

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

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1	2		2		3			2	2
2	3		1		3			2	1
3	2		2		1			2	1
4	3		1		2			3	1
5	3		1		2			2	1

EY22212	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.

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

OUTCOMES: At the end of the course the students would be able to

1	Identify the various bio-resources to convert it into useful alternative products in Indian and global scenario.
2	Describe the objectives for the bioenergy conversion process in terms of social and economic concern.
3	Demonstrate the conversion mechanism involved from biomass to useful liquid or gaseous fuels.
4	Differentiate the various liquid and gaseous fuels through different methods from the biomass resources.
5	Conclude the different applications of various liquid and gaseous fuels.

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.

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3	3	1	1		3			2	1
4	2	1	1		1			2	1
5	3	1	1		2			2	1

EY22213	GREEN BUILDINGS	L	T	P	C
		3	0	0	3

Course Objectives

1. To assert the need, opportunities and demand of green buildings
2. Classify different climatic zones and comfort environment.
3. Incorporate and assess various passive solar techniques in building design.
4. Modeling of heat distribution in the built environment.
5. Design & assess the energy efficient landscape through modification of microclimate.

UNIT – I INTRODUCTION **9**

Concept in building - thermal analysis and design for human comfort - thermal comfort; Criteria and various parameters; psychometric chart; thermal indices, climate and comfort Zones; concept of sol-air temperature and its significance; calculation of instantaneous heat Gain through building envelope

UNIT – II SOLAR RADIATION IN BUILDING **9**

Calculation of solar radiation on buildings; building orientation; Introduction to design of shading devices; Overhangs; Factors that effects energy use in buildings; Ventilation and its significance; Air-conditioning systems; Energy conservation techniques in air-conditioning systems

Passive Cooling And Heating Concepts - 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.

UNIT – III HEAT TRANSFER IN BUILDING **9**

Heat transmission in Buildings – surface coefficient air cavity – internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; solar temperature; Decrement factor; Phase lag. Design of day lighting.

UNIT – IV BUILDING LOADS **9**

Estimation of building loads – study state method, network method, numerical method - correlations; Computer packages for carrying out thermal design of buildings and predicting performance.

Bioclimatic Classification - Bioclimatic classification of India; Passive concepts appropriate for the various climatic zones in India; Typical design of selected buildings in various climatic zones; Thumb rules for design of buildings and building codes.

UNIT – V BULIDING DESIGN **9**

Energy Efficient Landscape Design -Modification of microclimatic through landscape element for energy conservation; Energy conservation through site selection, planning, and design; Siting and orientation – GRIHA – Certification of Green Buildings.

Total **45**

OUTCOMES: At the end of the course the students would be able to

1 Understand the concepts of green building, thermal comfort, psychrometric chart, sol-air temperature

2 Relate the influence of building orientation, shading devices, ventilation in energy consumption and understand the concepts of passive cooling and heating, identify the building design for different climate and building codes

3 Estimate the heat transfer through internal and external surfaces, ventilation , calculate phase lag, and thermal transmittance

4 Estimate the building loads, predict performance of building design by software.

5 Relate energy efficiency with site selection, landscape and building design and explain certification of green buildings

References:

1 M. S. Sodha, N.K. Bansal, P.K. Bansal, A. Kumar and M.A.S. Malik, Solar Passive Building, Science and Design, Pergamon Press, 1986.

2 J.R. Williams, Passive Solar Heating, Ann Arbar Science, 1983.

3 R.W.Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D. McFarland and W.O. Wray, Passive Solar Design Handbook, Vol. 3, Report of U.S. Department of Energy (DOE/CS-0127/3), 1982.

4 J Krieder and A Rabi Heating and Cooling of Buildings : Design for Efficiency, McGraw-Hill (1994)

5 Majumder Milli, Energy Efficient Buildings, TERI, New Delhi 2002

6 T A Markus, E N Morris, Building, Climate and Energy, Spottwoode Ballantype Ltd. London, 1980.

7 Sanjay Prakash (et al.), Solar architecture and earth construction in the NorthWest, Himalaya,Vikas, New Delhi,1991

8 Energy Research Group, CD Rom Version 2 , LIOR Ireland, Solar Bioclimatic Architecture,1999

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EY22214	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

OUTCOMES: At the end of the course the students would be able to

1 Describe the fundamental concepts of wind energy systems.

2 Summarise the components attached in a wind mill and their principle to produce the renewable energy.

3 Demonstrate the working of turbine, transformers and inverter of the wind mill to produce the electrical energy.

4 Illustrate the different types of generators and power condition used in wind systems.

5 Analyze 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	2	1		2			2	2
2	3	2	1		1			1	1
3	3	2	1		2			2	1
4	2	2	1		1			1	1
5	3	2	1		2			1	1

SEMESTER II (PROGRAM ELECTIVE III)

		L	T	P	C
EY22221	**DESIGN OF HEAT EXCHANGERS**	**3**	**0**	**0**	**3**

Course Objectives

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 **9**

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 **9**

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**

OUTCOMES: At the end of the course the students would be able to

1 Describe the concepts, types and applications of various types of heat exchangers

2 Summarize the importance of thermal and stress analysis of heat exchanger systems

3 Discover the design concept of various heat exchangers for industrial applications

4 Illustrate the design of heat exchangers for industrial requirements

5 Validate 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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EY22222 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.

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**

OUTCOMES: At the end of the course the students would be able to

1 Identify the concepts energy storage technologies for suitable applications.

2 Analyze the principles of energy storage systems.

3 Recognize the concepts and types of various energy storage technologies.

4 Categorize the various energy storage technologies.

5 Evaluate 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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EY22223 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**

OUTCOMES: At the end of the course the students would be able to

1 Describe the details of energy efficient buildings design.

2 Infer knowledge of energy efficient buildings design.

3 Manipulate the techniques of the energy model, energy efficient buildings design.

4 Categorize the different energy efficient buildings design models.

5 Validate the energy efficient buildings design.

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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EY22224	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 – CO2 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**

OUTCOMES: At the end of the course the students would be able to

1. Describe the operations of environmental engineering and pollution control.
2. Classify the different types of pollution control components.
3. Relate the pollution control components, transmission and distribution for different power plants.

4 Categorized the pollution control components and its action for environmental engineering

5 Review the environmental engineering and pollution control techniques.

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

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