REGULATIONS AND SYLLABUS

(University Department)

(For the candidates admitted from the academic year 2022-2023 onwards)

MASTER OF TECHNOLOGY IN ENERGY TECHNOLOGY

(Under Choice Based Credit System)

DEPARTMENT OF ENERGY SCIENCE AND TECHNOLOGY

SCHOOL OF ENERGY AND ENVIRONMENTAL SCIENCES

PERIYAR UNIVERSITY

(NAAC A^{++} Grade -State University- NIRF Rank 73, ARIIA Rank 10)

SALEM– 636 011

TAMIL NADU

Regulations & Scheme

M.Tech., Energy Technology

Choice Based Credit System (CBCS) Regulation,

Scheme and Syllabus

(W.e.f.2022-2023 onwards)

1. Eligibility for Admission

Candidate who has passed the **B.E/B.Tech degree in Aeronautical/Agricultural/ Automobile/ Chemical Engineering/ Civil/ Electrical/ Electronics/ Energy and Environment/ Instrumentation/ Mechanical/ Mechatronics/ Nano Technology** or **M.Sc., degree in Physics/ Chemistry/ Energy / Material Science** of this University or any other University shall be eligible for admission to M.Tech., Energy Technology degree of this University

2. Mode of Selection

The admission is subject to the prevailing rules and regulations for PG admission of this University and as per the norms of Tamil Nadu Government.

3. Duration of the Degree

The duration of the M.Tech., degree shall be two years consisting of four semesters. Each semester consists of 90 working days.

4. Distribution of Credit Points

The minimum credit requirement for M.Tech., degree shall be 94 Credits. The break-up of credits for the Programme is as follows;

- Core Courses : 69 credits
- Elective Courses : 16 credits
- Supportive Courses : 04 credits
- Human Rights : 02 credits
- Technical Seminar : 01 credit
- Swayam : 02 credits

5. Course of Study

The course of study for the M.Tech., degree shall be in Energy Technology (CBCS) with internal assessment according to syllabi prescribed from time to time.

5.1 Components of Internal Examination

The allotment of marks and scheme of examination as follows;

Internal Tests (Best 1 out of 2)	05 Marks
Model Examination	05 Marks
Seminar	05 Marks
Assignment	05 Marks
Attendance	05 Marks
Total	25 Marks

5.2 Theory Core Paper (100 Marks)

External	75 Marks
Internal	25 Marks
Total	100 Marks

5.3 Practical Internal & External (100 Marks)

Internal (40 Marks)		**External (60 Marks)**		
Internal Tests (Best 1 out of 2)	Model Exam	Record Work	Experimental Work	Viva Voce
20	20	10	40	10

5.4 Technical Seminar (100 Marks)

Technical Seminar aims to help students acquire the employability skills necessary for the workplace through technical presentation. It also attempts to meet the expectations of the employers by giving special attention to presentation skills and soft skills. This will be attained through expert guidance and teaching activities focusing on the above listed skills and language skills.

Internal (40 Marks)			**External (60 Marks)**		
Presentation I	Presentation II	Presentation III	Dissertation	Presentation	Viva Voce
10	10	20	20	30	10

5.5 Marks allotment for attendance as follows

Percentage of attendance	**Marks**
96% - 100%	5
91% - 95%	4
86%- 90%	3
81% - 85%	2
75% - 80%	1
Below 75%	No marks

6. Details of Project Marks

Project work	**Internal (40 Marks)**			**External (60 marks)**			
Phase I (100 Marks)	Review I	Review II	Review III	Thesis Evaluation (External)	Viva –Voce 45 Marks		
					Supervisor	External	Internal
	10	10	20	15	15	15	15

Project work	**Internal (80 Marks)**				**External (120 marks)**			
Phase II (200 Marks)	Review I	Review II	Review III	Conference Paper Presentation/ Journal Article/ Book Chapter Publication /Patent Filing	Thesis Evaluation (External)	Viva –Voce 90 Marks		
						Supervisor	External	Internal
	20	20	30	10	30	30	30	30

The project work is an important component of postgraduate programme. The Project work consists of Phase – I and Phase – II. The Phase – I is to be undertaken during III semester and Phase – II is a continuation of Phase – I which is to be undertaken during IV semester.

The Project work for Phase II should be pursued for a minimum of 90 working days during the final semester. Students may be permitted to carry out project work either internal or external mode (i.e., Industrial / Research Organization, etc.,) on the recommendations of the Head of the Department. In case of external Project, supervisor of the department shall guide the Project work jointly with an expert member as joint supervisor from the Industry/ Organization. The student shall be instructed to meet the supervisor periodically and attend the review committee meetings for evaluating the progress.

7. Question Paper Pattern

Time: 3 Hours **Maximum Marks: 75**

PART – A (20X1= 20 Marks)

Objective Type Questions

PART – B (3X5= 15 Marks)

Analytical Questions Any 3 out of 5 (One question from each Unit)

PART – C (5X8= 40 Marks)

Either or Type descriptive questions (Two questions from each Unit)

8. Passing Minimum

1. There shall be no Passing Minimum Marks for Internal.
2. For External Examination, Passing Minimum shall be of 50% (Fifty Percentage) of the maximum marks prescribed for the paper.
3. In aggregate (External +Internal) the passing minimum shall be of 50% for each Paper/Practical/Project and Viva-voce.
4. Grading shall be based on overall marks obtained (internal + external).

9. Classification of Successful Candidate

CGPA	Grade	Classification of final result
9.5-10.0	O+	First Class with Exemplary
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-appear

10. Marks and Grades

Range of Marks	Grade points	Letter Grade	Description
90 – 100	9.0 – 10.0	O	**Outstanding**
80-89	8.0 – 8.9	D+	**Excellent**
75-79	7.5 – 7.9	D	**Distinction**
70-74	7.0 – 7.4	A+	**Very Good**
60-69	6.0 – 6.9	A	**Good**
50-59	5.0 – 5.9	B	**Average**
00-49	0.0	U	**Re-Appear**
Absent	**0.0**	AAA	**Absent**

11. Internship

The students may undergo internship training at Research organization / University/ industry for a period as specified in the curriculum during summer vacation. In this case, the training has to be undergone continuously for the entire period.

Duration of Internship	Credits
2 Weeks to 4 weeks	2

At the end of internship, the student shall submit a report. A Two-member committee constituted by the Head of the Department will conduct the Viva-Voce Examination. The committee comprises of one expert member from an industry/institutions and One member (Coordinator) from the Department.

INTERNSHIP TRAINING (100 Marks)

Report	**Presentation**		**Viva Voce**		**Total**
External	External	Internal	External	Internal	
40	15	15	15	15	100

12. Supportive Paper

Supportive paper will be offered in second semester. Students are expected to select one Supportive Course (Non-major elective) offered by other departments. Students can earn four credits from supportive course.

13. Swayam Course

The students must attend a SWAYAM course mandatorily in first semester with two credits. The students are eligible for the award of Degree only if he gets pass in Swayam course.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.

The courses hosted on SWAYAM are in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology.

In order to ensure that best quality content is produced and delivered, nine National Coordinators conduct the exam. They are:

1. AICTE (All India Council for Technical Education) for self-paced and international courses
2. NPTEL (National Programme on Technology Enhanced Learning) for Engineering
3. UGC (University Grants Commission) for non technical post-graduation education
4. CEC (Consortium for Educational Communication) for under-graduate education
5. NCERT (National Council of Educational Research and Training) for school education
6. NIOS (National Institute of Open Schooling) for school education
7. IGNOU (Indira Gandhi National Open University) for out-of-school students
8. IIMB (Indian Institute of Management, Bangalore) for management studies
9. NITTTR (National Institute of Technical Teachers Training and Research) for Teacher Training programme

Courses delivered through SWAYAM are available free of cost to the learners, however learners wanting a SWAYAM certificate should register for the final proctored exams that come at a fee and attend in-person at designated centres on specified dates.

Eligibility for the certificate will be announced on the course page and learners will get certificates only if this criteria is matched. Universities/colleges approving credit transfer for these courses can use the marks/certificate obtained in these courses for the same.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

The Energy Technology 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 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 Technology, our students will exhibit ability to:

PO	Graduate Attribute	Programme Outcome
1	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	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.

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 software such as MATLAB, ANSYS- CFD, 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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Mapping of Course Outcome and Programme Outcome

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I YEAR	Semester 1	Energy Auditing and Management	✓		✓	✓		✓	✓	✓		✓		✓
		Fluid Flow and Heat Transfer	✓	✓	✓	✓	✓	✓	✓				✓	✓
		Thermodynamic Analysis of Energy Systems	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
		Research methodology and Intellectual Property Rights	✓	✓	✓	✓	✓	✓	✓				✓	✓
		Professional Elective –I												
		Energy Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Technical Seminar	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Semester 2	Energy conservation of Thermal Systems	✓	✓		✓	✓	✓	✓				✓	✓
		Energy conservation of Electrical Systems	✓			✓		✓	✓	✓		✓		✓
		Computational Fluid Dynamics	✓	✓	✓	✓	✓	✓	✓				✓	✓
		Advanced Power Plant	✓		✓		✓			✓	✓	✓		✓
		Professional Elective –II												
		Supportive												
		Fundamentals of Human Rights												
		Analysis and Simulation Laboratory	✓	✓	✓	✓	✓	✓			✓		✓	✓
II YEAR	Semester 3	Biofuels and Bioenergy Technologies		✓	✓		✓	✓	✓				✓	✓
		Nanomaterial's for Energy Storage Applications	✓	✓	✓		✓	✓	✓	✓			✓	✓
		Energy Efficient Buildings Design	✓	✓	✓	✓		✓						✓
		Professional Elective III												
		Professional Elective IV												
		Internship	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Project Work Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Semester 4	Project Work Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

PERIYAR UNIVERSITY, SALEM
UNIVERSITY DEPARTMENT REGULATIONS – 2022
CHOICE BASED CREDIT SYSTEM
M.TECH. ENERGY TECHNOLOGY

CURRICULUM AND SYLLABUS

SEMESTER I

S.No	Course Code	Course Title	Category	L	T	P	C
1	22UPEST2C01	Energy Auditing and Management	PC	3	1	0	4
2	22UPEST2C02	Fluid Flow and Heat Transfer	PC	3	1	0	4
3	22UPEST2C03	Thermodynamic Analysis of Energy Systems	PC	3	1	0	4
4	22UPEST2C04	Research methodology and Intellectual Property Rights	PC	4	0	0	4
5	-	Professional Elective –I	PE	4	0	0	4
6	-	Swayam Course	-	0	0	0	2
PRACTICALS							
7	22UPEST2C05	Energy Laboratory	PC	0	0	4	2
8	22UPEST2C06	Technical Seminar	-	0	0	2	1
			TOTAL	**17**	**3**	**6**	**25**

SEMESTER II

S.No	Course Code	Course Title	Category	L	T	P	C
1	22UPEST2C07	Energy conservation of Thermal Systems	PC	3	1	0	4
2	22UPEST2C08	Energy conservation of Electrical Systems	PC	3	1	0	4
3	22UPEST2C09	Computational Fluid Dynamics	PC	3	1	0	4
4	22UPEST2C10	Advanced Power Plant	PC	4	0	0	4
5	-	Professional Elective –II	PE	4	0	0	4
6	-	Supportive	-	4	0	0	4
7	22UPSOC2H01	Fundamentals of Human Rights	-	2	0	0	2
PRACTICALS							
8	22UPEST2C11	Analysis and Simulation Laboratory	PC	0	0	4	2
			TOTAL	**23**	**3**	**4**	**28**

SEMESTER III

S.No	Course Code	Course Title	Category	L	T	P	C
1	22UPEST2C12	Biofuels and Bioenergy Technologies	PC	4	0	0	4
2	22UPEST2C13	Nanomaterial's for Energy Storage Applications	PC	4	0	0	4
3	22UPEST2C14	Energy Efficient Buildings Design	PC	4	0	0	4
4	-	Professional Elective III	PE	4	0	0	4
5	-	Professional Elective IV	PE	4	0	0	4
6	22UPEST2C15	Internship	PC	0	0	0	2
PRACTICALS							
7	22UPEST2C16	Project Work Phase I	PC	0	0	10	5
			TOTAL	**20**	**0**	**10**	**27**

SEMESTER IV

S.No	Course Code	Course Title	Category	L	T	P	C
Project Work							
1	22UPEST2C17	Project Work Phase II	PC	0	0	28	14
			TOTAL	**0**	**0**	**28**	**14**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF DEGREE = 94

PROFESSIONAL CORE (PC)

S.No	Course Code	Course Title	Category	L	T	P	C
1.	22UPEST2C01	Energy Auditing and Management	PC	3	1	0	4
2.	22UPEST2C02	Fluid Flow and Heat Transfer	PC	3	1	0	4
3.	22UPEST2C03	Thermodynamic Analysis of Energy Systems	PC	3	1	0	4
4.	22UPEST2C04	Research methodology and Intellectual Property Rights	PC	4	0	0	4
5.	22UPEST2C05	Energy Laboratory	PC	0	0	4	2
6.	22UPEST2C06	Technical Seminar	PC	0	0	2	1
7.	22UPEST2C07	Energy conservation of Thermal Systems	PC	3	1	0	4
8.	22UPEST2C08	Energy conservation of Electrical Systems	PC	3	1	0	4
9.	22UPEST2C09	Computational Fluid Dynamics	PC	3	1	0	4
10.	22UPEST2C10	Advanced Power Plant	PC	4	0	0	4
11.	22UPEST2C11	Analysis and Simulation Laboratory	PC	0	0	4	2
12.	22UPEST2C12	Biofuels and Bioenergy Technologies	PC	4	0	0	4
13.	22UPEST2C13	Nanomaterial’s for Energy Storage Applications	PC	4	0	0	4
14.	22UPEST2C14	Energy Efficient Buildings Design	PC	4	0	0	4
15.	22UPEST2C15	Internship	PC	0	0	0	2
16.	22UPEST2C16	Project Work Phase I	PC	0	0	10	5
17.	22UPEST2C17	Project Work Phase II	PC	0	0	28	14

PROFESSIONAL ELECTIVE (PE)

S.No	Course Code	Course Title	Category	L	T	P	C
PROFESSIONAL ELECTIVE - I							
1.	22UPEST2E01	Solar Energy Technologies	PE	4	0	0	4
2.	22UPEST2E02	Hydro Power Systems	PE	4	0	0	4
3.	22UPEST2E03	Electrical Drives and Controls	PE	4	0	0	4
4.	22UPEST2E04	Environmental Engineering and Pollution Control	PE	4	0	0	4
PROFESSIONAL ELECTIVE - II							
5.	22UPEST2E05	Smart Grid Technologies	PE	4	0	0	4
6.	22UPEST2E06	Wind Energy Conversion Systems	PE	4	0	0	4
7.	22UPEST2E07	Instrumentation for Energy Systems	PE	4	0	0	4
8.	22UPEST2E08	Industrial Wastewater Pollution-Prevention and Control	PE	4	0	0	4
PROFESSIONAL ELECTIVE - III							
9.	22UPEST2E09	Solar Energy Appliances	PE	4	0	0	4
10.	22UPEST2E10	Nuclear Energy Technology	PE	4	0	0	4
11.	22UPEST2E11	Power Electronics for Renewable Energy Systems	PE	4	0	0	4
12.	22UPEST2E12	Waste Management and Energy Recovery Techniques	PE	4	0	0	4
PROFESSIONAL ELECTIVE - IV							
13.	22UPEST2E13	Solar Refrigeration and Air-conditioning	PE	4	0	0	4
14.	22UPEST2E14	Principles and Applications of Hydrogen Storage	PE	4	0	0	4
15.	22UPEST2E15	Entrepreneurship Development	PE	4	0	0	4
16.	22UPEST2E16	Climate change and Modeling	PE	4	0	0	4

NON-MAJOR ELECTIVE COURSES (NM)

S.No	Course Code	Course title	Category	L	T	P	C
1	22UPESTS01	Renewable Energy	NM	4	0	0	4
2	22UPESTS02	Climate Change and CO_2 Emission Assessment	NM	4	0	0	4
3	22UPESTS03	Energy Scenario and Policy	NM	4	0	0	4
4	22UPESTS04	Erection and Maintenance of Refrigeration and Air-Conditioning Equipment	NM	4	0	0	4
5	22UPESTS05	Green Concepts in Building	NM	4	0	0	4

VALUE ADDED COURSE

S. No	Course Code	Course title	Category
1	22UPESTVA01	Alternate Fuels and Emissions	**VA**
2	22UPESTVA02	Biomass and its Conversion Technologies	**VA**
3	22UPESTVA03	Materials for Energy Applications	**VA**
4	22UPESTVA04	Electric Vehicles	**VA**
5	22UPESTVA05	Design Thinking	**VA**
6	22UPESTVA06	First Aid, Fire Fighting & Safety Management	**VA**
7	22UPESTVA07	Refrigeration and Air Conditioning	**VA**
8	22UPESTVA08	Industrial Robotics	**VA**

22UPEST2C01 ENERGY AUDITING AND MANAGEMENT

L	T	P	C
3	1	0	4

COURSE OBJECTIVES

- To know Global and Indian Energy Scenario and Energy Conservation Act
- To know the energy efficiency and climate change policies
- To know the procedure of Energy Audit
- To understand the material and energy balance in the production
- To know the planning and targeting of energy in industries

UNIT – I: ENERGY SCENARIO AND ENERGY CONSERVATION ACT

Introduction - Primary and Secondary Scenario - Final Energy Consumption - India's Energy Scenario - Sector wise Energy Consumption in India - Energy Intensity on Purchasing Power Parity (PPP) - Energy Security - Salient Features of the Energy Conservation Act, 2001 - Scheme of BEE under the Energy Conservation Act-2001 - Electricity Act 2003 - National Action Plan on Climatic Change (NAPCC)

UNIT – II: ENERGY EFFICIENCY AND CLIMATE CHANGE

Energy and Environment - Global Environment Issues - Acid Rain - Ozone Layer Depletion - Global Warming and Climate Change - Global Warming and Climatic Change Impacts - United Nations Framework Convention on Climate Change (UNFCCC) - The Intergovernmental Panel on Climate Change (IPCC) - Conference of Parties (COP) - The Kyoto Protocol - CDM Methodology and Procedure - European Union's Efforts to Combat Climate Change - Sustainable Development

UNIT– III: OVERVIEW OF ENERGY MANAGEMENT AND AUDIT

Objectives of Energy Management - Need for Energy Audit - Types of Energy Audit and Approach – Understanding Energy Costs - Benchmarking - Energy Performance - Matching Energy Usage to Requirement - Maximizing System Efficiencies - Fuel and Energy Substitution - Instruments and Metering for Energy Audit

UNIT- IV: MATERIALS BALANCE, ENERGY BALANCE AND FINANCIAL MANAGEMENT

Introduction - Components of Materials and Energy Balance - Basic Principles of Material and Energy Balance - Classification of Processes - Material Balance - Energy Balance - Facility as an Energy System - Energy Analysis and the Sankey Diagram - Financial Analysis Techniques - Energy Performance Contracting and Role of ESCOs - Energy Efficiency in Building through ESCO

UNIT- V: PROJECT MANAGEMENT, ENERGY MONITORING AND TARGETING

Project Planning Techniques - Implementation Plan for Top Management - Planning Budget - Procurement Procedures – Construction - Measurement and Verification - Setting up Monitoring & Targeting - Key elements of Monitoring &Targeting System - Data and Information Sources - Data and Information Analysis - Energy Management Information System (EMIS)

COURSE OUTCOME

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

CO1	Adopt energy standards based on various acts officially established for qualitative and quantitative improvement in energy utilization	K1-K6
CO2	Learn Energy efficiency and climate change policies globally	K1-K6

CO3	Familiarized about energy auditing and energy management methods.	K1-K6
CO4	Find the production rate and energy consumption data	K1-K6
CO5	Involve in energy extraction and efficiency rate improvement	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. General Aspects of Energy Management and Energy Audit, Fourth Edition, Bureau of Energy Efficiency, New Delhi, India 2015,
2. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006
3. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
4. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
5. I.G.C. Dryden, "The Efficient Use of Energy" Butterworths, London, 1982

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	H	-	-	H	-	L	H	L	-	L	-	M	H	H	-
2	M	-	-	H	-	L	H	L	-	L	-	M	M	H	L
3	H	-	M	M	-	M	H	-	-	L	-	M	M	M	L
4	L	-	-	M	-	H	H	H	-	M	-	M	H	M	-
5	L	-	-	L	-	M	H	-	-	M	-	M	H	H	-

22UPEST2C02 **FLUID FLOW AND HEAT TRANSFER**

L	T	P	C
3	1	0	4

COURSE OBJECTIVES

- To lay the foundation and understand the equations of Euler and Bernoulli.
- To understand principles of laminar and turbulent flow
- To inculcate conduction, convection and radiation heat transfer
- To impart the knowledge of boiling and condensation
- To provide the details of types of heat exchangers

UNIT – I: INTRODUCTION AND BASIC CONCEPTS

Classification of fluid flows - Fluid statics - Buoyancy and Stability - Fluids in rigid-body motion - Fluid Kinematics - Lagrangian and Eulerian descriptions - Flow patterns and Flow visualization- Vorticity and Rotationality- Conservation of mass - Bernoulli equation - General energy equation

UNIT – II: ANALYSIS OF FLOW SYSTEMS

The Linear Momentum Equation - The Angular Momentum Equation - Internal Flow - Laminar and Turbulent Flows - Entrance Region - Laminar Flow in Pipes - Turbulent Flow in Pipes - Flow Rate and Velocity Measurement - The Stream Function - The Navier–Stokes Equation - External Flow - Drag and Lift

UNIT– III: CONDUCTION, CONVECTION AND RADIATION HEAT TRANSFER

One-Dimensional Heat Conduction Equation - Steady Heat Conduction in Plane Walls - Heat Conduction in Cylinders and Spheres - Transient Heat Conduction - Lumped System Analysis - fundamentals of convection - external forced convection – internal forced convection - fundamentals of thermal radiation - blackbody radiation - radiation intensity - radiative properties - emissivity

UNIT- IV: BOILING AND CONDENSATION

Boiling heat transfer - pool boiling - boiling regimes and the boiling curve - flow boiling - condensation heat transfer - film condensation - flow regimes - film condensation inside horizontal tubes - dropwise condensation

UNIT – V: HEAT EXCHANGERS

Heat exchangers -Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters – limitations - the overall heat transfer coefficient - analysis of heat exchangers - selection of heat exchangers

COURSE OUTCOME

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

CO1	Understand various types of fluid flow and able derive basic fundamental equations applied to fluid flow	K1-K6
CO2	Apply correctly the conservation principles of mass, linear momentum, and energy to fluid flow systems.	K1-K6
CO3	Solve the conduction, convection and radiation heat transfer problems	K1-K6
CO4	Understand the boiling and condensation of fluids	K1-K6
CO5	Design of heat exchanger according to industry requirements	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Yunus A. Çengel, John M. Cimbala, Fluid mechanics: fundamentals and applications, McGraw-Hill; 3rd edition, 2014
2. Yunus A. Cengel, Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals & Applications in SI Units, 6th Edition, McGraw-Hill Education, 2020
3. Bansal,R.K., Fluid Mechanics-2016.
4. Streeter, V.L., Wylie, E.B., and Bedford, K.W., Fluid Mechanics, WCB McGraw Hill, Boston, 1998.
5. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw Hill Co., 1985

CO	PO												PSO		
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2	H	H	M	H	L	H	L	-	-	-	-	H	-	-	H
3	H	H	M	H	L	H	L	-	-	-	-	H	-	-	H
4	H	H	M	H	M	H	M	-	-	-	-	H	-	H	H
5	H	H	M	H	M	H	M	-	-	-	-	H	-	H	H

22UPEST2C03	THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

- To understand the basic principles and the scope of thermodynamics.
- To understand the exergy and thermodynamic potential
- To understand Chemical Equilibrium
- To gain knowledge on atmospheric air properties and air conditioning process.
- To understand the laws of reacting systems

UNIT – I: INTRODUCTION AND BASIC CONCEPTS OF THERMODYNAMICS

Introduction- Systems and control volume - properties of system – State and Equilibrium - thermodynamic process and cycles – Zeroth Law of thermodynamics – Forms of energy – Energy transfer by heat and work – First and second law of thermodynamics.

UNIT – II: AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATION

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 Clapeyron equation, Joule – Thomson coefficient - Bridgeman tables for thermodynamic relations.

UNIT-III: CHEMICAL THERMODYNAMICS

Fuels and Combustion – Theoretical and Actual combustion process – Enthalpy of formation – Enthalpy of Combustion – First law analysis of reacting systems – Adiabatic Flame Temperature - Entropy change of reacting systems – Second law analysis of reacting systems

UNIT – IV: CHEMICAL AND PHASE EQUILIBRIUM

Criterion for Chemical Equilibrium - Equilibrium constant for Ideal gas mixtures - Chemical Equilibrium for Simultaneous Reactions – Phase Equilibrium

UNIT–V: GAS VAPOR MIXTURE AND AIR CONDITIONING

Properties of atmospheric air – specific and relative humidity of air – wet bulb, dry bulb, dew point temperature – pschrometric chart – human comfort and Air-Conditioning - Air-Conditioning process

COURSE OUTCOME

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

CO1	Categorize the performance of ideal gas, real gas and pure substance.	K1-K6
CO2	Evaluate Stoichiometric generation during a thermodynamic process.	K1-K6
CO3	Understand in chemical Equilibrium of ideal gas mixtures.	K1-K6
CO4	Determine air fuel mixture during combustion	K1-K6
CO5	Recognize gas vapor mixture and air conditioning	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Yunus A Cengel, Michael A. Boles, Mehmet Kanoglu Thermodynamics - An Engineering Approach 9th Edition 2019.
2. P. K. Nag Engineering Thermodynamics 6th edition, McGraw Hill publisher.
3. Natarajan. E, "Engineering Thermodynamics: Fundamentals and Applications", 2nd Edition (2014) Anuragam Publications, Chennai.
4. V. M. Domkundwar A Course in Internal Combustion Engines, (Dhanpat Rai & Co) 2018
5. R.P. Mathur, M.L. & Sharma Internal Combustion Engines, 2014

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3	H	H	H	H	H	M	M	-	M	-	-	H	H	H	M
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22UPEST2C04	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- Identify an appropriate research problem in their interesting domain
- Understand ethical issues and the Preparation of a research project thesis report.
- Understand significance, effective technical writing and report
- Understand the law of patent and copyrights
- Understand the adequate knowledge on patent and rights

UNIT – I: RESEARCH: A WAY OF THINKING

Meaning of research – characteristics and requirements - Types of research - an eight-step model - formulating a research problem - planning a research study - conceptualizing a research design - constructing an instrument for data collection - selecting a sample - collecting data - processing and displaying data - writing a research report

UNIT – II: LITERATURE REVIEW, TECHNICAL WRITING /EVALUATION

Bringing clarity and focus to your research problem – Searching for the existing literature - Reviewing the selected literature - Developing a theoretical framework - Developing a conceptual framework - analysis Plagiarism - Research ethics - Effective technical writing - Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT – III: SOFT COMPUTING

Computer and its role in research, Use of statistical software SPSS, GRETL etcin research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems

UNIT – IV: INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)

Intellectual Property - Meaning, Relevance, Business Impact, Protection of Intellectual Property - Intellectual Property as an Instrument of Development; Need for Protecting - Intellectual Property – Policy Consideration – National and International - intellectual Property Rights as Human Right – Copyrights – Trademarks

UNIT – V: PATENTS

Patents - Patentable Subject Matter - Patentability Criteria - Duration of Patents- Law and Policy Consideration - Procedure for Filing of Patent Application and types of Applications - Ownership and Maintenance of Patents - Patent Agent- Qualification and Registration Procedure - Computer Software - Traditional knowledge Case Studies.

COURSE OUTCOME

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

CO1	Understand the characteristics, objects of a good research problem	K1-K6
CO2	Understand the principles of ethics and ethical issues in science and engineering	K1-K6
CO3	Understand writing a research report as per format.	K1-K6
CO4	Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity	K1-K6
CO5	Ability to understand about IPR and filing patents in R & D	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners" 3rd Edition 2011, Sage Publication
2. Intellectual Property Rights-Law and Practice, Module 3, The Institute of Company Secretaries of India, 2018
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

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4	H	-	L	-	H	-	-	H	H	H	-	H	-	-	H
5	H	-	-	-	H	-	-	H	H	H	-	H	-	-	H

		L	T	P	C
22UPEST2C05	**ENERGY LABORATORY**	0	0	4	2

COURSE OBJECTIVES

- To gain practical knowledge on thermal energy Storage system using various PCM.
- To obtain the knowledge on working and characterization of Solar PV cell.
- To analyze the solar cell efficiency through solar cell simulator.
- To acquire the principle operation of biogas plant and analyze its constituents.
- To learn the working of Solar Hot Water heater.
- To characterize the properties of fuel.
- To assess the performance of Wind Energy Generator.
- To identify the concept of heat transfer in heat exchangers.
- To attain the methodology adopted for performance evaluation of various Energy Auditing devices

LIST OF EXPERIMENTS

1. Evaluation of heat loss and efficiency in thermosyphonic mode of heat flow at different radiation level in Solar Flat Plate Water Heating System.
2. Conduct an experiment to obtain I-V and P-V characteristics of PV module with varying radiation level using solar PV training & research System.
3. Performance analyses of PV module with various tilt angle using solar PV training & research System.
4. Effect of shading on the efficiency of PV module with regards to voltage current and power using Solar PV Training & research system.
5. Performance assessment of Wind Energy Generator based on wind velocity.
6. Determination of the flash point of a given sample using flash point apparatus.
7. Experiment on Nano Floating Drum Biogas Plant and evaluating the percentage of biogas formed for the given amount of organic waste using bio gas analyzer.
8. Experimental evaluation of a Paraffin wax as Phase Change Material for Thermal Energy Storage in TES Training System.
9. Experimental evaluation of a fatty acid as Phase Change Material for Thermal Energy Storage in TES Training System.
10. Experimental evaluation of a Paraffin wax and fatty acid (mixed) as Phase Change Material for Thermal Energy Storage during charging mode in TES Training System.
11. Experimental evaluation of a Paraffin wax and fatty acid (mixed) as Phase Change Material for Thermal Energy Storage during discharging mode in TES Training System.
12. Determination the overall heat transfer coefficient in a plate type heat exchanger at different hot fluid flow rate.
13. Experimental analysis on efficiency of solar cell under varying light intensity using Solar Simulator- SS50 AAA.
14. A study experiment on tools used in the assessment of illuminance (lux meter), wind speed (anemometer), pH level (pH indicator), Humidity (humidity sensor), Temperature (K-Type Thermocouple), sound level (sound meter).

COURSE OUTCOME

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

CO1	Understand the working of solar hot water heater and calculate the thermal efficiency of the system.	K1-K6
CO2	Operate solar PV devices under different operating parameter and evaluate their performance	K1-K6
CO3	Investigate the performance of Wind Energy Generator	K1-K6
CO4	Evaluate the thermal properties of various fuel	K1-K6
CO5	Examine thermal heat storage systems and determine the performance of various PCM materials	K1-K6
CO6	Handle solar simulator and assess solar cell performance	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

CO	**PO**												**PSO**		
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4	H	H	L	H	H	H	M	-	H	L	-	M	H	H	H
5	H	H	L	H	H	H	M	-	H	-	-	M	H	-	H
6	H	H	H	H	H	H	M	-	H	-	-	H	H	-	-

22UPEST2C06 **TECHNICAL SEMINAR**

L	**T**	**P**	**C**
0	0	2	1

COURSE OBJECTIVES

Technical Seminar aims to help students acquire the employability skills necessary for the workplace through technical presentation. It also attempts to meet the expectations of the employers by giving special attention to presentation skills and soft skills. This will be attained through expert guidance and teaching activities focusing on the above listed skills and language skills.

SEMINAR EVALUATION

Internal (40 Marks)			**External (60 Marks)**		
Presentation -I	Presentation – II	Presentation - III	Dissertation	Presentation	Viva Voce
10	10	20	20	30	10

22UPEST2C07	ENERGY CONSERVATION OF THERMAL SYSTEMS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

- To learn importance fuel properties and combustion
- To know the heat transfer modes in boiler and characteristics of steam and efficient utilization of steam
- To understand the operation of furnaces and refractories
- To know the importance of cogeneration in industrial utilities
- To know the process of heat recovery system and heat exchangers

UNIT – I: FUELS AND COMBUSTION

Introduction to Fuels - Properties of Liquid Fuels - Properties of Coal - Properties of Gaseous Fuels - Properties of Agro Residues – Combustion - Combustion of Oil - Combustion of Coal - Combustion of Gas - Combustion of Biomass - Type of Draft System - Type of Combustion Controls

UNIT – II: BOILERS AND STEAM SYSTEM

Introduction - Boiler Systems - Boiler Types and Classifications - Performance Evaluation of Boilers - Boiler Water Treatment - Boiler Blow Down - Improving Boiler Availability - Thermic Fluid Heaters - Energy Conservation Opportunities – Operation and Maintenance of Steam Traps - Performance Assessment of Steam Traps - Efficient steam utilization and Energy Saving Opportunities

UNIT–III: FURNACES, INSULATION AND REFRACTORIES

Types and Classification of Different Furnaces - Performance Evaluation of a Typical Fuel Fired Furnace - General Fuel Economy Measures in Furnaces - Purpose of Insulation - Types and Application - Calculation of Insulation Thickness - Refractories - Properties of Refractories - Classification of Refractories - Typical Refractories in Industrial Use - Selection of Refractories - Heat Losses from Furnace Walls

UNIT-IV: COGENERATION

Need for Cogeneration - Principle of Cogeneration - Technical Options for Cogeneration - Classification of Cogeneration Systems - Factors Influencing Cogeneration Choice - Important Technical Parameters for Cogeneration - Prime Moves for Cogeneration - Typical Cogeneration Performance Parameters - Relative Merits of Cogeneration Systems - Steam Turbine Efficiency - Cogeneration Heat Rate and Efficiency Assessment - Tri-generation - Micro turbine

UNIT – V: WASTE HEAT RECOVERY AND HEAT EXCHANGERS

Introduction - Classification and Application - Benefits of waste Heat Recovery - Development of a Waste Heat Recovery - Commercial Waste Heat Recovery Devices Heat Transfer Basics - Concept of Heat Exchanger - Pinch Analysis and pinch technology Application for process and Energy efficiency Improvements

COURSE OUTCOME

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

CO1	Evaluate the performance of fuel and biomass under different operating conditions	K1-K6
CO2	Know the Boiler, Steam and energy efficiency opportunities in steam systems	K1-K6

CO3	Calculate the performance assessment of furnaces and installation of refractories in industries	K1-K6
CO4	Know the working of FBC and classification and working of different cogeneration system	K1-K6
CO5	Know the design of different waste heat recovery and heat exchangers	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Energy Manager Training Manual (4Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004.
2. Yunus A. Cengel, Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals & Applications in SI Units, 6th Edition, McGraw-Hill Education, 2020
3. Fuels & Combustion by Sharma S.P. &Chander Mohan, Tata McGraw Hill Publishing Co. Ltd.
4. Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, John Wiley, 5th Edition 2001.
5. Stoecker, W.F., Design of Thermal Systems, McGraw Hill, 2011.

CO	**PO**												**PSO**		
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3	H	H	L	H	M	H	M	-	-	-	H	H	H	H	M
4	H	H	L	H	M	H	M	-	-	-	H	H	H	H	M
5	H	H	L	H	M	H	H	-	-	-	H	H	H	H	M

22UPEST2C08	ENERGY CONSERVATION OF ELECTRICAL SYSTEMS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

- To learn electrical transmission and distribution system and Electrical motors
- To obtain knowledge on working of air compressed system
- To know the HVAC and Refrigeration systems adopted in industries
- To understand the operation of pumps selection of pumps and fans based on application
- To know the energy conservation in lighting system

UNIT – I: ELECTRICAL SYSTEM AND ELECTRICAL MOTORS

Introduction to Electrical Power Supply Systems - Electricity Billing - Power Factor Improvement and Benefits – Transformers - Distribution Losses in Industrial System - Assessment of T&D Losses in Power Systems - Estimation of T&D Losses in Distribution System - Demand Side Management (DSM) – Harmonics - Analysis of Electrical Power System - Motor Types - Motor Characteristics - Motor Efficiency - Motor Selection - Energy Efficient Motors

UNIT – II: COMPRESSED AIR SYSTEM

Introduction - Compressor Types - Compressor Performance - Compressed Air System Components - Efficient Operation of Compressed Air System - Compressor Capacity Assessment

UNIT – III: HVAC AND REFRIGERATION SYSTEM

Introduction - Psychometrics and Air Conditioning Process - Types of Refrigeration System - Common Refrigerants and Properties - Compressor Types and Application - Selection of a Suitable Refrigeration System - Performance Assessment of Refrigeration Plants - Factors Affecting Performance and Energy Efficiency of Refrigeration Plants - Performance Assessment of Window , Split, and Package Air Conditioning Units

UNIT– IV: FANS, BLOWERS AND PUMPING SYSTEM

Introduction - Fan Types - Fan Performance Evaluation - Fan Design and Selection Criteria - Flow Control Strategies - Energy Saving Opportunities - Pump Types - System Characteristics - Flow Control Strategies - Boiler Feed Water Pumps - Municipal Water Pumps - Sewage Water Pumps - Agricultural Pumping System - Energy Conservation Opportunities in pumping Systems

UNIT- V: LIGHTING SYSTEM

Basic Parameters and Terms in Lighting System - Light Source and Lamp Types - General Energy Saving Opportunities - Energy Efficient Lighting Controls

COURSE OUTCOME

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

CO1	Evaluate the efficiency and losses in electrical system	K1-K6
CO2	Adopt the compressed air system based on application with energy conservation	K1-K6
CO3	Familiarized about the use of HVAC and refrigeration system	K1-K6
CO4	Determine the performance fans, blowers and pumping system and understand the parameters and terminologies used	K1-K6
CO5	Know the energy conservative measures and efficient in lighting systems	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Energy Manager Training Manual (4Volumes) available at www.energymanager training.com, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2015.
2. Handbook on Energy Efficiency, TERI, New Delhi, 2001
3. Barney L. Capehart, Wayne C. Turner, William J. Kennedy, Guide to energy management, eighth Edition. ©2016 by The Fairmont Press
4. A Textbook of Electrical Technology: Vol 2 Ac and Dc Machines: Ac And Dc Machines - Vol. 2B L Theraja
5. Energy Conservations in Buildings O. P. Jahkar Khanna publications

CO	PO												PSO		
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2	M	-	-	H	-	L	H	L	-	L	-	M	M	H	L
3	H	-	M	M	-	M	H	-	-	L	-	M	M	M	L
4	L	-	-	M	-	H	H	H	-	M	-	M	H	M	-
5	L	-	-	L	-	M	H	-	-	M	-	M	H	H	-

22UPEST2C09 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES

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

UNIT – I: GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - – Initial and Boundary Conditions — Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT – II: DIFFUSION PROCESSES: FINITE VOLUME METHOD

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

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

UNIT-IV: FLOW PROCESSES: FINITE VOLUME METHOD

Discretization of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT – V: MODELLING OF COMBUSTION AND TURBULENCE

Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical Reacting System (SCRS), Turbulence - Algebraic Models, One equation model & $k - \varepsilon$, $k - \omega$ models - Standard and High and Low Reynolds number models.

COURSE OUTCOME

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

CO1	Know the differences between various discretization techniques.	K1-K6
CO2	Learn the finite volume based numerical method for solving diffusion heat transfer problems.	K1-K6
CO3	Learn the finite volume based numerical method for solving convection-diffusion heat transfer problems.	K1-K6
CO4	Understand the discretization of incompressible flow governing equations	K1-K6
CO5	Recognize the impact of various turbulence modelling	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.
2. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill Publishing Company Limited, New Delhi, 1998.
3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer",Narosa Publishing House, New Delhi, 2003.
4. Subas and V. Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,1980.
5. JiyuanTu, Guan HengYeoh, Chaogun Liu, "Computational Fluid Dynamics A Practical Approach" Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008

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22UPEST2C10 **ADVANCED POWER PLANT**

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To obtain knowledge on the role of various components in Steam power plants
- To acquire knowledge on the working of gas turbine and diesel power plants
- To Learn the concept of nuclear power plants
- To absorb the various Renewable energy technologies and its applications.
- To explore the various Hybrid Systems

UNIT – I: STEAM POWER PLANT

Classification of steam power plant – layout of modern steam power plant - site selection for steam power plant – fuel Handling – combustion equipment's for boilers – fluidized bed combustion – ash handling – dust collection – types of chimney draught- Boiler's- Classification of boilers.

UNIT – II: DIESEL AND GAS POWER PLANT

Operation of Diesel power plant – Types of engines – layout of diesel power plant – performance of diesel power plant – Gas Turbines – Site selection – Classification of Gas Turbine power plant – constant pressure Gas Turbine power plant – Constant Volume Gas Turbine power plant.

UNIT–III: NUCLEAR POWER PLANT

General aspects of nuclear energy – Nuclear power systems – Nuclear reactors – Components of nuclear power plant – Pressurized water reactor – boiling water reactor – Canadian Deuterium uranium reactor – gas cooled Reactor – liquid metal cooled reactor – breeder reactor – Safety measures for Nuclear power plant -

UNIT-IV: RENEWABLE ENERGY SOURCES

Introduction – renewable energy sources – renewable energy in sustainable future - solar energy - Energy and power in wind - bio-energy - geothermal and ocean energy

UNIT – V: HYDRID ENERGY SYSTEMS

Hybrid Energy Systems - Principles and applications - Hybrid solar PV system - Wind Hybrid Systems - Hybrid OTEC – Hybrid MHD Systems - comparison of schemes - System design concept - Techno-economic performance; Energy storage schemes and estimation.

COURSE OUTCOME

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

CO1	Compute the steam rate, heat rate and cost for generating electricity from coal based thermal power plants	K1-K6
CO2	Analyze and suggest measures for improving the performance of gas turbine and diesel power plants	K1-K6
CO3	Identify a suitable type nuclear power plant commensurate with the prevailing conditions	K1-K6
CO4	Have knowledge in the various renewable energy systems	K1-K6
CO5	Examine the various Hybrid technologies	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Nag, P.K., Power Plant Engineering, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2002.
2. R.K. Rajput., "A Textbook of Power Plant Engineering" 5th edition-2016.
3. Arora and Domkundwar, A course in power Plant Engineering, Dhanpat Rai and CO, 2004.
4. Haywood, R.W., Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.

5. Wood, A.J., Wollenberg, B.F., Power Generation, operation and control, John Wiley, New York,1984.
6. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	H	H	M	M		-	-	-	-	-	L	M	H	M	-
2	H	H	M	M	M	L	L	-	-	-	L	M	H	M	-
3	H	H	M	M	M	L	L	-	-	-	L	M	H	M	-
4	H	H	M	M	M	L	L	-	-	-	L	M	H	M	-
5	H	H	M	L	L	L	L	-	-	-	L	M	H	M	-

22UPSOC2H01 FUNDAMENTALS OF HUMAN RIGHTS

L	T	P	C
4	0	0	4

UNIT – I: INTRODUCTION

Meaning and Definitions of Human Rights – Characteristics and Importance of Human Rights – Evolution of Human Rights – Formation, Structure and Functions of the UNO - Universal Declaration of Human Rights – International Covenants – Violations of Human Rights in the Contemporary Era.

UNIT – II: HUMAN RIGHTS IN INDIA

Development of Human Rights in India – Constituent Assembly and Indian Constitution – Fundamental Rights and its Classification – Directive Principles of State Policy – Fundamental Duties

UNIT–III: RIGHTS OF MARGINALIZED AND OTHER DISADVANTAGED PEOPLE

Rights of Women – Rights of Children – Rights of Differently Abled – Rights of Elderly - Rights of Scheduled Castes – Rights of Scheduled Tribes – Rights of Minorities – – Rights of Prisoners – Rights of Persons Living with HIVAIDS – Rights of LGBT.

UNIT-IV: HUMAN RIGHTS MOVEMENTS

Peasant Movements (Tebhaga and Telangana) – Scheduled Caste Movements (Mahar and Ad-Dharmi) – Scheduled Tribes Movements (Santhal and Munda) – Environmental Movements (Chipko and Narmada Bachao Andolan) – Social Reform Movements (Vaikom and Self Respect).

UNIT – V: REDRESSAL MECHANISMS

Protection of Human Rights Act, 1993 (Amendment 2019) – Structure and Functions of National and State Human Rights Commissions – National Commission for SCs – National Commission for STs – National Commission for Women – National Commission for Minorities – Characteristics and Objectives of Human Rights Education.

REFERENCE BOOKS

1. Sudarshanam Gankidi, Human Rights in India: Prospective and Retrospective, Rawat Publications, Jaipur, 2019.
2. Satvinder Juss, Human Rights in India, Routledge, New Delhi, 2020.
3. Namita Gupta, Social Justice and Human Rights in India, Rawat Publications, Jaipur, 2021.
4. Mark Frezo, The Sociology of Human Rights, John Willy & Sons, U.K. 2014.
5. Chiranjivi J. Nirmal, Human Rights in India: Historical, Social and Political Perspectives, Oxford University Press, New York, 2000.
6. Dr. S. Mehartaj Begum, Human Rights in India: Issues and perspectives, APH Publishing Corporation, New Delhi, 2010.
7. Asha Kiran, The History of Human Rights, Mangalam Publications, Delhi, 2011.
8. Bani Borgohain, Human Rights, Kanishka Publishers & Distributors, New Delhi-2, 2007.
9. Jayant Chudhary, A Textbook of Human Rights, Wisdom Press, New Delhi, 2011.

		L	T	P	C
22UPEST2C11	**ANALYSIS AND SIMULATION LABORATORY**	0	0	4	2

COURSE OBJECTIVES

- To provide a platform to learn and get familiar with computational analysis
- To learn the simulation and analysis software for solving of flow with heat transfer related problems
- To understand the boundary conditions for various problems
- To obtain information on the solver types in Ansys
- To analyze the fluid flow path and temperature distribution in various thermal applications

LIST OF EXPERIMENTS

1. Analysis of the one-dimensional steady state heat diffusion with and without heat generation in uniformly heated aluminium plate
2. Simulate the two-dimensional steady state heat diffusion in uniformly heated copper plate by applying different boundary condition.
3. Simulation and analysis of laminar flow through a pipe using computational fluid dynamics
4. Simulation and analysis of turbulent flow in a pipe using computational fluid dynamics
5. Computational analysis of mixing of hot and cold fluid through a pipe under steady flow conditions.
6. Two-dimensional computational analysis of steady compressible flow in a Convergent – Divergent nozzle
7. Aerodynamic analysis of two-dimensional steady state incompressible flow over an air foil using CFD
8. Computational analysis of flow over an Ahmed body at specified inlet velocity.
9. Numerical Investigation of 2D air flow over a cylinder using CFD
10. Modeling and analysis of transient heat transfer in Aluminium fins using CFD
11. Numerical simulation and analysis of air flow in an exhaust manifold using CFD.
12. Performance simulation nitrogen gas flow through a porous media in catalytic convertor using CFD
13. Analysis of combined natural convection and radiation heat transfer in a three-dimensional square box on a mesh consisting of hexahedral elements.
14. Simulate and observe fluid flow and heat transfer in the area of the mixing region of elbow.
15. Analysis of discharge behavior of a lithium-ion battery (MSMD Battery Model) using CFD

COURSE OUTCOME

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

CO1	Frame the boundary conditions for various operating conditions/equipments/process	K1-K6
CO2	Analyze the parameters influencing the performance of heat transfer in a solid system.	K1-K6
CO3	Learn modeling and measurement tools to solve flow problems related to different modes of heat transfer.	K1-K6
CO4	Gain knowledge on types of solver styles used in the CFD solution	K1-K6
CO5	Know about the flow direction and the distribution of the temperature in different heat applications	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	H	H	-	H	H	H	M	-	H	-	M	H	H	M	-
2	H	H	M	H	H	H	L	-	H	-	L	M	H	M	H
3	H	H	M	H	H	H	-	M	H	M	L	M	H	H	H
4	H	H	L	H	H	H	-	L	H	L	H	M	H	H	H
5	H	H	L	H	H	H	-	-	H	-	-	M	H	-	H

		L	T	P	C
22UPEST2C12	**BIOFUELS AND BIOENERGY TECHNOLOGIES**	4	0	0	4

COURSE OBJECTIVES

- To detail on the types of biomass, its surplus availability and characteristics.
- To create awareness on the technologies available for conversion of biofuels in terms of its technical competence and economic implications.
- To impart knowledge on production of methanol from various sources
- To elucidate on the influence of thermochemical conversion of biomass
- To provide insight to the possibilities of producing biofuels form waste

UNIT – I: INTRODUCTION TO BIOFUELS AND BIOENERGY

Global Energy Outlook – Sustainability - Biomass Feedstocks - Processes and Technologies - Feedstock Preparation and Pretreatments - Chemical and Biochemical Reaction - Heat Transfer Enhancement and Management - Downstream Processing of Raw or Intermediate Biofuel Products - Energy Integration and Energy Efficiency Enhancement - Product Purification and Separation - Environment and Ecology

UNIT– II: CROP OILS, ALGAE FUEL AND BIODIESEL,

Vegetable Oils - Production and Use of Vegetable Oils - Composition of Vegetable Oils - Use of Vegetable Oil as Alternative Diesel Fuel - Direct Heating - Combined Heat and Power - Algae Oil Extraction of Straight Vegetable Oil - Microalgae and Growth - Algae Harvesting - Algae Oil Extraction - Ultrasonically Assisted Extraction - Single-Step Extraction Process by Origin Oil - Solvent Extraction of Algae Oil. - Supercritical Fluid Extraction of Algae Oil - Background of Biodiesel Manufacture - Transesterification Process for Biodiesel - Properties of Biodiesel

UNIT– III: PRODUCTION OF ETHANOL

Fuel Ethanol from Corn - Corn Ethanol as Oxygenated Fuel -Industrial Significance of Grain Ethanol - Clean Air Act Amendments of 1990 - Net Energy Balance of Corn Ethanol Production - Food versus Fuel - Corn Ethanol Production Technologies - Chemistry of Ethanol Fermentation - Corn-to-Ethanol Process Technology - Lignocellulose and Its Utilization - Lignocellulose Conversion - Enzymatic Hydrolysis - Lignin Conversion

UNIT- IV: PYROLYSIS AND GASIFICATION OF BIOMASS

Biomass and Its Utilization - Renewability and Sustainability of Biomass Feedstock - Woody Biomass and Its Utilization - Thermal and Thermochemical Conversion of Biomass - Similarities and Differences between Biomass and Coal as Feedstock - Pyrolysis or Thermal Decomposition - Partial Oxidation - Steam Gasification - Boudouard Reaction or Carbon Dioxide Gasification Reaction – Hydrogasification –Biosyngas - Tar Formation - Fast Pyrolysis of Biomass - Biomass Gasification Processes

UNIT – V: CONVERSION OF WASTE TO BIOFUELS, BIOPRODUCTS, AND BIOENERGY

Types of Waste and Their Distributions - Waste Preparation and Pretreatment for Conversion - Combustion/Incineration -Grate Incinerators - Rotary Kilns - Fluidized Beds – Gasification – Pyrolysis – Liquefaction -Supercritical Technology - Economic and Environmental Issues Related to Waste Conversion - Future of the Waste Industry

COURSE OUTCOME

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

CO1	Estimate the surplus biomass availability and conversion to bioenergy	K1-K6

CO2	Design a process for extracting biodiesel from vegetable source	K1-K6
CO3	Determine and compare the various ethanol production process	K1-K6
CO4	Analyze the influence of process governing parameters in thermochemical conversion of biomass	K1-K6
CO5	Synthesize of biofuels, bioproducts and bioenergy for power generation from waste biomass	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Biofuels and Bioenergy Processes and Technologies, Sunggyu Lee and Y. T. Shah, CRC Press, 2005
2. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981
3. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester, 1984.
4. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
5. Mahaeswari, R.C. Bio Energy for Rural Energisation, Concepts Publication,1997

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	M	-	-	M	L	H	M	L	-	L	L	M	-	L
2	-	M	H	-	H	M	M	L	-	-	L	L	M	-	L
3	M	H	H	-	H	L	H	M	-	-	L	L	M	-	L
4	-	M	L	-	M	M	M	M	M	-	L	-	M	-	L
5	-	-	-	-	-	M	H	M	M	-	-	-	M	-	-

22UPEST2C13	NANOMATERIAL'S FOR ENERGY STORAGE APPLICATIONS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- To understand the basic concepts of energy systems.
- To Study the fundamental concepts of energy conversion systems.
- To learning the different energy storage methods
- To impart knowledge in different semiconducting materials introduced in batteries
- To gain knowledge in field of electrochemical batteries

UNIT – I: INTRODUCTION TO NANOMATERIALS

Introduction, Emergence of Nanotechnology, Bottom-Up and Top-Down Approaches, Challenges in Nanotechnology. Physical Chemistry of Solid Surfaces - Surface Energy, Chemical Potential as a Function of Surface Curvature, Electrostatic Stabilization, Steric Stabilization. Thermal Properties, Electrical Properties, Mechanical Properties, Optical Properties

UNIT – II: ENERGY CONVERSION SYSTEMS

Issues and Challenges of functional Nanostructured Materials for electrochemical Energy, Conversion Systems, Fuel Cells, Principles and nanomaterials design for; Proton exchange membrane fuel cells (PEMFC); Direct methanol fuel cells (DMFC); Solid-oxide fuel cells (SOFC), Current status and future trends.

UNIT– III: PHOTOVOLTAIC SYSTEMS

Principles of photovoltaic energy conversion (PV), Types of photovoltaic Cells, Physics of photovoltaic cells, Organic photovoltaic cell cells, thin-film Dye-Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Organic-Inorganic Hybrid Bulk Heterojunction (BHJ-SC) Solar cells, Current status and future trends.

UNIT- IV: ENERGY STORAGE SYSTEM - BATTERIES

Issues and Challenges of functional Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium-ion Batteries), Cathode and anode materials, Nanostructured Carbon-based materials, Nano-Oxides, Novel hybrid electrode materials, Current status and future trends.

UNIT – V: ELECTROCHEMICAL CAPACITORS

Capacitor, Electrochemical supercapacitors, electrical double layer model, Principles and materials design, Nanostructured Carbon-based materials, Redox capacitor Nano oxides, conducting polymers-based materials, Current status and future trends.

COURSE OUTCOME

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

CO1	Remember the basic concepts of energy conversion systems	K1-K6
CO2	Appraise the working of fuel cells	K1-K6
CO3	Understand the photovoltaic cells	K1-K6
CO4	Demonstrate the working principles of batteries Synthesize liquid biofuels for power generation from biomass	K1-K6

CO5	Analyze the importance of electrochemical energy storage devices with improved performance using nanoscience	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Nanostructures and nanomaterials, synthesis, properites and applciations, Guozhong Cao,USA, Imperial college Press, (2004).
2. Handbook of Photovoltaic Science and Engineering, Second Edition, Antonio Luque, Steven Hegedus, Wiley publishers, (2011)
3. Linden's Handbook of Batteries, Thomas B. Reddy, David Linden, 4nd Edition, McGraw Hill, (2011).
4. Allen J.Bard and Larry R Electrochemical methods: Fundamentals and Applications, Faulkner, 2ndEdition John Wiley & Sons. Inc, (2004)
5. Fuel Cell Fundamentals, Third Edition, Ryan O'hayre, Suk-Won Cha, Whitney G. Colella, Fritz B. Prinz, Wiley, Canada, (2016).
6. M. Wakihara, O. Yamamoto, (Eds.) Lithium Ion Batteries: Fundamentals and Performance,Wiley –VCH , Weinheim (1998).

CO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	H	M	L	-	L	-	H	M	-	-	-	H	-	-	-
2	H	M	M	-	L	-	H	M	-	-	-	H	M	L	-
3	H	M	H	-	M	M	H	H	-	-	M	H	M	L	-
4	H	M	H	-	M	M	H	H	-	-	M	H	M	L	-
5	M	M	H	-	M	M	H	H	-	-	M	H	M	L	-

22UPEST2C14 ENERGY EFFICIENT BUILDINGS DESIGN

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To know the future building aspects and need for modern living
- To gain knowledge in designing the energy efficient landscape system.
- Developing novel solutions for storage integration in buildings and will evolve passive building strategies.
- Performing building load estimates.
- Explaining the importance of renewable integration in buildings

UNIT – I: INTRODUCTION

Introduction - Building Definition as in the Energy Conservation (amendment) Bill 2010 Energy Conservation Building Code (ECBC) - Compliance Approaches - ECBC Guidelines on Building Envelope - ECBC Guidelines on Electrical Power - Building Water Pumping Systems - Uninterruptible Power Supply - Escalators and Elevators - Building Management System (BMS) - Star Rating of Buildings - Energy Efficiency Measures in Buildings

UNIT – II: LANDSCAPE AND BUILDING ENVELOPES

Energy efficient landscape design – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation, Design methods and tools

UNIT– III: HEATING, VENTILATION AND AIR CONDITIONING

Natural Ventilation, Passive cooling and heating: Thermal mass effects – Application of wind, water and earth for cooling, evaporative cooling, radiant cooling – Hybrid methods – energy conservation measures, thermal storage integration in buildings

UNIT– IV: HEAT RANSMISSION IN BUILDINGS

Surface co-efficient: 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. Thermal load estimation: Heat balance method. Degree day method for seasonal energy consumption.

UNIT – V: BUILDING COOLING AND RENEWABLE ENERGY IN BUILDINGS

Passive cooling concepts, Application of wind, water and earth cooling; shading, paints and cavity walls for cooling; roof radiation traps, Earth air tunnel. Solar sorption cooling and Solar vapour compression cooling for buildings – Solar water heating systems in buildings – Small wind turbines, standalone PV, Hybrid systems for residential buildings with economics

COURSE OUTCOME

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

CO1	Understand the future building aspects and need for modern living.	K1-K6
CO2	Design the energy efficient landscape system	K1-K6
CO3	Develop novel solutions for storage integration in buildings and will evolve passive building Strategies	K1-K6
CO4	Perform building load estimates.	K1-K6
CO5	Explain the importance of renewable integration in buildings	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Duffie, A and Beckmann, W. A., Solar Engineering of Thermal Processes, John Wiley, 1991.
2. Sukhatme, S.P., Solar Energy, Tata McGraw Hill, 2017
3. UrsalaEicker, "Solar Technologies for buildings", Wiley Publications, 2003.3 Guide book for national certification examination for energy managers and energy auditors (downloaded from www.energymanagertraining.com)
4. Michael Bauer, Peter Mosle and Michael Schwarz, Green Building - Guidebook for Sustainable Architecture, 2009.
5. R. Velraj, 'Sensible heat Storage for solar heating and cooling systems' in the book titled "Advances in Solar Heating and Cooling" – Pages 399 - 428 Elsevier Publication, 2016

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	L	M	L	-	-	M	-	-	-	-	-	M	H	-	-
2	L	M	L	L	-	M	-	-	-	-	-	M	H	L	-
3	L	L	M	M	-	M	-	-	-	-	-	M	H	L	-
4	L	L	M	M	-	M	-	-	-	-	-	M	H	L	-
5	H	M	M	M	-	M	-	-	-	-	-	M	H	M	-

22UPEST2C15 **INTERNSHIP**

COURSE OBJECTIVES

The students may undergo internship training at Research organization / University/ industry for a period as specified in the curriculum during summer vacation. In this case, the training has to be undergone continuously for the entire period.

Duration of Internship	Credits
2 Weeks to 4 weeks	2

At the end of internship, the student shall submit a report. A Two-member committee constituted by the Head of the Department will conduct the Viva-Voce Examination. The committee comprises of one expert member from an industry/institutions and One member (Coordinator) from the Department.

INTERNSHIP TRAINING EVALUATION

Report	Presentation		Viva Voce		Total
External	External	Internal	External	Internal	
40	15	15	15	15	100

22UPEST2C16 **PROJECT WORK PHASE I**

L	T	P	C
0	0	10	5

COURSE OBJECTIVES

A research project topic may be selected either from published lists or from the creative ideas of the students themselves in consultation with their project supervisor

EVALUATION

Project work evaluation is based on Regulations of Credit system University Departments Post graduate programs of Periyar University

Project work	Internal (40 Marks)			External (60 marks)			
Phase I	Review I	Review II	Review III	Thesis Evaluation (External)	Viva –voice 45 Marks		
					Supervisor	External	Internal
	10	10	20	15	15	15	15

OUTCOME

The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated in their project work phase – II.

		L	T	P	C
22UPEST2C17	**PROJECT WORK PHASE II**	0	0	28	14

COURSE OBJECTIVES

The objective of the research project work is to produce factual results of their applied research idea in the thermal Engineering, from phase – I.

EVALUATION

Project work evaluation is based on Regulations of Credit system University Departments Post graduate programs of Periyar University

Project work	**Internal (80 Marks)**				**External (120 marks)**			
Phase II	Review I	Review II	Review III	Conference Presentation/ Journal Article/ Book Chapter Publication/Patent	Thesis Evaluation (External)	Viva –voice 90 Marks		
						Supervisor	External	Internal
	20	20	30	10	30	30	30	30

OUTCOME

The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

PROFESSIONAL ELECTIVES

		L	T	P	C
22UPEST2E01	**SOLAR ENERGY TECHNOLOGIES**	4	0	0	4

COURSE OBJECTIVES

- To impart the knowledge on the basics of solar energy and laws related to it.
- To understand the physics of sun, angles and solar time.
- To provide insights of solar thermal collectors and basic solar cycles.
- To study the principle operations, types and applications of solar cells.
- To understand the concepts of various energy storage technologies

UNIT – I: FUNDAMENTALS

The Sun- The Solar Constant - Spectral Distribution and Variation of Extraterrestrial Radiation & Direction of Beam Radiation - Angles for Tracking Surfaces – Shading – Measurement of Solar Radiation - Beam and Diffuse Radiation - Radiation on Sloped Surfaces – Utilizability – Generalized – Daily

UNIT – II: HEAT TRANSFER AND RADIATION CHARACTERISTICS

The Electromagnetic Spectrum - Photon Radiation - The Blackbody - Planck's Law and Wien's Displacement Law - Stefan-Boltzmann Equation - Radiation Intensity and Flux - Radiation Heat Transfer Coefficient -Wind Convection Coefficients - Absorptance and Emittance - Kirchhoff's Law - Calculation of Emittance and Absorptance - Reflection of Radiation - Absorption by Glazing

UNIT– III: SOLAR THERMAL COLLECTORS

Flat-Plate Collectors - Basic Flat-Plate Energy Balance Equation - Temperature Distribution - Collector Overall Heat Loss Coefficient - Collector Heat Removal Factor and Flow Factor - Effects of Dust and Shading - Concentrating Collectors - Collector Configurations - Concentration Ratio - Thermal Performance of Concentrating Collectors - Paraboloidal Concentrators - Central-Receiver Collectors

UNIT- IV: SOLAR PHOTOVOLTAICS

Introduction – description and principle of working – performance characteristics of a solar cell – Problems - types of solar cell – cost – problems – photovoltaic system and applications - photovoltaics thermal collectors

UNIT – V: ENERGY STORAGE

Process Loads and Solar Collector - Energy Storage in Solar Process Systems - Water Storage - Stratification in Storage Tanks - Packed-Bed Storage - Storage Walls- Seasonal Storage - Phase Change Energy Storage - Chemical Energy Storage- Battery Storage

COURSE OUTCOME

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

CO1	Enumerate the basic laws related to the solar radiation.	K1-K6
CO2	Predict the solar time due to the motion of the earth with respect to sun	K1-K6

CO3	Provide accurate diagrams of solar cells and be able to classify solar cells	K1-K6
CO4	Formulate scientific questions about the imaging type concentrating collectors.	K1-K6
CO5	Identify and classify the different energy storage techniques.	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009
2. Sukhatme S.P. J K Nayak, Solar Energy, Tata McGraw Hills P Co., ISBN: 9789352607112, 4th Edition, 2017, pp. 568
3. M. Stix, The Sun, An Introduction, Second Edition, Springer 2002.3
4. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications (2011), 2nd edition, PHI Publications, pp. 512.
5. Joshwa Earnest., Wind Power Technologies, Second Edition, Eastern Economy Edition, 2014

CO	**PO**												**PSO**		
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1	H	H	H	L	L	L	-	-	-	-	-	L	-	L	L
2	H	H	H	M	M	M	L	-	-	-	-	L	-	L	L
3	H	H	H	H	H	M	M	-	-	-	-	L	-	M	M
4	H	H	H	H	H	M	M	-	-	-	-	-	-	H	H
5	M	M	H	H	L	M	M	-	-	-	-	-	-	H	H

22UPEST2E02 **HYDRO POWER SYSTEMS**

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To understand the process of generation of hydropower, its potential & energy extraction.
- To provide knowledge of planning, design and development of hydroelectric power plants
- To understand the aerodynamic principle of turbine blade design.
- To understand the recent developments and technologies in the wind & hydro energy
- To know about the operation and maintenance of civil engineering works

UNIT – I: INTRODUCTION

Overview of Hydropower Systems — Preliminary Investigation — Determination Requirements Preparation of Reports and Estimates — Review of World Resource Cost of Hydroelectric Power — Basic Factors in Economic Analysis of Hydropower Projects — Project Feasibility — Load Prediction and Planned Development.

UNIT – II: DEVELOPMENT OF PROTOTYPE SYSTEMS

Advances in Planning, Design and Construction of Hydroelectric Power Stations — Trends Development of Generating Plant and Machinery — Plant Equipment for Pumped Store Schemes— Some aspects of Management and Operation — Uprating and Refurbishing of turbines.

UNIT– III: POWER STATION OPERATION AND MAINTENANCE

Governing of Water Turbines - Function of Turbine Governor - Condition for Governing stability- Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing Future

UNIT- IV: RESERVOIRS

Problem of Management - Maintenance of Civil Engineering Works - Maintenance of electrical Engineering Works

UNIT – V: INFORMATION TECHNOLOGY IN HYDRO POWER SYSTEMS

Development of Software. Computer Aided Hydropower System Analysis - Design - Execution - Testing - Operation and Control and Monitoring of Hydropower Services

COURSE OUTCOME

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

CO1	Understand the hydrodynamics of open-channel flows.	K1-K6
CO2	Understand the hydraulic design/sizing of the main components of a Hydro power Plant	K1-K6
CO3	Compute steady-state profiles of open-channel flows with variable geometry and discharge.	K1-K6
CO4	Carry out the main hydrological analyses necessary for the design of hydroelectric systems and simulation of their productivity	K1-K6
CO5	Estimate the hydrological alterations induced by the presence of hydroelectric power stations	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Monition, L., M. Lenir and J. Roux, (1984) Micro Hydro Electric Power Station
2. Alen R. Inversin, (1986) Micro Hydro Power Source Book
3. Tyler G. Hicks (1988), Power Plant Evaluation and Design
4. Edwin Panks, Laren & keller, Hydro Power Engineering, Education, 2017

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	H	H	-	L	M	L	H	L	M	-	-	-	M	L	L
2	H	H	-	L	L	L	H	-	-	-	-	-	M	L	L
3	H	M	-	-	L	H	H	-	L	-	M	M	L	L	H
4	H	L	-	L	-	L	H	-	-	-	-	-	M	L	M
5	H	M	-	L	M	L	H	-	M	-	M	M	M	L	H

22UPEST2E03 ELECTRICAL DRIVES AND CONTROLS

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To expose students to the operation, application and control of power conversion systems employing electric drive to cater to industrial needs.
- To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications
- To provide strong foundation to assess performance of different industrial drives
- To Design new control and power conversion schemes
- To justify and implementing alternative solutions considering the critical and contemporary issues

UNIT – I: REVIEW OF CONVENTIONAL MOTOR DRIVES

Characteristics of DC and AC motors for various applications — starting and speed control — methods of breaking

UNIT – II: PHYSICAL PHENOMENA IN ELECTRICAL MACHINES

Various losses in motors - Saturation and Eddy current effects -mmf harmonics and their influenceof leakage - stray losses -vibration and noise.

UNIT– III: INTRODUCTION TO SOLID STATE POWER CONTROLLERS

Power devices - Triggering Circuits - Rectifiers - Choppers. Invertors - AC Controllers

UNIT- IV: SUPERCONDUCTIVITY

Super conducting generators — motors and magnets — Super conducting magnetic energy storage (SMES).

UNIT – V: SOLID STATE MOTOR CONTROLLERS

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

COURSE OUTCOME

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

CO1	Examine various applications in industrial and domestic areas where use of electric drives is essential.	K1-K6
CO2	Classify types of electric drives systems based on nature of loads, control objectives, performance and reliability.	K1-K6
CO3	Combine concepts of previously learnt courses such as, electrical machines, Control and power electronics to cater to the need of automations in industries.	K1-K6
CO4	Select most suitable type and specification of motor drive combination for efficient conversion and control of electric power.	K1-K6
CO5	Identify the critical areas in application levels, and derive typical solutions	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

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2. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication, 2005
3. Electric motor drives, R. Krishnan, Pearson, 2015
4. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education, 2001

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5	L	L	H	H	-	-	-	-	L	L	L	H	M	M	-

22UPEST2E04	ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

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

UNIT – I: INTRODUCTION

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

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

UNIT– III: AIR POLLUTION

Sources – Ambient Air Quality Standards – Emission Limits – Equipment for Ambient Air & Stack Monitoring – Principles of operation of Particulate Control Equipment (ESPs, Bag Filters, Cyclone Separators etc.,) – Vehicular Pollution and its Control

UNIT- IV: SOLID & HAZARDOUS WASTE MANAGEMENT

Types & Sources – Types (Municipal, Biomedical, Industrial, Hazardous etc.,) – Waste Generation – Composition – Physical / Chemical / Biological Properties – Transformation Technologies for Waste Treatment – Landfill Management – Leachate Generation – e Waste Disposal).

UNIT – V: GLOBAL WARMING & CLIMATE CHANGE

Impact of Global Warming / Climate Change on various sectors – Green House Gases & Effect– Carbon Cycle – CDM – Carbon Trading – Carbon Sequestration – Carbon Capture & Storage– UNFCCC – IPCC Protocols

COURSE OUTCOME

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

CO1	Types and effects of each type of pollution on man – earth will be made known.	K1-K6
CO2	Technical aspects of water pollution will make them understand the impact they have on climate	K1-K6
CO3	Technologies that are available for reduction of pollutants dumped into the atmosphere	K1-K6
CO4	Cursory / superficial formation - the students – had in Hazardous waste, waste disposal hitherto will be deep & sensible enough after studying this subject	K1-K6
CO5	Comprehend the different techniques available for safe disposal of hazardous waste	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. C. S. Rao, Environmental Pollution Control Engineering, New Age International Publishers, 2006
2. Peavy, H.S. and D.R. Rowe, G.Tchobanoglous: Environmental Engineering – McGraw Hill Book Company, New York, 1985
3. G. Masters: Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd, New Delhi, 2003
4. Ludwig, H. W.Evans: Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J, 1991
5. Arcadio P Sincero and G. A. Sincero, Environmental Engineering – A Design approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002

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22UPEST2E05 **SMART GRID TECHNOLOGIES**

L	T	P	C
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COURSE OBJECTIVES

- To understand concept of smart grid and developments on smart grid.
- To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
- To have Knowledge on smart substations, feeder automation and application for monitoring and protection.
- To have knowledge on micro grids and distributed energy systems.
- To know power quality aspects in smart grid

UNIT – I: INTRODUCTION TO SMART GRID

Evolution of electric grid- Concept of smart grid - Definitions – Need of smart grid- Functions of smart grid – Opportunities & barrier of smart grid- Difference between conventional & smart grid- Concept of resilient & self-healing grid present development & international policies on smart grid – case study of smart grid.

UNIT – II: SMART GRID TECHNOLOGIES

Introduction to smart meters- Real time prizing – Smart appliances- Automatic meter reading (AMR)- Outage management systems (OMS)- plug in hybrid electric vehicles (PHEV)-Vehicle to grid- Smart sensors- Home & building automation.

UNIT– III: SMART GRID TECHNOLOGIES

Smart Substations – Substation automation – Feeder automation – Intelligent electronic devices (IED) & their application for monitoring protection – Smart storage like battery – SMES- Pumped hydro – Compressed air energy storage – Wide area measurement system (WAMS)- Phasor measurement unit (PMU).

UNIT- IV: MICRO GRIDS AND DISTRIBUTED ENERGY RESOURCES

Concept of micro grid- Need & applications of micro grid- Formation of micro grid- Issues of interconnection – Protection & control of micro grid- Plastic & organic solar cells- Thin film solar cells – Variable speed wind generators- Fuel cells- Micro turbines- Captive power plants- Integration of renewable energy sources

UNIT – V: INFORMATION AND COMMUNICATION TECHNOLOGY FOR SMART GRID

Advanced metering infrastructure (AMI) - Home area network (HAN)- Neighborhood area Network (NAN)-Wide area network (WAN).

COURSE OUTCOME

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

CO1	Understand smart grids and analyze grid policies and development in smart grids.	K1-K6
CO2	Develop concepts of smart grid technologies in hybrid electrical vehicles etc.	K1-K6
CO3	Understand smart substation, feeder automation, GIS etc.	K1-K6
CO4	Analyze micro grids and distributed generation systems.	K1-K6

CO5	Analyze the effect of power quality in smart grid and to understand latest developments in ICT for smart grid	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Sudip Misra, Samaresh Bera Smart Grid Technology: A Cloud Computing and Data Management Approach Cambridge University Press, 2018
2. "Integration of Green and Renewable Enegry in Electric Power Systems", Ali Keyhani, Mohammad N. Marwail, Min Dai Wiley, 2009
3. "The Smart Grid: Enabling Energy Efficiency and Demand Response ", Clark W. Gellings, CRC Press, 2009
4. "Smart Grid: Technology and Applications", JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley, 2012
5. "Smart Grids", Jean Clude Sabonnadiere, Nouredine Hadjsaid, Wiley Blackwell, 2012
6. "Smart Power: Climate Changes the Smart Grid, and the Future of Electric Utilities", Peter S. Fox Penner, Island Press, 2010
7. "Microgrids and Active Distribution Networks." S. Chowdhury, S.P. Chowdhury, P.Crossley , Institution of Engineering and Technology, 2009

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5	H	M	-	L	M	L	H	-	M	-	M	M	M	L	H

22UPEST2E06 **WIND ENERGY CONVERSION SYSTEMS**

L	T	P	C
4	0	0	4

COURSE OBJECTIVE

- To understand the basic of Wind Energy and its measurements
- To understand the aerodynamic characteristics of wind turbine
- To acquire the knowledge to design the wind turbine
- To know the controlling methods and fault detection in Wind turbine
- To know the methods of wind energy storage

UNIT – I: MEASUREMENT AND INSTRUMENTATION

Nature of the Wind - Geographical Variation in the Wind Resource – Turbulence - Gust Wind Speeds - Wind-speed Prediction and Forecasting - Turbulence in Wakes and Wind Farms - Turbulence in Complex Terrain – Instrumentation for Wind Measurements

UNIT – II: WIND TURBINES AND CHARACTERISTICS

HAWT, VAWT– Momentum theory - Power coefficient - The Betz limit - Rotor Blade Theory - Effects of a Discrete Number of Blades - Performance Curves - Stall regulation - Pitch regulation - Aerodynamic Performance Assessment - Yaw control

UNIT– III: DESIGN OF WIND TURBINE

Blade materials and properties – Gearbox, Variable loads during operation - Braking loads – Generator, Induction generators – Variable speed generators - Variable speed using doubly fed induction generator - Yaw Drive – Tower

UNIT- IV: WIND TURBINE CONTROL

Introduction - Wind Turbine Control Systems - Wind Turbine Sensors -Wind Turbine Controllers - Control of Turbine Processes - Grid-connected Turbine Operation - Operating States - Fault Diagnosis - Dynamic Control Theory and Implementation.

UNIT – V: WIND ENERGY STORAGE TECHNOLOGIES

Parameters of an energy storage device - Energy storage technologies, Battery energy storage - Flow battery energy storage - Flywheel energy storage - Supercapacitor energy storage - Hydrogen energy storage system - Load management – Grid Integration of Wind Power

COURSE OUTCOME

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

CO1	Learn wind sources and its measurements	K1-K6
CO2	Gain aerodynamic characteristics of wind turbine	K1-K6
CO3	Design the components of wind turbine	K1-K6
CO4	Analyze Wind Power Control and detect the fault	K1-K6
CO5	Know Wind energy storage methods	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE AND TEXT BOOKS

1. Burton, T et.al, (2011) Wind Energy Handbook, 2nd Edition, John Wiley and Sons
2. Wei Tong (2010) Wind Power Generation and Wind Turbine Design WITPRESS, WITeLibrary, http://library.witpress.com.
3. J. F. Manwell and J. G. McGowan (2009) WIND ENERGY EXPLAINED Theory, Design and Application Second Edition John Wiley & Sons Ltd.,

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5. Joshua earnest (2015) Wind Power Technology, 2nd Edition Earnest Economy Edition

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4	H	M	L	-	-	-	-	-	-	-	-	M	H	M	-
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22UPEST2E07	INSTRUMENTATION FOR ENERGY SYSTEMS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

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

UNIT – I: MEASUREMENT SYSTEM: CHARACTERISTICS AND STATISTICAL ANALYSIS

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

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

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 – Sun photometers

UNIT- IV: MEASUREMENT OF THERMO-PHYSICAL PROPERTIES AND AIR POLLUTANTS

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

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

COURSE OUTCOME

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

CO1	Analyze and evaluate the uncertainties in measurement data.	K1-K6
CO2	Identify appropriate sensors for measuring electrical quantities and signal conditioning circuits.	K1-K6

CO3	Explain the digital measurement techniques of physical quantities.	K1-K6
CO4	Implement the measurement of thermo-physical properties and air pollutants.	K1-K6
CO5	Design and develop the appropriate measurement and control system for an application	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

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2. Bell C., "Beginning Sensor Networks with Arduino and Raspberry Pi", Apress, 2013.
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4	H	-	H	-	-	-	H	-	H	-	-	-	H	H	-
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22UPEST2E08	INDUSTRIAL WASTEWATER, POLLUTION-PREVENTION AND CONTROL	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- To understand the principle of various processes applicable to industrial wastewater treatment
- To impart knowledge on the concept and application of Industrial pollution prevention, cleaner technologies.
- To identify the best applicable technologies for wastewater treatment from the perspective of yield production.
- To impart knowledge on the concept and application of industrial wastewater treatment and residue management

UNIT – I: INTRODUCTION

Industrial scenario in India– industrial activity and environment - uses of water by industry – sources and types of industrial wastewater – nature and origin of pollutants - industrial wastewater and environmental impacts – regulatory requirements for treatment of industrial wastewater – industrial waste survey – industrial wastewater monitoring and sampling - generation rates, characterization and variables – toxicity of industrial effluents and bioassay tests – major issues on water quality management

UNIT – II: INDUSTRIAL POLLUTION PREVENTION & WASTE MINIMISATION

Prevention vis a vis control of industrial pollution – benefits and barriers – waste management Hierarchy - source reduction techniques – periodic waste minimization assessments – evaluation of pollution prevention options – cost benefit analysis – pay-back period – implementing & promoting pollution prevention programs in industries.

UNIT– III: INDUSTRIAL WASTEWATER TREATMENT

Flow and load equalization – solids separation – removal of fats, oil & grease- neutralization removal of inorganic constituents – precipitation, heavy METAL removal, nitrogen & phosphorous removal, Ion exchange, adsorption, membrane filtration, electro dialysis & evaporation – removal of organic constituents – biological treatment processes, chemical oxidation processes, advanced oxidation processes – treatability studies

UNIT- IV: WASTEWATER REUSE AND RESIDUAL MANAGEMENT

Individual and common effluent treatment plants – Joint treatment of industrial and domestic wastewater - zero effluent discharge systems - quality requirements for wastewater reuse industrial reuse , present status and issues - disposal on water and land – residuals of industrial wastewater treatment – quantification and characteristics of sludge – thickening, digestion, conditioning, dewatering and disposal of sludge – management of RO rejects.

UNIT – V: CASE STUDIES

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for textiles – tanneries – pulp and paper – metal finishing – Oil refining–pharmaceuticals–sugar and distilleries

COURSE OUTCOME

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

CO1	Explain the source and types of industrial wastewater and their environmental impacts and choose the regulatory laws pertaining to environmental protection.	K1-K6

CO2	Identify industrial wastewater pollution and implement pollution prevention, waste minimization in industries.	K1-K6
CO3	Apply knowledge and skills to design industrial wastewater treatment schemes.	K1-K6
CO4	Audit and analyze environmental performance of industries to internal, external client, regulatory bodies and design water reuse management technique.	K1-K6
CO5	Conduct research to develop effective management systems for industrial wastewater that are technically sound, economically feasible and socially acceptable.	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

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4	-	L	-	M	-	H	H	H	H	H	M	-	-	H	H
5	H	H	H	H	-	M	H	H	H	H	H	H	H	M	-

22UPEST2E09 **SOLAR ENERGY APPLIANCES**

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To learn the principle behind operation of solar PV cell and its application in lighting system.
- To understand the principle of working of solar cooker with types and its solar applications.
- To learn the need for solar drying and operation of different dryer types.
- To learn about various desalination techniques and factors influencing productivity of solar still with its types.
- To know about solar furnaces and its components

UNIT – I: SOLAR LIGHTING

Solar cell – Working principle of a solar cell – Solar home lighting systems – Solar street lighting systems - Solar lanterns – Applications - Rural electrification process – Case studies

UNIT – II: SOLAR COOKING

Introduction – Types of solar cookers – Advantages and disadvantages - Box type – Parabolic dish cooker - Performance evaluation of solar cookers – Testing of a solar cooker – Applications of solar cooking - Case studies.

UNIT– III: SOLAR DRYING

Introduction – Need for solar drying - Basics of solar drying – Types of solar dryers – Direct type solar dryer – Mixed mode type solar dryer – Forced circulation type dryers – Hybrid dryer – Bin type dryer – Solar timber drying – Applications - Case studies

UNIT- IV: SOLAR DESALINATION

Introduction – Necessity for desalination – Study on various desalination techniques – Comparison between conventional and solar desalination – Basics of solar still - Simple solar still – Material problems in solar still – Solar disinfection and its methods – Case studies on various desalination techniques

UNIT – V: SOLAR FURNACES

Introduction – Types of solar furnaces – Components of solar furnaces – Concentrator – Heliostat – Sun tracking – Typical solar furnace designs – Single concentrator furnace – Single heliostat solar furnace - Multiple heliostats solar furnace - Case studies on solar furnaces

COURSE OUTCOME

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

CO1	Diagnose the fundamental concepts about solar energy systems and devices.	K1-K6
CO2	Will be familiar with concepts of solar home lighting and solar street lighting systems.	K1-K6
CO3	Identify the solar cooker technologies for suitable applications.	K1-K6
CO4	Recognize the applications and types of solar dryers.	K1-K6
CO5	Aware about various desalination techniques and material problems in solar still	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Suhatme and Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, 2008.

2. HP Garg and J Prakash: Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2010.
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22UPEST2E10 **NUCLEAR ENERGY TECHNOLOGY**

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To understand the main aspects of Nuclear Engineering and history of nuclear energy
- Describes the interaction of radiation with matter and nuclear reactions
- To familiarize in nuclear fission and the chain reaction
- Introduction to nuclear reactor theory and heat removal from nuclear reactors
- To impart the knowledge of waste disposal and radiation protection

UNIT – I: BASIC NUCLEAR CONCEPTS

Atomic Structure, Nuclear models, Equivalence of mass and energy, binding energy, Radio activity, half-life, mechanism of nuclear fission and fusion, decay chains, critical mass and composition, neutron reactions

UNIT – II: NUCLEAR FUELS

Nuclear fuel reserves of Uranium and Thorium, Nuclear fuel cycles, characteristics, production and purification, other fuels Zirconium, Beryllium, Reprocessing of nuclear fuels, Thorium

UNIT– III: NUCLEAR REACTORS

Nuclear reactors and classification, boiling water reactors (BWR), pressurized heavy water reactor (PHWR), fast breeder reactor (FBR), basics of nuclear fusion reactor

UNIT- IV: NUCLEAR POWER PLANT -WASTE MANAGEMENT AND SAFETY

Nuclear Power Plant, Nuclear power plant safety systems, Nuclear Accidents- consequences– case study, criteria for safety, Nuclear Waste management, International Convention on safety aspects, radiation hazards and their prevention.

UNIT – V: NUCLEAR RADIATION APPLICATIONS

Radiation processing of food and allied products, applications of radio isotopes in Industry and Agriculture, Industrial radiotracer applications in Ground water exploration, Desalination

COURSE OUTCOME

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

CO1	How nuclear energy is produced today	K1-K6
CO2	The physical principles in which the production of nuclear energy is based how nuclear power systems work	K1-K6
CO3	Basic concepts of radiation and radiation protection	K1-K6
CO4	The basis of nuclear safety, the economic, issues and prospects of nuclear power today.	K1-K6
CO5	Nuclear waste disposal and radiation protection	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. TJ Cannoly, Fundamentals of Nuclear Engineering, John Wiley 2014
2. JR Lamarsh, Introduction to Nuclear Reactor Theory , Prentice-Hal, 2001
3. JG Collier and GF Hewitt, Introduction to Nuclear Power Hemisphere Publishing, New York, 2001
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5	H	H	M	L	H	-	M	M	H	-	-	-	M	M	-

22UPEST2E11	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

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

UNIT – I: INTRODUCTION

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

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

UNIT– III: POWER CONVERTERS

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

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

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

COURSE OUTCOME

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

CO1	Analyze the various conversion techniques in renewable energy technologies.	K1-K6
CO2	Apply the various mechanisms for the conversion of renewable energy sources.	K1-K6
CO3	Identify the appropriate power converters for renewable energy systems.	K1-K6
CO4	Implement the different conversion mechanisms for wind and solar systems.	K1-K6
CO5	Recognize the importance of various hybrid renewable energy systems	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Rashid.M. H “power electronics Hand book”, Academic press, 2007.
2. Leon Freris, David Infield, “Renewable energy in power systems”, John Wiley & Sons, 2008.

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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3	H	H	H	M	H	L	H	-	-	-	-	L	M	L	L
4	L	M	L	L	M	L	M	-	-	-	-	-	M	L	L
5	L	L	L	L	-	L	L	-	-	-	-	-	L	M	L

22UPEST2E12	WASTE MANAGEMENT AND ENERGY RECOVERY TECHNIQUES	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- To provide information on various methods of waste management
- To familiarize students with recent energy generation techniques
- To detail on the recent technologies of waste disposal
- To know about the disposal of hazardous wastes.
- To make student realize on the importance of healthy environment

UNIT – I: CHARACTERISTICS AND PERSPECTIVES

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

UNIT – II: UNIT OPERATIONS & TRANSFORMATION TECHNOLOGIES

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

UNIT– III: WASTE DISPOSAL

Landfill Classification – Types – Siting Considerations – Landfill Gas (Generation, Extraction, Gas Usage Techniques) – Leachates Formation, Movement, Control Techniques – Environmental Quality Monitoring – Layout, Closure & Post Closure Operation – Reclamation

UNIT- IV: TRANSFORMATION TECHNOLOGIES AND VALUE ADDITION

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

UNIT – V: HAZARDOUS WASTE MANAGEMENT & WASTE RECYCLING

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

COURSE OUTCOME

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

CO1	Waste characterization, Segregation, Disposal will be made known	K1-K6
CO2	Technologies that are available for effective waste disposal along with pros / cons will become cleaner to students	K1-K6
CO3	Able to convert waste into useful energy.	K1-K6
CO4	First-hand information on present day waste related problems (Hazardous Waste, Pharma Waste, Biomedical Waste etc).	K1-K6
CO5	Get awareness on the healthy environment	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. P. Jayarama Reddy Municipal Solid Waste Management CRC Press Taylor & Francis Group, 2011
2. Howard S. Peavy et al, Environmental Engineering, McGraw Hill International Edition, 1985

3. La Grega, M., et al., Hazardous Waste Management, McGraw Hill, c. 1200 pp., 2nd ed., 2001.
4. Stanley E. Manahan. Hazardous Waste Chemistry, Toxicology and Treatment, Lewis Publishers, Chelsea, Michigan, 1990
5. Parker, Colin and Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.

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22UPEST2E13	SOLAR REFRIGERATION AND AIR-CONDITIONING	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- To understand the fundamentals of solar air conditioning and refrigeration.
- Acquire the knowledge of psychometrics, cooling and heat load calculations, air distribution systems, duct design, vapor compression and absorption systems
- The course will build upon the fundamentals of thermodynamics
- Introduce elements of basic RAC machinery and its operating principles and design issues
- Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems

UNIT – I: INTRODUCTION

Potential and scope of solar cooling. Types of solar cooling systems, solar collectors and storage systems for solar refrigeration and air-conditioning.

UNIT – II: REFRIGERATION CYCLES

Solar operation of vapor absorption and compression refrigeration cycles and their assessment.

UNIT– III: THERMAL MODELLING

Thermal modelling and computer simulation for continuous and intermittent solar refrigeration and air conditioning systems.

UNIT- IV: SOLAR COOLING SYSTEMS

Solar desiccant cooling systems. Open cycle absorption/ desorption solar cooling alternatives. Advanced solar cooling systems. Refrigerant storage for solar absorption cooling systems

UNIT – V: ECONOMICS

Solar thermoelectric refrigeration and air-conditioning. Solar economics of cooling systems and Control and Monitoring of Hydropower Services.

COURSE OUTCOME

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

CO1	Illustrate the fundamental principles and applications of refrigeration and air conditioning system	K1-K6
CO2	Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems	K1-K6
CO3	Present the properties, applications and environmental issues of different refrigerants	K1-K6
CO4	Calculate cooling load for air conditioning systems used for various	K1-K6
CO5	Operate and analyze the refrigeration and air conditioning systems	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. A course in Refrigeration & Air –conditioning, S.Domakundwar & S.C.Arora, 2006
2. Solar Cooling & Heating Volumes, I, II, III., T.Negat Vezirogulu, 1976
3. Ursula Eicker, Low Energy Cooling for Sustainable Buildings, John Wiley and Sons , 2009
4. Hans-Martin Henning, Solar-assisted air conditioning in buildings: a handbook for planners, Springer , 2007
5. Santamouris, M. Asimakopoulos, D. Passive cooling of buildings, Earthscan, 1996
6. Sayigh, A. A. M., McVeigh, J. C. Solar air conditioning and refrigeration, Pergamon Press, 1992

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22UPEST2E14	PRINCIPLES AND APPLICATIONS OF HYDROGEN STORAGE	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

- To impart knowledge on use of hydrogen for achieving sustainable growth
- To facilitate analysis of the challenges in transition to hydrogen economy
- To understand and demonstrate the hydrogen production technologies, storage methods and strategies for transition to hydrogen economy
- To know the concepts and characteristics of various types of fuel
- To know the application of fuel cells with economic and environment analysis

UNIT – I: INTRODUCTION

History of hydrogen – origin of hydrogen emission – molecular hydrogen – hydrogen in engineering – hydrogen bond – photosynthesis – bio hydrogen.

UNIT – II: THERMODYNAMICS

Gibbs Phase Rule; Pressure-Composition-Temperature plots; Van't Hoff plots for absorption desorption enthalpies; Gravimetric capacities; Hysteresis in cycling; Joule-Thomson Effect, Non- ideal treatment of hydrogen gas.

UNIT– III: HYDROGEN PRODUCTION

Semiconductor catalyst – water splitting and nano technology – steam reforming – partial oxidation – electrolysis – thermolysis

UNIT- IV: DESIGN AND APPLICATIONS OF STORAGE SYSTEMS

Conventional methods of hydrogen storage – solid state; metal organic – Zeolites – carbons – interstitial hydrides – AB5 & AB2 compound

UNIT – V: HYDROGEN FUEL CELL

Hydrogen fuel cell design – proton exchange membrane fuel cells – preparation of nafion membrane - catalyst

COURSE OUTCOME

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

CO1	Evaluate the performance of fuel cells under different operating conditions.	K1-K6
CO2	Select and defend appropriate fuel cell technology for a given application.	K1-K6
CO3	Design and develop suitable hydrogen storage system to be used along with fuel cell system.	K1-K6
CO4	Minimize environmental hazards associated with the use of hydrogen storage and fuel cell	K1-K6
CO5	Understand the applications of fuel cells with economic and environment analysis	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Alexander Gavrilyuk, Hydrogen energy for Beginners, Pan Stanford, publishing Pvt, Ltd, 2014
2. Angelo Basile, Adolfo Iulianelli, Advances in Hydrogen Production, Storage and Distribution, 1st Edition, Woodhead Publishers, Cambridge (UK), 2014.
3. Michael Hirscher, Hand Book of Hydrogen Storage, 1st Edition, Wiley-VCN Verlag GmbH, 2010.
4. Gavin Walker, Solid State Hydrogen Storage: Materials and Chemistry, 1st Edition,Woodhead Publishers, Cambridge (UK), 2008.

5. Rober A. Varin, Tomasz Czujko, Zbigniew S. Wronski, Fuel Cells and Hydrogen Energy Series: Nanomaterials for Solid State Hydrogen storage, 1st Edition, Springer, 2009.
6. Lennie Klebanoff, Hydrogen Storage Technology: Materials and Applications, 1st Edition, CRC Press, 2012.
7. Darren P Broom, Hydrogen Storage Materials: The Characterisation of Their Storage Properties, 1st Edition, Springer, London, 2011.

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22UPEST2E15 ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.
- To Promote First Generation Businessman and Industrialists
- To facilitate strategic decision making among entrepreneurs.
- To Provide Knowledge about Government Plans and Programmes
- To Remove Doubts of Entrepreneurs, Give Solutions and Suggest Remedies of Problems

UNIT – I: ENTREPRENEURSHIP

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT – II: MOTIVATION

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT–III: BUSINESS

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT-IV: FINANCING AND ACCOUNTING

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT – V: SUPPORT TO ENTREPRENEURS

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

COURSE OUTCOME

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

CO1	Gain knowledge and skills needed to run a business successfully.	K1-K6
CO2	Familiarize the students with the latest programs of the government authorities in promoting small and medium industries.	K1-K6
CO3	Imparts essential knowledge of how to start one's own business venture and the various facts that influence successful setting up and operations.	K1-K6
CO4	Realize skills and inspiration for developing an entrepreneurial mindset.	K1-K6
CO5	Have a basic idea of the economics of Entrepreneurship.	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad, 1986.
2. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill, 2013.
3. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2 nd Edition Dream tech, 2005.
4. Rajeev Roy, "Entrepreneurship" 2 Edition, Oxford University Press, 2011.
5. Donald F Kuratko, "Entrepreneurship – Theory, Process and Practice", 9 th Edition, Cengage Learning, 2014.
6. Khanka. S.S., "Entrepreneurial Development" S.Chand& Co. Ltd., Ram Nagar, New Delhi, 2013

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4	-	-	-	-	-	M	L	M	-	L	L	L	-	L	-
5	-	-	-	-	-	M	L	M	-	L	-	L	-	L	-

22UPEST2E16 CLIMATE CHANGE AND MODELLING

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To Explain and evaluate the evidence for human-caused climate change, in the context of historical climate change
- Students will learn the physics behind the climate system, how climate has changed in the past and reasons why contemporary climate change is different, the scientific basis for anthropogenic climate change theory and how scientists use models to predict future climate.
- Provide an overview of the physical, ecological, biological, social and economic impacts of climate change
- Students will examine various mitigation and adaptation strategies which society can employ in a warmer world
- To understand concepts relevant for climate change, drawn from chemistry, physics, and economics, through homework problems

UNIT – I: CLIMATE CHANGE AND CLIMATE VARIABILITY

Introduction- atmosphere - weather and climate - climate parameters (Temperature, Rainfall, Humidity, Wind etc.,) Equations governing the atmosphere - numerical weather prediction models - introduction to GCMs - applications in climate change projections

UNIT – II: IPCC CLIMATE SCENARIOS

Intergovernmental PANEL on Climate Change (IPCC) - an overview - key assumptions – Representative Concentration Pathways (RCP 2.6, 4.5, 6.0, 8.5)

UNIT– III: GLOBAL CLIMATE MODEL AND REGIONAL CLIMATE MODEL

Climate model – types of model- General Circulation Models (GCM) - Issues with GCMs - Introduction to RCMs and LAMs - RCMs modellers -advantages and disadvantages of GCMs and RCMs

UNIT- IV: DOWNSCALING GLOBAL CLIMATE MODEL - AN OVERVIEW

Need for downscaling - selection of GCMs for regional climate change studies - ensemble theory selection of ensembles, model domain (Spatial domain and temporal domain), Resolution and climate variables - lateral boundary conditions - methods of downscaling (Statistical and Dynamical) - examples from each and their limitations.

UNIT – V: ANALYSIS AND POST PROCESSING

Model validation and calibration- evaluating model performance- post processing - introduction to analysis tools - Ferret, R, Grads, IDL, SPSS, ArcGIS - climate change impact – vulnerability assessment-case studies-Adaptation strategies

COURSE OUTCOME

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

CO1	Understand the basics of climate change and variability	K1-K6
CO2	Comprehend the latest IPCC climate scenarios.	K1-K6
CO3	Gain in-depth knowledge on climate models.	K1-K6
CO4	Downscale of climate scenarios through different modelling techniques, and validate climate models.	K1-K6
CO5	Post process the model outputs for climate impact assessment, know about adaptation strategies	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. IPCC Fifth Assessment Report, Cambridge University Press, Cambridge, UK, 2013
2. Neelin David J, "Climate Change and Climate Modelling", Cambridge University Press 2011
3. Kendal McGuffie, Ann Henderson, "A Climate Modelling" Primer 3rd Edition, John Wiley & Sons, Ltd, Chichester, UK 2005
4. Thomas Stocker, "Introduction to Climate Modelling", Advances in Geophysical and Environmental Mechanics and Mathematics. Springer Publication, 2011
5. David Archer, 'Global warming-Understanding the forecast', Blackwell publishing, 2007

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SUPPORTIVE COURSES

		L	T	P	C
22UPESTS01	**RENEWABLE ENERGY**	4	0	0	4

COURSE OBJECTIVES

- To acquire knowledge about the conventional and non-conventional energy sources
- To analyze the working of Solar Thermal and PV systems
- To gain knowledge on Wind energy conversion
- To know the importance and methods of conversion of bio-based waste into useful form of energy.
- To obtain information on the source and utilization of geothermal energy

UNIT – I: ENERGY SOURCES

Environment and sustainable development - Energy sources - sun as the source of energy – photosynthesis - classification of energy sources - fossil fuel reserves and resources - overview of global/ India's energy scenario.

UNIT – II: SOLAR ENERGY

Solar radiation: measurements and prediction - Solar thermal energy conversions systems: flat plate collectors - solar concentrators and other applications - Solar Photovoltaic: Principle of photovoltaic conversion of solar energy.

UNIT–III: WIND ENERGY

Wind Resource: Meteorology of wind, India's wind energy potential and challenges - distribution across the world - Eolian features - Biological indicators - Wind measurement systems - Wind Energy Conversion Systems.

UNIT-IV: BIOENERGY

Biomass as energy resources - Classification and estimation of biomass - Source and characteristics of biofuels – Biodiesel – Bioethanol – Biogas - Waste to energy conversions.

UNIT – V: GEOTHERMAL ENERGY

Introduction - Geothermal sources - advantages and disadvantages of geothermal energy over other energy forms - Geothermal energy in India: Prospects - Applications of Geothermal energy - Material selection for geothermal power plants

COURSE OUTCOME

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

CO1	Awareness and familiarization in the different forms of energy sources	K1-K6
CO2	Able to select the suitable Solar energy source based on the working principle.	K1-K6
CO3	The knowledge about importance of wind energy conservation and the impact on environment	K1-K6
CO4	Understand the concept of conversion of bio-based waste into useful form of energy.	K1-K6
CO5	Awareness on the existence of various mechanisms for conversion using geothermal	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFN Spon Ltd., UK, 2015
2. Godfrey Boyle, "Renewable Energy: Power for a Sustainable Future", Oxford University Press, U.K., 2012.
3. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2012
4. Sukhatme, S.P., Solar Energy, Tata McGraw Hill, 2017
5. Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015

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22UPESTS02	**CLIMATE CHANGE AND CO_2 EMISSION ASSESSMENT**	**L**	**T**	**P**	**C**
		4	0	0	4

COURSE OBJECTIVES

- To study the global climate change
- To analysis emission assessment
- To familiarize about impact of climate changes on the environment.
- To know the carbon dioxide conversion and carbon footprint
- To understand the concept of carbon credit.

UNIT – I: INTRODUCTION TO ENERGY

Introduction to Energy: Overview of energy sources and technologies - energy consumption Pattern - social and economic implications of energy uses - equity and disparity

UNIT – II: INTRODUCTION TO GLOBAL CLIMATE CHANGE

Introduction to global climate change: theory of global climate change - mechanism of Greenhouse Gases Emission - theory and proof of climate change impacts - global overview - International concern on Climate change and mitigation efforts.

UNIT– III: CARBON DIOXIDE (CO2) EMISSIONS AND CONVERSION/CONSUMPTION

Carbon dioxide (CO2) emissions in relation to energy conversion/consumption: theory of CO2 emission in relation to energy conversion processes.

UNIT- IV: METHODOLOGY FOR CO2 ASSESSMENT/CARBON FOOT PRINT

Methodology for CO2 assessment/carbon foot print: estimation of emission from fossil fuel combustion (Fuels and their composition - fuel to energy conversion - concept of emission factor) - emission from major sectors (industry – transport – agriculture – domestic - service)

UNIT – V: CARBON CREDIT

Carbon credit: Definition - concept and examples - Carbon credit - national policies vis-à-vis international market scenario - Current efforts and future prospect/limitation of carbon trading mechanism.

COURSE OUTCOME

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

CO1	Depth knowledge in global climate change and the impact of climate change on the living things.	K1-K6
CO2	Able to analysis emission characteristics and its impact on the globe.	K1-K6
CO3	Obtained elaborate knowledge about impact of climate changes on the environment.	K1-K6
CO4	Knowledge on carbon dioxide conversion and carbon footprint	K1-K6
CO5	Knowledge on concept of carbon credit and their importance	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Franchetti M. J. and Apul D. S., Carbon Footprint Analysis: concepts, methods, implementation and case studies, CRC Press, (2013).
2. Clean Development Mechanism, UNFCC Website; http://cdm.unfccc.int/
3. Stern N.,The Economics of Climate Change. The Stern Review. Cambridge University Press, (2007).

4. Barrett S. Why Cooperate? The Incentive to Supply Global Public Goods. Oxford University Press, (2007).

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3	-	-	L	M	H	M	H	M	-	-	L	-	M	L	-
4	-	-	L	M	M	L	H	M	-	-	L	-	M	L	-
5	-	-	L	M	M	L	H	M	-	-	L	-	M	L	-

22UPESTS03 **ENERGY SCENARIO AND POLICY**

L	T	P	C
4	0	0	4

COURSE OBJECTIVE

- To know the Energy Scenario in India and Global
- To know Indian Energy Conservation Act
- To understand the details on government policies in energy.
- To know the energy efficiency and climate change policies
- To know measures the impact of energy savings on environment

UNIT – I: ENERGY SCENARIO

Introduction - Primary and Secondary Scenario - Final Energy Consumption - India's Energy Scenario - Sector wise Energy Consumption in India - Energy Intensity on Purchasing Power Parity (PPP) - Energy Security

UNIT – II: ENERGY CONSERVATION ACT

Salient Features of the Energy Conservation Act, 2001 - Scheme of BEE under the Energy Conservation Act-2001 - Electricity Act 2003 - National Action Plan on Climatic Change (NAPCC)

UNIT–III: ENERGY POLICY

Global energy issues - National & State level energy issues - National & State energy policy - Industrial energy policy - Energy security - Energy vision - Energy pricing & Impact of global variations - Energy productivity (National & Sector wise productivity).

UNIT-IV: ENERGY EFFICIENCY AND CLIMATE CHANGE

Energy and Environment - Global Environment Issues - Acid Rain - Ozone Layer Depletion - Global Warming and Climate Change - Global Warming and Climatic Change Impacts - United Nations Framework Convention on Climate Change (UNFCCC) - The Intergovernmental Panel on Climate Change (IPCC) - Conference of Parties (COP) - The Kyoto Protocol

UNIT – V: IMPACT OF ENERGY ON ECONOMY AND DEVELOPMENT

Energy for Sustainable Development - Energy and Environmental policies - Need for use of new and renewable energy sources, present status and future of nuclear and renewable energy - Energy Policy Issues related Fossil Fuels, Renewable Energy, Power sector reforms, restructuring of energy supply sector, energy strategy for future.

COURSE OUTCOME

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

CO1	Familiar knowledge in energy scenario globally and locally.	K1-K6
CO2	Gain knowledge on Indian Energy Conservation Act	K1-K6
CO3	Acquire information on government energy policies	K1-K6
CO4	Understand the Energy efficiency and climate change policies.	K1-K6
CO5	Know about the effects of energy demand on environment	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE AND TEXT BOOKS

1. General Aspects of Energy Management and Energy Audit, Fourth Edition, Bureau of Energy Efficiency, New Delhi, India 2015

2. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw- Hill (2017).
3. Loulou, Richard, Waaub, Jean-Philippe; Zaccour, Georges, Energy and Environment Set: Mathematics of Decision Making, (Eds.), (2005), XVIII, 282 p. ISBN: 978-0-387- 25351- 0.
4. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A, Energy and the Environment, 2nd Edition, John Wiley, 2006, ISBN:9780471172482, Pub Wiley, New York, (2006).

CO	**PO**												**PSO**		
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2	M	-	-	H	-	L	H	L	-	L	-	M	M	H	L
3	H	-	M	M	-	M	H	-	-	L	-	M	M	M	L
4	L	-	-	M	-	H	H	H	-	M	-	M	H	M	-
5	L	-	-	L	-	M	H	-	-	M	-	M	H	H	-

		L	T	P	C
22UPESTS04	**ERECTION AND MAINTENANCE OF REFRIGERATION AND AIR- CONDITIONING EQUIPMENT**	4	0	0	4

COURSE OBJECTIVES

- To teach the principal of energy and environmental issues
- To explore the environmental impact of various energy sources and also the effects of different types of pollutants.
- To know the solar energy and conversion technologies.
- To understand the biomass and geothermal energy systems and conversion techniques.
- To get an elaborate knowledge on pollution control methods.

UNIT – I: INTRODUCTION

Refrigeration and air-conditioning plant layout, parameters affecting the location.

UNIT – II: ERECTION OF R&AC SYSTEMS

Erection methodology, foundation, padding, network analysis, critical path, interconnections; safety precautions, air handling equipment's. Maintenance procedures.

UNIT– III: CARBON DIOXIDE (CO2) EMISSIONS AND CONVERSION/CONSUMPTION

Carbon dioxide (CO2) emissions in relation to energy conversion/consumption: theory of CO2 emission in relation to energy conversion processes.

UNIT- IV: TOTAL PREVENTIVE MAINTENANCE

TPM Principles, Corrective and preventive measures and Reliability analysis.

UNIT – V: MAINTENANCE SCHEDULES

Studies on different maintenance schedules followed by various industries

COURSE OUTCOME

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

CO1	Explain the basic concepts of Refrigeration	K1-K6
CO2	Knowledge on erection of various kinds of R & AC systems.	K1-K6
CO3	Able to measure Carbon Dioxide (Co_2) Emissions and conversion	K1-K6
CO4	Explain the concepts of preventive maintenance in Air conditioning	K1-K6
CO5	Good knowledge on maintenance SCHEDULES	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Arora C.P., Refrigeration and Air conditioning II Ed. McGraw-Hill, Pub., (2000).
2. ASHRAE Hand book on Refrigeration & Air conditioning, Published by ISHRAE, Bangalore, (1998).

CO	PO												PSO		
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2	-	-	L	L	M	M	H	M	-	-	M	H	M	L	L
3	-	-	L	L	M	M	H	M	-	-	M	M	M	L	L
4	-	-	L	L	M	M	H	M	-	-	M	M	M	L	L
5	-	-	L	L	M	M	M	M	-	-	M	H	M	M	L

22UPESTS05 **GREEN CONCEPTS IN BUILDING**

L	T	P	C
4	0	0	4

COURSE OBJECTIVES

- To understand and apply the concept of availability and to calculate the behavior of real gases
- To predict the condition of systems and analyze them by the criteria of equilibrium
- To know the building technologies
- To get a knowledge on use of solar energy in green buildings.
- To know the concept of green composites for buildings.

UNIT – I: ENVIRONMENTAL IMPLICATIONS OF BUILDINGS

Environmental implications of buildings energy, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: transportation Energy for Building Materials; Maintenance Energy for Buildings.

UNIT – II: IMPLICATIONS OF BUILDING TECHNOLOGIES

Implications of Building Technologies Embodied Energy of Buildings: Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.

UNIT– III: COMFORTS IN BUILDING

Comforts in Building: Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings- Implications of Geographical Locations.

UNIT- IV: UTILITY OF SOLAR ENERGY IN BUILDINGS

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

UNIT – V: GREEN COMPOSITES FOR BUILDINGS

Green Composites for buildings: Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

COURSE OUTCOME

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

CO1	To calculate the availability of the systems and cycles	K1-K6
CO2	Analyze the engineering systems to improve and optimize its performance	K1-K6
CO3	Elaborate knowledge on the building technologies	K1-K6
CO4	Able to apply solar energy in green buildings.	K1-K6
CO5	Familiar in the concept of green composites for buildings	K1-K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- evaluate and K6- Create

REFERENCE BOOKS

1. Low Energy Cooling for Sustainable Buildings. John Wiley and Sons Ltd, (2009).
2. K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, (2007).

CO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	M	M	L	-	-	L	H	L	-	-	M	L	M	-	M
2	M	M	L	-	-	L	H	L	-	-	M	H	M	-	M
3	M	M	L	-	-	H	H	L	-	-	M	M	M	-	M
4	M	M	L	-	-	L	H	L	-	-	M	H	M	-	M
5	M	M	L	-	-	L	H	L	-	-	M	H	M	-	M

VALUE ADDED COURSE

22UPESTVA01 ALTERNATE FUELS AND EMISSIONS

COURSE OBJECTIVES

- To present a problem oriented in depth knowledge of Alternate fuel and energy system
- To address the underlying concepts and methods behind alternate fuel and energy system
- To know the basics of engine emission standards.

UNIT – I: INTRODUCTION

IC engines classifications (SI & CI engine, 2-stroke & 4-stroke engine), Thermodynamic Cycles Combustion in IC engine: Thermochemistry of Fuel-Air mixture, characterization of flame, Combustion stoichiometry, Chemical equilibrium, Chemical kinetics Properties of fuel and its effect on combustion: Engine knock & detonation, abnormal combustion

UNIT – II: ALTERNATE FUELS, PROPERTIES, SUITABILITY AND EMISSIONS

CNG, LPG, H2, Hythane, Di-Methyl Ether, Ethanol, Biodiesel.

UNIT– III: NOVEL TECHNOLOGIES AND STRATEGIES TO CURB EMISSIONS

Homogeneous charge CI (HCCI) engines, Premixed Charge Compression Ignition (PCCI), Emission control technologies (EGR, SCR, DOC, DPF etc.) (To be updated periodically with new technologies and strategies).

COURSE OUTCOME

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

- The student can identify different areas of alternate fuels and energy system.
- Can find the applications of all the areas in day-to-day life.
- Will understand the emission norms

REFERENCE BOOKS

1. Internal Combustion Engine Fundamentals: J B Heywood, Tata Mc-Graw Hill Publications,2011
2. Internal Combustion Engines: V Ganeshan, Tata Mc-Graw Hill Publications, 2012
3. IC Engines: Combustion and Emissions: BP Pundir, Narosa Publishing House, 2010
4. The Internal combustion Engine in theory and practice: C F Taylor, MIT Press, Cambridge , 1985
5. Alternative Fuels Guidebook, Properties, Storage, Dispensing, and Vehicle Facility Modifications: RL. Bechtold, SAE Publications, 1997

22UPESTVA02 **BIOMASS AND ITS CONVERSION TECHNOLOGIES**

COURSE OBJECTIVES

- Identify potential biomass feedstocks including energy crops;
- Have an understanding of the existing and emerging biomass to energy technologies;
- Develop a critical thinking about sustainability & resilience; and

UNIT – I: INTRODUCTION

Origin of Biomass: Resources: Classification and characteristics; Techniques for biomass assessment; Application of remote sensing in forest assessment; Biomass estimation

UNIT – II: THERMO-CHEMICAL CONVERSION

Direct combustion, incineration, pyrolysis, gasification and liquefaction; Economics of Thermo-chemical conversion. biomass processing, briquetting, palletization, biomass stoves, biomass carbonization, production of syngas from biomass.

UNIT– III: BIOMASS PRODUCTIVITY

Energy plantation and power Programme. Biomass renewable energy program of central govt. and state government Regulations, policies, feed in tariff policies, grid injection, hybrid systems, and cost economics.

COURSE OUTCOME

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

- Acquiring the knowledge of biomass energy.
- Understanding Biomass as a renewable energy and its importance with respect to environment protection
- To design bio-energy systems.

REFERENCE BOOKS

1. Fuel Cells by Bockris and Srinivasan; McGraw Hill, 1969
2. Solar Energy: Fundamentals and Applications by H.P. Garg& Jai Prakash, Tata McGraw Hill, 2000
3. Wind Power Technology, Joshua Earnest, PHI Learning, 2014
4. Non-Conventional Energy Resources by S. Hasan Saeed and D. K. Sharma, S. K. Kataria & Sons, 2019

22UPESTVA03 MATERIALS FOR ENERGY APPLICATIONS

COURSE OBJECTIVES

- To understand the concept of energy materials for energy generation.
- To analyze the material design, related to photovoltaic cell and energy storage
- To acquire information on phase change materials

UNIT – I: INTRODUCTION

Materials Glazing materials, Properties and Characteristics of Materials, Reflection from surfaces, Selective Surfaces: Ideal coating characteristics, Types and applications, Anti-reflective coating, Preparation and characterization. Reflecting Surfaces and transparent materials, Types of Insulation and properties

UNIT – II: MATERIALS FOR PHOTOVOLTAIC'S CONVERSION

Si and Non-Si materials, crystalline, semi-crystalline, Polycrystalline and Amorphous materials, p- n junction: homo and hetero junctions, Metal-semiconductor interface

UNIT– III: PHASE CHANGE MATERIALS

Phase Change Materials Selection criteria of Phase change, Materials use in Solar heating or cooling, Research Status

COURSE OUTCOME

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

- Apply the concept of materials required for energy storage and energy generation.
- Detailed study on properties of various energy-oriented materials for energy applications

REFERENCE BOOKS

1. Solar Thermal Energy Storage by HP Garg, Dordrecht, D. Reidel Publishing Company., 1985
2. Mathematical Modeling of Melting and Freezing process by V Alexiades and AD Solomon, Hemisphere Publishing Corporation, Washington. 1993
3. Chemical and Electrochemical Energy System by R Narayan, B Viswanathan, Universities Press
4. Energy Storage Systems by B Kilkis and S Kakac (Ed), KAP, London

22UPESTVA04 ELECTRIC VEHICLES

COURSE OBJECTIVES

- To present a comprehensive overview of Electric and Hybrid Electric Vehicle
- To know about the sources of energy for electrical vehicles
- To obtain knowledge on storage techniques on electrical vehicles

UNIT – I: INTRODUCTION

The Electric Vehicle Debate, Primary Energy Sources and Alternative Fuels for Transportation, History of electric Vehicles, Electrochemical Power Sources –Secondary Batteries and Fuel Cells

UNIT – II: SOURCES

Aqueous Electrolyte Batteries –Lead Acid, Nickel – Iron, Nickel – Zinc, Metal – Air Zinc – Halogen - Non-Aqueous Electrolyte Batteries- High Temperature Batteries, Organo Electrolyte and Solid-State Batteries

UNIT– III: OVERVIEW OF HYBRID ELECTRIC VEHICLES

Combustion Engine Hybrid Electric Vehicles, Laboratory Test of Electric Vehicle Batteries, Vehicle tests with Electric Vehicle Batteries, Future of Electric Vehicles

COURSE OUTCOME

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

- Choose a suitable drive scheme for developing an electric of hybrid vehicle depending on resources
- Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
- Understanding electric car energy resources
- Experience of electric car storage technology.

REFERENCE BOOKS

1. Hand Book of Batteries and Fuel cells, 3rd Edition, Edited by David Linden and Thomas. B. Reddy, McGraw Hill Book Company, N.Y. 2002.
2. Fuel Cells, Principles and Applications, Viswanathan, B. and Scibioh, Aulice M, Universities Press, 2006.
3. The Essential Hybrid Car Handbook: A Buyer's Guide (Paperback)by Nick Yost, The Lyons Press, N.Y. 2006.

22UPESTVA05 DESIGN THINKING

COURSE OBJECTIVES

- To introduce the idea of design thinking in product development
- To understand the practice of design thinking
- To leverage use of tools for the design process

UNIT – I: INTRODUCTION

Understanding Design thinking – Shared model in team-based design – Theory and practice in Design thinking – Exploring work of Designers across globe – Minimum Viable Products (MVP) or Prototyping

UNIT – II: TOOLS FOR DESIGN THINKING

Real-Time design interaction captures and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design

UNIT– III: DESIGN THINKING IN IT

Design Thinking to Business Process modeling – Agile in Virtual collaboration environment – Scenario based Prototyping

COURSE OUTCOME

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

- Apply design thinking for product development
- Use design thinking tools
- Identify need for products and disruption

REFERENCE BOOKS

1. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
2. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011 (Unit III).
3. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013. (Unit IV).

22UPESTVA06 FIRST AID, FIRE FIGHTING & SAFETY MANAGEMENT

COURSE OBJECTIVES

- Learn about FIRST AID measures
- Learn about accident investigations and preventive measures
- Understand safety, best practices and expectations

UNIT – I: FIRST AID

First Aider and Managing Incidents: First aider - Protection from infection - Dealing with a casualty - Requesting help - The use of medication - Remember your own needs - Action at an emergency – and Electrical incidents.

UNIT – II: INDUSTRIAL SAFETY

Accident History: Fundamentals of Safety, Importance of Safety Policy – Accident Types, Causes, Theories, Accident Prevention Measures.

UNIT– III: FIRE FIGHTING

Causes of Fires: Types of Flammable Materials – Solids – Liquids - Gases & Fire Triangle. Types of Fires: Classifications of Fires – Gas Fires – Liquid Fires – Solid Fire – Electrical Fire – Metal Fire & Kitchen Fire.

COURSE OUTCOME

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

- Students get practical knowledge FIRST AID measures
- Understanding importance of Industrial Safety
- To acquire knowledge about Fire Fighting

REFERENCE BOOKS

1. Fire Safety Management Handbook Third Edition By Daniel E Della Giustina, CRC Press, 2014
2. AIChE/CCPS, Guidelines for Hazard Evaluation Procedures second edition. Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York,1992
3. V.J. Davies and K.Tomasin, Construction Safety Handbook, Amer Society of Civil Engineers,1996

22UPESTVA07 REFRIGERATION AND AIR CONDITIONING

COURSE OBJECTIVES

- Explaining the different types of refrigerant, their properties, and selecting appropriate refrigerant for a HVAC system.Learn about accident investigations and preventive measures
- Explaining different types and components of RAC systems.
- Applying the safety and types of control in HVAC systems.

UNIT – I: INTRODUCTION, REFRIGERANTS AND THEIR ENVIRONMENTAL ISSUE

Applications of air-conditioning and refrigeration, energy usage in air-conditioning/buildings - Designation of refrigerants, Selection of refrigerants, Ozone Depletion Potential (ODP) and Global Warming (GW), Montreal and Kyoto protocols Total Equivalent Warming Index (TEWI), Azeotropic and zeotropic mixtures, alternative to existing CFC and HCFC refrigerants.

UNIT – II: AIR CONDITIONING SYSTEM TYPES AND AIR DISTRIBUTION

Major system types in air-conditioning: unitary, package, central chilled water based systems; components of chilled water system, concept of primary-secondary chilled water pumping; concept of variable flow systems, components of non-chilled water based system, types and role for energy efficiency, comparison of variable refrigerant flow and constant flow systems

UNIT– III: OTHER REFRIGERATION SYSTEMS, CONTROLS AND SAFETY IN RAC

Introduction to Building Management System, major components and use of BMS, instrumentation requirements, concept of Direct Digital Control.

COURSE OUTCOME

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

- Explain the different types of refrigerant, their properties, and select appropriate refrigerant for a HVAC system.
- Explain different types and components of RAC systems.
- Apply the safety and types of control in HVAC systems

REFERENCE BOOKS

1. Arora C P, Refrigeration and Air Conditioning, 3rd Edition, Tata McGraw-Hill, 2017.
2. Stoecker W.F and Jones J.W, Refrigeration and Air Conditioning, 2nd Edition, Tata McGrawHill, 1982.
3. ASHRAE Handbook Series: Fundamentals, Refrigeration, Systems and Equipments and HVAC Applications, 2014-18, ASHRAE Inc, Atlanta, USA

22UPESTVA08 INDUSTRIAL ROBOTICS

COURSE OBJECTIVES

- Explaining the concepts of industrial robots with respect to its classification, specifications and coordinate systems. Reviewing the need and application of robots in different engineering fields
- Exemplifying the different types of robot drive systems as well as robot end effectors.
- Implementing robots in various industrial sectors and interpolating the economic analysis of robots

UNIT – I: FUNDAMENTALS OF ROBOT

Robot - Definition - Robot Anatomy – Co-ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load-Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT – II: SENSORS AND MACHINE VISION

Requirements of a sensor, Principles and Applications of the types of sensors and Digitizing Image Data Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications, Inspection, Identification, Visual Serving and Navigation.

UNIT– III: IMPLEMENTATION AND ROBOT ECONOMIC

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

COURSE OUTCOME

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

- Explain the concepts of industrial robots with respect to its classification, specifications and coordinate systems. Review the need and application of robots in different engineering fields.
- Apply the different sensors and image processing techniques in robotics to improve the ability of robots.
- Implement robots in various industrial sectors and interpolate the economic analysis of robots

REFERENCE BOOKS

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2009.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
3. Koren Y., “Robotics for Engineers", McGraw Hill Book Co., 1992
4. Maja J Mataric, “The Robotics Primer “Universities Press. 2013.
5. Robin R. Murphy “ Introduction to AI Robotics” PHI Learning Private Limited, 2000