PERIYAR MANIAMMAI INSTITUTE OF SCIENCE & TECHNOLOGY

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Criterion 1 – Curricular Aspects

Key Indicator	1.1	Curriculum Design and Development
Metric	1.1.2	Percentage of Programmes where syllabus revision was carried out during academic year 2022-23

DEPARTMENT OF MECHANICAL ENGINEERING

Sl. No.	Programme Code	Programme name	Year of Introduction	Year of revision	Percentage of Syllabus content added or replaced
01.	301	M.Tech –Renewable Energy	2004-05	2022	23.08%

S.No	Contents
1.	Minutes of Board of Studies
2.	Extracts of minutes of the Academic Council Meeting
3.	Curiculum and Syllabus of the programme – Before Revision
4.	Curiculum and Syllabus of the programme – After Revision

Legend : Highlighted Color - Red – Indicates courses which are removed from syllabus before revision

Highlighted Color - Green – Indicates courses which are removed from syllabus after revision

1. a. Minutes of the Board of Studies for M.TECH- Renewable Energy(Full Time) held on 20.07.2022

Annex - 11, 12, 13, 14

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PERIYAR MANIAMMAI

BOARD OF STUDIES MEETING

MINUTES OF MEETING

Date : 20.07.2022 **Time : 10.00 am – 1.30 pm**

Mode : Online / GOOGLE MEET

Google Meet Link: https://meet.google.com/kpt-tjzf-vgv

The Board of Studies meeting was held in virtual mode on 20.07.2022 with the following agenda and minutes of the discussion is given below.

Meeting Agenda:

1. Implementation of actions taken against feedback received on curricular aspects from Stake holders for M.Tech. Renewable Energy Regulation 2022.
2. Presentation of PEOs and POs and discussion on programme articulation matrix (PO coverage by all COs) for M.Tech. Renewable Energy Regulation 2022.
3. Presentation of Curriculum and Syllabi for M.Tech. Renewable Energy Regulation 2022.
4. Presentation of syllabus for a new Open Elective course – Energy Studies – offered under B.Tech. Mechanical Engineering Regulation 2021 for other department students.
5. Presentation of Curriculum and Syllabi for the following two specializations with B.Tech. Mechanical Engineering Regulation 2021
   (a) B.Tech. (Hons.) Mechanical Engineering with Specialization in Robotics and Industrial Automation
   (b) B.Tech. (Hons.) Mechanical Engineering with Specialization in Energy Engineering

Members Present:

S.No.	Name of the Member	Designation	Representation	Signature
1.	Mr. A. Pugazhenthi	Assistant Professor & HOD / Mechanical Engineering.	Chairperson	
2.	Dr. M. Udayakumar	Professor HAG, Department of Mechanical Engineering, National Institute of Technology, Trichy.	External Member (Academic)	
3.	Dr. T. Sriharsha	Deputy Manager, Nanotechnology Research and Development, Bharat Heavy Electricals Limited, Trichy.	External Member (Industry)	

4.	Dr. D. Jeyasimman	Associate Professor / Mechanical Engineering	Member	
5.	Mr. N. Shivakumar	Assistant Professor / Mechanical Engineering	Member	
6.	Mr. S. P. Manikandan	Assistant Professor / Mechanical Engineering	Member	
7.	Mr.P. Srinivasan	Assistant Professor / Mechanical Engineering	Member	
8.	Mr.R. Thiyagarajan	Assistant Professor / Mechanical Engineering	Member	
9.	Mr. R. Udhayasankar	Assistant Professor / Mechanical Engineering	Member	
10.	Mr.V. Pandiaraj	Assistant Professor / Mechanical Engineering	Member	
11.	Mr. J. Senbagaraj (Reg.No – 121012301020)	II Year / M.Tech. Renewable Energy (Regulation: 2021-23)	Student Member	
12.	Mr. K. Pranesh (Reg.No – 1190120151417)	IV Year / B.Tech. Mechanical Engineering (Regulation: 2019-23)	Student Member	
13.	Mr. R. VR. Hariharan (Reg.No – 1190120151406)	IV Year / B.Tech. Mechanical Engineering (Regulation: 2019-23)	Student Member	
14.	Mr. T. Ivon Derek (Reg.No – 121012065557)	III Year / B.Tech. Mechanical Engineering (Regulation: 2020-24)	Student Member	

A. FEEDBACK ON CURRICULAR ASPECTS

The feedback collected and analyzed during 2019-20 and 2020-21 from the following stake holders were presented

1. Teachers
2. ~~Employers~~
3. Alumni students
4. Students

In addition, feedbacks obtained from Academic Expert, Industry Expert, Teachers, Alumni and students who participated in Department Advisory Committee Meeting (**DAC**) were also presented. The action taken for the feedbacks are given as "Remarks" column in the Table II.

B. PRESENTATION OF PEOs and POs

Four PEOs and seven POs for M.Tech. Renewable Energy Programme were presented to the members. The members have approved and recommended following.

Programme Educational Objectives (PEOs)

After three years of graduation, the graduates from M.Tech. Renewable Energy will be able to

1. Demonstrate their knowledge, skills and proficiency in usage of modern tools in analysis and design of renewable energy systems.
2. Involve in innovation, optimization, design and development of present and future renewable energy systems according to international standards as an individual or as a group.
3. Carry out research, pursue higher education and engage in life-long learning in the field of renewable energy.
4. Design and develop renewable energy systems for present and future energy requirements taking into account sustainability and environmental issues.

Programme Outcomes (POs)

A graduate at the end of the programme will be able to

1. *Demonstrate* in depth knowledge in the field of renewable energy with recent information on latest technologies and global trends.
2. *Analyze* complex renewable energy systems and formulate solutions as an individual or group through skills, tools, techniques, methods or literature survey.
3. *Create, select, learn and apply* appropriate techniques, resources, and modern engineering and IT tools to complex renewable energy problems with an understanding of the limitations
4. *Demonstrate* knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
5. *Communicate* with the engineering community and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, give and receive clear instructions.
6. *Recognize* the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
7. *Demonstrate* professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and understand the responsibility to contribute to the community for sustainable development of society.

C. PRESENTATION OF CURRICULUM AND SYLLABUS

All the courses which are framed by the department of Mechanical Engineering are presented individually. The deletion, addition and introduction of new courses related details are tabulated for all courses in the following table.

M.Tech. Renewable Energy

Table IIA: Discussions on courses with actions as remarks

S.No	Semester	Course Code	Course Name	Course content Deletion / Addition / New	Percentage of change	Remarks
1	I	YRE101	Solar Energy Systems	No change	No change	-
2	I	YRE102	Wind, Ocean and Geothermal Energy Systems	Added as new course	100 %	-
3	I	YRE103	Process Modelling and Simulation in Energy Systems	No Change	No Change	-
4	I	YRE104A	Fluid Dynamics and Heat Transfer	No Change	No Change	-
5	I	YRE104B	Energy Conservation in HVAC	No Change	No Change	-
6	I	YRE104C	Fuels and Combustion Technology	No Change	No Change	-
7	I	YRE105A	Environmental Engineering	No Change	No Change	-
8	I	YRE105B	Carbon Sequestration and Trading	No Change	No Change	-
9	I	YRE105C	Waste Management and Energy Recovery	No Change	No Change	-
10	I	YRE106	Solar Energy Laboratory	Added as new course	100 %	-
11	I	YRM107	Research Methodology and IPR	No Change	No Change	-
12	I	YEGOE1	English for Research Paper Writing	No Change	No Change	-
13	I	YRE109	Process Modelling and Simulation Laboratory	Added as new Course.	100 %	-
14	II	YRE201	Bio Energy Systems	No Change	No Change	-
15	II	YRE202	Computational Fluid Dynamics	No Change	No Change	-
16	II	YRE203	Electrical Energy Technology	No Change	No Change	-
17	II	YRE204A	Optimum Utilization of Heat and Power	No Change	No Change	-
18	II	YRE204B	Statistical Tools for Data analysis	No Change	No Change	-
19	II	YRE204C	Sustainable Development	No Change	No Change	-
20	II	YRE204D	Hydro Power Technology	No Change	No Change	
21	II	YRE205A	Instrumentation Technology for Energy Systems	No Change	No Change	-
22	II	YRE205B	Hydrogen, Fuel cells and Nuclear Energy	No Change	No Change	-
23	II	YRE205C	Energy Modelling, Economics and Project Management	No Change	No Change	-
24	II	YRE205D	Energy Efficient Building	No Change	No Change	

25	II	YRE206	Computational Fluid Dynamics Laboratory	Added as new Course.	60 %	-
26	II	YRE207	Bio Energy Laboratory	Added as new Course	60 %	-
27	II	YPSOE1	Constitution of India	No Change	No Change	-
28	III	YRE301	Dissertation Phase – I	No Change	No Change	-
29	III		Open Elective – I	-	-	-
30	III	YRE302A	Energy Audit and Management	No Change	No Change	-
31	III	YRE302B	Unit Operations in Industries	No Change	No Change	-
32	III	YRE302C	CAD/CAM and Simulation of Renewable Energy Systems	No Change	No Change	-
33	III	YRE302D	Industrial Safety	Added as new Course	100%	-
34	IV	YRE401	Dissertation Phase – II	No Change	No Change	-

B.Tech. Mechanical Engineering

Table IIB: Discussions on courses with actions as remarks

S.No	Semester	Course Code	Course Name	Course content Deletion/ Addition/New	Percentage of change	Remarks
1	-	XMEOE4	Energy Studies	Added as new Open Elective Course.	100 %	-

B.Tech. (Hons.) Mechanical Engineering with Specialization in Robotics and Industrial Automation

Table IIC: Discussions on courses with actions as remarks

S.No	Semester	Course Code	Course Name	Course content Deletion/Addition/New	Percentage of change	Remarks
1	III	XECHR1	Service Robotics with Drives and Sensors	Added as New Course.	100 %	-
2	IV	XECHR2	Industrial Robotics and Automation	Added as New Course.	100 %	-
3	V	XECHR3	Fundamentals of ROS and Embedded in Robotics	Added as New Course.	100 %	-
4	V	XECHR4	Artificial Intelligence and Computer Vision for Robotics	Added as New Course.	100 %	-
5	VI	XECHR5	Deep Learning for Robotics	Added as New Course.	100 %	-
5	VII	XECHR6	Mini Project	Added as New Course.	100 %	-

B.Tech. (Hons.) Mechanical Engineering Programme with Specialization in Energy Engineering

Table IID: Discussions on courses with actions as remarks

S.No	Semester	Course Code	Course Name	Course content Deletion/Addition/New	Percentage of change	Remarks
1	III	XMEHE1	Alternative Sources of Energy	Added as New Course.	100 %	#
2	IV	XMEHE2	Solar and Wind Energy Systems	Added as New Course.	100 %	-
3	IV	XMEHE3	Renewable Energy Laboratory – I	Added as New Course.	100 %	-
4	V	XMEHE4	Energy Storage Systems and Sustainable Development	Added as New Course.	100 %	-
5	VI	XMEHE5	Energy Audit, Conservation and Management	Added as New Course.	100 %	-
6	VI	XMEHE6	Renewable Energy Laboratory – II	Added as New Course.	100 %	-
7	VII	XMEHE7	Mini Project	Added as New Course.	100 %	-

The external BOS member Dr. M. Udayakumar has recommended to include topics on liquid bio fuels and the same have been included in the course 'Alternative Sources of Energy'

D. LIST OF NEWLY INTRODUCED COURSES

M.Tech. Renewable Energy

1. Wind, Ocean and Geothermal Energy Systems
2. Solar Energy Laboratory
3. Process Modelling and Simulation Laboratory
4. Computational Fluid Dynamics Laboratory
5. Industrial Safety

B.Tech. Mechanical Engineering

1. Energy Studies

E. LIST OF COURSES REMOVED

Table III : Table of courses removed with remarks

M.Tech. Renewable Energy

S.No	Course Code and Title	Remarks
1	Mini Project	This core course has been removed as Practical Project component is added in all Laboratory courses.
2.	MAT and SCI Lab	This core course has been replaced with a new core course – Process Modelling and Simulation Laboratory – retaining relevant experiments.

F. PERCENTAGE CHANGE IN THE SYLLABUS

M.Tech. Renewable Energy

Number of new core courses added = 4 with 9 credits

Number of core courses removed = 2 with 3 credits

% change = (12/52) x 100 =23.08%

G. NOTES ON BENCHMARKING WITH AICTE MODEL CURRICULUM

It is fond that AICTE has not given any model syllabus for Renewable Energy. The AICTE curriculum related to Post Graduate Programme in Mechanical Engineering (Specialization in Thermal Engineering) was presented in the BoS. The members compared the designed curriculum and discussed the following

a. The credits of the two curriculum are found to be same.
b. The courses which are mandatory and as Open Electives in the AICTE curriculum are present in the designed curriculum.

H. NOTES ON CREDIT DISTRIBUTION AND COMPARISION WITH AICTE GUIDELINES

Table IV: Credit distribution

M.Tech. Renewable Energy

AICTE Course Types	Number of courses		Total credits		
	PMIST Adoption	AICTE Recommendation	PMIST Adoption	AICTE Recommendation	Deviation
Professional Core Courses (PCC)	6	4	18	12	6
Professional Core Courses Lab (PCC-L)	4	4	8	8	0
Professional Elective Course (PEC)	4	4	12	12	0
Open Elective (OE)	1	1	3	3	0
Proj	2	3	26	28	- 2
AICTE Mandatory Course (AICTE – MC)	1	1	2	2	0
AICTE Audit Course (AICTE – Audit)	2	2	0	0	0
Total	22	21	72	68	4

I. COURSES ON EMPLOYABILITY/ENTREPRENEURSHIP/SKILL DEVELOPMENT

The curriculum for M.Tech. Renewable Energy Programme focus of including **97.06 %** of courses with either/and employability/entrepreneurship/skill development. The courses are given below.

Table V Categorization of courses

M.Tech. Renewable Energy

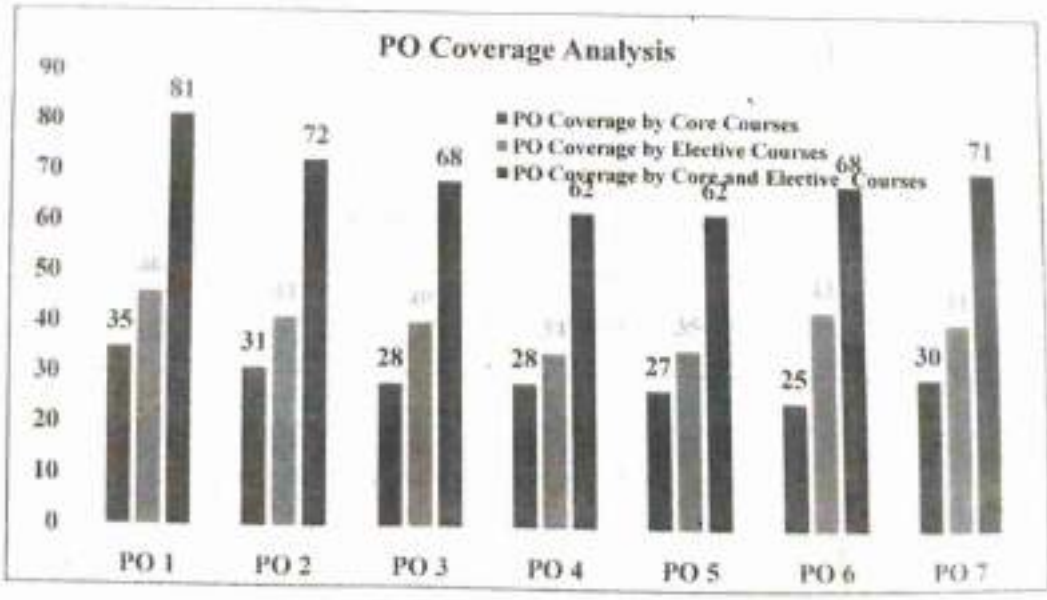
S. No	Course Code	Course Name	Category
1	YRE101	Solar Energy Systems	Employability
2	YRE102	Wind, Ocean and Geothermal Energy Systems	Employability
3	YRE103	Process Modelling and Simulation in Energy Systems	Employability
4	YRE104A	Fluid Dynamics and Heat Transfer	Employability / Entrepreneurship / Skill Development
5	YRE104B	Energy Conservation in HVAC	Employability / Entrepreneurship / Skill Development
6	YRE104C	Fuels and Combustion Technology	Employability / Entrepreneurship / Skill Development
7	YRE105A	Environmental Engineering	Employability / Entrepreneurship / Skill Development
8	YRE105B	Carbon Sequestration and Trading	Employability / Entrepreneurship / Skill Development
9	YRE105C	Waste Management and Energy Recovery	Employability / Entrepreneurship / Skill Development
10	YRE106	Solar Energy Laboratory	Skill Development
11	YRM107	Research Methodology and IPR	Entrepreneurship / Skill Development
12	YEGOE1	English for Research Paper Writing	Entrepreneurship / Skill Development
13	YRE109	Process Modelling and Simulation Laboratory	Skill Development
14	YRE201	Bio Energy Systems	Employability
15	YRE202	Computational Fluid Dynamics	Employability
16	YRE203	Electrical Energy Technology	Employability
17	YRE204A	Optimum Utilization of Heat and Power	Employability / Entrepreneurship / Skill Development
18	YRE204B	Statistical Tools for Data analysis	Employability / Entrepreneurship / Skill Development
19	YRE204C	Sustainable Development	Employability / Entrepreneurship / Skill Development
20	YRE204D	Hydro Power Technology	Employability / Entrepreneurship / Skill Development
21	YRE205A	Instrumentation Technology for Energy Systems	Employability / Entrepreneurship / Skill Development
22	YRE205B	Hydrogen, Fuel cells and Nuclear Energy	Employability / Entrepreneurship / Skill Development
23	YRE205C	Energy Modelling, Economics and Project Management	Employability / Entrepreneurship / Skill Development

24	YRE205D	Energy Efficient Building	Employability / Entrepreneurship / Skill Development
25	YRE206	Computational Fluid Dynamics Laboratory	Skill Development
26	YRE207	Bio Energy Laboratory	Skill Development
27	YPSOE1	Constitution of India	Employability
28	YRE301	Dissertation Phase – II	Employability / Entrepreneurship / Skill Development
29		Open Elective – I	----
30	YRE302A	Energy Audit and Management	Employability / Entrepreneurship / Skill Development
31	YRE302B	Unit Operations in Industries	Employability / Entrepreneurship / Skill Development
32	YRE302C	CAD/CAM and Simulation of Renewable Energy Systems	Employability / Entrepreneurship / Skill Development
33	YRE302D	Industrial Safety	Employability / Entrepreneurship / Skill Development
34	YRE401	Dissertation Phase – II	Employability / Entrepreneurship / Skill Development

J. DISCUSSION ON PROGRAMME ARTICULATION MATRIX (PO COVERAGE BY ALL COs)

M.Tech. Renewable Energy

It is found that the curriculum covers all POs with small deviations. The members agreed that there need not be any changes in the POs.



The BOS members recommended to submit the outcome of this meeting in the forthcoming 40th Academic council meeting for approval.

HoD/Mechanical Engineering
(A. PUGAZHENTHI)

Dean (FET)
(Dr. S. SENTHAMIL KUMAR)

Dean (Academic)
(Dr. A. GEORGE)

2. a. Extracts of the Minutes of 40th ACM Meeting for B.Tech & M.Tech held on 27.08.2022

B.TECH MECHANICAL ENGINEERING –FULL TIME AND PART TIME

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PERIYAR MANIAMMAI

MINUTES OF FORTIETH MEETING OF THE ACADEMIC COUNCIL

Date : 27.08.2022 Venue: Richard Dawkins Hall
Time : 10.30 A.M Place : PMIST, Vallam – Thanjavur

The Fortieth Meeting of the Academic Council of the Periyar Maniammai Institute of Science & Technology (PMIST), Vallam, Thanjavur held on 27.08.2022 at 10.30 a.m. Prof.S.Velusami, Hon'ble Vice-Chancellor, chaired the meeting.

The following Academic Council Members were present.

1.	Dr.D.Aarthi Saravanan	Member
2.	Dr.A.Anand Jerard Sebastine	Member
3.	Dr.S.Arumugam	Member
4.	Dr.P.Aruna	Member
5.	Dr.S.Asokan	Member
6.	Dr.S.Buvaneswari	Member
7.	Dr.A.George	Member
8.	Dr.S.Gomathi	Member
9.	Dr.P.Guru	Member
10.	Dr.V.Hamsadhwani	Member
11.	Dr.R.Jayanthi	Member
12.	Dr.N.Jayanthi	Member
13.	Dr.J.Jeyashidra	Member
14.	Mr.I.Karthic Subramaniayan	Member
15.	Dr.T.Kavitha	Member
16.	Dr.K.Kesavan	Member
17.	Dr.R.Krishnamurthi	Member
18.	Dr.S.P.Kuiamthaivel Babu	Member

1

Sl. No.	Programme	Duration	Intake
4	B.Tech.-Civil Engineering B.Tech. (Hons.) – Civil Engineering with specialization in *GIS and Remote Sensing*	4 Years	60
5	B.Tech.-Computer Science and Engineering B.Tech. (Hons.) – CSE with specialization in *AI and ML* B.Tech. (Hons.) – CSE with specialization in *Data Science*	4 Years	120
6	B.Tech.-Electrical and Electronics Engineering B.Tech. (Hons.) – EEE with specialization in *Electric Vehicles* B.Tech. (Hons.) – EEE with specialization in *Energy Engineering*	4 Years	60
7	B.Tech.-Electronics and Communication Engineering B.Tech. (Hons.) – ECE with specialization in *AI and ML* B.Tech. (Hons.) – ECE with specialization in *Robotics and Industrial Automation*	4 Years	60
8	B.Tech.-Mechanical Engineering B.Tech. (Hons.) – Mechanical Engineering with specialization in *Robotics and Industrial Automation* B.Tech. (Hons.) – Mechanical Engineering with specialization in *Energy Engineering*	4 Years	60
9	B.C.A.	3 Years	180
10	B.Sc - Data Science	3 Years	60
11	B.Sc - Computer Science	3 Years	120
12	B.Sc - Animation & Multimedia	3 Years	30
13	B.Sc - Artificial Intelligence	3 Years	30
14	B.Sc - Mathematics	3 Years	30
15	B.Sc - Physics	3 Years	60
16	B.Sc - Chemistry	3 Years	60
17	B.Com.	3 Years	120
18	B.Com. (Hons.)	3 Years	60
19	B.Com - Corporate Secretaryship	3 Years	60
20	B.Com - Computer Applications	3 Years	60
21	B.B.A.	3 Years	60
22	B.B.A - Hospitality Management	3 Years	30
23	B.B.A - Logistics and Supply Chain Management	3 Years	30
24	B.A. - English	3 Years	30
25	B.A. - Tamil	3 Years	30
26	B.A. - Journalism and Mass Communication	3 Years	30
27	B.Sc. B.Ed. (4 Years Integrated) - stream: Mathematics, Physics & Chemistry	4 Years	60
28	B.Ed.	2 Years	100

6

Dean Academic 40.2.5

TO INFORM AND RECORD the closure of the following UG & PG Programmes from the academic year 2022-23.

Notes:

Due to few enquiries and less intake, it is proposed to close the following programmes from the academic year 2022-23.

Closures:

1. B.Tech.-Civil Engineering (Part-Time)
2. B.Tech.-Electrical and Electronics Engineering (Part-Time)
3. B.Tech.-Mechanical Engineering (Part-Time)
4. M.Tech.- Environmental Engineering (Part-Time)
5. M.Tech.- Nano Technology (Part-Time)
6. M.Tech.- Renewable Energy (Part-Time)
7. M.Tech.- Wireless Communications (Part-Time)
8. M.Tech.- Power Electronics and Drives (Part-Time)

The matter is placed before the Academic Council for information and record.

Resolution

RESOLVED TO TAKE INTO RECORD the closure of the above mentioned UG & PG Programmes from the academic year 2022-23.

Dean Academic 40.2.6

TO INFORM AND RECORD reducing the number of intake for the following PG Programmes from the academic year 2022-23 onwards.

Notes:

Based on the guidelines given in the AICTE hand book of approval process 2022-23, and less intakes in the previous years; it is proposed to reduce the intake in the following PG Programmes from the academic year 2022-23 onwards:

1. M.Tech.- Environmental Engineering – from 20 to 18
2. M.Tech.- Nano Technology – from 20 to 18
3. M.Tech.- Renewable Energy – from 20 to 18
4. M.Tech.- Wireless Communications – from 20 to 18

The matter is placed before the Academic Council for information and record.

Resolution

RESOLVED TO RECORD reducing the number of intake for the above mentioned PG Programmes from the academic year 2022-23 onwards.

Resolution

RESOLVED TO APPROVE the Curriculum and Syllabi for M.Tech. - Power Electronics and Drives under Full-Time (Regulation 2022).

DEPARTMENT OF MECHANICAL ENGINEERING

FET B.Tech.-Mech 40.3.9 **TO CONSIDER AND APPROVE** the curriculum and syllabi for B.Tech. (Hons).- Mechanical Engineering with specialization in a) Robotics and Industrial Automation (b) Energy Engineering (Regulation 2021, Revision 1: Full time mode). The courses pertaining to the specialization and their credits (In addition to the courses in B.Tech–Mechanical Engineering curriculum and syllabi, Regulation 2021) are given below:

a). Robotics and Industrial Automation

Course Code	Semester	Course Title	L	T	P	C	H
XECHR1	III	Service Robotics with Drives and Sensors	1	0	2	3	5
XECHR2	IV	Industrial Robotics and Automation	1	0	2	3	5
XECHR3	V	Fundamentals of ROS and Embedded in Robotics	1	0	2	3	5
XECHR4	V	Artificial Intelligence and Computer Vision for Robotics	1	0	2	3	5
XECHR5	VI	Deep Learning for Robotics	1	0	2	3	5
XECHR6	VII	Mini Project	0	0	5	5	10
		Total	5	0	10	20	35

b). Energy Engineering

Course Code	Semester	Course Title	L	T	P	C	H
XMEHE1	III	Alternative Sources of Energy	3	0	0	3	3
XMEHE2	IV	Solar and Wind Energy Systems	3	1	0	4	4
XMEHE3	IV	Renewable Energy Laboratory – I	0	0	1	1	2
XMEHE4	V	Energy Storage Systems and Sustainable Development	3	0	0	3	3
XMEHE5	VI	Energy Audit, Conservation and Management	3	0	0	3	3
XMEHE6	VI	Renewable Energy Laboratory – II	0	0	1	1	2
XMEHE7	VII	Mini Project	0	0	5	5	10
		Total	12	1	7	20	29

The complete Curriculum and Syllabi are given in Annexure.

Notes:

In the 39th Academic Council Meeting, the specialization considered was "Robotics". But, as per the recommendations of the Board of Studies the specialization "Robotics and Industrial Automation" is offered.

The matter is placed before the Academic Council for approval.

Resolution

RESOLVED TO APPROVE the Curriculum and Syllabi for B.Tech. (Hons).- Mechanical Engineering with specialization in a) Robotics and Industrial Automation (b) Energy Engineering (Regulation 2021, Revision 1: Full time mode). The courses pertaining to the specialization and their credits (In addition to the courses in B.Tech–Mechanical Engineering curriculum and syllabi, Regulation 2021).

FET Mech 40.3.10

TO CONSIDER AND APPROVE the introduction of new Open Elective course offered by the Department of Mechanical Engineering for other department students.

Course Code	Course Title	L	T	P	C	H
XMEOE04	Energy Studies	3	0	0	3	3

Notes:

The Board of Studies of Department of Mechanical Engineering recommended the Open Elective course and its syllabus.

The matter is placed before the Academic Council for approval.

Resolution

RESOLVED TO APPROVE the introduction of new Open Elective course offered by the Department of Mechanical Engineering for other department students.

FET M.Tech.-RE 40.3.11

TO CONSIDER AND APPROVE the Programme Educational Objectives (PEO) and Programme Outcomes (PO) for M.Tech Renewable Energy programme.

M.TECH – RENEWABLE ENERGY – FULL TIME AND PART TIME

Notes:

The faculty of the department along with the guidance of External academic experts framed PEOs and POs. The changes given by the stakeholders are considered and they are reflected in the COs as well. The PEOs and POs are given along with the Curriculum and Syllabi in Annexure.

The matter is placed before the Academic Council for approval.

Resolution

RESOLVED TO APPROVE the Programme Educational Objectives (PEO) and Programme Outcomes (PO) for M.Tech Renewable Energy programme.

FET M.Tech.-RE 40.3.12

TO CONSIDER AND APPROVE the Curriculum and Syllabi for M.Tech. Renewable Energy under Full Time (Regulation 2022).

Notes:

The Board of Studies of the M.Tech. Renewable Energy under Department of Mechanical Engineering recommended the Curriculum from I to IV Semesters and Syllabi from I to IV Semesters for M.Tech. Renewable Energy (Regulation 2022). The Curriculum is in line with AICTE guidelines 2018 with 23.08% revision from previous syllabus. The syllabus revision is based on feedback on curricular aspects from stakeholders. The syllabus contains 97.06% courses having focus on employability / entrepreneurship / skill development.

New Courses offered by the department under Regulation 2022:

1. Wind, Ocean and Geothermal Energy Systems
2. Solar Energy Laboratory
3. Process Modelling and Simulation Laboratory
4. Computational Fluid Dynamics Laboratory
5. Industrial Safety

Open elective offered by the department under Regulation 2022:

1. Industrial Safety

23

The matter is placed before the Academic Council for approval.

Resolution

RESOLVED TO APPROVE the Curriculum and Syllabi for M.Tech. Renewable Energy under Full Time (Regulation 2022) and the open elective "Industrial Safety" offered by the department under Regulation 2022.

3. a. Curicullum and Syllabus of the M.Tech FT programme – Before Revision

CURRICULUM AND SYLLABUS – FULL TIME

REGULATIONS – 2019

(Applicable to the students admitted from the Academic year 2019-20)

SEMESTER I

Code No.	Course Title	L	T	P	C	HRS
YRE101	Solar Energy Systems	3	0	0	3	3
YRE102	Wind energy, Tidal energy and OTEC	3	0	0	3	3
YRE103	Process Modelling and Simulation in Energy Systems	3	0	0	3	3
YRE104***	Elective – I	3	0	0	3	3
YRE105***	Elective – II	3	0	0	3	3
YRE106	Solar Energy Lab	0	0	1	1	2
YRM107*- (MC)	Research Methodology and IPR	2	0	0	0	2
YEGOE1**- (MC-Audit)	Audit courses (Student's Choice)- English for Research Paper Writing	2	0	0	0	2
YRE109	MAT and SCI Lab	0	0	1	1	2
Total		**19**	**0**	**2**	**17**	**23**

SEMESTER II

Code No.	Course Title	L	T	P	C	HRS
YRE201	Bio Energy Systems	3	0	0	3	3
YRE202	Computational Fluid Dynamics	3	0	0	3	3
YRE203	Electrical Energy Technology	3	0	0	3	3
YRE204***	Elective – III	3	0	0	3	3
YRE205***	Elective – IV	3	0	0	3	3
YRE206	Bio Energy and CFD Lab	0	0	1	1	2
YRE207	Mini Project	0	0	2	2	4
YPSOE1** (MC-Audit)	Audit courses (Student's Choice)- Constitution of India	2	0	0	0	2
Total		**17**	**0**	**3**	**18**	**23**

SEMESTER III

Code No.	Course Title	L	T	P	C	HRS
YRE301	Project Phase – I	0	0	10	10	20
YRE302***	Elective - V	3	0	0	3	3
YREOE****	Open Elective Course(Student's Choice)	3	0	0	3	3
Total		**6**	**0**	**10**	**16**	**26**

SEMESTER IV

Code No.	Course Title	L	T	P	C	HRS
YRE401	Project Phase – II	0	0	16	16	32
Total		**0**	**0**	**16**	**16**	**32**

Total Credits - 67

* - Mandatory Course
**- Mandatory Course - Audit
***- Elective Course
****- Open Elective Course

Mandatory Courses – Audit (**)

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

LIST OF ELECTIVES (***)

ELECTIVE GROUP - I:

Code No.	Course Title	L	T	P	C	HRS
YRE104A	Fluid Dynamics and Heat Transfer	3	0	0	3	3
YRE104B	Energy Conservation in HVAC	3	0	0	3	3
YRE104C	Fuels and Combustion Technology	3	0	0	3	3

ELECTIVE GROUP - II:

Code No.	Course Title	L	T	P	C	HRS
YRE105A	Environmental Engineering	3	0	0	3	3
YRE105B	Carbon Sequestration And Trading	3	0	0	3	3
YRE105C	Waste Management and Energy Recovery	3	0	0	3	3

ELECTIVE GROUP - III:

Code No.	Course Title	L	T	P	C	HRS
YRE204A	Optimum Utilization of Heat and Power	3	0	0	3	3
YRE204B	Statistical Tools for a Data analysis	3	0	0	3	3
YRE204C	Sustainable Development	3	0	0	3	3

ELECTIVE GROUP - IV:

Code No.	Course Title	L	T	P	C	HRS
YRE205A	Instrumentation Technology for Energy Systems	3	0	0	3	3
YRE205B	Hydrogen and Nuclear energy	3	0	0	3	3
YRE205C	Energy Modeling, Economics and Project Management	3	0	0	3	3

ELECTIVE GROUP - V:

Code No.	Course Title	L	T	P	C	HRS
YRE302A	Energy Audit and Management	3	0	0	3	3
YRE302B	Unit Operations in Industries	3	0	0	3	3
YRE302C	CAD/CAM and Simulation of Renewable Energy Systems	3	0	0	3	3

LIST OF OPEN ELECTIVE COURSES (****)

Code No.	Course Title	L	T	P	C	HRS
YREOE1	Hydro Power Technology	3	0	0	3	3
YREOE2	Energy Efficient Building	3	0	0	3	3

Note:

1. The credit distribution is followed as per the guidelines given by AICTE/UGC.

Course type	Credits				Contact Hours			
	L	T	P	Total	L	T	P	Total
Lecture course	3	0	0	3	3	0	0	3
Lecture + Practical course	3	0	1	4	3	0	2	5
Lecture + Tutorial course	3	1	0	4	3	2	0	5
	2	1	0	3	2	2	0	4
Lecture + Tutorial + Practical course	3	1	1	5	3	2	2	7

YRE101- SOLAR ENERGY SYSTEMS 3 0 0 3
(Use of approved data book permitted in the examination)

UNIT - I SOLAR RADIATION 9

Source of radiation – Sun earth relationship- extra terrestrial radiation.– Atmospheric attenuation – terrestrial radiation-radiation on a horizontal surfaces and inclined planes-relations between horizontal radiation and inclined surfaces – relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation- pyroheliometer, pyranometer, pyrogeometer, net pyradiometer-sunshine recorder – an overview of solar radiation data in India.

UNIT – II SOLAR COLLECTORS – FLAT PLATE COLLECTORS 9

Design considerations – classification- Flat plate collectors- air heating collectors liquid heating – Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors-for efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors. Solar green house. Solar tracking. solar kilns

UNIT- III CONCENTRIC SOLAR COLLECTORS AND THERMAL APPLICATION 9
Concentric collectors-Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats. Solar powered absorption A/C system (Ammonia/water) solar water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker.

UNIT – IV SIMULATION AND ENERGY STORAGE 9
Simulation in Solar Process Design- TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change- Glauber's salt-organic compounds -solar ponds.

UNIT- V SOLAR PV SYSTEM 9

Photovoltaic cell – characteristics -maximum power- tracking-cell arrays-power electric circuits for output of solar panels--inverters-batteries-charge regulators, Construction concepts. Latest trends in PV systems, Life cycle analysis of solar energy system time value of money, evaluation of carbon credit of solar energy system.
A compulsory seminar / assignment on design / case study/analysis /application in any one of the solar thermal energy system

L:45; T:15; Total:60

TEXT BOOKS:

1. DuffieJ.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley& Sons Inc., Newyork, 1991
2. G.N. Tiwari."Solar Energy ; Fundamentals ,design,modelilg and applications " Third RePrint , Narosa Publishing House, New Delhi,2006

REFERENCES:

1. Edward E.Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pubCO.,1983.
2. Fank Kreith,,Jan F.Kreider,:Principles of solar Engg", 1978.
3. Koushika M.D," Solar Energy Principles and Applications", IBT publications and distributors, 1988.
4. Kaushik S.C, Tiwari G.N and Nayak J.K, "Thermal control in passive solar buildings" .IBT Publishers & Distributors, 1988.

YRE 102 - WIND ENERGY, TIDAL ENERGY AND OTEC 3 0 0 3

UNIT - I MEASUREMENT TECHNIQUES 12
(Use of approved data book permitted in the examination)

Introduction-measurement and instrumentation-Beau fort number Guest parameters-wind type-power law index betz constant Terrain value.Wind speed characterization-site survey and site analysis - Energy in wind-Highest, lowest wind speeds-wind speed for return periods-study of wind applicable Indian standards-steel Tables, Structrual Engineering.

UNIT - II WINDMILL AND WIND TURBINE 10

Wind mill characteristics – types of wind mills- performance analysis -Merits and limitation-variables in wind energy conversion system-wind power density-power in a wind stream-wind turbine efficiency-power of a wind turbine for given in-coming wind velocity - forces on the blades of a propeller-examples of wind farm site-mean wind velocity-wind velocity duration curve-energy pattern factor-wind power duration characteristics - Tip speed ratios - Solidity curves.
Terms-study of all types of turbines (HAWT, VAWT)-typical large capacity wind turbines-sizing-tower design-power duration curves-wind rows diagrams –study of characteristics-actuator theory – analysis of Hourly, daily, monthly, annual, wind behavior-control and instrumentations. syncln & power stabilization synchronization & power stabilization.

UNIT - III POWER GENERATION AND HYBRIDISATION 10

Types of wind energy system-alternators -Grid-combination of diesel generator, Battery storage-wind turbine circuits-wind map of India-Wind farm-indefinitely developed wind turbine-study of various wind turbines manufactured indigenously - kilowatt rating-retrofits-R&M-OP & FC-speed limitation-fatigue stress.

UNIT - IV WAVE AND TIDAL ENERGY 7

Wave energy -Tidal changes – Ecological changes – Types Tidal Power – Energy from Sea – Tidal Turbines – Tidal Power Generation – Recent Trends and Developments – Problems and solutions – Case Studies.

UNIT - V OTEC 6

The concepts- construction and operational problems – history of OTEC development Alternative energy technology – Ocean thermal energy conversion – Techniques – Problems and solutions – Case Studies-ecological and environmental aspects.

A compulsory seminar / assignment on design / case study/analysis /application in any one of the Wid energy,Tidal and OTEC

L:45; Total:45

TEXT BOOKS:

1. E.L Wakil ”Power plant technology”, McGrawGill Publishers,New York
2. G. D Rai “Non Conventional Energy sources” Khanna publishers. New Delhi

REFERENCES:

1. S.Rao & B.B.Parulekar,”Energy Technology”, 3rd edition,Khanna publishers,1995.
2. Anna Mani & Dr.Nooley,”wind Energy Data for India”, 1983.
3. IS 875 part IV and IS 1893 material STDS IS 226 (IS 2862, ASTM A-36, BS. 4360 Gr 43 D)
4. Logan (EARL),”Turbo Machinary Basic theory and applications”, 1981.

YRE 103- PROCESS MODELLING AND SIMULATION IN ENERGY SYSTEMS

3 0 0 3

UNIT – I **6**

Introduction to modeling, a systematic approach to model building, classification of models. Modeling Techniques-Response function and Numerical methods- Conservation principles, thermodynamic principles of process systems

UNIT-II **9**

Introduction to development of steady state and dynamic lumped and distributed parameters models based on first principles, Analysis of ill-conditioned systems, Block diagrams and computer simulation, Modeling of process elements consisting of Mechanical (translational and rotational) electro- Mechanical ,fluid flow, thermal and chemical reaction system elements

UNIT-III **9**

Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.

UNIT-IV **12**

Solution strategies for lumped parameter models. Stiff differential equations. Solution methods for initial value and boundary value problems. Euler's method. R-K method. shooting method,fnite difference methods. Solving problems using MATLAB/ SCILAB

UNIT- V **9**

Solution strategies for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equations. Finite element and finite volume methods.

L:45; T:15; Total:60

TEXT BOOKS

1. K.M. Hangos and I.T Cameron," Process Modelling and Model analysis".academic Press 2001.
2. W. L Luyben, " Process Modelling, Simulation and control for chemical Engineers" 2nd Edn, McGraw Hill Book Co, New York,1990
3. W.F Ramirez " Computational Methods for Process Simulation" Butterworths,1995

REFERENCES

1. Mark E. Davis," Numerical Methods and Modelling for Chemical Engineers" JohnWiley & Sons,1984.
2. Singiresu S. Rao "Applied Numerical Methods for Engineers and Scientists" Prentice hall, Upper saddle River , NJ 2001
3. Francis vanek, Louis D. Albright," Energy systems Engineering" McGraw- Hill book Company, N.Y 2008
4. "Power System Engineering" 2nd Ed.D.P Kothari, I.J. Nagrath, Tata MaGraw- Hill Co 2008.

YRE106 - SOLAR ENERGY LAB **0 0 1 1**

Solar Energy

1. Performance evaluation of solar flat plate collector
2. Performance evaluation of concentrating solar collector
3. Performance evaluation of solar cooker
4. Performance evaluation air dryer
5. Performance evaluation of a solar PV panel in series and parallel combination
6. Charging characteristics of a battery using PV panel
7. Effect of tilt angle and Effect of shadow on solar PV panel

YRE109– MAT and SCI LAB **0 0 1 1**

1. Integration Techniques: Trapezoidal method, Simpson's 1/3 rd rule, Simpson's 3/8 rule
2. Finding root of Arithmetic Equation
3. Optimization Techniques
4. LPP methods
5. Transportation problems.
6. Image process of Bio gasification process

YRM107 (*) – Research Methodology and IPR (MC) **2 0 0 0**

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:
1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007. Mayall , "Industrial Design", McGraw Hill, 1992.
5. Niebel , "Product Design", McGraw Hill, 1974.
6. Model Curriculum of Engineering & Technology PG Courses [Volume -II] 125 Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

YRE 201 - BIO ENERGY SYSTEMS 3 0 0 3

UNIT- I BIO FULES 9

Bio fuels: types, Properties and sources- Bio fuels first, second and third generation production processes and technologies- Bio diesel comparison with diesel - Biofuel applications – Bio diesel and Ethanol as a fuel for I.C. engines - Relevance with Indian Economy - Bio-based Chemicals and Materials - Commercial and Industrial Products - Govt. Policy and Status of Bio-fuel technologies in India.

UNIT - II CHARACTERISATION OF BIOMASS 9

Biomass: Sources and Classification. – Properties - Energy plantation - Preparation of biomass. Size reduction- Briquetting of loose biomass - Drying, storage and handling of biomass. Conversion of biomass. Biomass processing for liquid and gaseous fuel production. Effect of

particle size, temperature, on products obtained – Processing of various biomass for gas production for Thermal and Electrical application.

UNIT- III BIOGAS TECHNLOGY 10

Feed stock for biogas production, animal residues, Aqueous wastes containing biodegradable organic matter- Microbial and biochemical aspects- factors and operating parameters for biogas production- Kinetics and mechanism-Dry and wet fermentation. Digesters-types-digesters for rural application – High rate digesters for industrial waste water treatment

UNIT- IV GASIFICATION OF BIOMASS 10

Thermo chemical Principles: Effect of pressure, temperature and introducing, steam and oxygen. Design and operation of fixed and fluidized bed Gasifier, circulating fluidized bed gasifiers, Safety aspects, operating characteristics of moving bed and fluidized bed gasifier- different types- advantages and disadvantages- performance analysis of gasifiers.

UNIT – V COMBUSTION OF BIOMASS & COGENERATION SYSTEMS 7

Combustion of woody biomass – theory, calculations and design of equipments, Cogeneration in biomass processing industries. – Economic Case studies: Combustion of rice husk. Use of bagasse for cogeneration.

A compulsory seminar / assignment on design / case study/analysis /application in any one of the Bio Energy systems

L:45; Total:45

TEXT BOOKS;

1. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilisation of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.
2. Mittal K.M " Biogas Systems : "Principles and Applications" New age international publishers (P) Ltd 1996, Nijaguna, B.T Biogas Technology, New age International publishers (P) Ltd

REFERENCES:

1 Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", ISBN 81-85419- 25-6, Tata Energy Research Institute, 1996.
2. Klass D.L and Emert G.M, "Fuels from Biomass and Wastes", Ann Arbor Since Publ. Inc. Michigan, 1985.
3. O.P.Chawla, "Advances in Bio-gas Technology" I.C.A.R., New Delhi, 1970.

YRE 202 - COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

UNIT - I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT - II CONDUCTION HEAT TRANSFER 8

Steady one-dimensional conduction, Two and Three-dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT - III INCOMPRESSIBLE FLUID FLOW 7

Governing Equations, Stream Function - Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite deference approach.

UNIT - IV CONVECTION HEAT TRANSFER AND FEM 10

Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection -Diffusion, Unsteady two-dimensional convection - Diffusion - Introduction to finite element method - Solution of steady heat conduction by FEM - Incompressible flow - Simulation by FEM.

UNIT - V TURBULENCE MODELS 10

Algebraic Models - One equation model, K-I Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

L:45; T:15; Total :60

TEXT BOOK

1. Anderson ,D.A Tannehill, I I and Pletcher , R,H "Computational Fluid Mechanics and Heat transfer" Narosa Publication House, NewYork, USA,1984

REFERENCES:

1. Muralidhar, K.,and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa PublishingHouse ,New Delhi1995.
2. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill PublishingCompany Ltd., 1998.
3. Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H., "Computational Fluid Mechanics and Heat Transfer",Hemishphere Publishing Corporation, New York, USA, 1984.
4. Flectcher, C.A.J., "Computational Techniques for Different Flow Categories, Springer-Verlage 1987.

YRE 203 - ELECTRICAL ENERGY TECHNOLOGY **3 0 0 3**

UNIT - I POWER SYSTEM FUNDAMENTALS **7**

Single line representation – power flow study – power factor improvement, Protection, types of relays, symmetrical components, asymmetrical components, Introduction: Hybrid power system. HVDC - introduction, various coupling methods.

UNIT - II ELECTRIC ENERGY CONVERSION DEVICES **9**

Transformers – Parallel operation, auto transformers, DC machines, Applications of DC machines – performance equation - generator characteristics - motor characteristics – applications of Synchronous machines - alternators – Induction machines.

UNIT - III SOLID-STATE POWER CONVERTERS AND DRIVES **9**

Controlled rectifiers, choppers, inverters, voltage regulators and cyclo -converters. Speed control of dc motors and ac motors – converter fed chopper –fed control Inverter –
ac voltage regulators, VFD.

UNIT - IV HYBRID POWER GENERATION **9**

Types of hybrid systems, Integration issues - Steady state performance of Wind-driven induction generators. Grid connected solar photo voltaic system - line commutated converters - Boost converters- selection of inverter. Three phase AC voltage controllers for wind power plants - uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

Micro Grids, Intelligent Grids, Smart grids, Phase Monitoring Unit (PMU), Case studies.

UNIT - V POWER QUALITY IMPROVEMENT 11

Introduction – Characterisation of Power Quality, impacts, Types of Harmonic filters: passive, Active and hybrid filters. Custom power devices: Load compensation using STATCOM / DSTATCOM, Voltage regulation.

FACT controlled devices, DVR. UPQC control strategies, UPFC, P-Q theory, Status of application of custom power devices. **L:45; Total:45**

TEXT BOOKS:

1. John J Graigner and W.D Stevenson “Power system analysis” McGrawHill publishinig company, 1994.
2. T.JE. Miller “FACT controlled device” Johan willey Publications.
3. M.H.Rasheed “Power Electronics” Tata Mc Graw Hill.
4. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, kluwer Academic Publishers, 2002

YRE206- BIO ENERGY AND CFD LAB **0 0 1 1**

Bio Energy:

1. Flue gas analysis – IC engine and gasifier
2. Proximate and Ultimate analysis of fuels
3. Analysis of chemical oxygen demand (COD)
4. Analysis of biological oxygen demand (BOD)

5. Determining the Flash point, Fire point and Calorific value of Biofuel
6. Effect of P_H on total dissolved solids (TDS)
7. Heat pipes demonstration

Computational Fluid Dynamics:

1. Experiments on flow patterns.
2. Velocity profile in an air pipe.
3. Wind tunnel calibration.
4. Draining of a tank..
5. Pipe friction..
6. Boundary layer studies.
7. Falling ball experiments.
8. Viscosity measurement.

YRE207 MINI PROJECT 0 0 1 2

Syllabus contents:-

Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

Semester	Course name	Course Code	`L	T	P	C
II	Constitution of India	YPSOE1	-	-	-	0

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions : National Emergency, President Rule, Financial

Emergency

12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19 Scope of the Right to Life and Personal Liberty under Article 21

YRE301 Project phase - I 0 0 10 10

Guidelines:

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

YRE401 Project Phase - II 0 0 16 16

Guidelines:

It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of

the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. . The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide.

LIST OF ELECTIVES (***)

YRE104A - FLUID DYNAMICS AND HEAT TRANSFER 3 0 0 3

UNIT – I 8

Basic equations and flow of non viscous fluids – Fluid and Fluid Properties – The differential equation of fluid flow – Flow of Non viscous fluids.

UNIT - II 12

The flow of viscous fluids – Laminar flow in closed conduits – turbulence – Dimensional analysis and its application to fluid dynamics – Turbulent flow in closed conduits – the laminar sub layer - Flow in the entrance section of closed conduits – Flow of incompressible fluids past immersed bodies – Flow in the shell side of multitude heat exchangers.

UNIT - III 10

The convection-heat – transfer coefficient – Dimensional Analysis in convection heat transfer – Heat transfer during laminar flow in closed conduits – turbulent flow heat transfer in closed conduits – Empirical correlation for high – Prandtl – Number fluids.

UNIT - IV 8

The analogy between momentum and heat transfer – Heat transfer with liquid metals – Heat transfer during incompressible flow past immersed bodies.

UNIT – V 7

Recent development in the designing of heat exchanger – Plate heat exchanger – run around coils – heat pipes – regenerators - effectiveness of heat exchanger.

L:45; Total:45

TEXT BOOKS;

1. James G. Knudsen, Donald L. Katz., “Fluid Dynamics and Heat Transfer”, 1958, Mc Graw Hill Publishers

REFERENCES:

1. Kern D.C., “Process Heat Transfer”, Mc Graw Hill Publishers.

YRE104B - ENERGY CONSERVATION IN HVAC 3 0 0 3

UNIT - I DESIGN OF HVAC SYSTEM COMPONENTS 9

Vapour compression Systems-Refrigerant properties- Energy Efficient compressor-Condensers-Evaporators-expansion devices- Cooling Systems other auxiliaries-Design and Analysis for Energy conservation- Case Studies- VAR Systems- Utilization of Waste heat and other sources- Analysis for Energy Efficiency Ratio.

UNIT – II AIR CONDITIONING SYSTEMS 9

Psychrometry – Comfort conditions -Types of A/c Systems- Energy conservation of Humidifiers, Air Washers- Air distribution and handling systems-Controls for AHU-Passive and Active A/c Systems-Thermal Properties and Energy content of Building materials.

UNIT - III ESTIMATION OF BUILDING LOADS 9

Steady state method – Network method-Numerical method – correlations – computer packages for carrying out thermal design of buildings and predicting performance- Thermal comfort – Ventilation and air quality – Air conditioning requirement – Visual perception –Illumination Requirement – Auditory requirement – Energy Management Options – Energy Audit and Energy Targeting – Technological Options for Energy Management-standards on indoor parameters.

UNIT - IV FACTORS AFFECTING THE ENERGY USE 9

Factors that affect energy use in building- functional factors, environmental factors-Envelope factors-Air conditioning system factors- Energy source factors and Electrical systems factors- Fenestration design for optimal day lighting- Lighting and Visual ability – Light sources and Luminaries – Lighting System- Design-Day lighting-Day light factors- Luminance Efficacies- CRI for Lighting source and Usage- Economics and Aesthetics.

UNIT-V MODELING AND SIMULATION 9

Evaluation of natural ventilation in buildings, determination of probable indoor wind speed and direction- Ventilation heat transfer - Solar-air temperature-Introduction to Natural and artificial ventilation simulation systems- Energy Calculations- Degree Days procedure- BIN methods-Comprehensive simulation methods

L:45; Total: 45

TEXT BOOKS:

1. Faye C. McQuiston and Jerald D. Parker " Heating, Ventilating and Air Conditioning – Analysis and Design", 4th Edition, John-Wiley & Sons, Inc, NewYork.1994.
2. C.P.Arora " Refrigeration and Air-conditioning", Tata-McCraw Hill Publishers, New Delhi

REFERENCES:

1. J.Krieder and A.Rabi "Heating and Cooling of Buildings. Design for Efficiency Mcgraw Hill (1994).
2. J.R.Williams, Passive Solar Heating, Ann Arbar Science(1983).
3. R.W.Jones, J.D.Balcomb, C.E.Kosiewiez, G.S.Lazarus, R.D.Mc Farland and W.O.Waray, Passive Solar Design Handbook, Vol.3 Report of U.S. Department of Energy (DOE/CS-0127/3) (1982).

YRE104C - FUELS AND COMBUSTION TECHNOLOGY 3 0 0 3

UNIT – I FUELS, FUEL ANALYSIS & COMBUSTION STOICHIOMETRY 8

FUELS & FUEL ANALYSIS: Types of fuel-Physical and chemical characteristics of solid, liquid, and gaseous fuels-Nonconventional fuel-producergas, hydrogen, biogas etc- Determination of Calorific values-Ultimate and proximate analysis-problems associated with handlings, storage and combustion

COMBUSTION STOICHIOMETRY

Stoichiometry relations – conservation of mass principles – theoretical & actual combustion processes – calculation of air fuel ratio for a fuel of known combustion – calculation of flue gas composition of fuel and excess air supplied from exhaust gas analysis – combustion calculation with sub-stoichiometry air – calculation of atmospheric air moisture – Dew point temperature of the combustion products – Flue gas analysis- Boiler performance analysis

UNIT - II THERMODYNAMICS OF COMBUSTION PROCESSES 10

COMBUSTION KINETICS: Degree of reactions-reactions equilibrium-Laws of mass action-criteria of equilibrium-heat and temperature-Gibbs free energy – equilibrium constant-Vant hoffs isotherm – rate of reaction-factors affecting rate of reaction-calculation of equilibrium constant and composition of reating systems .

UNIT- III FLAME, FLAME STRUCTURE, IGNITION AND IGNITORS 10

Flame – flame structure – flame propagation – deflagaration – detonations – flame front – Ignition – self & forced ignition – Ignition temperature & ignition limits – Factors influencing ignition – SIT – Ignition lag – limits of inflammability & its determination – factors affecting inflammability limits – calculation of inflammability limits – flame blow off, blow out & flash back – flame quenching, Flame structure – flame stability – premixed & diffused flames – velocity of flame propagation – various methods of flame stabilization – swirl number & its significance – Turndown ratio – Ignitors – various types of ignitors – NFPA class I, II & III ignitors – Eddy plate ignitor – plasma ignitor – High energy Arc ignitor – DIPC ignitor.

UNIT- IV BASICS OF FURNACES 10

Industrial furnaces – process furnaces Steam generating furnaces – Kilns – Batch & continuous furnaces – Advantages of ceramic coating – Heat source – Distributions of head source in furnaces – Blast furnace – open hearth furnace – pot & crucible furnaces – waste heat recovery in furnaces – Recuperator – Regenerators – Furnace atmospheres – Furnace Insulation – Furnace Heat balance calculations, Pipe still Heater.

UNIT - V COAL BURNING EQUIPMENTS 7

Coal burning methods – over feed & underfeed supply of coal – Mechanical Stokers – Travelling grate & spreader stoker – vibrating grate stoker – Advantages & disadvantages of stoker firing over pulverized systems of firing – problems encountered with burning of high ash coal. Pulverized fuel burners – streamlined burner – turbulent burners – Tangential burner – cyclone burner – special type burners.

A compulsory seminar / Assignment on design /case study / Analysis/ Application in any one of the combustion system and accessories (viz Burner,Draught etc)

L:45; Total:45

Text Books:

1. Dr. SamirSarkar, "Fuels & Combustion", Orient Longman, Second edition, 1990.
2. Gupta O.P. "Elements of Fuels, Furnaces & Refractories", 3rd edition, Khanna Publishers, 1996.

REFERENCES:

1. S.P. Sharma & Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co.Ltd., 1984
2. J.D. Gilchrist, "Fuels, Furnaces & Refractories", Pergamon Press, ISBN-008-029430-9 ----
3. Blokh A.G. "Heat Transmission in Steam Boiler furnaces", Hemisphere Publishing Corpn.ISBN-089-116-626-2

YRE105A - ENVIRONMENTAL ENGINEERING 3 0 0 3

UNIT - I ENVIRONMENTAL POLLUTION 10

Mass and energy transfer – units of measurements, material balance and energy fundamentals – Environmental chemistry stoichiometry, chemical equilibria. Mathematics of growth – exponential growth, resource consumption and population growth, resource consumption and population growth – problems. Atmosphere – Regions of atmosphere – Earth's natural atmosphere – consequences of population growth – classification of pollution – pollution of Air, Water & Soil – Effect of pollutants on living system – Environmental legislation.

UNIT - II AIR POLLUTION CONTROL METHODS & EQUIPMENT 10

Sources of air pollution –classification & properties of air pollutants – scales of concentration – Effects of air pollution – meteorological aspects of air pollution – urban air pollution – carbon-di-oxide & climate change – Acid deposition – Industrial air pollution – Automobile air pollution – Sampling, measurement and analysis of air pollutants such as SOx, NOx, CO, NH_3, CnHn, SPM, Opacity, Volatile organic compounds, Trace metals.

UNIT - III WATER POLLUTION 9

Water Sources – Origin of waste water – Classification of Water Pollutions – Effects of water pollutants – Water Pollution Laws and Standards – Water Pollution & Health – Waste Water Sampling – BOD – COD analysis – Waste Water Treatment – primary treatment – secondary treatment – Advanced waste water treatment – Anaerobic Digestion. Desalination – micro filtration – ultra filtration – Reverse Osmosis.

UNIT - IV SOLID WASTE DISPOSAL 9

Solid waste- Sources, types, Compositions and Properties - Land Fill Method of Solid Waste Disposal – Land Fill Classification, Types, Methods and Sitting Consideration – Layout and Preliminary Design of Land Fills – Composition, Characteristics, generation, Movement and Control of Landfill Leach ate and Gases – Environmental Monitoring System for Land Fill Gases.

UNIT - V OTHER TYPES OF POLLUTION 7

Noise Criteria - Noise Sources - Noise Control Measures - Thermal Pollution - Oil pollution – Pesticides - Radioactivity Pollution control - Tanneries and other Industries and their control

L:45, Total: 45

TEXT BOOKS

1. James Gilbert M.Masters, "Introduction to Environmental Engineering And Science", 2nd edition, Prentice Hall, 1998.

REFERENCES:

1. Rao C.S Environmental Engineering and Pollution Control, 1st edition, New Age International Publishers, 1991.

YRE105B - CARBON SEQUESTRATION AND TRADING 3 0 0 3

UNIT - I GREENHOUSE GAS 9

Stabilization of greenhouse gas concentrations – greenhouse gas risks and reservoirs – green gas mitigation – Carbon di oxide and climate change, acid rain, global warming, impacts of global warming-Kyeto-procal.

UNIT - II CARBON 9

Practices for sequester carbon - car bon sequestration types – carbon credits – carbon testing – potential for carbon sequestration.

UNIT - III MANAGEMENT 9

Risk management and risk reduction – carbon economics – Verification of carbon change.

UNIT - IV CASE STUDIES 9

Carbon trading model – Century Model – Case Studies.

UNIT - V RULES AND REGULATIONS **9**

Implication Methanol and Nitrous Oxide carbon bank – Best Management Practices 0 Publics issues – policies.

L:45; Total:45 implication

TEXT BOOKS

1. Emission Trading:Environmental Policies New approach-Richard F. Kosobud, Douglas L. Schreder, Holly M. Biggs Published 2000 John Wiley and Sons.

REFERENCES:

1. Agricultural Practices and Policies for Carbon Sequestration in Soil By John M. Kimble, Rattan Lal Published 2002CRCPress
2. The Impact of Carbon Dioxide and Other Greenhouse Gases on Forest Ecosystems By David F. Karnosky Published 2001 CABI Publishing.

YRE105C- WASTE MANAGEMENT AND ENERGY RECOVERY 3 0 0 3

UNIT – I SOLID WASTE **8**

Definitions – Sources, types, Compositions, Properties of Solid Waste – Municipal Solid Waste – Physical, Chemical and Biological Property – Collection – Transfer Stations – Waste Minimization and Recycling of Municipal Waste.

UNIT – II WASTE TREATMENT **8**

Size Reduction – Aerobic Composting – Incineration – Furnace Type and Design, Medical/Pharmaceutical Waste Incineration – Environmental Impacts – Measures of Mitigate Environmental Effects due to Incineration

UNIT – III WASTE DISPOSAL **9**

Land Fill Method of Solid Waste Disposal – Land Fill Classification, Types, Methods and Sitting Consideration – Layout and Preliminary Design of Land Fills – Composition, Characteristics, generation, Movement and Control of Landfill Leachate and Gases – Environmental Monitoring System for Land Fill Gases.

UNIT – IV HAZARDOUS WASTE MANAGEMENT **10**

Definition and Identification of Hazardous Waste – Sources and Nature of Hazardous Waste – Impact on Environment – Hazardous Waste Control – Minimization and Recycling Assessment of Hazardous Waste – Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation and Closure.

UNIT – V ENERGY GENERATION FROM WASTE **10**

Types – Biochemical Conversion – Sources of Energy Generation – Industrial Waste, Agro Residues – Anaerobic Digestion – Biogas Production - Types of Biogas Plant Thermochemical Conversion – Sources of Energy Generation – Gasification – Types of Gasifiers – Briquetting – Industrial Applications of Gasifiers – Utilization and Advantages of Briquetting – Environment Benefits of Biochemical and Thermochemical Conversion.

L:45; Total:45

REFERENCES:

1. Parker, Colin & Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsievier Applied Science, London, 1985.
2. Shah, Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
3. Rich, Gerald et.al., Hazardous Waste Management Technology, Podevan Publishers, 1997.
4. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.

YRE204A - OPTIMUM UTILISATION OF HEAT AND POWER 3 0 0 3

UNIT - I ENERGY CONVERSION TECHNIQUES 12

Energy resource assessment – energy supply, demand and storage planning methods – economic feasibility and assessment methods – energy transfer and conversion methods – thermodynamic and efficiency analysis methods – system analysis methodologies.

UNIT - II TOTAL ENERGY SCHEMES 12

Basic concepts of CHP – The benefits of CHP – Problems associated with CHP – The balance of energy demand – Types of Prime demand – Types of prime movers – The economics of CHP generation – CHP in the industrial sector – CHP in the commercial sector – CHP in the domestic sector district heating – Conclusions.

UNIT - III PROCESS INTEGRATION AND PINCH TECHNOLOGY 10

Pinch Technology – Basic concepts of pinch technology – Streams networks – The significance of the Pinch – Design of energy recovery systems – Selection of pinch temperature difference – Tabular method – Stream splitting – Process retrofit – Installation of heat pumps – Installation of heat engines – The grand composite curve – General comments about process integration.

UNIT - IV ENERGY RECOVERY 6

Insulation – Recuperative heat exchanger – Run -around coil systems – Regenerative heat exchangers – Heat pumps – Heat pipes – Selection of energy recovery methods, Cogeneration.

UNIT - V APPLICATION OF CHP 5

CHP in agricultural sector - processing - energy requirements - potential. CHP in industrial sector - Processing - energy requirements - source of waste heat.

L:45; Total:45

Text Books;

1. Eastop T.D & Croft D.R, "Energy efficiency for engineers and Technologists", 2nd edition, Longman Harlow, 1990.

REFERENCES:

1. O'Callaghan, Paul W, "Design and Management for energy conservation", Pergamon, ,1993.

YRE204B - STATISTICAL TOOLS FOR DATA ANALYSIS 3 0 0 3

UNIT - I RESEARCH 8

Objectives – types: descriptive, analytical, applied fundamental, quantitative, qualitative, conceptual, empirical – approach – significance – methods – process – Research design – need – concepts – sampling design.

UNIT - II LITERATURE SEARCH 11

Offline search: Abstracts-subject index, author index, formula index and other indices-examples-current. Contents – organization – titles and index. On line Search: Computer browsing for literature search and down loading-basics of internet services-sources of abstracts, articles for browsing for literature search and down loading – basics of internet services-sources of abstracts, articles for browsing and downloading, technique for conversion form one format to another.

UNIT - III STATISTICAL PROCESS CONTROL (SPC) 9

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT - IV DESIGN AND ANALYSIS OF EXPERIMENTS 9

Treatment and interpretation of engineering data. Curve fitting non linear least square regression.. Tests of significance – test of hypothesis, chi square test, analysis of variance and covariance. Introduction to factorial designs- 2^k factorial designs, introduction-Blocking and confounding in two level factorial designs- 2^{k-p} fractional factorial designs, introduction -Random factors in experiments - Random factors in factorial experiments, mixed models

UNIT - V ERROR ANALYSIS IN MECHANICAL MEASUREMENTS 8

Types of errors-Precision and accuracy-Statistical tests on the accuracy of results-Binomial distribution-Gaussian distribution T-tests, Comparison of precision of two methods by test.

L:45; Total :45

TEXT BOOKS

1. C.R.Kothari, Research Methodology – Methods and techniques, Wishwa Prakashan, New Delhi, 1996.
2. Design and Analysis of Experiments, 5th edition, by D.C. Montgomery, John Wiley & Sons, New York, 2001

REFERENCES:

1..W.I.Cochron, 'Statistical methods', Oxford and IBH publishers.
2.http://www.sciencedirect.com/science/journal
3.James R.Evans & William M.Lidsay, The Management and Control of Quality, (5thEdition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5

YRE204C – SUSTAINABLE DEVELOPMENT 3 0 0 3

UNIT - I INTRODUCTION 12

Industrial activity and Environment industrialization and sustainable development – Industrial Ecology – Prevention versus control of industrial pollution – Regulations to encourage cleaner production based approached.

UNIT - II CLEANER PRODUCTION CONCEPT 7

Importance – Historical evolution – Benefits – promotion – barriers – Role of Industry, government and Institutional – Resume, recovery, recycle, substitution – Internet information & other CP resources.

UNIT- III CLEANER PRODUCTION PROJECT DEVELOPMENT 10

Overview of CP Assessment steps & skills – preparing for the site – material balance – Technical and Environmental feasibility analysis – Economic Evolution of alternatives – Total cost analysis – CP financing - Established programme – Preparing & programme plan – reset audit – Environmental statement

UNIT - IV LIFE CYCLE ANALYSIS & ENVIRONMENTAL MANAGEMENT SYSTEM 8

Elements of LCA - life cycle costing – ECO labelling - Design for the Environment Environmental standards – ISO 14001 – Environmental audit.

UNIT - V CASE STUDY 8

Industrial application of CP, LCA, EMS & Environmental audit

L:45; Total: 45

REFERENCES:

1. Pollution prevention: Fundamental and Practice, Paul L Bishap, McGrawhill , INC
2. Pollution prevention and abatement Handbook – Towards cleaner production – World bank and UNDP, Washinghton, D.C
3. Cleaner Production Audit, Prasad Modak, Asian Institute of Technology, Bangkok

YRE205A- INSTRUMENTATION TECHNOLOGY FOR ENERGY SYSTEMS

3 0 0 3

UNIT - I INTRODUCTION TO MEASUREMENT TECHNIQUES 6

General concepts of measurements, static and dynamic characteristics, Introduction to calibrations, calibration standards – characteristics of instruments – Definition – True value – Accuracy – Precision – Sensitivity – Resolution – errors & its measurements, Data acquisition & Display.

UNIT - II MEASUREMENT OF PRESSURE AND TEMPERATURE 9
MEASUREMENT OF PRESSURE

Different units of pressure – Classification of pressure gauges – manometers – pressure balance gauges – force balancing gauge – elastic deformation – commercial pressure gauges using the above principles – ring balance type elements. Measurement of vacuum–Mcleod gauge – Pirani gauge. Measurement using strain gauges. Measurement of Pressure using electronic / micro processor based transmitter, calibration of the instrumentation.

UNIT-III MEASUREMENT OF TEMPERATURE & HEAT FLUX 9

Difference temperature scales – Non-electrical methods – change in volume of liquid – change in pressure of gas – change in vapour pressure. Electrical methods – Thermocouple – Resistance Temperature Detector – Radiation Pyrometer – Optical Pyrometer – Thermostats. Temperature measurement using electronic / micro processor based transmitter, Incidental radiation heat flux, conduction heat flux, calibration. Measurement of Electrical Energy – Voltage – Current – Power Factor.

UNIT - IV MEASUREMENT OF FLOW, LEVEL, HUMIDITY AND OTHER

MISCELLANEOUS PARAMETERS **12**

Flow measurement – types – differential pressure type flow meter – orifice meter – ventury tube – flow nozzle – pitot tube – positive displacement type flow meter – Inferential flow meter – turbine flow meter – variable area flow meter (rotameter) – mass flow meter. Low flow measurement using pizzo ring, Ultra Sonic flow meter for high flow. Level measurement – Basic methods – Measuring hydrostatic pressure – measuring the movement of the float – electric conduction method – sight glass. Non-Contact measurement techniques. Level measurement by DP transmitter. Definition of humidity – hydrometer & psychrometer – Humidity measurement. Measurement of pH:-pH scale – methods of pH measurements.mass spectrometer & Chromotograph. Hazardous area and its classification, calibration.

UNIT - V TRANSDUCERS & PROCESS CONTROL

Classification of Transducers – Active and passive transducers - Analog and digital transducers. Advantages of electrical transducers over mechanical transducers – Different types: Resistance – Inductance – Capacitance – Piezo electric transducers.

Functional block diagram of a process control loop and their elements. Definition of set point, dead zone, dead time, disturbance, deviation- Control system – Open and closed loop control system – feed forward control – Ratio control – cascade control. Closed loop conyrollers with examples. Programmable logic controllers & Disturbed controlled system. Computer control using Supervisory Computer.

L:45; T:15; Total: 60

TEXT BOOKS

1. John P.Bentley, “Principles of Measurement System”, 3rd edition, Addision Wsley Longman Ltd.UK,2000.

REFERENCES:

1. Instrument Transducers: An introduction, Neubert H.K.P., Their performance and Design. 2nd edition, Oxford University Press, Cambridge, 1999, Sensors and Transducers, Patranabis, Wheeler Publishing 1999.
2. Stephanopoulos, “Chemical Process Control – An Introduction, to Theory and practice”, PHI, New Delhi, 1984.

YRE 205B - HYDROGEN AND NUCLEAR ENERGY **3 0 0 3**

UNIT - I HYDROGEN ENERGY **9**

Hydrogen as a renewable energy source - Sources of Hydrogen - Fuel for Vehicles - Hydrogen Production - Direct electrolysis of water - direct thermal decomposition of water - biological and biochemical methods of hydrogen production - Storage of hydrogen - Gaseous, Cryogenic and Metal hydride - Utilization of hydrogen.

UNIT - II BATTERIES & FUEL CELL **12**

Battery – Storage cell Technologies -storage cell fundamentals- characteristics – Emerging trends in batteries-Carbon- Zinc & alkaline cells, Mercury, Zinc –air &Silver oxide button cells, Lead acid, Edison, Ni cad & Ni mg cells and lithium Technology

Fuel cell – Principle of working- construction- Design and performance analysis of fuel cells-The alkaline fuel cell, Acidic fuel cells, PEM Fuel cells, SOFC - Emerging trends in fuel cells, - Applications – Industrial and commercial

UNIT - III NUCLEAR POWER **9**

Nuclear energy conversion - Chemical and nuclear equations - Nuclear reactions -Fission and fusion - Energy from fission and fuel burn-up - Radioactivity – Neutron energies - Fission reactor types - Nuclear power plants - Fast breeder reactor and power plants - Production of nuclear fuels.

UNIT - IV NUCLEAR POWER **10**

Fuel rod design - Steam cycles for nuclear power plants - reactor heat removal – Coolant channel orificing - Core thermal design - Thermal shields - Fins in nuclear plants – Core thermal hydraulics - Safety analysis - LOCA - Time scales of transient flow and heat transfer processes.

UNIT - V NUCLEAR WASTE MANAGEMENT **5**

Segregation and safe disposal of nuclear waste –case studies

L:45; Total:45

TEXT BOOKS'

1. M. M. El-Wakil: Power Plant Technology, McGraw Hill, 1985
2. Hand book of Batteries and Fuel cells ,3rd Edision, Edited by David and Thomas, B. Reddy, McGrawhill Book company,N.Y 2002
3. Fuel cell, Principles and applications ,Viswanathan,B and Scibioh,Aulice M. Universities Press.2006

REFERENCES:

1. A. W. Culp Jr: Principles of Energy Conversion, McGraw Hill, 2001
2. Principles of fuel cells by Xianguo Li, Taylor & francis,2006
3. T. F. Morse: Power Plant Engineering, Affiliated East West Press, 1978
4. R. H. S. Winterton: Thermal Design of Nuclear Reactors, Pergamon Press, 1981
5. R. L. Murray: Introduction to Nuclear Engineering, Prentice Hall, 1961

YRE205C - ENERGY MODELING, ECONOMICS AND PROJECT MANAGEMENT **3 0 0 3**

UNIT - I MODELS AND MODELING APPROACHES **8**

Macroeconomic Concepts - Measurement of National Output - Investment Planning and Pricing - Economics of Energy Sources - Reserves and Cost Estimation.

UNIT - II INPUT OUTPUT ANALYSIS **9**

Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation – Econometric Energy Demand Modeling - Overview of Econometric Methods.

UNIT - III ENERGY DEMAND ANALYSIS AND FORECASTING **12**

Methodology of Energy Demand Analysis - Methodology for Energy Technology Forecasting - Methodology for Energy Forecasting - Sectoral Energy Demand Forecasting.

UNIT - IV ECONOMICS OF STANDALONE POWER SUPPLY SYSTEMS **10**

Solar Energy - Biomass Energy - Wind Energy and other Renewable Sources of Energy -Economics of Waste Heat Recovery and Cogeneration - Energy Conservation Economics.

UNIT - V PROJECT MANAGEMENT-FINANCIAL ACCOUNTING **6**

Cost Analysis - Budgetary Control - Financial Management - Techniques for Project Evaluation.

L:45; Total:45

REFERENCES:

1. M.Munasinghe and P.Meier (1993): Energy Policy Analysis and Modeling, Cambridge University Press.
2. W.A.Donnelly (1987): The Econometrics of Energy Demand: A Survey of Applications, New York.
3. S.Pindyck and Daniel L.Rubinfeld (1990): Econometrics Models and Economic Forecasts, 3rd edition MC Graw -Hill, New York.
4. Energy Management handbook, Turner.

YRE302A ENERGY AUDIT AND MANAGEMENT 3 0 0 3

UNIT - I INTRODUCTION 10

Energy scenario – Principles and imperatives of energy conversion – Energy consumption pattern – Resource availability – Why save energy – reasons to save energy – an over view of energy consumption and its effects – current energy consumption in India – Role of Energy Managers in Industries.

UNIT - II ENERGY CONSERVATION OF THERMAL UTILITIES 10

Energy Audit–Characteristic Methods Employed in Certain Energy Intensive Industries – Various Energy Conservation Measures in Steam – Losses in Boiler. Methodology of Upgrading Boiler Performance – Boiler Blow Down Control – Excess Air control – Pressure Reducing Stations. Energy Conservation in Steam Systems – Importance of correct Pressure, Temperature, & Quality of Steam – Condensate Recovery – Condensate Pumping – Thermo Compressors – Recovery of Flash Steam – Air Removal & Venting – Moisture Removal. Steam Traps – Types, Function, Necessity – Section and application. Co-generation – in-plant power generation systems – co-generation Schemes and configuration – Design Considerations – Heat Rate Improvement. Case studies.

UNIT - III ENERGY CONSERVATION OF UTILITIES 10

Centrifugal pumps – energy consumption & energy saving potentials – Design consideration minimizing over design – case studies – Fans & Blowers – Specification – Safety margin – choice of fans controls – design considerations. Air compressor & compressed air systems – selection of compressed air layout – Encon aspects to be considered at design – Design consideration. Refrigeration & Air conditioning – Heat load estimation – methods of minimizing heat loads – optimum selections of equipments – case studies. Energy conservation in cooling towers & spray ponds – Case studies.

UNIT - IV ENERGY AUDITING 8

Potential areas for Electrical Energy Conservation in various Industries – Conservation methods – Energy Management Opportunities in Electrical Heating, Lighting System, Cable Selection – Energy Efficient Motors – Factors Involved in Determination of Motor Efficiency Adjustable AC Drivers, Application & its Uses – Variable speed Drivers / Belt Drives Energy Efficiency in Electrical Systems – HT Power Distribution – Control system in HT/LT side, Harmonics – Energy Efficiency in Lighting – Case studies.

UNIT - V ENERGY MANAGEMENT 7

Organizational background desired for energy management persuation / motivation / publicity role, tariff analysis, detailed process of M&T Energy monitoring, auditing & targeting – Economics of various Energy conservation schemes, instrumentation and calibrationElectronics Control and Industrial Energy Management Systems. Thermostats, Boiler controls; proportional, differential and integral control, optimizers; compensators.

L:45; T:15; Total:60

TEXT BOOKS

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

REFERENCES:

1. Reay D.A, Industrial Energy Conservation, 1st edition, Pergamon Press, 1977.
2. Larry C whitetal, Industrial Energy Management & Utilization.

YRE302B- UNIT OPERATIONS IN INDUSTRIES 3 0 0 3

UNIT - I CRUSHING, GRINDINGSIZE SEPARATION & CONVEYING OF BULK SOLIDS 12

Various Laws of Crushing – classification of crushing and grinding machineries – Coarse crushers – Intermediate crushers – fine grinders – jaw crusher – Gyratory Crusher – Crushing rolls – Hammer mills – Ball and tube mills – Ultrafine grinders – Closed circuit grinding – Grindability Index. Introduction – characterization of solid particles – standard screens – screen analysis – Types of screening equipments – Air separation methods – Cyclone and bag filters – Size separation by settling - Laws of Settling – Classifiers – Material separation by difference in density – Heavy media cyclone - Froth floatation – Hindered settling – working of thickener. Conveying of bulk solids – conveyor of bulk materials – screw conveyors – Belt conveyors – Bucket Elevators – Pneumatic Conveyers.

UNIT - II MIXING AND FILTRATION 8

Introduction – mixing of liquids/Liquids, Liquids/Gases, Liquids/Solid – Types of mixers – various mixing equipments – Power requirement for an Impeller Mixer. Theory of Industrial filtration – Constant pressure and constant rate filtration – Filter Aids – Filtration Equipment Classification – Filter Presses – Leaf Filters – Rotary Drum Filter – Centrifuges

UNIT - III EVAPORATION 8

Introduction – Duhrings Chart – Boiling Point Elevation – Capacity and Economy of Evaporators – Evaporators Classification – Short tube and Long Tube Evaporators – Forced Circulation Evaporators – Climbing and Falling Film Evaporators – Multiple Effect Evaporator – Evaporator Accessories

UNIT - IV HUMIDIFICATION AND DRYING 8

Definition – Adiabatic Saturation Temperature – Humidity Chart – Wet bulb Temperature and Measurement of Humidity – Spray Ponds and Cooling Towers – Cooling Tower Designing considerations. Introduction – Drying Theory – Equilibrium Moisture Content – Bound, Unbound, Free Moisture – Drying Rate Curves – Constant Drying Rate – Falling Rate Period – Classification of Dryers – Tray Dryers – Rotary Dryers – Turbo Dryer – Cylinder Dryer – Festoon Dryer – Drum Dryer – Spray Dryer – Fluid Bed Dryer

UNIT - V DISTILLATION 9

Introduction – Various Distillation Methods – Flash Distillation – Batch Distillation – Steam Distillation – Continuous Distillation – Minimum Reflux Ratio- Total Reflux – Optimum Reflux Ratio – Steam Distillation Calculations – Ideal Plate – Actual Plate – Plate Efficiency - Distillation column Internals – Concepts of Azeotropic and Extractive Distillation – Enthalpy Balance for a Continuous Distillation Column (for binary system)

L:45; Total:45

REFERENCES:

1. P.Chattopadhyay, "Unit operations of chemical Engineering", 2nd edition, Khanna Publishers, 1996.
2. W.L.McCabe and J.C.Smith, "Unit operations of Chemical Engineering",5th edition, McGraw Hill International editions, 1993.
3. Alan S Foust, "Principles of Unit Operations", 2nd edition, Wiley International Edition, 1960.
4. J.M. Coulson & Richardson, Chemical Engineering, 5th edition, Butterworth Heinemann, 1996.

YRE302C- CAD/CAM AND SIMULATION OF RENEWABLE ENERGY SYSTEMS **3 0 0 3**

UNIT - I BASIC CONCEPTS OF CAD **9**

CAD Hardware and software operating system, application software, CAD workstation Principles of computer graphics – graphics programming, input techniques, transformation. Elements of mechanical drafting package, graphic standards, graphic libraries, design and drafting interface. Advanced modeling techniques.

UNIT - II ADVANCED MODELLING TECHNIQUES **9**

Modeling of curve and surface, non uniform rotational of splines , commercial surface modeling software – principles of solid modeling – rendering methods – CAD/CAM data base development and database management systems –principles of optimum design

UNIT- III COMPUTER AIDED MANUFACTURING AND PROCESS **9**

Computer aided manufacturing- fundamentals of CAD/CAM – computers in manufacture – Programming languages, process interface hardware – hierarchy of computers in CAM. Computer process monitoring, types of production monitoring systems – process control – modeling and analysis – direct digital control – supervisory computer control – steady state optimal control – adaptive control, on – line search strategies. Systems for manufacturing support.

UNIT- IV CAD MODELLING AND SIMULATION OF SOLAR AND WIND ENERGY SYSTEMS **9**

Solar collectors, solar cooker, solar water heater, solar pasteuriser, solar drier, wind mill and wind generator.

UNIT- V CAD MODELLING AND SIMULATION OF SYSTEMS USING BIOMASS **9**

Updraft gasifier – downdraft gasifier, cross draft gasifier – multi fuel gasifier – fixed and fluid bed gasifier –Biogas plant.

L:45; Total: 45

REFERENCES:

1. William M Newman and Robert Sproul “principles of interactive graphics” McGraw Hill, 1984.
2. Radha Krishnan.P. & Kothandaraman.C.P. “Computer graphics design” Dhanpat Rai and Sons, 1990.
3. Groover.M.P. “Automation, Production systems and Computer Aided Manufacturing” Prentice Hall, 1984.
4. CAD/CAM Theory & practice, Inbrahim & Zeid Pub: Tata McGraw Hill.

OPEN ELECTIVES (****)

YREOE1 – HYDRO POWER TECHNOLOGY 3 0 0 3

UNIT - I HYDROLOGY` 9

Overview of Hydropower systems-Preliminary Investigation-Rainfall and run off measurements-Hydrographs-Flow duration graph and mass storage graphs-determination of site selection- Types hydro electric power plants-General arrangements and layouts - preparation of Reports and Estimates-Review of World Resources- Basic Factors in Economic Analysis of Hydropower projects-Project Feasibility-Load Prediction and Planned Development

UNIT- II DEVELOPMENT OF PROTO TYPE SYSTEMS 9

Advances in Planning, Design and Construction of Hydroelectric Power Stations-Trends in Development of Generating Plant and Machinery-Plant Equipment for pumped Storage Schemes-Some aspects of Management and Operations-Updating and Refurbishing of Turbines- case studies

UNIT – III SELECTION AND ANALYSIS OF TURBINES 9

Pelton,Francis and Kaplan Turbine Measurement of pressure head, Velocity-Various parameters for finding out the potential of Hydro energy-Selection of turbines based on specific quantities –case study.

UNIT - IV HYDRO POWER STATION OPERATION, MAINTENANCE AND TROBLE SHOOTING 9

Governing of Power Turbines-Functions of Turbine Governor-Condition for Governor Stability-Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing in Future- Planning, Design and Construction of Hydroelectric Power Stations-Remaining Life cycle analysis

UNIT–V SMALL, MINI AND MICRO HYDRO POWER PLANTS TURBINES 9

Introduction – analysis of micro hydro and mini hydro turbines – Economical and electrical aspects of small, mini and micro hydro turbines potential developments – design reliability of small, mini micro hydro turbines – case studies.

L:45; Total: 45

TEXT BOOKS:

1. P.K Nag “Power plant Engineering” Tata McGrawHill, New Delhi,2004

2. Domkundwar and Arora “a course inPower plant Engineering’’ Khanna publishers, New Delhi

REFERENCES:

1. L.Monition,M.Lenir and J.Roux,Micro Hydro Electric Power Station(1984)
2. AlenR. Inversin,Micro Hydro Power Source Book(1986)

YREOE2 ENERGY EFFICIENT BUILDING 3 0 0 3

UNIT - I INDOOR ENVIRONMENT 9

Introduction of Architecture as the art and science of designing. Building Science its significance indoor Environment. Components of Indoor Environment. Quality of Indoor Environment.

UNIT - II THERMAL ANALYSIS AND DESIGN FOR HUMAN COMFORT 12

Human comfort- Thermal, Visual, Acoustical and Olfactory comfort, comfort, En ergy and indoor Environment. Concept of Solar temperature and its significance. Calculation of instantaneous heat gain through building envelops. Calculation of solar radiation on buildings. Building orientation and significance. Introduction to design of shading devices (horizontal, vertical and egg-crate). Factors that affect energy use in buildings. Ventilation and its significance. Lighting and visual ability- Lighting system Design – Day lighting Economics.

UNIT - III SOLAR PASSIVE CONCEPTS FOR COOLING FOR BUILDINGS 8

Passive concepts- passive heating concepts, passive cooling concepts and passive heating & cooling concepts. passive concepts appropriate for the various climatic zones in India.

UNIT-IV ENERGY MANAGEMENT AND ENERGY AUDIT OF BUILDINGS 9

Introduction to energy management of buildings and energy audit of buildings. Aims of energy management of buildings. The historical and diagnostic energy audit, their objectives and benefits. Introduction energy management matrix monitoring and targeting. Building energy survey and audit report form.

UNIT V ENERGY EFFICIENT LANDSCAPE DESIGN 7

Modification of microclimate through landscape elements for energy conservation. Energy conservation through site selection, sitting & orientation. Energy conservation through integration of buildings and site, site planning and design.

L:45; Total:45

REFERENCES:

1. Sodha M. Bansal, N.K.bansal, P.K., Kumar. A, and Malik, M.A.S., “Solar Passive Buildings” Pergamon Press, 1986.
2. Evans, Martin, “ Housing , Climate and Comfort.” ISBN 0 85139 102 8, The Architectural Press, London, 1980.
3. Bureau of Indian standards, I.S. 11907- 1986 Recommendations for calculation of Solar Radiation Building, 1986.
4. Givoni,. B, “ Man, Climate and Architecture”, Elsevier, Amsterdam, 1986.
5. Smith Ajitha, D. ., “ Building Environment”, Tata McGraw Hill publishing company Limited, New Delhi, 1985
6. Robinette, G.O., (ed), “ Landscape Planning for Energy Conservation”. Van Nostrand Reinhold, New Yark, 1990.

MANDATORY COURSES – AUDIT COURSES

1. ENGLISH FOR RESEARCH PAPER WRITING

UNIT 1:- Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness **4**

UNIT 2:- Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction **4**

UNIT 3:- Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. **4**

UNIT 4:- key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, **4**

UNIT 5:- Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions **4**

UNIT 6:- useful phrases, how to ensure paper is as good as it could possibly be the first- time submission **4**

Suggested Studies:

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

2. DISASTER MANAGEMENT:-

UNIT 1:- Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude. **4**

UNIT 2:- Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts. **4**

UNIT 3:- Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics **4**

UNIT 4:- Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness. **4**

UNIT 5:- Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. **4**

UNIT 6:- Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India. **4**

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

3. SANSKRIT FOR TECHNICAL KNOWLEDGE

UNIT 1 :-

Alphabets in Sanskrit
Past/Present/Future Tense **8**
Simple Sentences

UNIT 2 :-

Order
Introduction of roots **8**
Technical information about Sanskrit Literature

UNIT 3:-

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics **8**

Suggested reading:-

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

4. VALUE EDUCATION:-

UNIT 1:-

1. Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
2. Moral and non- moral valuation. Standards and principles. **4**
3. Value judgements

UNIT 2 :-

1.Importance of cultivation of values.
2.Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
3.Honesty, Humanity. Power of faith, National Unity. **6**
4.Patriotism.Love for nature ,Discipline

UNIT 3:-

1.Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking.
2. Integrity and discipline.
3.Punctuality, Love and Kindness.
4.Avoid fault Thinking. **6**
5.Free from anger, Dignity of labour.
6.Universal brotherhood and religious tolerance.
7.True friendship.
8.Happiness Vs suffering, love for truth.
9. Aware of self-destructive habits.
10.Association and Cooperation.

11.Doing best for saving nature

UNIT 4:-
1.Character and Competence –Holy books vs Blind faith.
2.Self-management and Good health. **6**
3.Science of reincarnation.
4.Equality, Nonviolence ,Humility, Role of Women.
5.All religions and same message.
6.Mind your Mind, Self-control.
7.Honesty, Studying effectively

Suggested reading:-

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

5. CONSTITUTION OF INDIA:-

UNIT 1-
History of Making of the Indian Constitution:
History Drafting Committee, (Composition & Working) **4**

UNIT 2 –
Philosophy of the Indian Constitution:• Preamble Salient Features **4**

UNIT 3 –
Contours of Constitutional Rights & Duties:
1. Fundamental Rights
2. Right to Equality
3. Right to Freedom
4. Right against Exploitation **4**
5. Right to Freedom of Religion
6. Cultural and Educational Rights
7. Right to Constitutional Remedies
8. Directive Principles of State Policy
9. Fundamental Duties.

UNIT 4-
Organs of Governance:
1. Parliament **4**
2. Composition
3. Qualifications and Disqualifications
4. Powers and Functions
5. Executive
6. President
7. Governor
8. Council of Ministers
9. Judiciary, Appointment and Transfer of Judges, Qualifications
10. Powers and Functions

UNIT 5-
Local Administration:

1. District's Administration head: Role and Importance,
2. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.
3. Pachayati raj: Introduction, PRI: Zila Pachayat. **4**
4. Elected officials and their roles, CEO Zila Pachayat: Position and role.
5. Block level: Organizational Hierarchy (Different departments),
6. Village level: Role of Elected and Appointed officials,
7. Importance of grass root democracy

UNIT 6 –

Election Commission:

1. Election Commission: Role and Functioning. **4**
2. Chief Election Commissioner and Election Commissioners.
3. State Election Commission: Role and Functioning.
4. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested reading:-

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

6. PEDAGOGY STUDIES:-

UNIT 1 –

1.Introduction and Methodology
2.Aims and rationale, Policy background, Conceptual framework and terminology **4**
3.Theories of learning, Curriculum, Teacher education.
4.Conceptual framework, Research questions.
5.Overview of methodology and Searching.

UNIT 2-

1. Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
2. Curriculum, Teacher education. **2**

UNIT 3 –

1.Evidence on the effectiveness of pedagogical practices
2.Methodology for the in depth stage: quality assessment of included studies.
3.How can teacher education (curriculum and practicum) and the school **4**
4.curriculum and guidance materials best support effective pedagogy? Theory of change.
5.Strength and nature of the body of evidence for effective pedagogical
6.practices. Pedagogic theory and pedagogical approaches.
7.Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT 4-

1.Professional development: alignment with classroom practices and follow-up support
2.Peer support
3.Support from the head teacher and the community.
4.Curriculum and assessment **4**
5.Barriers to learning: limited resources and large class sizes

UNIT 5-

1. Research gaps and future directions

2.Research design
3.Contexts
4.Pedagogy
5.Teacher education
6.Curriculum and assessment 7.Dissemination and research impact. **2**

Suggested reading:-

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

7. STRESS MANAGEMENT BY YOGA:-

UNIT 1 –

Definitions of Eight parts of yog. (Ashtanga) **8**

UNIT 2-

Yam and Niyam.
Do`s and Don't's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha **8**
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT 3-

Asan and Pranayam
i) Various yog poses and their benefits for mind & body **8**
ii) Regularization of breathing techniques and its effectsTypes of pranayam

Suggested reading:-

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

8. PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

UNIT 1- Neetisatakam-Holistic development of personality
1.Verses- 19,20,21,22 (wisdom) **8**
2.Verses- 29,31,32 (pride & heroism)
3.Verses- 26,28,63,65 (virtue)
4.Verses- 52,53,59 (dont's)
5.Verses- 71,73,75,78 (do's)

UNIT 2-

1.Approach to day to day work and duties. **8**
2.Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,
3.Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
4.Chapter 18-Verses 45, 46, 48

UNIT 3-
Statements of basic knowledge. **8**
1.Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
2.Chapter 12 -Verses 13, 14, 15, 16,17, 18
Personality of Role model. Shrimad Bhagwad Geeta:
Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39
Chapter18 – Verses 37,38,63

Suggested reading:-

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

CURRICULUM AND SYLLABUS

REGULATIONS – 2022

(Applicable to the students admitted from the Academic year 2022-23)

SEMESTER I

Category	Code No.	Course Title	L	T	P	C	H
PCC	YRE101	Solar Energy Systems	3	0	0	3	3
PCC	YRE102	Wind, Ocean and Geothermal Energy Systems	3	0	0	3	3
PCC	YRE103	Process Modelling and Simulation in Energy Systems	3	0	0	3	3
PEC		Professional Elective – I	3	0	0	3	3
PEC		Professional Elective – II	3	0	0	3	3
PCC-L	YRE106	Solar Energy Laboratory	0	0	2	2	4
AICTE Mandatory Course*	YRM107	Research Methodology and IPR	2	0	0	2	2
AICTE - Audit**	YEGOE1	English for Research Paper Writing	2	0	0	0	2
PCC-L	YRE109	Process Modelling and Simulation Laboratory	0	0	2	2	4
	Total		**19**	**0**	**4**	**21**	**27**

SEMESTER II

Category	Code No.	Course Title	L	T	P	C	H
PCC	YRE201	Bio Energy Systems	3	0	0	3	3
PCC	YRE202	Computational Fluid Dynamics	3	0	0	3	3
PCC	YRE203	Electrical Energy Technology	3	0	0	3	3
PEC		Professional Elective – III	3	0	0	3	3
PEC		Professional Elective – IV	3	0	0	3	3
PCC-L	YRE206	Computational Fluid Dynamics Laboratory	0	0	2	2	4
PCC-L	YRE207	Bio Energy Laboratory	0	0	2	2	4
AICTE - Audit	YPSOE1	Constitution of India	2	0	0	0	2
	Total		**17**	**0**	**4**	**19**	**25**

SEMESTER III

Category	Code No.	Course Title	L	T	P	C	H
PROJ	YRE301	Dissertation Phase – I	0	0	10	10	20
PEC		Professional Elective - V	3	0	0	3	3
OEC		Open Elective Course	3	0	0	3	3
		Total	**6**	**0**	**10**	**16**	**26**

SEMESTER IV

Category	Code No.	Course Title	L	T	P	C	H
PROJ	YRE401	Dissertation Phase – II	0	0	16	16	32
		Total	**0**	**0**	**16**	**16**	**32**

Total Credits - 72

Legend

PCC – Professional Core Course

PEC- Professional Elective Course

OEC – Open Elective Course

PCC-L – Professional Core Course – Lab

PROJ – Project

* - Mandatory Course

**- Mandatory Course - Audit

Note:

1. The credit distribution is followed as per the guidelines given by AICTE/UGC.

Course type	Credits			Hours		
	L	T	P	L	T	P
Lecture course	3	0	0	3	0	3
Practical / Project course	0	0	1	0	0	2

LIST OF PROFESSIONAL CORE ELECTIVES

ELECTIVE GROUP - I:

Code No.	Course Title	L	T	P	C	H
YRE104A	Fluid Dynamics and Heat Transfer	3	0	0	3	3
YRE104B	Energy Conservation in HVAC	3	0	0	3	3
YRE104C	Fuels and Combustion Technology	3	0	0	3	3

ELECTIVE GROUP - II:

Code No.	Course Title	L	T	P	C	H
YRE105A	Environmental Engineering	3	0	0	3	3
YRE105B	Carbon Sequestration and Trading	3	0	0	3	3
YRE105C	Waste Management and Energy Recovery	3	0	0	3	3

ELECTIVE GROUP - III:

Code No.	Course Title	L	T	P	C	H
YRE204A	Optimum Utilization of Heat and Power	3	0	0	3	3
YRE204B	Statistical Tools for Data Analysis	3	0	0	3	3
YRE204C	Sustainable Development	3	0	0	3	3
YRE204D	Hydro Power Technology	3	0	0	3	3

ELECTIVE GROUP - IV:

Code No.	Course Title	L	T	P	C	H
YRE205A	Instrumentation Technology for Energy Systems	3	0	0	3	3
YRE205B	Hydrogen, Fuel cells and Nuclear Energy	3	0	0	3	3
YRE205C	Energy Modelling, Economics and Project Management	3	0	0	3	3
YRE205D	Energy Efficient Building	3	0	0	3	3

ELECTIVE GROUP - V:

Code No.	Course Title	L	T	P	C	H
YRE302A	Energy Audit and Management	3	0	0	3	3
YRE302B	Unit Operations in Industries	3	0	0	3	3
YRE302C	CAD/CAM and Simulation of Renewable Energy Systems	3	0	0	3	3
YRE302D	Industrial Safety	3	0	0	3	3

LIST OF OPEN ELECTIVE COURSES

Code No.	Course Title	L	T	P	C	H
YREOE1	Industrial Safety	3	0	0	3	3

Semester	**I**	
Course Name	**Solar Energy Systems**	
Course Code	**YRE101**	
L –T –P –C **3 – 0 – 0– 3**	**C:P: A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** proper solar radiation site	**K3**
CO2	***Design*** solar flat plate collectors	**K3**
CO3	***Design*** solar concentric collectors	**K3**
CO4	***Apply*** concepts related to solar energy storage systems	**K3**
CO5	***Apply*** the concepts for selection of PV systems	**K3**
CO6	***Apply*** the economics concepts for PV systems	**K3**

COURSE CONTENT

UNIT I	**SOLAR RADIATION**	**9 Hours**

Source of radiation – Sun earth relationship- extra terrestrial radiation.– Atmospheric attenuation – terrestrial radiation-radiation on a horizontal surfaces and inclined planes-relations between horizontal radiation and inclined surfaces – relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation-pyroheliometer, pyranometer, pyrogeometer, net pyradiometer-sunshine recorder – an overview of solar radiation data in India.

UNIT II	**SOLAR COLLECTORS – FLAT PLATE COLLECTORS**	**9 Hours**

Design considerations – classification- Flat plate collectors- air heating collectors liquid heating – Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors-for efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors. Solar green house. Solar tracking. solar kilns

UNIT III	**CONCENTRIC SOLAR COLLECTORS AND THERMAL APPLICATION**	**9 Hours**

Concentric collectors-Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats. Solar powered absorption A/C system (Ammonia/water) solar water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker.

UNIT IV	**SIMULATION AND ENERGY STORAGE**	**9 Hours**

Simulation in Solar Process Design- TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change- Glauber's salt-organic compounds -solar ponds.

UNIT V	**SOLAR PV SYSTEM**	**9 Hours**

Photovoltaic cell – characteristics -maximum power- tracking-cell arrays-power electric circuits for output of solar panels--inverters-batteries-charge regulators, Construction concepts. Latest trends in PV systems, Life cycle analysis of solar energy system time value of money, evaluation of carbon credit of solar energy system.

Lecture =45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. DuffieJ.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley& Sons Inc., Newyork, 1991
2. G.N. Tiwari."Solar Energy ; Fundamentals ,design,modelilg and applications " Third RePrint , Narosa Publishing House, New Delhi,2006

REFERENCE BOOKS

5. Edward E.Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pubCO.,1983.
6. Fank Kreith,,Jan F.Kreider,:Principles of solar Engg", 1978.
7. Koushika M.D," Solar Energy Principles and Applications", IBT publications and distributors, 1988.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	2	3
CO2	3	3	2	2	3	2	3
CO3	3	3	2	2	3	2	3
CO4	3	3	2	2	3	2	3
CO5	3	3	2	2	3	2	3
CO6	3	3	2	2	3	2	3
Tot	18	18	12	12	18	12	18

1 - Low, 2 – Medium, 3- High

Semester	I	
Course Name	WIND, OCEAN AND GEOTHERMAL ENERGY SYSTEMS	
Course Code	YRE102	
L –T –P –C 3 – 0 – 0– 3	C:P:A 3:0:0	L –T –P –H 3–0– 0 – 3

CO Number	CO STATEMENT	Knowledge Level
CO1	***Identify*** the wind resource assessment methods.	K3
CO2	***Develop*** the wind flow models.	K3
CO3	***Select*** the optimum design for variable operations of wind turbine	K3
CO4	***Choose*** the suitable site for the layout of wind farm.	K3
CO5	***Identify*** the electrical and control systems for wind energy conversion.	K3
CO6	***Categorize*** the ocean energy systems and geothermal energy systems	K4

Objectives

- Understand and apply basic concepts of hydrogen energy and storage cells.
- Apply the concept of nuclear energy for power generation by optimizing the design and following safety norms.
- Understand the concept of nuclear waste management and use proper techniques for efficient management.

COURSE CONTENT

UNIT I	WIND RESOURCE AND ASSESSMENT	9 Hours
	Introduction – Modern Wind Turbines – Betz Constant, Limit - Wind Resource – Wind vs. Traditional Generation – Technology Advancements – Material Usage – Wind Energy Penetration Levels – Applications. Wind Resource Assessment – Introduction – Characteristics of Steady Wind – Weibull Wind Speed Distribution Function – Vertical Profiles of the steady Wind – Wind Rose – Energy Pattern Factor – Energy Content of the Wind Resource Assessment.	
UNIT II	**AERODYNAMICS**	**9 Hours**
	Introduction – Aerofoil – Wind Flow Models – Axial Momentum Theory – Momentum Theory for a Rotating Wake – Blade Element Theory – Strip Theory – Tip Losses – Tip Losses Correction – Drag Translator Device – Wind Machine Characteristics.	
UNIT III	**WIND TURBINE, SITING AND WIND FARM DESIGN**	**10 Hours**
	Introduction – Classification of Wind Turbines – Turbine Components – Wind Turbine Design – Rotor Torque and Power – Optimum Design for Variable Operation – Influence of Reynolds Number – Cambered Aerofoils – Load Calculation – Cost Modelling – Power Control – Braking Systems – Turbine Blade design – Rotor Hub. Wind Flow Modelling – Capacity Factor – Planning of Wind Farm – Sitting of Wind Turbines – Ecological Indicators – Site Analysis – Methodology – Layout of Wind Farm – Initial Site Selection – Measure Correlate Predict (MCP) Technique – Micrositing – Wake Models.	
UNIT IV	**ECONOMICS , ELECTRICAL AND CONTROL SYSTEMS**	**9 Hours**
	Cost Calculation – Annual Energy Output (AEO) –Capital Recovery Factor – Depreciation – Life Cycle Costing – Environmental Impact - Biological Impact – Surface	

	Water and Wetlands – Visual Impact – Sound Impact – Communication Impact. Classification of Generators – Synchronous Generators – Induction Generator – Variable Speed Generators – Control Systems – Power Collection Systems – Earthing of Wind Farms – Embedded Wind Generation.	
UNIT V	**OCEAN AND GEOTHERMAL ENERGY SYSTEMS**	**8 Hours**
	Wave energy -Tidal changes – Ecological changes – Types Tidal Power – Energy from Sea – Tidal Turbines – Tidal Power Generation - Ocean thermal energy conversion (OTEC) - construction and operational problems – history of OTEC development Alternative energy technology - Problems and solutions - Recent Trends and Developments. A compulsory seminar / assignment on design / case study/analysis /application in any one of the Wind energy, Tidal and OTEC - Geothermal energy systems.	
Lecture = 45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS

1. Siraj Ahmed "Wind Energy Theory and Practice". June 2013.

2. S.N.Bhadra, D.Kastha, S.Banerjee,"Wind Electrical Systems", Oxford University,Press,2014.

3. Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Pvt. Ltd., New Delhi, 2011.

4. J. F. Manwell, J. G. McGowan and A. L. Rogers, "Wind Energy Explained – Theory, Design and Application", Wiley, 2009.

5. E.L Wakil "Power plant technology", McGrawGill Publishers,New York

6. G. D Rai "Non Conventional Energy sources" Khanna publishers. New Delhi

REFERENCES:

1. Freris. L. L., "Wind Energy Conversion Systems", Prentice Hall 1990.

2. Earnest Joshua, "Wind Power Technology", Second edition, PHI Learning Pvt. Ltd., New Delhi, 2015.

3. Spera D. A., "Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering", ASME Press, New York, 2009.

4. Voker Quashning, "Understanding Renewable Energy Systems", Earthscan, Second edition, 2016.

5. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, "Wind Energy Handbook" JOHN WILEY & SONS, LTD , Second Edition,2011.

6. S.Rao & B.B.Parulekar,"Energy Technology", 3rd edition,Khanna publishers,1995.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	3	3
CO2	3	3	2	2	3	3	3
CO3	3	3	2	2	3	3	3
CO4	3	3	2	2	3	3	3
CO5	3	3	2	3	2	2	3
CO6	3	3	2	2	2	2	3
Tot	18	18	12	13	16	16	18

1 - Low, 2 – Medium, 3- High

Semester	**I**	
Course Name	**PROCESS MODELLING AND SIMULATION IN ENERGY SYSTEMS**	
Course Code	**YRE103**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***solve*** problems related to modelling	**K3**
CO2	***solve*** problems related to different types of models such as lumped, distributed models and steady, dynamic state models	**K3**
CO3	***solve*** problems related to various systems involving variety of elements.	**K3**
CO4	***solve*** problems related to model building	**K3**
CO5	***solve*** problems related to Solution strategies for lumped parameter models	**K3**
CO6	***solve*** problems related to Solution strategies for distributed parameter models.	**K3**

Objectives

- To learn about the modelling
- To understand different types of models, systems and its elements
- To solve different types of modelling related problems
- To solve problems related to model building

COURSE CONTENT

UNIT I	**MODELLING**	**7 Hours**
	Introduction to modelling, a systematic approach to model building, classification of models. Modelling Techniques-Response function and Numerical methods-Conservation principles, thermodynamic principles of process systems	
UNIT II	**MODELS, SYSTEMS AND ELEMENTS**	**11 Hours**
	Introduction to development of steady state and dynamic lumped and distributed parameters models based on first principles, Analysis of ill-conditioned systems, Block diagrams and computer simulation, Modelling of process elements consisting of Mechanical (translational and rotational) electro- Mechanical, fluid flow, thermal and chemical reaction system elements	
UNIT III	**MODEL DEVELOPMENT**	**9 Hours**
	Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.	
UNIT IV	**SOLUTION STRATEGIES-I**	**9 Hours**
	Solution strategies for lumped parameter models. Stiff differential equations. Solution methods for initial value and boundary value problems. Euler's method. R-K method. shooting method, finite difference methods. Solving problems using MATLAB/ SCILAB	
UNIT V	**SOLUTION STRATEGIES-II**	**9 Hours**
	Solution strategies for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equations. Finite element and finite volume methods.	

Lecture = 45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. K.M. Hangos and I.T Cameron," Process Modelling and Model analysis".academic Press 2001.
2. W. L Luyben, " Process Modelling, Simulation and control for chemical Engineers" 2 nd Edn, McGraw Hill Book Co, New York,1990
3. W.F Ramirez " Computational Methods for Process Simulation" Butterworths,1995

REFERENCES
1. Mark E. Davis," Numerical Methods and Modelling for Chemical Engineers" JohnWiley &amp Sons,1984. 2. Singiresu S. Rao "Applied Numerical Methods for Engineers and Scientists" Prentice hall, Upper saddle River , NJ 2001 3. Francis vanek, Louis D. Albright," Energy systems Engineering" McGraw- Hill book Company, N.Y 2008 4. "Power System Engineering" 2 nd Ed.D.P Kothari, I.J. Nagrath, Tata MaGraw- Hill Co 2008

Mapping of COs with Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	2	3
CO2	3	3	2	2	3	2	3
CO3	3	3	2	2	3	2	3
CO4	3	3	2	2	3	2	3
CO5	3	3	2	2	3	2	3
CO6	3	3	2	2	3	2	3
Tot	18	18	12	12	18	12	18

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**SOLAR ENERGY LABORATORY**
Subject Code	**YRE106**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 2– 2	**0:1:0**	**0- 0– 2 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***identify*** the performance of various solar collectors.	**P3**
CO2	***identify*** the performance of various solar gadgets like air dryer, cooker and solar PV panels.	**P3**
CO3	***Experiment*** the Charging characteristics of a battery using Solar PV panel and various effects on it.	**P3**
CO4	***identify*** the direct normal, global horizontal irradiance and also solar tracking accuracy using solar energy gadgets.	**P3**
CO5	***Optimize*** the flow rate for maximum heat absorption using various samples.	**P3**
CO6	***Simulate*** PV cell using Matlab / Simulink software.	**P3**

Objectives

- Study the performance of solar thermal energy applications flat plate and concentric type collectors.
- Study the performance solar photovoltaic (PV) panels at different combinations and conditions.
- Study and Optimize the performance of various Solar energy gadgets.

- Model the Solar PV cell using software.

COURSE CONTENT

CO Relation

LIST OF EXPERIMENTS		CO
1.	Performance evaluation of solar flat plate collector	1
2.	Performance evaluation of concentrating solar collector	1
3.	Performance evaluation of solar box cooker	2
4.	Performance evaluation air dryer	2
5.	Performance evaluation of a solar PV panel in series and parallel combination	2
6.	Charging characteristics of a battery using PV panel	3
7.	Effect of tilt angle and Effect of shadow on solar PV panel	3
8.	Solar Energy Measurements - Pyrheliometer	4
9.	Solar Energy Measurements - Pyranometer	4
10.	Parabolic Trough -Flow Rate	4
11.	External Compound Parabolic Collector (XCPC) - Oil and Water	5
12.	Mathematical modeling of photovoltaic cell/module/arrays with tags in Matlab /Simulink	6

TOTAL HOURS - 30

TEXT BOOKS

1. DuffieJ.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley& Sons Inc., Newyork, 1991
2. G.N. Tiwari."Solar Energy ; Fundamentals ,design,modelling and applications " Third RePrint , Narosa Publishing House, New Delhi,2006

REFERENCES

1. Edward E.Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pub CO., 1983.
2. Fank Kreith,,Jan F.Kreider,:Principles of solar Engg", 1978.
3. Koushika M.D," Solar Energy Principles and Applications", IBT publications and distributors, 1988.
4. Kaushik S.C, Tiwari G. N and Nayak J.K,"Thermal control in passive solar buildings" .IBT Publishers & Distributors, 1988.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	1	2	2	3
CO2	2	3	3	1	2	2	3
CO3	2	3	3	1	2	2	3
CO4	2	3	3	1	2	2	3
CO5	2	3	3	1	2	2	3
CO6	2	3	3	1	2	2	3
Tot	12	18	18	6	12	12	18

COURSE CODE	COURSE NAME	L	T	P	C
YRM107	RESEARCH METHODOLOGY AND IPR	2	0	0	2

After completion of the course, a student will be able to

1. Identify and formulate a research problem, collect data, identify research gap for the identified problem
2. Able to consolidate literature survey and provide inference on own words
3. Describe Patents, Designs, Trade and Copyright
4. Appraise, discuss and categorize Patent Rights
5. Identify and describe new developments in IPR

UNIT I	6
Meaning of research problem, Sources of research problem, Criteria-Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	
UNIT II	**6**
Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	
UNIT III	**6**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	
UNIT IV	**6**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	
UNIT V	**6**
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	

	LECTURE	TUTORIAL	TOTAL
	30	0	30

REFERENCES

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
5. Mayall, “Industrial Design”, McGraw Hill, 1992.
6. Niebel, “Product Design”, McGraw Hill, 1974.
7. Asimov, “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				1	3	3	3
CO2				1	3	3	3
CO3				1	3	3	3
CO4				1	3	3	3
CO5				3	3	3	3

COURSE CODE	COURSE NAME	L	T	P	C
YEGOE1	ENGLISH FOR RESEARCH PAPER WRITING	2	0	0	0

UNIT I — **6**

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

UNIT II — **6**

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

UNIT III — **6**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV — **6**

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT V — **6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

LECTURE	TUTORIAL	TOTAL
30	0	30

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1			3	1	3	2	2
CO2			3	1	2	3	3
CO3			3	1	2	3	3
CO4			3	1	3	3	3
CO5			3	3	2	3	3

Semester	**I**	
Course Name	**Process Modelling and Simulation Laboratory**	
Course Code	**YRE109**	
L –T –P –C **0 – 0 – 2– 2**	**C:P:A** **0:1:0**	**L –T –P –H** **0–0– 2 – 4**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	*Code* root-finding algorithms	**K6**
CO2	*Code* integration algorithms	**K6**
CO3	*Simulate* Continuously Stirred Tank Reactor (CSTR) under gravity conditions	**K3**
CO4	*Simulate* Continuously Stirred Tank Reactor (CSTR) under 3D isothermal (open loop and closed loop) conditions	**K3**
CO5	*Simulate* Continuously Stirred Tank Reactor (CSTR) under 3D isothermal and nonisothermal conditions	**K3**
CO6	*Simulate* an inhouse biomass energy related problem.	**K3**

LABORATORY EXERCISES

1.Iterative bubble point calculation using “Newton-Raphson” optimization algorithm.

2.Iterative bubble point calculation using “interval-halving” algorithm.

3.First-order explicit Euler integration of a given function.

4.Runge-kutta integration algorithm of a given function.

5.Simulation of Gravity-flow tank simulation

6.Simulation of Three-isothermal CSTR (Open loop)

7. Simulation of Three-isothermal CSTR (closed loop)

8. Simulation of nonisothermal CSTR (Open loop)

9.Simulation of Root locus program for three-CSTR process.

10.Study of biomass gasification plant

11. Preparation of Process modelling system for biomass gasification plant

12. Simulation of Process modelling system for biomass gasification plant under varying load conditions.

Lecture = 0 Hours **Tutorial = 0 Hours** **Practical =30 Hours** **Total = 30 Hours**

REFERENCES

1.W. L Luyben, “Process Modelling, Simulation and control for chemical Engineers” 2 nd Edn, McGraw Hill Book Co, New York,1990

Mapping of COs with POs

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO1	3	3	3	1	0	2	2
CO2	3	3	3	1	0	2	2
CO3	3	3	3	1	0	2	2
CO4	3	3	3	1		2	2
CO5	3	3	3	1	0	2	2
CO6	3	3	3	1	0	2	2
Total	18	18	18	6	0	12	12

Semester	II	
Course Name	BIO ENERGY SYSTEMS	
Course Code	YRE201	
L –T –P –C 3 – 0 – 0– 3	C:P:A 3:0:0	L –T –P –H 3–0– 0 – 3

CO	CO STATEMENT	Knowledge Level
CO1	***Identify*** different Biofuel types and explain their properties	K3
CO2	***Summarize*** the Government Policies and status of bio fuel in India.	K3
CO3	***Categorize*** Biomass types and explain their properties and applications	K4
CO4	***Develop*** bioenergy conversion through biochemical route.	K3
CO5	***Develop*** bioenergy conversion through thermochemical route.	K3
CO6	***Plan*** to improve the thermal efficiency by designing suitable systems for heat recovery and co-generation	K3

Objectives

- Describe the fundamentals of biofuel types and their generations.
- Identify the sources and definitions used for biomass and basic biomass conversion.
- Clearly define the extent of bioenergy use worldwide and the incentives or disincentives for use in India.
- Detail the digestion and fermentation Technologies in biogas plants.
- Detail the combustion and Gasification Technologies in common use.
- Describe the power generation scenario, the layout components of power plant and analyze Cogeneration cycle.

COURSE CONTENT

UNIT I	BIO FULES	9 Hours
	Bio fuels: types, Properties and sources- Bio fuels first, second and third generation production processes and technologies- Bio diesel comparison with diesel - Biofuel applications – Bio diesel and Ethanol as a fuel for I.C. engines – Relevance with Indian Economy - Bio-based Chemicals and Materials - Commercial and Industrial Products - Govt. Policy and Status of Bio-fuel technologies in India.	
UNIT II	**CHARACTERISATION OF BIOMASS**	**9 Hours**
	Biomass: Sources and Classification. – Properties - Energy plantation - Preparation of biomass. Size reduction- Briquetting of loose biomass - Drying, storage and handling of biomass. Conversion of biomass. Biomass processing for liquid and gaseous fuel production. Effect of particle size, temperature, on products obtained – Processing of various biomass for gas production for Thermal and Electrical application.	
UNIT III	**BIOGAS TECHNLOGY**	**9 Hours**
	Feed stock for biogas production, animal residues, Aqueous wastes containing biodegradable organic matter- Microbial and biochemical aspects- factors and operating parameters for biogas production- Kinetics and mechanism-Dry and wet fermentation. Digesters-types-digesters for rural application – High rate digesters for industrial waste water treatment	
UNIT IV	**GASIFICATION OF BIOMASS**	**9 Hours**
	Thermo chemical Principles: Effect of pressure, temperature and introducing, steam and oxygen. Design and operation of fixed and fluidized bed Gasifier, circulating fluidized bed gasifiers, Safety aspects, operating characteristics of moving bed and fluidized bed gasifier- different types- advantages and disadvantages- performance analysis of gasifiers.	
UNIT V	**COMBUSTION OF BIOMASS & COGENERATION SYSTEMS**	**9 Hours**
	Combustion of woody biomass – theory, calculations and design of equipment, Cogeneration in biomass processing industries. – Economic Case studies: Combustion of rice husk. Use of bagasse for cogeneration.	

Lecture =45 Hours	Tutorial = 0 Hours	Total = 45 Hours

TEXT BOOKS

1. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilisation of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.
2. Mittal K.M "Biogas Systems: "Principles and Applications" New age international publishers (P) Ltd 1996, Nijaguna, B.T Biogas Technology, New age International publishers (P) Ltd

REFERENCE BOOKS

1. Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", ISBN 81-85419- 25-6, Tata Energy Research Institute, 1996.
2. Klass D.L and Emert G.M, "Fuels from Biomass and Wastes", Ann Arbor Since Publ. Inc. Michigan, 1985.
3. O.P.Chawla, "Advances in Bio-gas Technology" I.C.A.R., New Delhi, 1970.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	2	1
CO2	2	1	1	3	3	3	3
CO3	2	2	2	1	2	1	3
CO4	2	2	2	1	2	1	3
CO5	2	2	2	1	2	1	3
CO6	3	3	2	1	3	2	2
Total	14	12	10	9	13	10	15

Semester	**II**	
Course Name	**ELECTRICAL ENERGY TECHNOLOGY**	
Course Code	**YRE203**	
L –T –P –C **3- 0– 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3- 0– 0 – 3**

Course Outcome		**Domain/Level C or P or A**
CO1	***Demonstrate*** the power system and its fundamentals.	K2
CO2	***Illustrate*** the various electric energy conversion devices and its applications.	K2
CO3	***Classify*** various Solid-state Power Converters and drives and its importance.	K2
CO4	***Demonstrate*** the various Hybrid Power generation methods and its importance.	K2
CO5	***Demonstrate*** the various Smart grid systems and its importance.	K2
CO6	***Relate*** various Power quality improvements methods and its significances.	K2

The objective of this course

- To learn about work various power system components.
- To learn about application of various electric energy conversion devices
- To classify about various Power converters and drives.
- To understand the various methods of hybrid power generation and power quality improvement.

COURSE CONTENT		
UNIT I	**POWER SYSTEM FUNDAMENTALS**	**7 HRS**
	Single line representation – power flow study – power factor improvement, Protection, types of relays, symmetrical components, asymmetrical components, Introduction: Hybrid power system. HVDC - introduction, various coupling methods.	
UNIT II	**ELECTRIC ENERGY CONVERSION DEVICES**	**9 HRS**
	Transformers – Parallel operation, auto transformers, DC machines, Applications of DC machines – performance equation - generator characteristics - motor characteristics – applications of Synchronous machines - alternators – Induction machines.	
UNIT III	**SOLID-STATE POWER CONVERTERS AND DRIVES**	**9 HRS**
	Controlled rectifiers, choppers, inverters, voltage regulators and cyclo -converters. Speed control of dc motors and ac motors – converter fed chopper –fed control Inverter –ac voltage regulators, VFD.	
UNIT IV	**HYBRID POWER GENERATION**	**6 HRS**
	Types of hybrid systems, Integration issues - Steady state performance of Wind-driven induction generators. Grid connected solar photo voltaic system - line commutated converters - Boost converters- selection of inverter. Three phase AC voltage controllers for wind power plants - uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.	
UNIT V	**SMART GRIDS**	**3 HRS**
	Micro Grids, Intelligent Grids, Smart grids, Phase Monitoring Unit (PMU), Case studies	
UNIT V	**POWER QUALITY IMPROVEMENT**	**11 HRS**
	Introduction – Characterisation of Power Quality, impacts, Types of Harmonic filters: passive, Active and hybrid filters. Custom power devices: Load compensation using STATCOM / DSTATCOM, Voltage regulation. FACT controlled devices, DVR. UPQC control strategies, UPFC, P-Q theory, Status of application of custom power devices.	
Lecture = 45 hrs Tutorial = 0 hrs Practical=0 hrs Total = 45 hrs		

TEXT BOOKS

1. John J Graigner and W.D Stevenson “Power system analysis” McGrawHill publishinig company, 1994.
2. T.JE. Miller “FACT controlled device” Johan willey Publications.
3. M.H.Rasheed “Power Electronics” Tata Mc Graw Hill.
4. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, kluwer Academic Publishers, 2002.

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3	2	1	3
CO2	3	2	3	2	2	1	2
CO3	3	2	3	2	2	1	2
CO4	3	2	3	3	2	1	3
CO5	3	1	3	3	2	1	3
CO6	3	3	3	2	2	1	2
Total	**18**	**12**	**18**	**15**	**12**	**6**	**15**

Semester	**II**	
Course Name	**Computational Fluid Dynamics Laboratory**	
Course Code	**YRE206**	
L –T –P –C **0 – 0 – 2– 2**	**C:P:A** **1:0:0**	**L –T –P –H** **0–0– 2 – 4**

CO	**CO STATEMENT**	**Knowledge Level**
CO1	*Simulate* lid-driven cavity and convection process	**K3**
CO2	*Simulate* incompressible laminar fluid flow problems in pipe	**K3**
CO3	*Simulate* incompressible turbulent fluid flow problems in pipe	**K3**
CO4	*Simulate* wind turbine models in compressible fluid flow environment	**K3**
CO5	*Simulate* draining tank, falling ball experiments and CSTR.	**K3**
CO6	*Explain* various convection aspects of Renewable Energy systems.	**K3**

List of Experiments

1. Simulation of lid-driven cavity.
2. Simulation of heat convection for 3D radiator.
3. Incompressible laminar fluid flow simulation in elbow pipe.
4. Incompressible laminar fluid flow simulation in T-shaped pipe.
5. Incompressible turbulent fluid flow simulation in elbow pipe.
6. Incompressible turbulent fluid flow simulation in T-shaped pipe.
7. Wind Turbine simulation.
8. Draining of a 3D fluid filled tank.
9. Falling ball experimental simulation.
10. Simulation of 3D CSTR.
11. Study of Natural convection in Renewable energy systems.
12. Study of forced convection in Renewable Energy systems.

Lecture = 0 Hours **Tutorial = 0 Hours** **Practical =30 Hours** **Total = 45 Hours**

REFERENCES

1. https://cfd-training.com/2018/08/12/turbulent-flow-in-a-90-bend/
2. https://www.openfoam.com/documentation/tutorial-guide/

Mapping of COs with PO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	3	1	1
CO2	3	3	2	2	3	1	1
CO3	3	3	2	2	3	1	1
CO4	3	3	2	2	3	1	1
CO5	3	3	2	2	3	1	1
CO6	3	3	2	2	3	1	1
Total	18	18	12	12	18	6	6

1 - Low, 2 – Medium, 3- High

Semester	**I**
Subject Name	**BIO ENERGY LABORATORY**
Subject Code	**YRE207**

L –T –P –C	**C:P:A**	**L –T –P –H**
0- 0 – 2– 2	**0:1:0**	**0- 0– 2 – 4**

Course Outcome		**Domain/Level C or P or A**
CO1	***Calibrate*** the performance of Flue gas analysis and properties of given sample.	**P3**
CO2	***identify*** the chemical, Biological oxygen demand and calorific values of given fuel.	**P3**
CO3	***identify*** the Effect P_H levels on total dissolved solids	**P3**
CO4	***identify*** effect of milling time and particle size.	**P3**
CO5	***identify*** High Heating Value of given sample.	**P3**
CO6	***Demonstrate*** the operations in briquetting, biomass gasifier and biomethanation plant.	**P3**

Objectives

- Study the performance of Flue gas analysis
- Study the performance Bio fuels Flash point, Fire point and Calorific value

COURSE CONTENT

CO Relation

LIST OF EXPERIMENTS		**CO**
1.	Flue gas analysis – IC engine and gasifier	1
2.	Determine the Density and Specific Gravity of a given sample	1
3.	Proximate and Ultimate analysis of given sample	1
4.	Analysis of chemical oxygen demand (COD)	2
5.	Analysis of biological oxygen demand (BOD)	2
6.	Determining the Flash point, Fire point and Calorific value of Biofuel	2
7.	Effect of P_H on total dissolved solids (TDS)	3
8.	Determine the effect of milling time on the Particle size and size reduction of given sample using Ball milling machine	4
9.	Determine the higher heating value (HHV) of unleaded gasoline (or a similar fuel	5

	supplied by the instructor) using the adiabatic oxygen bomb calorimeter.	
10.	Briquetting operation demonstration and study	6
11.	Biomethanation plant demonstration and study	6
12.	2kW Biomass gasifier demonstration and study	6

TOTAL HOURS - 30

TEXT BOOKS

1. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilisation of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.
2. Mittal K.M "Biogas Systems: "Principles and Applications" New age international publishers (P) Ltd 1996, Nijaguna, B.T Biogas Technology, New age international publishers (P) Ltd

REFERENCES

1. Venkata Ramana P and Srinivas S.N, "Biomass Energy Systems", ISBN 81-85419- 25-6, Tata Energy Research Institute, 1996.
2. Klass D.L and Emert G.M, "Fuels from Biomass and Wastes", Ann Arbor Since Publ. Inc. Michigan, 1985.
3. O.P.Chawla, "Advances in Bio-gas Technology" I.C.A.R., New Delhi, 1970.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	3	1	2	1
CO2	3	3	2	2	1	2	1
CO3	3	3	2	2	1	2	1
CO4	3	3	3	3	1	2	3
CO5	3	2	3	3	1	2	1
CO6	3	3	2	2	1	2	1
Tot	18	15	15	15	6	12	8

COURSE CODE	COURSE NAME	L	T	P	C
YPSOE1	CONSTITUTION OF INDIA	2	0	0	0
UNIT I HISTORY AND PHIOLOSOPHY					6
History of Making of the Indian Constitution: History-Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble-Salient Features					
UNIT IICONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES:					6
Fundamental Rights -Right to Equality-Right to Freedom-Right against Exploitation-Right to Freedom of Religion-Cultural and Educational Rights-Right to Constitutional Remedies-Directive Principles of State Policy-Fundamental Duties.					
UNIT IIIORGANS OF GOVERNANCE:					6
Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive-President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications-Powers and Functions					

UNIT IVLOCAL ADMINISTRATION	6
District's Administration head: Role and Importance, -Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	
UNIT VELECTION COMMISSION:	**6**
Election Commission: Role and Functioning. -Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	

	LECTURE	TUTORIAL	TOTAL
	30	0	30

REFERENCES

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

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1				3		1	1
CO2				3		1	1
CO3				3		1	1
CO4				3		1	1
CO5				3		1	1

PROFESSIONAL CORE ELECTIVES

Semester	**I**	
Course Name	**FLUID DYNAMICS AND HEAT TRANSFER**	
Course Code	**YRE104A**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***solve*** problems related to Fluid flow	**K3**
CO2	***solve*** problems related to different types of Fluid flow	**K3**
CO3	***Solve*** problems related to heat transfer variety of elements.	**K3**
CO4	***solve*** problems related to turbulent flow heat transfer in closed conduits	**K3**
CO5	***solve*** problems related to Heat transfer with liquid metals	**K3**

CO6	***solve*** problems related to heat exchanger	**K3**

COURSE CONTENT

UNIT I	**INTRODUCTION**	**8 Hours**
	Basic equations and flow of non-viscous fluids – Fluid and Fluid Properties – The differential equation of fluid flow – Flow of Non viscous fluids	
UNIT II	**VISCOUS AND INCOMPRESSIBLE FLUID FLOW**	**11 Hours**
	The flow of viscous fluids – Laminar flow in closed conduits – turbulence – Dimensional analysis and its application to fluid dynamics – Turbulent flow in closed conduits – the laminar sub layer - Flow in the entrance section of closed conduits – Flow of incompressible fluids past immersed bodies.	
UNIT III	**CONVECTIVE HEAT TRANSFER THROUGH FLUIDS**	**10 Hours**
	The convection-heat – transfer coefficient – Dimensional Analysis in convection heat transfer – Heat transfer during laminar flow in closed conduits – turbulent flow heat transfer in closed conduits – Empirical correlation for high – Prandtl – Number fluids.	
UNIT IV	**CONVECTIVE HEAT TRANSFER THROUGH LIQUID METALS**	**8 Hours**
	The analogy between momentum and heat transfer – Heat transfer with liquid metals – Heat transfer during incompressible flow past immersed bodies.	
UNIT V	**DESIGN OF HEAT EXCHANGERS**	**8 Hours**
	Recent development in the designing of heat exchanger – Plate heat exchanger – run around coils – heat pipes – regenerators - effectiveness of heat exchanger. Flow in the shell side of multitude heat exchangers	

Lecture = 45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. James G. Knudsen, Donald L. Katz., "Fluid Dynamics and Heat Transfer", 1958, Mc Graw Hill Publishers

REFERENCES

1. Kern D.C., "Process Heat Transfer", Mc Graw Hill Publishers.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	0	0	2	2
CO2	3	2	2	0	0	2	2
CO3	3	2	2	0	0	2	2
CO4	3	2	3	0	0	2	1
CO5	2	2	2	0	0	1	1
CO6	2	2	2	0	0	1	1
Total	16	12	13	0	0	10	9

Semester	**I**	
Course Name	**ENERGY CONSERVATION IN HVAC**	
Course Code	**YRE104B**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***solve*** problems related to HVAC system components	**K3**
CO2	***solve*** problems related to Air conditioning systems	**K3**
CO3	***solve*** problems related to Thermal Properties and Energy	**K3**
CO4	***solve*** problems related to Estimation Of Building Loads	**K3**
CO5	***solve*** problems related to factors affecting the energy use	**K3**
CO6	***solve*** problems related to modelling and simulation in buildings	**K3**

COURSE CONTENT

UNIT I	**DESIGN OF HVAC SYSTEM COMPONENTS**	**9 Hours**

Vapour compression Systems-Refrigerant properties- Energy Efficient compressor-Condensers-Evaporators-expansion devices- Cooling Systems other auxiliaries-Design and Analysis for Energy conservation- Case Studies- VAR Systems- Utilization of Waste heat and other sources- Analysis for Energy Efficiency Ratio.

UNIT II	**AIR CONDITIONING SYSTEMS**	**9 Hours**

Psychrometry – Comfort conditions -Types of A/c Systems- Energy conservation of Humidifiers, Air Washers- Air distribution and handling systems-Controls for AHU-Passive and Active A/c Systems-Thermal Properties and Energy content of Building materials.

UNIT III	**ESTIMATION OF BUILDING LOADS**	**9 Hours**

Steady state method – Network method-Numerical method – correlations – computer packages for carrying out thermal design of buildings and predicting performance- Thermal comfort – Ventilation and air quality – Air conditioning requirement – Visual perception –Illumination Requirement – Auditory requirement – Energy Management Options – Energy Audit and Energy Targeting – Technological Options for Energy Management-standards on indoor parameters.

UNIT IV	**FACTORS AFFECTING THE ENERGY USE**	**9 Hours**

Factors that affect energy use in building- functional factors, environmental factors-Envelope factors-Air conditioning system factors- Energy source factors and Electrical systems factors- Fenestration design for optimal day lighting- Lighting and Visual ability – Light sources and Luminaries – Lighting System- Design-Day lighting-Day light factors- Luminance Efficacies- CRI for Lighting source and Usage- Economics and Aesthetics.

UNIT V	**MODELLING AND SIMULATION**	**9 Hours**

Evaluation of natural ventilation in buildings, determination of probable indoor wind speed and direction- Ventilation heat transfer - Solar-air temperature-Introduction to Natural and artificial

ventilation simulation systems- Energy Calculations- Degree Days procedure- BIN methods- Comprehensive simulation methods
Lecture = 45 Hours Tutorial = 0 Hours Total = 45 Hours
TEXT BOOKS / REFERENCE BOOKS
1. Faye C. McQuiston and Jerald D. Parker " Heating, Ventilating and Air Conditioning – Analysis and Design", 4th Edition, John-Wiley & Sons, Inc, NewYork.1994. 2. C.P.Arora " Refrigeration and Air-conditioning", Tata-McCraw Hill Publishers, New Delhi **REFERENCES:** 1. J.Krieder and A.Rabi "Heating and Cooling of Buildings. Design for Efficiency Mcgraw Hill (1994). 2. J.R.Williams, Passive Solar Heating, Ann Arbar Science(1983). 3. R.W.Jones, J.D.Balcomb, C.E.Kosiewiez, G.S.Lazarus, R.D.Mc Farland and W.O.Waray, Passive Solar Design Handbook, Vol.3 Report of U.S. Department of Energy (DOE/CS-0127/3) (1982).

CO- PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	0	0	2	3
CO2	3	2	2	0	0	2	3
CO3	3	2	2	0	0	2	3
CO4	3	2	3	0	0	2	3
CO5	2	2	2	0	0	1	2
CO6	2	2	2	0	0	1	2
Total	16	12	13	0	0	10	16

Semester	**I**	
Course Name	**FUELS AND COMBUSTION TECHNOLOGY**	
Course Code	**YRE104C**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***solve*** problems related to fuels, fuel analysis	**K3**
CO2	***solve*** problems related to combustion stoichiometry fuels & fuel analysis	**K3**
CO3	***solve*** problems related to various systems involving variety of elements.	**K3**
CO4	***solve*** problems related to flame, flame structure, ignition and ignitors	**K3**
CO5	***solve*** problems related to basics of furnaces	**K3**

CO6	***solve*** problems related to coal burning equipment	**K3**

COURSE CONTENT

UNIT I	**FUELS, FUEL ANALYSIS & COMBUSTION STOICHIOMETRY FUELS & FUEL ANALYSIS:**	**8 Hours**
	Types of fuel-Physical and chemical characteristics of solid, liquid, and gaseous fuels-Nonconventional fuel-producer gas, hydrogen, biogas etc- Determination of Calorific values-Ultimate and proximate analysis-problems associated with handlings, storage and combustion	
UNIT II	**COMBUSTION STOICHIOMETRY**	**10 Hours**
	Stoichiometry relations – conservation of mass principles – theoretical & actual combustion processes – calculation of air fuel ratio for a fuel of known combustion – calculation of flue gas composition of fuel and excess air supplied from exhaust gas analysis – combustion calculation with sub- stoichiometry air – calculation of atmospheric air moisture – Dew point temperature of the combustion products – Flue gas analysis- Boiler performance analysis **COMBUSTION KINETICS:** Degree of reactions-reactions equilibrium-Laws of mass action-criteria of equilibrium-heat and temperature-Gibbs free energy – equilibrium constant-Vant hoffs isotherm – rate of reaction-factors affecting rate of reaction-calculation of equilibrium constant and composition of reating systems .	
UNIT III	**FLAME, FLAME STRUCTURE, IGNITION AND IGNITORS**	**10 Hours**
	Flame – flame structure – flame propagation – deflagaration – detonations – flame front – Ignition – self & forced ignition – Ignition temperature & ignition limits – Factors influencing ignition – SIT – Ignition lag – limits of inflammability & its determination – factors affecting inflammability limits – calculation of inflammability limits – flame blow off, blow out & flash back – flame quenching, Flame structure – flame stability – premixed & diffused flames – velocity of flame propagation – various methods of flame stabilization – swirl number & its significance – Turndown ratio – Ignitors – various types of ignitors – NFPA class I, II & III ignitors – Eddy plate ignitor – plasma ignitor – High energy Arc ignitor – DIPC ignitor.	
UNIT IV	**BASICS OF FURNACES**	**10 Hours**
	Industrial furnaces – process furnaces Steam generating furnaces – Kilns – Batch & continuous furnaces – Advantages of ceramic coating – Heat source – Distributions of head source in furnaces – Blast furnace – open hearth furnace – pot & crucible furnaces – waste heat recovery in furnaces – Recuperator – Regenerators – Furnace atmospheres – Furnace Insulation – Furnace Heat balance calculations, Pipe still Heater.	
UNIT V	**COAL BURNING EQUIPMENT**	**7 Hours**
	Coal burning methods – over feed & underfeed supply of coal – Mechanical Stokers – Travelling grate & spreader stoker – vibrating grate stoker – Advantages & disadvantages of stoker firing over pulverized systems of firing – problems encountered with burning of high ash coal. Pulverized fuel burners – streamlined burner – turbulent burners – Tangential burner – cyclone burner – special type burners. A compulsory seminar / Assignment on design /case study / Analysis/ Application in any one of the combustion system and accessories (viz Burner,Draught etc)	

Lecture =45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

Text Books
1. Dr. SamirSarkar, "Fuels & Combustion", Orient Longman, Second edition, 1990. 2. Gupta O.P. "Elements of Fuels, Furnaces & Refractories", 3rd edition, Khanna Publishers, 1996. **REFERENCES** 1. S.P. Sharma & Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co.Ltd., 1984 2. J.D. Gilchrist, "Fuels, Furnaces & Refractories", Pergamon Press, ISBN-008-029430-9 3. Blokh A.G. "Heat Transmission in Steam Boiler furnaces", Hemisphere Publishing Corpn.ISBN-089-116-626-2

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	0	0	2	2
CO2	3	2	2	0	0	2	2
CO3	3	2	2	0	0	2	2
CO4	3	2	3	0	0	2	1
CO5	2	2	2	0	0	2	1
CO6	2	2	2	0	0	2	1
Total	16	12	13	0	0	12	9

Semester	**I**	
Course Name	**ENVIRONMENTAL ENGINEERING**	
Course Code	**YRE105A**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	*Recognize* various biotic and abiotic environmental transformation processes of pollutants.	**K3**
CO2	*Identify* air pollution problems and interpret air quality data on chemical characteristic.	**K3**
CO3	*Understand* the importance of various microbial processes in wastewater treatment.	**K3**
CO4	*Assess* the bacteriological status of water and aquatic systems.	**K3**
CO5	*Understand* the importance of various microbial processes in Solid Waste Disposal treatment.	**K3**

CO6	*justify* the use of pollution control equipment and their design.	**K3**

Objectives

- To inculcate among student sensitivity towards social and corporate responsibilities.
- To understand the transformation and degradation of organic pollutants in the environment.
- To understand different types of pollutions in the environment.
- To impart knowledge on soil sciences and develop understanding about pollutants fate and partitioning processes in soil.
- To understand the role of various microbes in waste water treatment.

COURSE CONTENT

UNIT I	**ENVIRONMENTAL POLLUTION**	**10 Hours**
	Mass and energy transfer – units of measurements, material balance and energy fundamentals – Environmental chemistry stoichiometry, chemical equilibria. Mathematics of growth – exponential growth, resource consumption and population growth, resource consumption and population growth – problems. Atmosphere – Regions of atmosphere – Earth's natural atmosphere – consequences of population growth – classification of pollution – pollution of Air, Water & Soil – Effect of pollutants on living system – Environmental legislation.	
UNIT II	**AIR POLLUTION CONTROL METHODS & EQUIPMENT**	**10 Hours**
	Sources of air pollution –classification & properties of air pollutants – scales of concentration – Effects of air pollution – meteorological aspects of air pollution – urban air pollution – carbon-di-oxide & climate change – Acid deposition – Industrial air pollution – Automobile air pollution – Sampling, measurement and analysis of air pollutants such as SOx, NOx, CO, NH_3, CnHn, SPM, Opacity, Volatile organic compounds, Trace metals.	
UNIT III	**WATER POLLUTION**	**09 Hours**
	Water Sources – Origin of waste water – Classification of Water Pollutions – Effects of water pollutants – Water Pollution Laws and Standards – Water Pollution & Health – Waste Water Sampling – BOD – COD analysis – Waste Water Treatment – primary treatment – secondary treatment – Advanced waste water treatment – Anaerobic Digestion. Desalination – micro filtration – ultra filtration – Reverse Osmosis.	
UNIT IV	**SOLID WASTE DISPOSAL**	**09 Hours**
	Solid waste- Sources, types, Compositions and Properties - Land Fill Method of Solid Waste Disposal – Land Fill Classification, Types, Methods and Sitting Consideration – Layout and Preliminary Design of Land Fills – Composition, Characteristics, generation, Movement and Control of Landfill Leach ate and Gases – Environmental Monitoring System for Land Fill Gases.	
UNIT V	**OTHER TYPES OF POLLUTION**	**07 Hours**
	Noise Criteria - Noise Sources - Noise Control Measures - Thermal Pollution - Oil pollution –Pesticides - Radioactivity Pollution control - Tanneries and other Industries and their control	

Lecture = 45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS
1.James Gilbert M.Masters, "Introduction to Environmental Engineering And Science", 2nd edition, Prentice Hall, 1998. 2.Rao C.S Environmental Engineering and Pollution Control, 1st edition, New Age International Publishers, 1991.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	3	2	3
CO2	3	2	1	2	3	3	3
CO3	3	2	2	1	2	2	3
CO4	3	2	2	1	2	2	3
CO5	3	2	2	1	1	2	3
CO6	3	2	2	3	3	3	3
Total	18	12	11	10	14	14	18

Semester	**I**	
Course Name	**CARBON SEQUESTRATION AND TRADING**	
Course Code	**YRE105B**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** the greenhouse gas concentration and analyses their impacts.	**K3**
CO2	***Examine*** the potential for carbon sequestration	**K4**
CO3	***Distinguish*** risk management and risk reduction techniques.	**K4**
CO4	***Develop*** suitable carbon economics for sustainability.	**K3**
CO5	***Interpret*** case studies for optimized carbon trading models.	**K5**
CO6	***Apply*** rules and regulations as best practice for managing public issues.	**K3**

Objectives

- Understand the problem of greenhouse gas and analyse the cause and effects.
- Apply principles for carbon Sequestration
- Manage risk associated with carbon trading and apply rules and regulation for problems.

COURSE CONTENT

UNIT I	**GREENHOUSE GAS**	**9 Hours**
	Stabilization of greenhouse gas concentrations – greenhouse gas risks and reservoirs – green gas mitigation – Carbon di oxide and climate change, acid rain, global warming, impacts of global warming-Kyeto-procal.	
UNIT II	**CARBON**	**9 Hours**
	Practices for sequester carbon - car bon sequestration types – carbon credits – carbon testing – potential for carbon sequestration.	
UNIT III	**MANAGEMENT**	**9 Hours**
	Risk management and risk reduction – carbon economics – Verification of carbon change.	

UNIT IV	**CASE STUDIES**	**9 Hours**
	Carbon trading model – Century Model – Case Studies.	
UNIT V	**RULES AND REGULATIONS**	**9 Hours**
	Implication Methanol and Nitrous Oxide carbon bank – Best Management Practices Publics issues – policies.	
Lecture = 45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS

1. Emission Trading:Environmental Policies New approach-Richard F. Kosobud, Douglas L. Schreder, Holly M. Biggs Published 2000 John Wiley and Sons.

REFERENCES

1. Agricultural Practices and Policies for Carbon Sequestration in Soil By John M. Kimble, Rattan Lal Published 2002 CRC Press
2. The Impact of Carbon Dioxide and Other Greenhouse Gases on Forest Ecosystems By David F. Karnosky Published 2001 CABI Publishing.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	2	3	2	3
CO2	2	2	1	2	2	3	3
CO3	2	2	2	1	2	3	3
CO4	2	2	2	1	2	3	3
CO5	2	2	2	1	1	2	3
CO6	2	2	2	2	3	3	3
Total	12	12	11	9	13	16	18

Semester	**I**	
Course Name	**WASTE MANAGEMENT AND ENERGY RECOVERY**	
Course Code	**YRE105C**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Categorize*** the different types and properties of solid waste	**K4**
CO2	***Develop*** appropriate methods for size reduction and composting	**K3**
CO3	***Analyze*** the environmental effects of incineration	**K4**
CO4	***Organize*** methods for efficient waste disposal.	**K3**
CO5	***Categorize*** the types hazardous waste and illustrate the management techniques and disposal methods.	**K4**
CO6	***Apply*** appropriate principles for energy generation from waste	**K3**

Objectives

- Understand the different sources of wastages and their properties.
- Apply principle for energy generation from the waste.

COURSE CONTENT

UNIT I	**SOLID WASTE**	**9 Hours**
	Definitions – Sources, types, Compositions, Properties of Solid Waste – Municipal Solid Waste – Physical, Chemical and Biological Property – Collection – Transfer Stations – Waste Minimization and Recycling of Municipal Waste.	
UNIT II	**WASTE TREATMENT**	**9 Hours**
	Size Reduction – Aerobic Composting – Incineration – Furnace Type and Design, Medical/Pharmaceutical Waste Incineration – Environmental Impacts – Measures of Mitigate Environmental Effects due to Incineration	
UNIT III	**WASTE DISPOSAL**	**9 Hours**
	Land Fill Method of Solid Waste Disposal – Land Fill Classification, Types, Methods and Sitting Consideration – Layout and Preliminary Design of Land Fills – Composition, Characteristics, generation, Movement and Control of Landfill Leachate and Gases – Environmental Monitoring System for Land Fill Gases.	
UNIT IV	**HAZARDOUS WASTE MANAGEMENT**	**9 Hours**
	Definition and Identification of Hazardous Waste – Sources and Nature of Hazardous Waste – Impact on Environment – Hazardous Waste Control – Minimization and Recycling Assessment of Hazardous Waste – Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation and Closure.	
UNIT V	**ENERGY GENERATION FROM WASTE**	**9 Hours**
	Types – Biochemical Conversion – Sources of Energy Generation – Industrial Waste, Agro Residues – Anaerobic Digestion – Biogas Production - Types of Biogas Plant Thermochemical Conversion – Sources of Energy Generation – Gasification – Types of Gasifiers – Briquetting – Industrial Applications of Gasifiers – Utilization and Advantages of Briquetting – Environment Benefits of Biochemical and Thermochemical Conversion.	
Lecture =45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

1. Parker, Colin & Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsievier Applied Science, London, 1985.
2. Shah, Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997.
3. Rich, Gerald et.al., Hazardous Waste Management Technology, Podevan Publishers, 1997.
4. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi, 1983.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	3	2	3
CO2	3	2	2	2	3	2	3
CO3	3	3	2	2	3	2	3
CO4	3	3	2	3	3	2	3
CO5	3	3	2	3	3	2	3
CO6	3	3	2	3	3	3	3
Total	18	16	12	16	18	13	18

COURSE CODE	COURSE NAME	L	T	P	C
YRE204A	OPTIMUM UTILISATION OF HEAT AND POWER	3	0	3	3

After completion of the course, a student will be able to

1. ***Discuss*** the energy transfer and conversion methodologies.
2. ***Discuss*** the concepts of Combined Heat and Power and their usage in various sectors.
3. ***Explain*** the pinch technology and their concepts
4. ***Design*** the process retrofit and its integration
5. ***Analysis*** of energy recovery through heat exchangers, heat pumps and heat pipes
6. ***Describe*** the application of combined heat and power.

UNIT I ENERGY CONVERSION TECHNIQUES **12**

Energy resource assessment – energy supply, demand and storage planning methods – economic feasibility and assessment methods – energy transfer and conversion methods – thermodynamic and efficiency analysis methods – system analysis methodologies.

UNIT II TOTAL ENERGY SCHEMES **12**

Basic concepts of CHP – The benefits of CHP – Problems associated with CHP – The balance of energy demand – Types of Prime demand – Types of prime movers – The economics of CHP generation – CHP in the industrial sector – CHP in the commercial sector – CHP in the domestic sector district heating – Conclusions.

UNIT III PROCESS INTEGRATION AND PINCH TECHNOLOGY **10**

Pinch Technology – Basic concepts of pinch technology – Streams networks – The significance of the Pinch – Design of energy recovery systems – Selection of pinch temperature difference – Tabular method – Stream splitting – Process retrofit – Installation of heat pumps – Installation of heat engines – The grand composite curve – General comments about process integration.

UNIT IV ENERGY RECOVERY **6**

Insulation – Recuperative heat exchanger – Run-around coil systems – Regenerative heat exchangers – Heat pumps – Heat pipes – Selection of energy recovery methods, Cogeneration.

UNIT V APPLICATION OF CHP **5**

CHP in agricultural sector - processing - energy requirements - potential. CHP in the industrial sector - Processing - energy requirements - source of waste heat.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. Eastop T.D & Croft D.R, “Energy efficiency for engineers and Technologists”, 2nd edition, Longman Harlow, 1990.
2. O’Callaghan, Paul W, “Design and Management for energy conservation”, Pergamon, 1993.

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	1	1	2	1
CO2	3	3	2	2	1	1	1
CO3	3	3	3	1	1	1	1
CO4	2	2	3	1	1	1	1
CO5	1	3	3	2	1	1	1
CO6	3	3	2	2	1	1	1
Total	15	16	16	9	6	7	6

COURSE CODE	COURSE NAME	L	T	P	C
YRE204B	STATISTICAL TOOLS FOR DATA ANALYSIS	3	0	3	3

After completion of the course, a student will be able to

7. Discuss the types of research and its design and need.
8. Discuss the literature search
9. Search articles through browsing and downloading methods
10. Analysis the various curves and concepts of statistical process control
11. Design and analysis of experiments
12. Describe the error analysis through various tests.

UNIT I RESEARCH	8

Objectives – types: descriptive, analytical, applied fundamental, quantitative, qualitative, conceptual, empirical – approach – significance – methods – process – Research design – need – concepts – sampling design.

UNIT II LITERATURE SEARCH	11

Offline search: Abstracts-subject index, author index, formula index and other indices-examples-current. Contents – organization – titles and index. On line Search: Computer browsing for literature search and down loading-basics of internet services-sources of abstracts, articles for browsing for literature search and down loading – basics of internet services-sources of abstracts, articles for browsing and downloading, technique for conversion form one format to another.

UNIT III STATISTICAL PROCESS CONTROL (SPC)	9

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV DESIGN AND ANALYSIS OF EXPERIMENTS	9

Treatment and interpretation of engineering data. Curve fitting nonlinear least square regression.. Tests of significance – test of hypothesis, chi square test, analysis of variance and covariance. Introduction to factorial designs- 2k factorial designs, introduction-Blocking and confounding in two level factorial designs- 2k-p fractional factorial designs, introduction -Random factors in experiments - Random factors in factorial experiments, mixed models

UNIT V ERROR ANALYSIS IN MECHANICAL MEASUREMENTS	8

Types of errors-Precision and accuracy-Statistical tests on the accuracy of results-Binomial distribution-Gaussian distribution T-tests, Comparison of precision of two methods by test.

	LECTURE	TUTORIAL	TOTAL
	45	0	45

REFERENCES

1. C.R.Kothari, Research Methodology – Methods and techniques, Wishwa Prakashan, New Delhi, 1996.
2. Design and Analysis of Experiments, 5th edition, by D.C. Montgomery, John Wiley & Sons, New York, 2001.
3. W.I.Cochron, ‘Statistical methods’, Oxford and IBH publishers.
4. http://www.sciencedirect.com/science/journal
5. James R.Evans & William M.Lidsay, The Management and Control of Quality, (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5)

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	1	2	2	1	3
CO2	2	1	3	1	2	2	3
CO3	1	3	3	2	1	2	3
CO4	2	3	1	1	2	1	3
CO5	1	3	3	2	1	2	3
CO6	1	3	2	3	3	1	3
Total	9	16	13	11	11	9	18

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
YRE204C	**SUSTAINABLE DEVELOPMENT**	**3**	**0**	**3**	**3**

After completion of the course, a student will be able to

13. Discuss the effect of industrial ecology and analyze industrial pollution control.
14. Discuss the barriers and role of industry in cleaner production concept
15. Derive the cleaner production assessment and technical feasibility analysis
16. Analysis of cleaner production economics and financing
17. Describe the environment management system
18. Explain the environment audit system.

UNIT I INTRODUCTION **12**

Industrial activity and Environment industrialization and sustainable development – Industrial Ecology – Prevention versus control of industrial pollution – Regulations to encourage cleaner production-based approaches.

UNIT II CLEANER PRODUCTION CONCEPT **7**

Importance – Historical evolution – Benefits – promotion – barriers – Role of Industry, government and Institutional – Resume, recovery, recycle, substitution – Internet information & other CP resources.

UNIT III CLEANER PRODUCTION PROJECT DEVELOPMENT **10**

Overview of CP Assessment steps & skills – preparing for the site – material balance – Technical and Environmental feasibility analysis – Economic Evolution of alternatives – Total cost analysis – CP financing - Established programme – Preparing & programme plan – reset audit – Environmental statement

UNIT IV LIFE CYCLE ANALYSIS & ENVIRONMENTAL MANAGEMENT SYSTEM **8**

Elements of LCA - life cycle costing – ECO labelling - Design for the Environment Environmental standards – ISO 14001 – Environmental audit.

UNIT V CASE STUDY **8**

Industrial application of CP, LCA, EMS & Environmental audit

LECTURE	**TUTORIAL**	**TOTAL**
45	**0**	**45**

REFERENCES
1. Pollution prevention: Fundamental and Practice, Paul L Bishap, McGrawhill , INC 2. Pollution prevention and abatement Handbook – Towards cleaner production – World bank and UNDP, Washinghton, D.C 3. Cleaner Production Audit, Prasad Modak, Asian Institute of Technology, Bangkok

CO Vs PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	2	1	1	2
CO2	3	3	3	2	1	1	1
CO3	2	2	3	1	2	2	3
CO4	2	3	1	2	2	2	3
CO5	2	2	3	3	2	3	1
CO6	2	2	3	3	2	3	1
Total	11	18	16	13	10	12	11

Semester	**II**	
Course Name	**HYDRO POWER TECHNOLOGY**	
Course Code	**YRE204D**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0– 3**

CO Number	CO STATEMENT	Knowledge Level
CO1	***Discuss*** the fundamental concepts behind the hydrology and hydro power projects with their terminologies	**K2**
CO2	***Describe*** the principles of conversion of these water resources to useful form of energy through the development of proto type systems	**K3**
CO3	***Select*** the suitable water turbines based on the requirements and the necessity of the project work.	**K3**
CO4	***Explain*** the concepts of water turbines with their basic design requirements in relation to the economic operation hydro power projects.	**K3**
CO5	***Describe*** basic design and construction of hydroelectric power stations and their life cycle analysis	**K3**
CO6	***Explain*** the small, mini, micro hydro power plants with their turbines in relation to reliability, energy generation and economical aspects.	**K3**

Objectives

- To learn and understand the fundamental concepts behind the hydrology and hydro power projects.
- Understanding principles of conversion of water resources to useful form of energy through the development of proto type systems
- Understand the basic design concepts of various water turbines along with their selection parameters and their maintenance
- Ability to define the small, mini, micro hydro power plants with their turbines in relation to energy generation and economical aspects.

COURSE CONTENT

UNIT I	**HYDROLOGY`**	**10 Hours**
	Overview of Hydropower Systems-Preliminary Investigation-Rainfall and run off measurements-Hydrographs-Flow duration graph and mass storage graphs-determination of site selection- Types hydroelectric power plants-General arrangements and layouts - preparation of Reports and Estimates-Review of World Resources- Basic Factors in Economic Analysis of Hydropower projects-Project Feasibility-Load Prediction and Planned Development.	
UNIT II	**DEVELOPMENT OF PROTO TYPE SYSTEMS**	**8 Hours**
	Advances in Planning, Design and Construction of Hydroelectric Power Stations-Trends in Development of Generating Plant and Machinery-Plant Equipment for pumped Storage Schemes-Some aspects of Management and Operations- case studies.	
UNIT III	**SELECTION AND ANALYSIS OF TURBINES**	**9 Hours**
	Pelton, Francis and Kaplan Turbine Measurement of pressure head, Velocity-Various parameters for finding out the potential of Hydro Energy-Selection of turbines based on specific quantities Updating and Refurbishing of Turbines- case study.	
UNIT IV	**HYDRO POWER STATION OPERATION, MAINTENANCE AND TROBLE SHOOTING**	**10 Hours**
	Governing of Power Turbines-Functions of Turbine Governor-Condition for Governor Stability-Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing in Future- Planning, Design and Construction of Hydroelectric Power Stations-Remaining Life cycle analysis	
UNIT V	**SMALL, MINI AND MICRO HYDRO POWER PLANTS TURBINES**	**8 Hours**
	Introduction – analysis of micro hydro and mini hydro turbines – Economical and electrical aspects of small, mini and micro hydro turbines potential developments – design reliability of small, mini micro hydro turbines – case studies.	

Lecture = 45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

1. L.Monition,M.Lenir and J.Roux,Micro Hydro Electric Power Station, Published by Wiley, New York, (1985)
2. AlenR. Inversin,Micro Hydro Power Source Book (1986)
3. J. Paul Guyer ,An Introduction to Mechanical design of Hydro Electric Power Plants (Dams and Hydro Electric Power Plants)
4. Charles simeons ,Hydro Power-the use of water as an alternative source of Energy

5. Jog, M. G Hydro-Electric and Pumped Storage Plants, Published by Wiley, New York, (1989)
6. Bryan Leyland ,Small hydroelectric engineering practice-, Published by CRC Press
7. C.C. Warnik, Hydropower Engineering- Published by Prentice Hall

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	1	1	1	1
CO2	2	1	1	1	1	1	1
CO3	2	1	1	1	1	1	1
CO4	2	1	1	1	1	1	1
CO5	2	1	1	1	1	1	1
CO6	2	1	1	1	1	1	1
Total	12	6	6	6	6	6	6

1 - Low, 2 – Medium, 3- High

Semester	**II**	
Course Name	**INSTRUMENTATION TECHNOLOGY FOR ENERGY SYSTEMS**	
Course Code	**YRE205A**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Select*** appropriate Measurement techniques for static and dynamic conditions	**K3**
CO2	***Apply*** suitable method for Pressure measurement	**K3**
CO3	***Identify*** the different temperature measurement techniques.	**K3**
CO4	***List*** methods for measuring flow, level, humidity	**K4**
CO5	***Categorize*** measurements for miscellaneous parameters	**K3**
CO6	Know the ***Function*** of different types of transducers and process control.	**K4**

Objectives

- To be able to select appropriate measuring techniques for measuring variables under different parameters.
- To able to measure pressure and temperature using different measuring techniques.

- Understand the Transducers and process control units.

COURSE CONTENT

UNIT I	**INTRODUCTION TO MEASUREMENT TECHNIQUES**	**6 Hours**
	General concepts of measurements, static and dynamic characteristics, Introduction to calibrations, calibration standards – characteristics of instruments – Definition – True value – Accuracy – Precision – Sensitivity – Resolution – errors & its measurements, Data acquisition & Display.	
UNIT II	**MEASUREMENT OF PRESSURE**	**9 Hours**
	Different units of pressure – Classification of pressure gauges – manometers – pressure balance gauges – force balancing gauge – elastic deformation – commercial pressure gauges using the above principles – ring balance type elements. Measurement of vacuum–Mcleod gauge – Pirani gauge. Measurement using strain gauges. Measurement of Pressure using electronic / micro processor based transmitter, calibration of the instrumentation.	
UNIT III	**MEASUREMENT OF TEMPERATURE & HEAT FLUX**	**9 Hours**
	Difference temperature scales – Non-electrical methods – change in volume of liquid – change in pressure of gas – change in vapour pressure. Electrical methods – Thermocouple – Resistance Temperature Detector – Radiation Pyrometer – Optical Pyrometer – Thermostats. Temperature measurement using electronic / micro processor based transmitter, Incidental radiation heat flux, conduction heat flux, calibration. Measurement of Electrical Energy – Voltage – Current – Power Factor.	
UNIT IV	**MEASUREMENT OF FLOW, LEVEL, HUMIDITY AND OTHER MISCELLANEOUS PARAMETERS**	**12 Hours**
	Flow measurement – types – differential pressure type flow meter – orifice meter – venturi tube – flow nozzle – pitot tube – positive displacement type flow meter – Inferential flow meter – turbine flow meter – variable area flow meter (rotameter) – mass flow meter. Low flow measurement using piezo ring, Ultra Sonic flow meter for high flow. Level measurement – Basic methods – Measuring hydrostatic pressure – measuring the movement of the float – electric conduction method – sight glass. Non-Contact measurement techniques. Level measurement by DP transmitter. Definition of humidity – hydrometer & psychrometer – Humidity measurement. Measurement of pH: -pH scale – methods of pH measurements. Mass spectrometer &Chromatograph. Hazardous area and its classification, calibration.	
UNIT V	**TRANSDUCERS & PROCESS CONTROL**	**9 Hours**
	Classification of Transducers – Active and passive transducers - Analog and digital transducers. Advantages of electrical transducers over mechanical transducers – Different types: Resistance – Inductance – Capacitance – Piezo electric transducers. Functional block diagram of a process control loop and their elements. Definition of set point, dead zone, dead time, disturbance, deviation- Control system – Open and closed loop control system – feed forward control – Ratio control – cascade control. Closed loop controllers with examples. Programmable logic controllers & Disturbed controlled system. Computer control using Supervisory Computer.	

Lecture =45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

1. John P.Bentley, “Principles of Measurement System”, 3rd edition, Addision Wsley Longman Ltd.UK,2000.

REFERENCES:

1. Instrument Transducers: An introduction, Neubert H.K.P., Their performance and Design. 2nd edition, Oxford University Press, Cambridge, 1999, Sensors and Transducers, Patranabis, Wheeler Publishing 1999.
2. Stephanopoulos, "Chemical Process Control – An Introduction, to Theory and practice", PHI, New Delhi, 1984.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	2	3	2
CO2	3	3	2	1	2	3	2
CO3	3	3	2	1	2	3	2
CO4	3	3	2	1	2	3	2
CO5	3	3	2	1	2	3	2
CO6	3	3	2	1	2	3	2
Tot	18	18	12	6	12	18	12

1 - Low, 2 – Medium, 3- High

Semester	**II**	
Course Name	**HYDROGEN, FUEL CELLS AND NUCLEAR ENERGY**	
Course Code	**YRE205B**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** the production and storage method for hydrogen energy	**K3**
CO2	***Develop*** storage technologies for batteries	**K3**
CO3	***Develop*** storage technologies for fuel cell	**K3**
CO4	***Examine*** the nuclear energy conversion and different types of reactors.	**K4**
CO5	***Inspect*** the nuclear power plant by considering safety aspects.	**K4**
CO6	***Plan*** appropriate techniques for managing nuclear wastes.	**K3**

Objectives

- Understand and apply basic concepts of hydrogen energy and storage cells.
- Apply the concept of nuclear energy for power generation by optimizing the design and

following safety norms.

- ❖ Understand the concept of nuclear waste management and use proper techniques for efficient management.

COURSE CONTENT

UNIT I	**HYDROGEN ENERGY**	**9 Hours**
	Hydrogen as a renewable energy source - Sources of Hydrogen - Fuel for Vehicles - Hydrogen Production - Direct electrolysis of water - direct thermal decomposition of water - biological and biochemical methods of hydrogen production - Storage of hydrogen - Gaseous, Cryogenic and Metal hydride - Utilization of hydrogen.	
UNIT II	**BATTERIES & FUEL CELL**	**12 Hours**
	Battery – Storage cell Technologies -storage cell fundamentals- characteristics – Emerging trends in batteries-Carbon- Zinc & alkaline cells, Mercury, Zinc –air &Silver oxide button cells, Lead acid, Edison, Ni cad & Ni mg cells and lithium Technology Fuel cell – Principle of working- construction- Design and performance analysis of fuel cells-The alkaline fuel cell, Acidic fuel cells, PEM Fuel cells, SOFC - Emerging trends in fuel cells, - Applications – Industrial and commercial	
UNIT III	**NUCLEAR ENERGY AND FUELS**	**9 Hours**
	Nuclear energy conversion - Chemical and nuclear equations - Nuclear reactions -Fission and fusion - Energy from fission and fuel burn-up - Radioactivity – Neutron energies - Fission reactor types - Nuclear power plants - Fast breeder reactor and power plants - Production of nuclear fuels.	
UNIT IV	**NUCLEAR POWER**	**10 Hours**
	Fuel rod design - Steam cycles for nuclear power plants - reactor heat removal – Coolant channel orificing - Core thermal design - Thermal shields - Fins in nuclear plants – Core thermal hydraulics - Safety analysis - LOCA - Time scales of transient flow and heat transfer processes.	
UNIT V	**NUCLEAR WASTE MANAGEMENT**	**5 Hours**
	Segregation and safe disposal of nuclear waste –case studies	

Lecture = 45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. M. M. El-Wakil: Power Plant Technology, McGraw Hill, 1985
2. Hand book of Batteries and Fuel cells ,3rd Edision, Edited by David and Thomas, B. Reddy, McGrawhill Book company,N.Y 2002
3. Fuel cell, Principles and applications ,Viswanathan,B and Scibioh,Aulice M. Universities Press.2006

REFERENCES:

1. A. W. Culp Jr: Principles of Energy Conversion, McGraw Hill, 2001
2. Principles of fuel cells by Xianguo Li, Taylor & francis,2006
3. T. F. Morse: Power Plant Engineering, Affiliated East West Press, 1978
4. R. H. S. Winterton: Thermal Design of Nuclear Reactors, Pergamon Press, 1981
5. R. L. Murray: Introduction to Nuclear Engineering, Prentice Hall, 1961

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	2
CO2	3	2	2	2	2	3	3
CO3	3	2	2	2	2	2	2
CO4	3	2	2	2	3	2	1
CO5	3	2	2	2	3	2	1
CO6	3	3	2	2	3	3	3
Tot	18	13	12	12	15	14	12

1 - Low, 2 – Medium, 3- High

Semester	**II**	
Course Name	**ENERGY MODELLING, ECONOMICS AND PROJECT MANAGEMENT**	
Course Code	**YRE205C**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Select*** appropriate Modelling approaches for understanding the energy scenario.	**K3**
CO2	***Examine*** the input and output to analyze energy aggregation.	**K4**
CO3	***Identify*** suitable methods for Energy Demand analysis	**K3**
CO4	***List*** suitable methods for Energy Forecasting	**K4**
CO5	***Develop*** model for understanding the Economics of power supply system	**K3**
CO6	***Organize*** Project management and apply financial accounting.	**K3**

Objectives

- Understand the concept of developing models for energy scenarios.
- Analyze the input and output parameters to optimize the energy needs.
- To be able to forecast energy demand and develop model for power supply system.

COURSE CONTENT

UNIT I	**MODELS AND MODELLING APPROACHES**	**8 Hours**
	Macroeconomic Concepts - Measurement of National Output - Investment Planning and Pricing - Economics of Energy Sources - Reserves and Cost Estimation.	
UNIT II	**INPUT OUTPUT ANALYSIS**	**9 Hours**
	Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation –Econometric Energy Demand Modelling - Overview of Econometric Methods.	
UNIT III	**ENERGY DEMAND ANALYSIS AND FORECASTING**	**12 Hours**
	Methodology of Energy Demand Analysis - Methodology for Energy Technology Forecasting -Methodology for Energy Forecasting - Sectoral Energy Demand Forecasting.	
UNIT IV	**ECONOMICS OF STANDALONE POWER SUPPLY SYSTEMS**	**10 Hours**
	Solar Energy - Biomass Energy - Wind Energy and other Renewable Sources of Energy - Economics of Waste Heat Recovery and Cogeneration - Energy Conservation Economics.	
UNIT V	**PROJECT MANAGEMENT-FINANCIAL ACCOUNTING**	**6 Hours**
	Cost Analysis - Budgetary Control - Financial Management - Techniques for Project Evaluation.	
Lecture =45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

REFERENCES

1. M.Munasinghe and P.Meier (1993): Energy Policy Analysis and Modelling, Cambridge University Press.
2. W.A.Donnelly (1987): The Econometrics of Energy Demand: A Survey of Applications, New York.
3. S.Pindyck and Daniel L.Rubinfeld (1990): Econometrics Models and Economic Forecasts, 3rd edition MC Graw -Hill, New York.
4. Energy Management handbook, Turner.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	1
CO2	3	3	2	1	2	2	1
CO3	3	3	1	1	2	2	1
CO4	3	3	1	3	2	2	1
CO5	3	3	1	3	2	2	1
CO6	3	3	1	3	2	2	1
Tot	18	18	9	13	12	12	6

1 - Low, 2 – Medium, 3- High

Semester	**II**
Course Name	**ENERGY EFFICIENT BUILDING**
Course Code	**YRE205D**

L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0– 3**

CO Number	CO STATEMENT	Knowledge Level
CO1	***Describe*** the building science and its significance in the indoor Environment.	**K2**
CO2	***Explain*** the thermal, visual, acoustical and all factory comfort in relation to indoor environment	**K3**
CO3	***Demonstrate*** the solar energy temperature concepts, ventilation with its effects and lighting system design on buildings	**K3**
CO4	***Describe*** the **s**olar passive heating and cooling concepts.	**K3**
CO5	***Discuss*** the energy audit, their objectives and building energy survey and audit report	**K3**
CO6	***Explain*** the energy conservation through building design and site planning.	**K3**

Objectives

- To understand the importance of indoor environment and the art and science of designing behind the quality indoor environment.
- To get the knowledge of solar energy concepts behind the heating, ventilation and lighting of the buildings construction.
- To understand the basics of energy management and energy audit of buildings
- To explain the energy conservation through building design and site planning.

COURSE CONTENT

UNIT I	**INDOOR ENVIRONMENT**	**8 Hours**
	Introduction of Architecture as the art and science of designing. Building Science its significance indoor Environment. Components of Indoor Environment. Quality of Indoor Environment.	
UNIT II	**THERMAL ANALYSIS AND DESIGN FOR HUMAN COMFORT**	**10 Hours**
	Human comfort- Thermal, Visual, Acoustical and all factory comfort, comfort, Energy and indoor Environment. Concept of Solar temperature and its significance. Calculation of instantaneous heat gain through building envelops. Calculation of solar radiation on buildings. Building orientation and significance. Introduction to design of shading devices (horizontal, vertical and egg-crate). Factors that affect energy use in buildings. Ventilation and its significance. Lighting and visual ability- Lighting system Design – Day lighting Economics	
UNIT III	**SOLAR PASSIVE CONCEPTS FOR COOLING FOR BUILDINGS**	**8 Hours**
	Pelton, Francis and Kaplan Turbine Measurement of pressure head, Velocity-Various parameters for finding out the potential of Hydro energy-Selection of turbines based on specific quantities –case study.	
UNIT IV	**ENERGY MANAGEMENT AND ENERGY AUDIT OF BUILDINGS**	**9 Hours**
	Introduction to energy management of buildings and energy audit of buildings. Aims of energy management of buildings. The historical and diagnostic energy audit, their	

	objectives and benefits. Introduction energy management matrix monitoring and targeting. Building energy survey and audit report form.	
UNIT V	**ENERGY EFFICIENT LANDSCAPE DESIGN**	**9 Hours**
	Modification of microclimate through landscape elements for energy conservation. Energy conservation through site selection, sitting & orientation. Energy conservation through integration of buildings and site, site planning and design.	
Lecture = 45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

1. Sodha M.,Bansal, N.K., Bansal,P.K., Kumar, A.. and Malik, M.A.S.,"Solar Passive Buildings", Pergamon Press, 1986.
2. Koenigsberger, O.H., Ingersoll, T.G., Mayhew Alan and Szokolay, S. V., "Manual of Tropical Housing and Building part 1: Climatic Design", OLBN 0 00212 0011,Orient Longman Limited, 1973.
3. N K Bansal , "Energy Conservation in Buildings"
4. Evans, Martin, " Housing , Climate and Comfort." ISBN 0 85139 102 8, The Architectural Press, London, 1980.
5. Bureau of Indian standards, I.S. 11907- 1986 Recommendations for calculation of Solar Radiation Building, 1986.
6. Givoni,. B, " Man, Climate and Architecture", Elsevier, Amsterdam, 1986.
7. Smith Ajitha, D. ., " Building Environment", Tata McGraw Hill publishing company Limited, New Delhi, 1985
8. Robinette, G.O., (ed), "Landscape Planning for Energy Conservation". Van Nostrand Reinhold, New Yark, 1990.
9. Bureau of Indian Standards, I.S. 11907 –1986 Recommendations for calculation of Solar Radiation Buildings, 1986.
10. Smith, R. J., Phillips, G.M. and Sweeney, M. "Environmental Science", Longman Scientific and Technical, Essex, 1982.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	1	1	1	1
CO2	2	1	1	1	1	1	1
CO3	2	1	1	1	1	1	1
CO4	2	1	1	1	1	1	1
CO5	2	1	1	1	1	1	1
CO6	2	1	1	1	1	1	1
Total	12	6	6	6	6	6	6

1 - Low, 2 – Medium, 3- High

Semester	**III**	
Course Name	**Energy Audit and Management**	
Course Code	**YRE302A**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** the need for energy savings.	**K3**
CO2	***Develop*** process for energy conservation of thermal applications and calculate the efficiencies.	**K3**
CO3	***Apply*** the knowledge to calculate the efficiency of various thermal utilities.	**K3**
CO4	***Apply*** the concept of Energy Audit to reduce energy consumption	**K3**
CO5	***Identify*** suitable energy monitoring system to analyze and optimize the energy consumption in an organization.	**K3**
CO6	***Plan*** cost-benefit analysis of various investment alternatives for meeting the energy needs of the organization.	**K3**

Objectives

COURSE CONTENT

UNIT I	**INTRODUCTION**	**9 Hours**
	Energy scenario – Principles and imperatives of energy conversion – Energy consumption pattern – Resource availability – Why save energy – reasons to save energy – an over view of energy consumption and its effects – current energy consumption in India – Role of Energy Managers in Industries.	
UNIT II	**ENERGY CONSERVATION OF THERMAL UTILITIES**	**9 Hours**
	Energy Audit–Characteristic Methods Employed in Certain Energy Intensive Industries – Various Energy Conservation Measures in Steam – Losses in Boiler. Methodology of Upgrading Boiler Performance – Boiler Blow Down Control – Excess Air control – Pressure Reducing Stations. Energy Conservation in Steam Systems – Importance of correct Pressure, Temperature, & Quality of Steam – Condensate Recovery – Condensate Pumping – Thermo Compressors – Recovery of Flash Steam – Air Removal & Venting – Moisture Removal. Steam Traps – Types, Function, Necessity – Section and application. Co-generation – in-plant power generation systems – co-generation Schemes and configuration – Design Considerations – Heat Rate Improvement. Case studies.	
UNIT III	**ENERGY CONSERVATION OF UTILITIES**	**9 Hours**
	Centrifugal pumps – energy consumption & energy saving potentials – Design consideration minimizing over design – case studies – Fans & Blowers – Specification – Safety margin – choice of fans controls – design considerations. Air compressor & compressed air systems – selection of compressed air layout – Encon aspects to be considered at design – Design consideration. Refrigeration & Air conditioning – Heat load estimation – methods of minimizing heat loads – optimum selections of equipment – case studies. Energy conservation in cooling towers & spray ponds – Case studies.	

UNIT IV	**ENERGY AUDITING**	**9 Hours**
	Potential areas for Electrical Energy Conservation in various Industries – Conservation methods – Energy Management Opportunities in Electrical Heating, Lighting System, Cable Selection – Energy Efficient Motors – Factors Involved in Determination of Motor Efficiency Adjustable AC Drivers, Application & its Uses – Variable speed Drivers / Belt Drives Energy Efficiency in Electrical Systems – HT Power Distribution – Control system in HT/LT side, Harmonics – Energy Efficiency in Lighting – Case studies.	
UNIT V	**ENERGY MANAGEMENT**	**9 Hours**
	Organizational background desired for energy management persuasion / motivation / publicity role, tariff analysis, detailed process of monitoring & targeting (M&T). Energy monitoring, auditing & targeting – Economics of various Energy conservation schemes, instrumentation and calibration -Electronics Control and Industrial Energy Management Systems. Thermostats, Boiler controls; proportional, differential and integral control, optimizers; compensators.	
Lecture = 45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

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

Reference Book

1. Reay D.A, Industrial Energy Conservation, 1st edition, Pergamon Press, 1977.
2. Larry C whitetal, Industrial Energy Management & Utilization.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	3	2	3	2
CO2	2	2	1	3	2	1	1
CO3	2	2	1	2	2	2	1
CO4	1	1	2	2	3	3	3
CO5	1	1	2	2	3	3	3
CO6	1	1	2	2	3	3	3
Total	9	10	11	14	15	15	13

1 - Low, 2 – Medium, 3- High

Semester	**III**	
Course Name	**UNIT OPERATIONS IN INDUSTRIES**	
Course Code	**YRE302B**	
L –T –P –C **3 – 0 – 0– 3**	**C:P: A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** material crushing and handling methods in industries.	**K3**
CO2	***Develop*** mixers for mixing different phases and understand the basics of filtration.	**K3**
CO3	***Apply*** the principle of different evaporator types in industries.	**K3**
CO4	***Apply*** humidity charts to achieve optimal results in industries.	**K3**
CO5	***Identify*** appropriate Dryer and calculate drying rate.	**K3**
CO6	***Utilize*** appropriate distillation method in industries	**K3**

Objectives

Upon successful completion of course, the student will able to

- Characteristics of particulate solids, Principles of size reduction, crushing and grinding equipment.
- Mixing of solids and separation methods for different types of mixtures like solid-solid, solid -gas, solid-liquid
- Analyze a multi stage equilibrium separation processes, simultaneous phase equilibrium and mass balances in distillation process.
- Apply humidity charts and understand the basics of drying process.

COURSE CONTENT

UNIT I	**CRUSHING, GRINDINGSIZE SEPARATION & CONVEYING OF BULK SOLIDS**	**12 Hours**
	Various Laws of Crushing – classification of crushing and grinding machineries – Coarse crushers – Intermediate crushers – fine grinders – jaw crusher – Gyratory Crusher – Crushing rolls – Hammer mills – Ball and tube mills – Ultrafine grinders – Closed circuit grinding – Grindability Index. Introduction – characterization of solid particles – standard screens – screen analysis – Types of screening equipment – Air separation methods – Cyclone and bag filters – Size separation by settling - Laws of Settling – Classifiers – Material separation by difference in density – Heavy media cyclone - Froth floatation – Hindered settling – working of thickener. Conveying of bulk solids – conveyor of bulk materials – screw conveyors – Belt conveyors – Bucket Elevators – Pneumatic Conveyers	
UNIT II	**MIXING AND FILTRATION**	**8 Hours**
	Introduction – mixing of liquids/Liquids, Liquids/Gases, Liquids/Solid – Types of mixers – various mixing equipment – Power requirement for an Impeller Mixer. Theory of	

	Industrial filtration – Constant pressure and constant rate filtration – Filter Aids – Filtration Equipment Classification – Filter Presses – Leaf Filters – Rotary Drum Filter – Centrifuges	
UNIT III	**EVAPORATION**	**8 Hours**
	Introduction – Duhrings Chart – Boiling Point Elevation – Capacity and Economy of Evaporators – Evaporators Classification – Short tube and Long Tube Evaporators – Forced Circulation Evaporators – Climbing and Falling Film Evaporators – Multiple Effect Evaporator – Evaporator Accessories	
UNIT IV	**HUMIDIFICATION AND DRYING**	**8 Hours**
	Definition – Adiabatic Saturation Temperature – Humidity Chart – Wet bulb Temperature and Measurement of Humidity – Spray Ponds and Cooling Towers – Cooling Tower Designing considerations. Introduction – Drying Theory – Equilibrium Moisture Content – Bound, Unbound, Free Moisture – Drying Rate Curves – Constant Drying Rate – Falling Rate Period – Classification of Dryers – Tray Dryers – Rotary Dryers – Turbo Dryer – Cylinder Dryer – Festoon Dryer – Drum Dryer – Spray Dryer – Fluid Bed Dryer	
UNIT V	**DISTILLATION**	**9 Hours**
	Introduction – Various Distillation Methods – Flash Distillation – Batch Distillation – Steam Distillation – Continuous Distillation – Minimum Reflux Ratio- Total Reflux – Optimum Reflux Ratio – Steam Distillation Calculations – Ideal Plate – Actual Plate – Plate Efficiency - Distillation column Internals – Concepts of Azeotropic and Extractive Distillation – Enthalpy Balance for a Continuous Distillation Column (for binary system)	
Lecture =45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

Reference Book

1. P.Chattopadhyay, "Unit operations of chemical Engineering", 2nd edition, Khanna Publishers, 1996.
2. W.L.McCabe and J.C.Smith, "Unit operations of Chemical Engineering",5th edition, McGraw Hill International editions, 1993.
3. Alan S Foust, "Principles of Unit Operations", 2nd edition, Wiley International Edition, 1960.
   J.M. Coulson & Richardson, Chemical Engineering, 5th edition, Butterworth Heinemann, 1996.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	3	2	3	2
CO2	2	2	1	3	2	1	1
CO3	2	2	1	2	2	2	1
CO4	1	1	2	2	3	3	3
CO5	1	1	2	2	3	3	3
CO6	1	1	2	2	3	3	3
Total	9	10	11	14	15	15	13

Semester	**III**	
Course Name	**CAD/CAM AND SIMULATION OF RENEWABLE ENERGY SYSTEMS**	
Course Code	**YRE302C**	
L –T –P –C **3 – 0 – 0– 3**	**C:P:A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***explain*** various aspects of CAD.	K2
CO2	***solve*** problems related to spline forms and modelling techniques.	K3
CO3	***explain*** various aspects of Computer Aided Manufacturing (CAM)	K2
CO4	***explain*** various aspects of Process planning systems.	K2
CO5	***simulate*** solar and wind energy systems	K3
CO6	***simulate*** biomass energy systems.	K3

Objectives

- Understand various aspects of CAD in relation to energy systems.
- Understand various aspects of CAM in relation to energy systems.
- Understand various aspects of Process planning systems in relation to energy systems.
- Analyze aspects of solar and wind and biomass energy systems.

COURSE CONTENT

UNIT I	**BASIC CONCEPTS OF CAD**	**9 Hours**
	CAD Hardware and software operating system, application software, CAD workstation Principles of computer graphics – graphics programming, input techniques, transformation. Elements of mechanical drafting package, graphic standards, graphic libraries, design and drafting interface. Advanced modelling techniques.	
UNIT II	**ADVANCED MODELLING TECHNIQUES**	**9 Hours**
	Modelling of curve and surface, non uniform rotational of splines , commercial surface modelling software – principles of solid modelling – rendering methods – CAD/CAM data base development and database management systems –principles of optimum design	
UNIT III	**COMPUTER AIDED MANUFACTURING AND PROCESS**	**9 Hours**
	Computer aided manufacturing- fundamentals of CAD/CAM – computers in manufacture – Programming languages, process interface hardware – hierarchy of computers in CAM. Computer process monitoring, types of production monitoring systems – process control – modelling and analysis – direct digital control – supervisory computer control – steady state optimal control – adaptive control, on – line search strategies. Systems for manufacturing support.	

UNIT IV	**CAD MODELLING AND SIMULATION OF SOLAR AND WIND ENERGY SYSTEMS**	**9 Hours**
	Solar collectors, solar cooker, solar water heater, solar pasteuriser, solar drier, wind mill and wind generator.	
UNIT V	**CAD MODELLING AND SIMULATIONOF SYSTEMS USING BIOMASS**	**9 Hours**
	Updraft gasifier – downdraft gasifier, cross draft gasifier – multi fuel gasifier – fixed and fluid bed gasifier –Biogas plant.	
Lecture =45 Hours	**Tutorial = 0 Hours**	**Total = 45 Hours**

TEXT BOOKS / REFERENCE BOOKS

Reference Book

1. William M Newman and Robert Sproul "principles of interactive graphics" McGraw Hill, 1984.
2.Radha Krishnan.P. & Kothandaraman.C.P. "Computer graphics design" Dhanpat Rai and Sons, 1990.
3.Groover.M.P. "Automation, Production systems and Computer Aided Manufacturing" Prentice Hall, 1984.
4.CAD/CAM Theory & practice, Inbrahim & Zeid Pub: Tata McGraw Hill.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	3	2	3	2
CO2	2	2	1	3	2	1	1
CO3	2	2	1	2	2	2	1
CO4	1	1	2	2	3	3	3
CO5	1	1	2	2	3	3	3
CO6	1	1	2	2	3	3	3
Tot	9	10	11	14	15	15	13

1 - Low, 2 – Medium, 3- High

Semester	**III**	
Course Name	**Industrial Safety**	
Course Code	**YRE302D**	
L –T –P –C **3 – 0 – 0– 3**	**C:P: A** **3:0:0**	**L –T –P –H** **3–0– 0 – 3**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	**Evaluate** the safety performance of an organization from accident records	**K3**
CO2	**Explain** the functions and activities of maintenance engineering	**K3**
CO3	**Identify** wear failure for prevention and control	**K3**
CO4	**Identify** causes of fault in industrial systems	**K3**
CO5	**Implement** periodic maintenance procedures	**K3**
CO6	**Implement** important preventive maintenance procedures	**K3**

COURSE CONTENT

UNIT I	**INDUSTRIAL SAFETY AND ACCIDENT**	**9 hrs**

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

UNIT II	**FUNDAMENTALS OF MAINTENANCE ENGINEERING:**	**9 hrs**

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

UNIT III	**WEAR AND CORROSION AND THEIR PREVENTION**	**9 hrs**

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

UNIT IV	**FAULT TRACING**	**9hrs**

Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine

tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V	PERIODIC AND PREVENTIVE MAINTENANCE	9hrs

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

Lecture =45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

REFERENCE BOOK

1. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	3	2	3	2
CO2	2	2	1	3	2	1	1
CO3	2	2	1	2	2	2	1
CO4	1	1	2	2	3	3	3
CO5	1	1	2	2	3	3	3
CO6	1	1	2	2	3	3	3
Total	9	10	11	14	15	15	13

Semester	**III**	
Course Name	**Dissertation Phase – I**	
Course Code	**YRE301**	
L –T –P –C **0 – 0 –10– 10**	**C:P:A** **2:0.5:0.5**	**L –T –P –H** **0–0– 20– 20**

CO Number	**CO STATEMENT**	**Knowledge Level**
CO1	***Identify*** an open ended problem in the area of renewable energy which requires further investigation –(Identification of relevant project title)	**K3**
CO2	***Describe*** the methodology/modelling for solving and proceeding the problem	**K3**
CO3	***Select*** the optimal model of the project work from the proposed different solutions.	**K3**
CO4	***Design*** the project model with relevant detailed subassemblies and technical drawings with detailed action plan for implementation.	**K3**
CO5	***Identify*** the methods and materials required for manufacturing the project work	**K3**
CO6	***Prepare*** a consolidated technical report of the project apart from developing a presentation	**K3**

Objectives

- To collect various literatures in the research interest area, study, understand the works already prevailing in the interested project work area.
- To get the knowledge about various elements of research works, various methods in proceeding the project work and selecting suitable one with action plan
- Understand and able to apply the basics concepts of design in the role of making the project into reality.
- To prepare a project report and presentation with the collected data ,with available details

LOOK INTO THE FOLLOWING DETAILS TO MEET THE OUTCOMES

IDENTIFICATION OF PROJECT WORK AREA

Overview of various renewable energy topics for performance improvement, optimality, etc. Hydropower systems-Wind energy systems, Solar energy systems, and other systems about Project Feasibility-Literature review collections

SELECTION OF RELEVANT PROJECT TITLE

Based on the detailed literature review, Identification of gap area and formulation of suitable project title

DESIGN THE PROJECT WORK MODEL WITH DETAILED DRAWINGS / CHARECTERIZATION METHODS

Design the project model with its assemblies into sketches /technical drawings with dimensions with CAD tools. For performance and analysis characterization projects , needs to identify the characterization sequences

IDENTIFICATION OF METHODS AND MATERIALS REQUIRED TO MANUFACTURE THE PROJECT

Identification of suitable methods and bill of materials, cost involved and suitable manufacturing method, to make the design model into reality and performing the activities , Execution of the activities production and running of the system.

DATA COLLECTION, ANALYSIS, PROJECT REPORT PREPARATION

Checking the working of the system/model, Fundamental knowledge of data collection, analysis, interpretation of data with details and project report writing and making ready the power point presentation

TEXT BOOKS / REFERENCE BOOKS

1. Old approved project reports of our department and other department project report copies.
2. Refer other university and engineering college project reports.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	1	1	1	1
CO2	2	2	1	1	1	1	1
CO3	2	2	1	1	1	1	1
CO4	2	2	1	1	1	1	1
CO5	2	2	1	1	1	1	1
CO6	2	2	1	1	1	1	1
Total	12	12	6	6	6	6	6

1 - Low, 2 – Medium, 3- High

Semester	IV	
Course Name	Dissertation Phase – II	
Course Code	YRE401	
L –T –P –C 0 – 0 –16– 16	C:P:A 0:1.5:1.5	L –T –P –H 0–0– 32– 32

CO	CO STATEMENT	Knowledge Level
CO1	*build* individual parts or samples related to project	P5
CO2	*Assemble* individual parts to finished assembly related to project	P5
CO3	*Perform* characterization study or design calculation on objects related to project.	A5
CO4	*Compose* the important findings as scientific drawing, chart, plot and table	P7
CO5	*Prepare* a consolidated technical report of the project	A4
CO6	*Present* a consolidated technical report of the project	A2

Objectives

- To prepare sample / parts related to project work.
- To characterize prepared samples or parts related to project work.
- To compose important findings as scientific data.
- To prepare and present technical report of the project.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	2	1	1	1	1
CO2	3	2	2	2	1	1	1
CO3	2	3	2	1	1	1	1
CO4	3	3	2	2	3	1	1
CO5	3	1	3	3	2	1	1
CO6	3	1	2	3	1	1	1
Total	16	11	13	12	9	6	6

1 - Low, 2 – Medium, 3- High

OPEN ELECTIVE COURSE

Course Name	Industrial Safety	
Course Code	YREOE1	
L –T –P –C 3 – 0 – 0– 3	C:P: A 3:0:0	L –T –P –H 3–0– 0 – 3

CO Number	CO STATEMENT	Knowledge Level
CO1	**Evaluate** the safety performance of an organization from accident records	K3
CO2	**Explain** the functions and activities of maintenance engineering	K3
CO3	**Identify** wear failure for prevention and control	K3
CO4	**Identify** causes of fault in industrial systems	K3
CO5	**Implement** periodic maintenance procedures	K3
CO6	**Implement** important preventive maintenance procedures	K3

COURSE CONTENT

UNIT I	INDUSTRIAL SAFETY AND ACCIDENT	9 hrs

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

UNIT II	FUNDAMENTALS OF MAINTENANCE ENGINEERING:	9 hrs

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

UNIT III	WEAR AND CORROSION AND THEIR PREVENTION	9 hrs

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

UNIT IV	FAULT TRACING	9hrs

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

UNIT V	PERIODIC AND PREVENTIVE MAINTENANCE	9hrs

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

Lecture =45 Hours **Tutorial = 0 Hours** **Total = 45 Hours**

TEXT BOOKS

1.Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2.Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

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Mapping of COs with POs

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CO3	2	2	1	2	2	2	1
CO4	1	1	2	2	3	3	3
CO5	1	1	2	2	3	3	3
CO6	1	1	2	2	3	3	3
Total	9	10	11	14	15	15	13

1 - Low, 2 – Medium, 3- High