

(Established under Gujarat Private Universities Act, 2009)

## Shroff S.R. Rotary Institute of Chemical Technology

### Curriculum for Postgraduate Degree Courses in Thermal Engineering

#### Semester-III (Thermal Engineering) Structure

Sr. No	Category	Sub Code	Course Title	Hours Per Week			Total Hours	Credits	E	M	I	V	Total
				L	T	P							
1	Program Elective V	TE3201 TE3202	Program Elective V	3	0	0	3	3	70	30	0	0	100
2	Open Elective-II	TE3203 TE3204	Open Elective-II	3	0	0	3	3	70	30	0	0	100
3	Open Elective-III	TE3205 TE3206	Open Elective-III	3	0	0	3	3	70	30	0	0	100
4	Seminar	MH3201	Seminar	0	0	4	4	2	0	0	20	30	50
5	Dissertation-I /Industrial Project	MH3202	Project	0	0	14	14	7	0	0	50	100	150
<b>Total</b>							<b>27</b>	<b>18</b>					<b>500</b>

Program Elective V	Sub Code	Open Elective-II	Sub Code
Energy conservation opportunities in thermal utilities	TE3201	Energy Audit and Management	TE3203
Fuel cells and hydrogen technologies	TE3202	Project management	TE3204

Open Elective-III	Sub Code
Alternate fuels & emissions	TE3205
Environmental pollution and control	TE3206

#### Semester-IV (Thermal Engineering) Structure

Sr No	Category	Sub Code	Course Title	Hours Per Week			Total Hours	Credits	E	M	I	V	Total
				L	T	P							
1	Dissertation-II	MH3203	Project	0	0	36	36	18	0	0	100	200	300
<b>Total</b>							<b>36</b>	<b>18</b>					<b>300</b>

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**Course code and definition:**

<b>Course code</b>	<b>Definitions</b>
L	Lecture
T	Tutorial
P	Practical
E	Theory External Examination Marks
M	Theory Internal Examination Marks
I	Practical Internal Examination Marks
V	Practical External Examination Marks

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**Mater of Engineering**

**Subject Code: TE 3201**

**Subject Name: Energy conservation opportunities in thermal utilities**

## Shroff S.R. Rotary Institute of Chemical Technology

### Semester: III

**Type of course:** Program Elective-V

**Prerequisite:** Fundamentals of Thermal engineering

**Rationale:** The course provides basic understanding of energy conservation and energy audit. Energy conservation can be achieved through energy audit and management Energy audit is a process to determine when, where, why and how energy is used in a plant or building. Collection of these information helps to identify the situation where there is need to improve energy efficiency and decrease production cost.

#### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

#### Content:

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Fuels and Combustion:</b> Introduction to Fuels, Properties of Fuel oil, Coal and Gas, Storage, handling and preparation of fuels, Principles of Combustion, Combustion of Oil, Coal, and Gas.	4
2	<b>Boilers:</b> Types, Combustion in boilers, Performances evaluation, Analysis of losses, Feed water treatment, Blow down, Energy conservation opportunities.  <b>FBC boilers:</b> Introduction, Mechanism of fluidized bed combustion, Advantages, Types of FBC boilers, Operational features, Retrofitting FBC system to conventional boilers, Saving potential.	8

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**Subject Name: Energy conservation opportunities in thermal utilities**

<b>3</b>	<b>Steam System:</b> Properties of steam, Assessment of steam distribution losses, Steam leakages, and Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings.	<b>6</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Insulation and Refractories:</b> Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractories, Heat loss.	<b>5</b>
<b>5</b>	<b>Waste Heat Recovery:</b> Classification, Advantages and applications, Commercially viable waste heat recovery devices, Saving potential.	<b>7</b>
<b>6</b>	<b>Cogeneration:</b> Definition, Need, Application, Advantages, Classification, Performance terms, Saving potentials.	<b>6</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>15</b>	<b>15</b>	<b>20</b>	<b>25</b>	<b>20</b>	<b>5</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Text Books:**

- Handbook on Refractories by D N Nandi, Tata McGraw-Hill Publishing Company Limited, New Delhi Energy Conservation and Audit, B.L.Singhal and P.G.Jamdade.
- Fuels and combustion by Samir Sarkar, Univeristy press (India) private limited, Hyderabad, India.

**Reference Books:**

- Combustion Engineering and Fuel Technology, Oxford & IBH Publishing Company - A.K.Shaha

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**Subject Code: TE 3201**

**Subject Name: Energy conservation opportunities in thermal utilities**

2. Practical Boiler Water Treatment by Leo.I.Pincus, McGraw Hill Inc, New York, 1962.
3. Steam Generation, Distribution and Utilisation by TERI, GTZ and EMC4. Energy Management Principles, C.B.Smith, Pergamon Press
4. Industrial Energy Conservation, D.A. Reay, Pergamon Press
5. Thermal Insulation and Refractories –PCRA
6. Heat Recovery Systems by D.A.Reay, E & F.N.Span, London, 1979.

Sr. No.	CO statement
CO-1	Understand the importance of thermal utilities in industries.
CO-2	Know about fuels and their preparation for the combustion.
CO-3	Inculcate the skills required for identification of energy conservation opportunities.
CO-4	Identify and assess energy conservation opportunities in thermal system.
CO-5	Recognize and recover the waste heat.
CO-6	Apply the concept of cogeneration for energy saving.

**List of Open Source Software/learning website:**

- <https://beeindia.gov.in/>
- [www.pera.org](http://www.pera.org)
- [https://lbre.stanford.edu/sem/energy\\_conservation](https://lbre.stanford.edu/sem/energy_conservation)
- [www.eren.doe.gov](http://www.eren.doe.gov)

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Master of Engineering

Subject Code: TE3221

Subject Name: Fuel Cells and Hydraulic Technologies

## Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Program Elective

Prerequisite: Enthusiasm to learn the course

Rationale: The course is designed to provide the fundamental concept of hydrogen and fuel cell and relevant engineering and technologies

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Hydrogen Energy:</b> Introduction to hydrogen economy, production, storage and transportation systems, hydrogen from fossil fuels, electrolysis of water, thermo chemical cycles, transmission and infrastructure requirements, safety and environmental impacts, economics of transition to hydrogen systems	5
2	<b>Hydrogen Storage and Applications:</b> Production of hydrogen, steam reforming, water electrolysis, gasification and woody biomass conversion, biological hydrogen production, photo dissociation, direct thermal or catalytic splitting of water, hydrogen storage options, compressed gas, liquid hydrogen, hydride, chemical storage, safety and management of hydrogen, applications of hydrogen	13
<b>SECTION-B</b>		
3	<b>Fuel Cells:</b> Types: Brief history, principle, working, thermodynamics and kinetics of fuel cell process, types of fuel cells, relative merits and demerits, performance evaluation of fuel cell, comparison of battery and fuel cell	10
4	<b>Fuel Cells-Application and Economics:</b> Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell,	8

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**Master of Engineering**

**Subject Code: TE3221**

**Subject Name: Fuel Cells and Hydraulic Technologies**

	future trends of fuel cells	
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**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
<b>20</b>	<b>30</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>10</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)**

**Reference Books:**

1. Fuel cell Fundamentals, John Wiley and sons, Willey
2. Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press
3. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma
4. Bent Sorensen (Sorensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier Academic Press, UK
5. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany

**Course Outcomes:**

Sr. No.	CO statement
CO-1	To understand the concept of Hydrogen as an energy
CO-2	To demonstrate the hydrogen production technologies
CO-3	To understand fundamental concept of Hydrogen storage technologies
CO-4	To know the concepts and characteristics of various types of fuel cell
CO-5	To demonstrate the working of fuel cells
CO-6	To know the application of fuel cells with economic and environment analysis

**List of Open Source Software/learning website:**

- nptel.ac.in

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**Master of Engineering**

**Subject Code: TE 3203**

**Subject Name: Energy Audit and Management**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: III**

**Type of course:** Open Elective-II

**Prerequisite:** Fundamentals of Thermal engineering and Electrical engineering.

**Rationale:** The course provides basic understanding of energy management and energy audit. Energy conservation can be achieved through energy audit and management. Energy audit is a process to determine when, where, why and how energy is used in a plant or building. Collection of these information helps to identify the situation where there is need to improve energy efficiency and decrease production cost.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>Introduction to Energy Audit:</b> Energy audit and its benefits, Types of energy audit, Preliminary, Detailed energy audit., Methodology of preliminary energy audit and Detailed energy audit – Phase I, Pre audit, Phase II- Audit and Phase III- Post audit, Energy audit report. IE rules and regulations for energy audit, Electricity act.	<b>6</b>
<b>2</b>	<b>Energy Audit Methodology:</b> General Philosophy, need of Energy Audit and Management, Definition and Objective of Energy Management, General Principles of Energy Management. Energy Management Skills, Energy Management Strategy, energy saving opportunities and recommendation.	<b>6</b>



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**Subject Code: TE 3203**

**Subject Name: Energy Audit and Management**

<b>3</b>	<b>Measuring instruments:</b> Thermal and electrical parameter measuring Instruments - Power Analyser, Combustion analyzer, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and luxmeter.	<b>6</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Energy Action Planning:</b> Key elements, Force field analysis, Energy policy purpose, perspective, Contents, Formulation, Ratification, Organizing –location of energy management, Top management support, Managerial function, Roles and responsibilities of energy manager, Accountability. Motivating-motivation of employees: Information system-designing barriers, Strategies; Marketing and communicating-training and planning.	<b>6</b>
<b>5</b>	<b>Financial Management:</b> Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs.	<b>7</b>
<b>6</b>	<b>Energy Monitoring and Targeting:</b> Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences (CUSUM).	<b>5</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>30</b>	<b>30</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>0</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Text Books:**

1. Energy Conservation and Audit, M.A.Chaudhari, S.M.Chaudhari and S.A Asarkar
2. Energy Conservation and Audit, B.L.Singhal and P.G.Jamdade

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**Subject Code: TE 3203**

**Subject Name: Energy Audit and Management**

**Reference Books:**

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
4. Energy Management Principles, C.B.Smith, Pergamon Press
5. Industrial Energy Conservation, D.A. Reay, Pergammon Press
6. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
7. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
8. Hand Book of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press Course Outcomes:

Sr. No.	CO statement
CO-1	Understand the importance of energy management and energy audit.
CO-2	Inculcate the skills required for energy audit and management.
CO-3	Apply the concept of energy audit methodology to find energy saving measures.
CO-4	Recognize the instruments used to measure performance parameters.
CO-5	Know the financial management techniques for economic evaluation.
CO-6	Learn the energy action planning, energy monitoring and targeting.

**List of Open Source Software/learning website:**

- <https://beeindia.gov.in/>
- <http://nptel.ac.in/>
- [https://lbre.stanford.edu/sem/energy\\_conservation](https://lbre.stanford.edu/sem/energy_conservation)

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Master of Engineering

Subject Code: TE3225

Subject Name: Environmental pollution and control

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Open Elective-III

Prerequisite: Requires environmental emission causes & rules & regulations.

**Rationale:** This subject is intended to know various types of pollutions & their causes. Also to ensure which are the governing bodies, rules & regulations to control or prevent such kind of pollutions. To impart knowledge on the atmosphere and its present condition, global warming and eco-legislations. To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation. To elaborate on the technologies available for generating energy from waste.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	Introduction: Global atmospheric change, greenhouse effect, Ozone depletion, natural cycles, mass and energy transfer, material balance, environmental chemistry and biology, impacts, environmental Legislations.	6
2	Air-Pollution: Pollutants, sources and effect, air pollution meteorology, atmospheric dispersion, indoor air quality, control methods and equipments, issues in air pollution control, air sampling and measurement.	8
3	Water Pollution: Water resources, water pollutants, characteristics, quality, water treatment systems, waste water treatment, treatment, utilization and disposal of sludge, monitoring compliance with standards.	8
<b>SECTION-B</b>		

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**Master of Engineering**

**Subject Code: TE3225**

**Subject Name: Environmental pollution and control**

<b>4</b>	Waste Management: Sources and Classification, Solid waste, Hazardous waste, Characteristics, Collection and Transportation, Disposal, Processing and Energy Recovery, Waste minimization.	<b>8</b>
<b>5</b>	Industrial Pollutions: Noise pollution and its impact, oil pollution, pesticides, instrumentation for pollution control, water pollution from tanneries and other industries and their control, environment impact assessment for various projects, case studies. Radiation pollution: types, sources, effects, control of radiation pollution.	<b>8</b>
<b>6</b>	Environmental Audit: Introduction, Principles and Elements of Successful environmental management. ISO Principles, EMS, Creating an environmental management system in line with ISO 14000. Benefits of an environmental management system.	<b>4</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>5%</b>	<b>35%</b>	<b>25%</b>	<b>20%</b>	<b>15%</b>	<b>0%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Reference Books:**

1. Arcadio P Sincero and G.A. Sincero, "Environmental Engineering – A Design Approach", Prentice Hall of India Pvt Ltd, New Delhi, 2002.
2. Bishop P., "Pollution Prevention: Fundamentals and Practice", McGraw-Hill International, Edition, McGraw-Hill book Co, Singapore, 2000.
3. G.Masters, "Introduction to Environmental Engineering and Science", Prentice Hall of India Pvt. Ltd, New Delhi, 2003.
4. Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd Edition, Prentice Hall, 1998.
5. H.Ludwig, W.Evans, "Manual of Environmental Technology in Developing Countries", International Book Company, Absecon Highlands N.J. (1991).
6. H.S.Peavy, D.R.Rowe and G.Tchobanoglous, "Environmental Engineering", McGraw- Hill, Book Company, NewYork, (1985).

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**Master of Engineering**

**Subject Code: TE3225**

**Subject Name: Environmental pollution and control**

7. Rao C.S., “Environmental Pollution Control Engineering”, 2<sup>nd</sup> Edition, New Age International Publishers, 2006.

**Course Outcomes:**

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Understand the different types & effects of pollutions.
CO-2	Know the emission standards, governing boards & regulations.
CO-3	Explain waste management techniques/processes.
CO-4	Describe case studies on the pollution effects, remedies.
CO-5	Assess the overall effect of Air, Water & Industrial pollution on environment.
CO-6	Know the benefits & usefulness of environment audit, environment management system & ISO standards.

**List of Open Source Software/learning website:**

- <https://cpcb.nic.in>
- <https://lwvc.org>

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**Bachelor of Engineering**  
**Subject Code: TE3204**  
**Subject Name: Project Management**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: III**

**Type of course:** Open Elective -2

**Prerequisite:** Nil

**Rationale:**

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>The world of Project Management</b> Definition of project, Project Management Vs. General Management, Three goals of project, The life cycle of projects, Selecting projects to meet organizational goals, Confronting Uncertainty, Project portfolio process, An approach to Project Formulation	
<b>2</b>	<b>Organizing the project</b> The PM's Roles, The PM's responsibility to the project, Selection of a Project Manager, Project Management as a profession, Fitting projects into the parent organization, The project team <b>Planning the project</b> The contents of a project plan, The planning process-overview, The planning process- Nuts and Bolts, The work breakdown structure and other aids, Multidisciplinary Teams-Balancing Pleasure and Pain,	
<b>3</b>	<b>Budgeting the Project</b> Methods of budgeting, Cost estimating, Improving Cost Estimates, Budget Uncertainty and risk management <b>Scheduling the Project</b> PERT and CPM Networks, Project uncertainty and risk management, Simulation, The Gantt chart, Extensions to PERT/CPM	

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**Bachelor of Engineering**  
**Subject Code: TE3204**  
**Subject Name: Project Management**

<b>SECTION-B</b>	
<b>4</b>	<b>Allocating the Resources to the Project</b> Expediting a Project, Resource Loading, Resource Leveling, Allocating Scarce resources to projects, Allocating several resources to the several projects, Goldratt's critical chain
<b>5</b>	<b>Monitoring and Controlling the Project</b> The plan-monitor-control cycle, Data collection and reporting, Earned value, Project control, Designing the control system, Scope creep and change control
<b>6</b>	<b>Evaluating and Terminating the Project</b> Evaluation, Project Auditing, Project Termination

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>15%</b>	<b>25%</b>	<b>25%</b>	<b>20%</b>	<b>15%</b>	<b>0%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Reference Books:**

1. Project Management by Samuel J. Mantel, Jr. , Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton with M. R. Gopalan (WILEY-INDIA)
2. Project Management and Appraisal by Sitangshu Khatua (Oxford)

**Course Outcomes:**

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Understand Project Management.
CO-2	Understand Organizing, planning of project.
CO-3	Budgeting and scheduling of the project
CO-4	Allocating the resources of the project
CO-5	Monitoring and Controlling the Project
CO-6	Evaluating and Terminating the Project.