

(Established under Gujarat Private Universities Act, 2009)

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

Ref: UPL University /SRICT/BOS/ME/2023-24/

Date:

### Teaching Scheme for Fourth Year Bachelor of Mechanical Engineering

#### Semester-VII (Mechanical Engineering) Structure

Sl. No	Category of Course	Code No.	Course Title	Hours per week			Total contact hrs/ week	Total Credits	E	M	I	V	Total Marks
				L	T	P							
1	Professional Core Course	ME2401	Design for Manufacturing and Assembly	3	0	0	3	3	70	30	0	0	100
2	Professional Core Course	ME2402	Fluid Power Engineering	3	0	2	5	4	70	30	20	30	150
3	Professional Elective courses -5			3	0	2	5	4	70	30	20	30	150
4	Professional Elective courses -6			3	0	0	3	3	70	30	0	0	100
5	Open Elective Course - 4			3	0	0	3	3	70	30	0	0	100
6	In Plant Training	MH2401	In Plant Training	0	0	0	0	3	0	0	20	80	100
				<b>15</b>	<b>0</b>	<b>4</b>	<b>19</b>	<b>20</b>	<b>350</b>	<b>150</b>	<b>60</b>	<b>140</b>	<b>700</b>

3	Professional Elective courses -5	ME2403	Solar Thermal and Photovoltaic Systems
		ME2404	Advanced HVAC Systems Design
		ME2405	Cogeneration and Heat Recovery Systems
4	Professional Elective courses -6	ME2406	Welding and Corrosion Control in Manufacturing
		ME2407	Supply Chain Management in Manufacturing
		ME2408	Tooling Design and Analysis
5	Open Elective Course - 4	ME2409	Energy from Waste and Biomass
		ME2410	Energy Efficiency in Industrial Processes
		ME2411	Energy Policy and Economics for sustainability

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**Semester-VIII (Mechanical Engineering) Structure**

Sl. No	Category of Course	Code No.	Course Title	Hours per week			Total contact hrs/week	Total Credits	E	M	I	V	Total Marks
				L	T	P							
1	Professional Core Course	ME2412	Computer Aided Numeric Control	3	0	2	5	4	70	30	20	30	150
2	Professional Elective courses -7			3	0	0	3	3	70	30	0	0	100
3	Open Elective Course - 5			3	0	0	3	3	70	30	0	0	100
4	Project	MH2402		0	0	18	18	9	0	0	100	100	200
				<b>9</b>	<b>0</b>	<b>20</b>	<b>29</b>	<b>19</b>	<b>210</b>	<b>90</b>	<b>120</b>	<b>130</b>	<b>550</b>

Professional Elective courses -7	ME2413	Design of Material Handling Equipment
	ME2414	Industrial Automation and Control
	ME2415	Precision Engineering and Metrology
Open Elective Course - 5	ME2416	Nano engineering in Mechanical Systems
	ME2417	Composite Materials in Engineering
	ME2418	Industry 4.0

**❖ Course code and definition:**

Course code	Definitions
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

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2401**

**Subject Name: Design for Manufacturing and Assembly**

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

**Semester: VII**

**Type of course:** Professional Core Course

**Prerequisite:** Manufacturing Processes & Machine Design

**Rationale:** The subject of Design for Manufacturing and Assembly presents a considerable challenge. The goal of this course is to acquaint students with the fundamental design process, incorporating various facets of both manufacturing and assembly. Students will gain insight into diverse design criteria, including various manufacturing processes, as well as an understanding of environmental factors.

**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>Introduction to DFM:</b> Introduction: Design philosophy, steps in design process, general design rules for manufacture ability, basic principles of designing for economical production, creativity in design; materials: Selection of materials for design, developments in material technology, criteria for material selection, and material selection interrelationship with process selection, process selection charts.	<b>05</b>
<b>2</b>	<b>Design for Machining &amp; Forging:</b> <b>Machining Process:</b> Overview of various machining processes, general design rules for machining, dimensional tolerance and surface roughness, design for machining ease, redesigning of components for machining ease with suitable examples, general design recommendations for machined parts. <b>Forging:</b> Design factors for forging, closed die forging design, parting lines of dies, drop forging die design, general design recommendations.	<b>07</b>
<b>3</b>	<b>Design for Metal Casting &amp; Metal Joining:</b> <b>Metal Casting:</b> Appraisal of various casting processes, selection of casting process, general design considerations for casting, casting tolerances, use of	<b>06</b>

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**Bachelor of Engineering**

**Subject Code: ME2401**

**Subject Name: Design for Manufacturing and Assembly**

	<p>solidification simulation in casting design, product design rules for sand casting</p> <p><b>Metal Joining:</b> Appraisal of various welding processes, Factors in design of weldments. General design guidelines, pre and post treatment of welds, effects of thermal stresses in weld joints, design of brazed joints.</p>	
<b>SECTION-B</b>		
<b>4</b>	<p><b>Introduction to Assembly:</b></p> <p>The assembly process, Characteristics and applications, Example of common assembly, Economic significance of assembly, General taxonomies of assembly operation and systems, Assembling a product, Design for Assembly: Introduction, Design consideration, Design for Fasteners: Introduction, Design recommendation for fasteners.</p>	<b>05</b>
<b>5</b>	<p><b>Design of Manual Assembly:</b></p> <p>Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.</p>	<b>08</b>
<b>6</b>	<p><b>Design for the Environment:</b></p> <p>Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards.</p>	<b>05</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
15%	10%	25%	30%	15%	05%

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

**Reference Books:**

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2401**

**Subject Name: Design for Manufacturing and Assembly**

1. George E Deiter, “Engineering Design”, McGraw Hill International, 2002.
2. Keven Otto and Kristin Wood, Product Design. Pearson Publication, 2004.
3. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill.
4. A K Chitale and R C Gupta, Product Design and Manufacturing, Prentice Hall of India, New Delhi, 2003.
5. Geoffrey Boothroyd, Dewhurst P and Knight W, Product design for manufacture and assembly, CRC press, 2002.
6. ASM Handbook, Design for manufacture, 2000.
7. Fixel, J. Design for the Environment McGraw Hill., 1996.
8. James G. Bralla, Design for Manufacturability handbook, McGraw hill, 1999.

**List of Practical/ Tutorials: NA**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>List</b> key considerations for designing products for efficient manufacturing and assembly.
CO-2	<b>Interpret</b> manufacturing and assembly constraints and their implications on design decisions.
CO-3	<b>Apply</b> the concept of DFM for machining, casting, welding, forming and assembly.
CO-4	<b>Analyze</b> product designs to identify features that may pose challenges during assembly.
CO-5	<b>Generate</b> new product designs that are optimized for easy assembly.
CO-6	<b>Evaluate</b> the effectiveness of DFE strategies in reducing environmental impact and promoting sustainability.

**List of Open-Source Software/Learning Website:**

- <http://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2402**  
**Subject Name: Fluid Power Engineering**

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

### Semester: VII

**Type of course:** Professional Core Course

**Prerequisite:** Basics of Mechanical Engineering

**Rationale:** The course is designed to provide the detailed understanding of fluid power and different major equipment which can produce power from fluid.

**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	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Hydropower Plant:</b> Introduction, Major applications of hydropower plant, Classification of hydropower plant, Essential components of hydropower plant, Advantages and disadvantages of hydropower plant, selection of site for a hydropower plant	03
2	<b>Impact of Jet:</b> Introduction, Force exerted on stationary plate held normal and inclined to jet, Force exerted on curved plate, force exerted on moving plate held normal and inclined in direction of moving jet, Force on a plate when vane is moving in direction of jet, jet striking on curved vane tangentially at one tip and leaving at other end	08
3	<b>Hydraulic Turbines:</b> Introduction, Classification of turbines, Impulse and reaction turbines, construction, working and performance of Pelton, Francis and Kaplan Turbines, Draft tube, Governing of hydraulic turbines, Cavitation	07
<b>SECTION-B</b>		
4	<b>Pumps:</b> Pump classification and selection criterion, operation of Centrifugal pumps, Velocity vector diagrams, Pump losses and efficiencies, Net positive suction head, Pressure rise in impeller, Characteristic curves of centrifugal pumps, Operation of Reciprocating	07

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**Bachelor of Engineering**  
**Subject Code: ME2402**  
**Subject Name: Fluid Power Engineering**

	pump, discharge coefficient, volumetric efficiency, slip, work done and power required to drive reciprocating pumps, priming, cavitation, pump selection	
<b>5</b>	<b>Compressors:</b> Classification, Construction and working of reciprocating compressors, Intercooling, Efficiency, Rotary compressors, Centrifugal compressors, Velocity diagram, Degree of reaction, surging and choking, Losses in centrifugal compressor, Axial flow compressors, performance characteristics	<b>08</b>
<b>6</b>	<b>Hydraulic Machines:</b> Construction and working of hydraulic press, Hydraulic accumulator, Hydraulic intensifier, Hydraulic crane, Hydraulic jack, hydraulic lift, Hydraulic ram, Fluid couplings, Fluid torque converter and air lift pump	<b>03</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
10%	15%	25%	25%	15%	10%

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

**Reference Books:**

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S.K. Kataria & Sons.
2. Fluid Power Engineering by R.N. Patel and V.L. Patel Mahajan Publication
3. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Prakashan.
4. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S. Chand & Co.
5. Turbines, Compressors and Fans by S.M. Yahya., TMH Publishers
6. Fluid Mechanics and Turbomachines by Das, Madan Mohan, PHI Learning

**List of Practical/ Tutorials:**

1. To study about hydropower plant.
2. To Verify Impulse-momentum principle for impact of jet on stationary vane.
3. Performance test on Pelton turbine.
4. Performance test on Kaplan turbine.
5. Performance test on Francis turbine.
6. Performance test on Centrifugal pump.

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2402**  
**Subject Name: Fluid Power Engineering**

7. Performance test on Reciprocating pump.
8. To study about different Compressors
9. Performance test on Hydraulic ram.
10. To study about Hydraulic machines.

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Develop</b> a comprehensive understanding of hydropower plant operations
CO-2	<b>Analyze</b> theory of impact of jet and apply the same for hydraulic machines
CO-3	<b>Distinguish</b> different hydraulic turbines with evaluation of their performances
CO-4	<b>Evaluate</b> performance of different pumps
CO-5	<b>Deduce</b> characteristics of different compressors
CO-6	<b>Understand</b> working of various hydraulic machines

**List of Open-Source Software/Learning Website:**

<https://nptel.ac.in>



(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2403**

**Subject Name: Solar Thermal and Photovoltaic Systems**

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

**Semester: VII**

**Type of course:** Professional Elective Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** The course is designed to give knowledge and relevant technologies in the area of solar energy. This subject is offered to emphasize the role of solar energy and its potentials. The course aims to introduce the basic concepts of solar energy and the preliminary analysis to estimate the energy generation from the solar systems. Various components involved in the solar system are covered and the control approaches to improve the performance of the systems are also included. In addition to the various applications of solar generation systems, the course also covers the issues related to the integration of these systems in the existing network. Thus, the course is intended to provide the foundation for the solar PV and thermal generation systems.

**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	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Solar Radiation:</b> Energy available from the sun, spectral distribution, solar radiation outside the earth's atmosphere and at the earth's surface, solar radiation geometry, Instruments for solar radiation measurements, empirical equations for prediction of availability of solar radiation on horizontal, radiation on and tilted surface.	06
2	<b>Solar Collector :</b> Solar energy conversion into heat, types and working of solar collectors, evacuated and non-evacuated solar air heater, concentrated collectors, losses in liquid flat plate collector, thermal analysis of liquid flat plate collector, air heater and cylindrical parabolic concentrating collector.	06

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2403**

**Subject Name: Solar Thermal and Photovoltaic Systems**

<b>3</b>	<b>Solar Thermal Applications:</b> Active and passive solar water heating system, solar space heating, solar cooling with absorption and adsorption refrigeration, solar desalination systems, solar powered absorption air conditioning system, solar irrigation system, solar chimney, drier, dehumidifier, solar still	<b>06</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Introduction to PV Systems:</b> Introduction, Status and prospects of PV Systems, Location issue – position of sun – sun path, PV cell – module – array, Irradiation on PV module, Shadowing, Maximum power point tracking, Types and component of PV system, Energy storage – types of battery - hydrogen storage - fuel cell, PV system load and availability, Associated electronic components, Generators – types and size – characteristics, maintenance - selection, Wiring and code compliance, Balance of system, PV System design – load profile – Meteorological effect – Design of grid and off grid PV system, PV system economy and ecology.	<b>06</b>
<b>5</b>	<b>Solar PV Applications:</b> Introduction, PV powered fan – module, fan with battery backup, PV powered pumping system – system component requirement – design approach for simple pumping system, PV powered area lighting system – lightning load calculation and system.	<b>06</b>
<b>6</b>	<b>Economic Analysis:</b> Initial and annual cost, Basic definitions Fundamentals of economic analysis, time value of money, payback period, present worth calculations, repayment of loan in equal annual installments, annual solar savings, cumulative saving and life cycle cost analysis, economic analysis of solar system, clean development mechanism.	<b>06</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
15%	30%	25%	10%	10%	10%

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

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**Bachelor of Engineering**  
**Subject Code: ME2403**  
**Subject Name: Solar Thermal and Photovoltaic Systems**

**Reference Books:**

1. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, McGrawHill Education.
2. Solar Engineering of Thermal Processes, John A. Duffie, William A. Beckman, John Wiley, New York.
3. Solar Energy Engineering, Soteris Kalogirou, Elsevier/Academic Press.
4. Non-conventional energy resources, Shobh Nath Singh, Pearson India.
5. Solar Photovoltaic: Fundamentals, Technologies and Applications, Chetan Singh Solanki, PHI learning Pvt. Ltd.
6. Handbook for Solar Photovoltaic Systems, Energy market authority, Building and Construction authority

**List of Practical/ Tutorials:**

1. Study of Solar Radiation and measurements.
2. Study of solar water pumping
3. Study of Solar Distillation or Solar Still.
4. To study the constructional details of a box type solar cooker.
5. Study of Solar Water Heater.
6. Study of Forced circulation solar water heating system
7. Study of a Solar Dryer.
8. Study of I-V & P-V Characteristics of a Solar PV Panel
9. Study of Solar Street Lighting and Lanterns.
10. Study of Horizontal Wind Mill.

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Estimate</b> solar radiation on the various surfaces and its applications for thermal and photovoltaic system
CO-2	<b>Analyze</b> the performance of various solar collectors
CO-3	<b>Understand</b> the applications for solar thermal system
CO-4	<b>Describe</b> solar photovoltaic system and its components.
CO-5	<b>Understand</b> applications of solar photovoltaic system.
CO-6	<b>Evaluate</b> the life cycle cost and carry out economic analysis of renewable energy sources.



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**Bachelor of Engineering**

**Subject Code: ME2403**

**Subject Name: Solar Thermal and Photovoltaic Systems**

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### List of Open-Source Software/Learning Website

<https://nptel.ac.in>

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**Bachelor of Engineering**

**Subject Code: ME2404**

**Subject Name: Advanced HVAC Systems Design**

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

**Semester: VII**

**Type of course:** Professional Core Course

**Prerequisite:** Basic knowledge of Refrigeration and Air-conditioning

**Rationale:** The course is designed to provide the detailed understanding of HVAC systems and different aspects of their design.

**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	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>Introduction to HVAC:</b> Fundamentals, basics of refrigeration and air conditioning (AC) systems, p-h, h-s charts, components of refrigeration and AC system, refrigerant and brine, types of air AC system, Psychometric chart, Properties of Air (DBT, % RH, WBT, DPT, Enthalpy), Refrigerant Pipe sizing methods	<b>05</b>
<b>2</b>	<b>Heat Load Estimation:</b> Basics of Heat transfer in a building envelop, Understanding of Outdoor & Indoor Conditions, Factors effecting the loads estimate, Sources of Heat Gain, Heat loss calculations, Basics of Heat loss in a building envelop, Sources of Heat loss	<b>06</b>
<b>3</b>	<b>Design of Air Distribution System:</b> Components of Air distribution system, Types of Ducts, Duct Fittings, Dampers, Types of Diffusers, Duct Elbows selections, Duct Material Calculation, Duct designing methods, Components of Air Distribution (Duct) System, Fan selection, Static pressure calculation, Supply & Return Duct configuration, Introduction to Ventilation system, Types of Ventilation, Components of Ventilation system	<b>07</b>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2404**  
**Subject Name: Advanced HVAC Systems Design**

SECTION-B		
<b>4</b>	<b>Chilled Water system design:</b> Introduction to Chilled water system, Hot water system, Classification of chillers, Chiller arrangements, Cooling tower arrangement, Types of cooling tower & Expansion tank connections, Pumps required in Chilled water system, Piping fittings and Components, Friction loss calculation for the piping system, Valves used in Chilled Water System	<b>06</b>
<b>5</b>	<b>Equipment Selection &amp; erection:</b> AHU & FCU classification and selection, Package Unit Selection DX- Chiller Selection, Condenser Selection (Air cooled, Water Cooled, Evaporative), Cooling Tower Selection Mixed Air Temperature HRF for Open and Closed Compressor, Expansion Tank Selection, Detailing & Installation of Chillers and other components	<b>07</b>
<b>6</b>	<b>Drafting of HVAC Systems:</b> Introduction to Drafting, Types of Drawings used in the industry, Study & Preparation of Floor Drawings, Roof Drawings, Sectional Drawings, Builders Work Drawings, Co-ordination, Drawings & Riser Diagram, Abbreviations & Symbols used	<b>05</b>

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

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	15%	25%	25%	15%	10%

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

**Reference Books:**

1. HVAC Fundamentals Volume-I / James E. Brumbou / Audel / 4th Edition
2. Fundamentals of HVAC Systems / Robert Mcdowall / Academic Press / 2007
3. Home Heating & Air Conditioning systems / James Kittle / MGH
4. HVAC Fundamentals / Samuel C. Sugarman / Fairmont Press / 2005.
5. Principles of Refrigeration – Dossat, Pearson
6. R&AC Hand Book by ISHRAE
7. Refrigeration and air conditioning, C. P. Arora, McGraw Hill
8. Refrigeration and air conditioning, Stocker, McGraw Hill

**List of Practical/ Tutorials:**

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2404**  
**Subject Name: Advanced HVAC Systems Design**

1. To compare and analyze advance refrigeration cycle for different refrigerants.
2. Performance analysis of VCR system
3. Performance analysis of air conditioning test rig.
4. Study of various instruments used in air conditioning.
5. To study air distribution system.
6. To carry out cooling load calculation of a residential/commercial building
7. To analyze chilled water system design.

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Demonstrate</b> a comprehensive understanding of the fundamental principles of HVAC
CO-2	<b>Apply</b> principles of load calculations to determine the heating and cooling requirements for different types of buildings
CO-3	<b>Design</b> the effective and efficient air distribution systems for HVAC applications
CO-4	<b>Exhibit</b> the ability to design efficient and sustainable chilled water systems for HVAC applications
CO-5	<b>Express</b> expertise in equipment selection, system design, installation techniques, and compliance with industry standards of HVAC
CO-6	<b>Develop</b> detailed HVAC system drawings using industry-standard tools

**List of Open-Source Software/Learning Website:**

<https://nptel.ac.in>

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**Bachelor of Engineering**

**Subject Code: ME2405**

**Subject Name: Cogeneration and Heat Recovery Systems**

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

Semester: VII

**Type of course:** Professional Elective Course

**Prerequisite:** Thermodynamics and Thermal Engineering

**Rationale:** To provide knowledge of cogeneration systems, waste heat potential, its effective recovery based on economic analysis, energy storage using various waste heat recovery methods and devices.

**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	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Introduction:</b> Principles of thermodynamics – cycles – topping – bottoming – combined cycle – organic Rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri and quad generation.	05
2	<b>Cogeneration Technologies:</b> Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.	07
3	<b>Issues and Application of Cogeneration Systems:</b> Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment.	06



(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2405**  
**Subject Name: Cogeneration and Heat Recovery Systems**

<b>SECTION-B</b>		
<b>4</b>	<b>Waste Heat Recovery Systems:</b> Selection criteria for waste heat recovery technologies- recuperators- regenerators- economizers- plate heat exchangers- thermic fluid heaters Waste heat boilers-classification, location, service conditions, design considerations-fluidized bed heat exchangers-heat pipe exchangers-heat pumps –absorption systems.	<b>07</b>
<b>5</b>	<b>Prime Movers Exhausts:</b> Incineration plants; heat pump systems; thermoelectric devices. Utilization of low grade reject heat from power plants, Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems. Thermoelectric system to recover waste heat.	<b>06</b>
<b>6</b>	<b>Economic Analysis:</b> Investment cost –economic concepts–measures of economic performance –procedure for economic analysis–examples–procedure for optimized system selection and design–load curves - sensitivity analysis –regulatory and financial frame work for cogeneration and waste heat recovery system.	<b>05</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
10%	25%	25%	15%	15%	10%

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

**Reference Books:**

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001.
3. Shah, Kanti L.,(2000) Basics of Solid & Hazardous Waste Management Technology, Prentice Hall of India.
4. Parker, Colin & Roberts, Energy from Waste1985 An Evaluation of Conversion Technologies Elsevier Applied Science
5. Cogeneration – BEE Book

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2405**  
**Subject Name: Cogeneration and Heat Recovery Systems**

6. Handbook for cogeneration and combined cycle power plant – 2<sup>nd</sup> Edition, ASME
7. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.

**List of Practical/ Tutorials:**

1. Study of different types of cogeneration system.
2. Study of various waste heat recovery systems.
3. Study of different types of thermodynamic cycles.
4. Study of waste heat recovery in Boilers.
5. Study of waste heat recovery in Economiser.
6. Study of waste heat recovery in Air Preheater.
7. Study of waste heat recovery in Heating Ventilation and Air Conditioning.
8. Study of waste heat recovery in Heat Exchanger.
9. Study of waste heat recovery in Internal Combustion Engines.
10. Economic analysis of waste heat recovery systems.

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Comprehend</b> the Rankine cycle, coupled cycles for combined plants for energy conservation.
CO-2	<b>Understand</b> different types of cogeneration systems.
CO-3	<b>Identify</b> different issues and application of cogeneration plant.
CO-4	<b>Analyze</b> the waste heat recovery technologies developed for various thermal systems.
CO-5	<b>Acquire</b> knowledge on waste heat recovery in heat pump, thermoelectric and HVAC systems.
CO-6	<b>Apply</b> the economic analysis concepts for the effective implementation of waste heat recovery.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2406**

**Subject Name: Welding and Corrosion Control in Manufacturing**

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

**Semester: VII**

**Type of course:** Professional Elective courses

**Prerequisite:** Zeal to learn the subject

**Rationale:** This subject aims to provide students with a comprehensive understanding of corrosion control in manufacturing, including both fundamental principles and advanced techniques. The syllabus is divided into two sections, with Section A: focusing on corrosion control in general and Section B specifically addressing corrosion issues during welding processes.

**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>Fundamentals of Corrosion</b> Introduction to Corrosion Mechanisms, Types of Corrosion: Uniform, Galvanic, Pitting, and Crevice Corrosion, Factors Influencing Corrosion in Manufacturing Environments, The role of Temperature and Humidity in Corrosion.	<b>05</b>
<b>2</b>	<b>Corrosion Prevention Techniques</b> Protective Coatings and Surface Treatments, Cathodic and Anodic Protection Methods, Corrosion Inhibitors and their Applications in Manufacturing, Green Inhibitors: Environmentally Friendly Corrosion Prevention.	<b>08</b>
<b>3</b>	<b>Materials Selection and Design for Corrosion Resistance</b> Corrosion-Resistant Alloys and Composites, Material Compatibility in Aggressive Environments, Design Considerations for Corrosion	<b>06</b>

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

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2406**

**Subject Name: Welding and Corrosion Control in Manufacturing**

	Prevention in Manufacturing Components, Nanomaterials for Corrosion Resistance.	
<b>SECTION-B</b>		
<b>4</b>	<b>Welding Fundamentals</b> Basics of Various Welding Processes, Heat-Affected Zone (HAZ) and its Impact on Corrosion, Weldability of Different Materials, Welding of Dissimilar Metals: Challenges and Solutions	<b>05</b>
<b>5</b>	<b>Welding Defects and Corrosion</b> Types of Welding Defects and their Corrosion Risks, Inspection and Quality Control in Welded Joints, Non-Destructive Testing (NDT) Techniques for Detecting Corrosion in Welds	<b>06</b>
<b>6</b>	<b>Advanced Welding Techniques for Corrosion Control</b> Corrosion-Resistant Welding Consumables, Welding in Controlled Atmospheres, Innovative Approaches to Minimize Corrosion During Welding, Friction Stir Welding for Corrosion-Prone Materials	<b>08</b>

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
10%	20%	30%	20%	20%	0%

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

**Reference Books:**

1. Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering by R. Winston Revie and Herbert. H. Uhlig.
2. Corrosion Engineering: Principles and Practice by Pierre R. Roberge.
3. Corrosion Prevention by Protective Coatings by Charles V. Hale.
4. Materials Selection in Mechanical Design by Michael F. Ashby.
5. Welding Engineering and Technology by R S Parmar.
6. Welding Technology, by O.P.Khanna, Dhanpat Rai publishers.
7. Elements of workshop Technology (Volume I & II) – S. K. Hajra Chaudary, Bose & Roy, Media Promoters and Publishers Limited.

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2406**

**Subject Name: Welding and Corrosion Control in Manufacturing**

**List of Practical/ Tutorials: NA**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Understand</b> the basic principles of corrosion mechanisms.
CO-2	<b>Demonstrate</b> knowledge of corrosion inhibitors and their applications in manufacturing.
CO-3	<b>Apply</b> design considerations for corrosion prevention in manufacturing compo
CO-4	<b>Understand</b> the fundamentals of various welding processes and <b>Analyze</b> the impact of heat-affected zones (HAZ) on corrosion
CO-5	<b>Identify</b> types of welding defects and their associated corrosion risks.
CO-6	<b>Implement</b> welding in controlled atmospheres for corrosion prevention.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2407**

**Subject Name: Supply Chain Management in Manufacturing**

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

**Semester: VII**

**Type of course:** Professional Elective Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** Supply chain management in manufacturing needs to optimize processes, reduce costs, manage risks, and ultimately enhance customer satisfaction through efficient and effective management of the entire supply chain ecosystem.

**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>Introduction to Supply Chain Management:</b> Definition and objectives of SCM. Evolution of SCM in manufacturing, Importance of SCM in enhancing competitiveness. Supply Chain Operations: Forecasting and demand planning, Inventory management techniques (JIT, EOQ, etc.), Materials requirement planning (MRP).	05
2	<b>Logistics and Transportation:</b> Modes of transportation (road, rail, air, sea), Transportation management, Procurement and Supplier Management: Strategic sourcing, Supplier selection and evaluation, Contract management.	06
3	<b>Manufacturing and Production Planning:</b> Production planning and scheduling, Lean manufacturing principles, Capacity planning. Case Studies and Project Work: Analysis of real-world supply chain issues, Group projects on SCM optimization or improvement.	07
<b>SECTION-B</b>		
4	<b>Emerging Trends in SCM:</b> Industry 4.0 and digitalization, Block-chain in supply chain, Sustainable and circular supply chains.	05

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2407**

**Subject Name: Supply Chain Management in Manufacturing**

<b>5</b>	<b>Sustainability in Supply Chain:</b> Environmental considerations in SCM, Social responsibility and ethical sourcing, Sustainable supply chain practices.	<b>06</b>
<b>6</b>	<b>Quality Management in Supply Chain:</b> Total Quality Management (TQM), Six Sigma principles, Quality control and assurance in SCM, Identification and assessment of supply chain risks, Risk mitigation strategies.	<b>07</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
15%	30%	25%	10%	10%	10%

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

**Reference Books:**

1. Supply Chain Management: Text and Cases by S. Anil Kumar and N. S. Rajput.
2. Lean Supply Chain Management: Indian Practices and Perspectives by Dr. Amiya Kumar Das.
3. Inventory Management: Indian Context by Prof. Bhaba Patra.
4. Operations and Supply Chain Management: Indian Cases by Prof. Debashis Paul and Dr. Soumyadeep Das.
5. Supply Chain Management: Strategy, Planning, and Operation" by Prof. G. Raghuram and Prof. D.V. R. Seshadri.
6. Lean Supply Chain Management: Concepts and Practices" by Prof. Shivanand P. Shinde (McGraw Hill Education)
7. Supply Chain Management: Concepts, Techniques, and Practices" by Dr. B. S. Sahay (Tata McGraw Hill Education)

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2407**

**Subject Name: Supply Chain Management in Manufacturing**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Identify and explain</b> the key components, functions, and flows within a manufacturing supply chain.
CO-2	<b>Apply</b> various supply chain management techniques to improve operational efficiency within a manufacturing setting.
CO-3	<b>Interpret</b> key performance indicators (KPIs) to identify areas for improvement within manufacturing supply chain.
CO-4	<b>Describe</b> lean manufacturing principles to streamline processes and eliminate waste in the manufacturing supply chain.
CO-5	<b>Assess</b> the environmental, social, and economic impacts of supply chain activities within a manufacturing context.
CO-6	<b>Identify, assess and mitigate</b> the risk of supply chain by quality management principles.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>



(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2408**  
**Subject Name: Tooling Design and Analysis**

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

### Semester: VII

**Type of course:** Professional Elective Course

**Prerequisite:** Basic knowledge of Machine Tools and Engineering Materials

**Rationale:** After completion of the course students appreciate and realize the importance of the relation between tooling with design, cost and production. They can apply jigs and fixtures in production and design them as per demand.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits	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>Cutting Tools:</b> Development of Cutting Tool Materials. Design of Single Point Tools for Turning, Nomenclatures of Single Point Cutting Tools, Inserts & Holders. Calculations of Tool Profile for Flat Form Tools & Circular Form Tools. Design & Nomenclatures of Drills, Reamers, Boring Tools.	<b>06</b>
2	<b>Design of Jigs:</b> Definition, Location Principles, Six Point Location Principle, Locators, Clamping Principles, Clamping Devices, Drill Jigs, Drill Bushes, Drill Jig Types, Design and Development of Jigs for given components.	<b>06</b>
3	<b>Design of Fixtures:</b> Milling Fixtures, Milling Methods, Milling Fixture Types, Turning Fixtures, Broaching Fixtures, Grinding Fixtures,	<b>06</b>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2408**  
**Subject Name: Tooling Design and Analysis**

	Assembly, Inspection and Welding Fixtures, Modular Fixtures, Design and Development of Fixtures for given components.	
<b>SECTION-B</b>		
<b>4</b>	<b>Design of Dies:</b> Power Presses, Cutting (Shearing) Operations, Die and Punch Design, Design of Progressive Dies. Design of Compound Dies. Design of Combination Dies.	<b>06</b>
<b>5</b>	<b>Drawing Dies:</b> Metal Flow and Factors affecting Drawing, Blank Size Calculations, Drawing Force, Single and Double acting Drawing Dies, Design and Development of Drawing Dies for different components.	<b>06</b>
<b>6</b>	<b>Bending and Forming Dies:</b> Types of Bending Dies, Spring Back, Bend Allowance, Calculation of Development Length, Bending Force Calculations, Curling Dies.	<b>06</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
15%	30%	25%	10%	10%	10%

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

**Reference Books:**

1. Tool Design, by Cyril Donaldson, McGraw Hill.
2. Press Tools Design and Construction by P. H. Joshi, S. Chand
3. Jigs and Fixtures: Design Manual by P. H. Joshi, McGraw Hill.
4. Design of Jigs, Fixtures and Press Tools by C. Elanchezhian, Eswar Press.
5. Die Design Handbook by D. Smith, SME

**Course Outcomes:**

At the end of the course, the student will be able to:

<b>Sr. No.</b>	<b>CO Statement</b>
CO-1	<b>Design</b> proper cutting tool for given manufacturing operation.

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2408**  
**Subject Name: Tooling Design and Analysis**

CO-2	<b>Select</b> and <b>design</b> a jig of various component for mass production.
CO-3	<b>Select</b> and <b>design</b> a fixture of various component for mass production.
CO-4	<b>Understand</b> the various types of press tool operations performed on different types of dies.
CO-5	<b>Design</b> draw die to suit mechanical or hydraulic press.
CO-6	<b>Decide</b> the type of bending & forming die and design accordingly.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

<https://www.sme.org/sme-store/fundamentals-of-tool-design/>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2409**

**Subject Name: Energy from Waste and Biomass**

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

**Semester: VII**

**Type of course:** Open Elective Course

**Prerequisite:** Recent Advances in Renewable Energy

**Rationale:** The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is designed to provide an understanding of the various aspects of Waste to Energy. The various sources of waste generation is analyzed with a focus on its potential for energy production. The need for characterization of wastes will be discussed along with the existing norms for waste utilization for alternate energy source. Various Technological options available for the production of energy form waste will delineated along with economics of using alternate sources.

**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>Introduction to Energy from Waste:</b> Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	03
2	<b>Biomass Pyrolysis:</b> Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications	07
3	<b>Biomass Gasification:</b> Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier	08

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2409**

**Subject Name: Energy from Waste and Biomass**

	engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation	
<b>SECTION-B</b>		
<b>4</b>	<b>Biomass:</b> Biomass resources, types, production, classification and characterization; Techniques for biomass assessment. Concept of Waste segregation, management and treatment.	<b>03</b>
<b>5</b>	<b>Biomass Combustion:</b> Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors	<b>07</b>
<b>6</b>	<b>Biogas:</b> Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India	<b>08</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
35%	30%	15%	10%	05%	05%

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

**Reference Books:**

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996
5. Guide to Energy management, by Barney L.Capehart, Wayne C.Turner, and William J.Kennedy, The fairmont press, INC. Fourth edition
6. Handbook of Energy Audits by Albert Thumann. CRC press 9th edition

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2409**

**Subject Name: Energy from Waste and Biomass**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	Enable students to understand of the concept of Waste to Energy.
CO-2	Understand about Agriculture waste, Industrial waste and their conversion process
CO-3	Design construction and operation of Gasifiers.
CO-4	Understand about biomass and their conversion process
CO-5	Enable students for analyzing and describing the nature and principles of bioenergy systems.
CO-6	Develop, designs and distinguish the bioenergy systems and learn technical analysis.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2410**

**Subject Name: Energy Efficiency in Industrial Processes**

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

**Semester: VII**

**Type of course:** Open Elective Course

**Prerequisite:** Knowledge of general engineering

**Rationale:** The aim of the course is to provide knowledge of energy efficiency for thermal and electrical utilities used for industrial process. This course also gives an insight of energy saving measures to improve the energy efficiency of industrial utilities.

**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>		
1	<b>Introduction:</b> Energy scenario - supply and demand, Energy intensive industries, Industrial use of energy, Importance of energy in industrial promotion and employment, Energy efficiency, Energy efficiency benefits, Energy efficiency in thermal and electrical utilities, Hydrogen as a fuel for industrial applications.	05
2	<b>Energy efficiency in Boiler and Steam system:</b> Combustion in boilers, Performances evaluation, Analysis of losses, Feed water treatment, Blow down, Properties of steam, Assessment of steam distribution losses, Steam leakages, Condensate and flash steam recovery system, Identifying opportunities for energy savings.	07
3	<b>Energy efficiency in Waste heat recovery and Cogeneration:</b> Classification, Advantages and applications, Commercially viable waste heat recovery devices, Saving potential, Need and principle of cogeneration, Classification of Cogeneration Systems.	06
<b>SECTION-B</b>		

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2410**  
**Subject Name: Energy Efficiency in Industrial Processes**

<b>4</b>	<b>Energy efficiency in Compressed air system:</b> Types of air compressors, Compressor efficiency, Efficient compressor operation, Compressed air system components, Capacity assessment, Leakage test, Factors affecting the performance and efficiency.	<b>06</b>
<b>5</b>	<b>Energy efficiency in Fans and Blowers:</b> Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities.	<b>06</b>
<b>6</b>	<b>Energy efficiency in Pumping system:</b> Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities.	<b>06</b>

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

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	10%	30%	20%	20%	10%

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

**Reference Books:**

1. Principles of Energy Conversion: A.W. Culp
2. Direct Energy Conversion: M.A. Kettani
3. Energy Conversion systems: Begamudre, Rakoshdas
4. Efficient Use of Energy: I.E.C.Dryden (Butterworths)
5. Energy management and control system –Vol-I, II –M.C.Macedo (John Willy)
6. Energy Conservation guide book Patrick/Patrick/Fardo (Prentice hall1993)
7. Handbook on Energy efficiency

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Understand</b> the energy scenario, energy efficiency and its importance.
CO-2	<b>Calculate</b> the relevant performance indicators for process utility boilers and steam system.
CO-3	<b>Knowledge</b> of waste heat recovery and cogeneration system.
CO-4	<b>Determine</b> the energy efficiency in compressed air system.
CO-5	<b>Evaluate</b> the performance of fans and blowers.
CO-6	<b>Compute</b> the energy efficiency in pumping system.





(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2410**

**Subject Name: Energy Efficiency in Industrial Processes**

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**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2411**

**Subject Name: Energy Policy and Economics for Sustainability**

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

**Semester: VII**

**Type of course:** Open Elective Course

**Prerequisite:** Basic knowledge of energy production and usage

**Rationale:** In this course, an emphasis will be given on studying the interactions between technology, performance, cost, and government decision-making, with an eye towards placing specific renewable technologies in the context of policy decisions.

**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>		
1	<b>Introduction:</b> Origin and Definitions of Energy Economics, Link between Economics and Energy, Energy Resources and Energy Commodities; Properties of Energy Resources and Energy Commodities, concept of Energy conservation and Energy efficiency.	07
2	<b>Energy Scenario:</b> Global and National scenario Trend and Patterns of Energy Consumption and the Energy Crisis (since 1970 the Oil shocks and other events).	04
3	<b>Energy Pricing and Taxation:</b> Production Cost versus Return on Investment, Models of Pricing, Market Failures, Peak and Off-peak Pricing, Subsidies, The role of regulatory bodies like MERC, Energy Finance: Banks, International organisations, Green Finance initiatives.	07
<b>SECTION-B</b>		
4	<b>Demand and Supply of Energy:</b> Demand for Energy as a Derived Demand, World Energy Consumption – Economic Growth and World Energy Consumption, Demand substitution and energy use Classification of Energy supplies: renewable and non-renewable, Fossil fuels (coal, oil,	06

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2411**

**Subject Name: Energy Policy and Economics for Sustainability**

	natural gas), Renewable energy (Hydro, Marine, wind, solar, Geothermal, bio), Nuclear power, Trend and patterns of energy production.	
<b>5</b>	<b>Sustainable Development:</b> Concept of Sustainable Development, Energy Security: India's initiatives, Energy and Climate Change, Energy Efficiency and carbon emissions: Global and National trends, Energy Policy, Environmental, social, and governance (ESG).	<b>06</b>
<b>6</b>	<b>The Economics of Climate Change:</b> Climate Change Background, Overview of GHG Emissions, Economic Approach to Control the Greenhouse Effect, Options to Cope with Global Warming, Generic Options, National Policy Options, Emissions Trading System (ETS).	<b>06</b>

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

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15%	30%	25%	10%	10%	10%

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

**Reference Books:**

1. Pindyck, R., and D. Rubinfeld. Microeconomics. 6th ed. Upper Saddle River, NJ: Prentice Hall, 2005. ISBN: 0130084611
2. International Energy Markets: Understanding Pricing, Policies, and Profits. 2nd Edition. Carol A. Dahl. PennWell.
3. Energy Economics: Concepts, Issues, Markets and Governance by Subhes C. Bhattacharyya
4. Springer Science & Business Media, 28-Feb-2011
5. Energy Economics: Theory and Applications Peter Zweifel, Aaron Praktiknjo, Georg Erdmann Springer, 27-Mar-2017

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2411**

**Subject Name: Energy Policy and Economics for Sustainability**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Understand</b> the motivations for energy economics and policy making.
CO-2	<b>Knowledge</b> of patterns of energy consumption and the energy crisis.
CO-3	<b>Describe</b> the process of energy pricing and taxation.
CO-4	<b>Identify</b> the factors causing the gap between supply and demand of energy.
CO-5	<b>Develop</b> and effectively communicate policy-related arguments.
CO-6	<b>Understand</b> the economics of climate change.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2412**

**Subject Name: Computer Aided Numeric Control**

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

**Semester: VIII**

**Type of course:** Professional Core Course

**Prerequisite:** Manufacturing Processes, Manufacturing Technology

**Rationale:** Computer Aided Manufacturing is highly demanded area now a day. Computer Aided Manufacturing deals with Design of components to manufacturing and also includes Planning and controlling the processes. Industries widely use CNC, FMS and Robotics technology now a day. Students will be familiar with its hardware and software and also able to write programs for machining. **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	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>Computer Aided Manufacturing:</b> CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM, Role of management in CAM, Concepts of Computer Integrated Manufacturing, Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel to understand basic functions.	<b>5</b>
<b>2</b>	<b>NC/CNC Machine Tools:</b> NC and CNC Technology: Types, Classification, Specification and components, Construction Details, Controllers, Sensors and Actuators, CNC hardware: Re circulating ball screw, anti-friction slides, step/servo motors. Axis designation, NC/CNC tooling. <b>Programmable Logic Controllers:</b> Relay Device components, Programmable controller architecture, programming a programmable controller, tools for PLC logic design.	<b>6</b>
<b>3</b>	<b>Part programming:</b> Types of format, Part Programming, G and M codes for turning for drilling, lathe and milling machine operations, subroutines,	<b>7</b>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2412**

**Subject Name: Computer Aided Numeric Control**

	do loops, canned Cycles, parametric subroutines. Simple part programming using various compensations (Tool length, Tool Radius, Tool offset)	
<b>SECTION-B</b>		
<b>4</b>	<b>Group Technology and CAPP:</b> Introduction, part families, part classification and coding systems: OPITZ, PFA, FFA, Cell design, rank order clustering, composite part concepts, Benefits of group technology. Approaches to Process Planning, Different CAPP system, application and benefits.	<b>06</b>
<b>5</b>	<b>Flexible Manufacturing System:</b> Introduction & Component of FMS, Needs of FMS, general FMS consideration, Objectives, Types of flexibility and FMS, FMS layout and advantages. Automated material handling system: Types and Application, Automated Storage and Retrieval System, Automated Guided Vehicles, Cellular manufacturing, Tool Management, Tool supply system, Tool Monitoring System, Flexible Fixturing, Flexible Assembly Systems.	<b>06</b>
<b>6</b>	<b>Robot Technology &amp; Integrated Production Management System:</b> Introduction: Robot Anatomy, Laws of Robot, Human System and Robotics, Coordinate system, Specifications of Robot. Power sources, actuators and Transducers, Robotic Sensors, Grippers, Robot Safety, Robot Programming and Robot Applications, Economic Considerations of Robotics system, Robot Kinematics and Dynamics, Robot Arm Dynamics. Concepts of Computer Vision and Machine Intelligence. Introduction to Integrated Production Management System, ERP. Just in Time philosophy, concepts of Expert System in Manufacturing and Management Information System.	<b>06</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
10%	20%	15%	25%	10%	20%

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

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2412**  
**Subject Name: Computer Aided Numeric Control**

**Reference Books:**

1. Computer Aided Manufacturing by Tien Chien Chang, Pearson Education.
2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P Groover, Pearson Education.
3. Robotics Technology and Flexible Automation, by S R Deb, S Deb, McGraw Hill Education Private Limited.
4. Flexible Manufacturing Cells and System -William. W. Luggen Hall, England Cliffs, Newjersy.
5. P.Radhakrishnan, "Computer Numerical Control ", New Central Book Agency, 1992.
6. Computer integrated manufacturing -S. Kant Vajpayee – Prentice Hall of India.
7. System Approach to Computer Integrated Manufacturing. Nanua Singh, Wiley and sons Inc, 1996.
8. Computer Aided Manufacturing- Rao, Tewari, Kundra, McGraw Hill, 1993.
9. CAD/CAM, Principles and Applications –P N Rao, McGraw Hill, 2010.
10. CAD/CAM, Introduction, -Ibrahim Zeid, Tata McGraw Hill, 2007.

**List of Practical/ Tutorials:**

1. Study of Computer Integrated System: Basics, Types of Manufacturing, role of management and CIM wheel
2. NC/CNC technology: Definition, Classification, Specification, Construction details, Sensors and Actuators, and different controllers.
3. CNC part Programming: Lathe and Milling jobs
4. Exercise on PLC for Simple problems.
5. Problems on GT and Industrial case problems on coding
6. Problems on CAPP and Industrial case problems
7. Study of Flexible Manufacturing system
8. Study of Robotics Technology
9. Study of Expert System in Manufacturing and MIS

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	Illustrate Computer Aided Manufacturing with NC, CNC and PLC technology for Industry
CO-2	Understand NC/CNC Machine Tools, and Programmable Logic Controllers:
CO-3	Create Part Program for computer numeric controlled: drilling, lathe and milling

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2412**

**Subject Name: Computer Aided Numeric Control**

CO-4	Explore various approaches to Computer aided process planning, different CAPP systems, and their applications
CO-5	Evaluate Flexible Manufacturing Systems (FMS) application in industry.
CO-6	Demonstrate Robot Technology and Integrated Production Management system.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>



(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2413**

**Subject Name: Design of Material Handling Equipment**

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

**Semester: VIII**

**Type of course:** Professional Core Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** The course aims is to describe basic skills of force and stress analysis for design of machine Elements.

**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>Introduction:</b> Objectives of material handling system, Principal groups of materials handling equipment and classification, Scope of Material Handling, Criteria for selection of Material Handling Equipment's, Basic kind of material handling problems, Various methods to analyze material Handling problems.	04
2	<b>Conveyor Design:</b> Introduction to Apron conveyors , Pneumatic conveyors, Belt Conveyors, Chain conveyors, Screw conveyors and vibratory conveyors and their applications, Design of Belt conveyor- Belt selection procedure and calculation of drop energy, Idler design.	07
3	<b>Design of bucket and Cage Elevator:</b> Introduction, Types of Bucket Elevator, Design of Bucket Elevator- loading and bucket arrangements, Cage elevators.	07
<b>SECTION-B</b>		
4	<b>Design of Hoists:</b> Design of hoisting elements: Welded and roller chains – Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments.	07
5	<b>Design of Cranes:</b> Hand-propelled and electrically driven overhead traveling cranes; Traveling mechanisms of cantilever and monorail cranes , goliath cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post	07

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2413**

**Subject Name: Design of Material Handling Equipment**

	and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes	
<b>6</b>	<b>Packaging and storage of bulk materials:</b> Steps for design of packages, protective packaging, testing the physical characteristics of packaging, container testing, types of storage and industrial containers, Automatic guided vehicles, Automatic storage and retrieval system.	<b>04</b>

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

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15%	20%	25%	20%	10%	10%

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

**Reference Books:**

1. Belt conveyors for bulk materials Conveyor Equipment Manufacturer's Association, 6th edition, The New CEMA Book.
2. Materials handling equipment, Rudenko N., Elnvee Publishers.
3. Material Handling Handbook, Raymond A Kulwiec, John Wiley & Sons.
4. Engineering Science and application design for belt conveyor , Ishwar G Mulani and Mrs. Madhu I Mulani, Madhu I. Mulani.
5. Materials Handling Equipments, Alexandrov, M, MIR Publishers.
6. Bulk Materials Handling Handbook, Jacob Fruchtbaum, Springer Science Business Media

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	Define the selection of material handling equipment for material transportation.
CO-2	Construct the conveyors for handling bulk materials
CO-3	Prepare the design of bucket and cage elevator.
CO-4	Analyze elements of hoisting mechanisms used in industry for material handling
CO-5	Discuss the design consideration used in crane.
CO-6	Examine packaging and storage systems used in industry.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME 2414**

**Subject Name: Industrial Automation and Control**

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

**Semester: VIII**

**Type of course:** Open elective course

**Prerequisite:** Zeal to learn the subject

**Rationale:** The purpose of course is to introduce about the basic automation and to provide understanding of its components and various control systems. Students can think and get innovative idea in the area of shop floor automation. This subject is useful to understand the different types of automation and control system used in industries.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits	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:</b> Definition of Automation, Automation in production system, Principles and strategies of automation, Basic elements of an automated system, levels of Industrial Automation Systems, various types of Automations.	<b>05</b>
<b>2</b>	<b>Programmable Logic Control system and Micro Controller:</b> Introduction to Programmable logical controller, PLC basics, Basic ladder logic programming, PLC timer function, PLC counter functions. Basics of microcontrollers, Basic components of Microcontrollers, Application of microcontrollers for automations.	<b>06</b>
<b>3</b>	<b>Automated Machinery:</b> Introductions, Automated transfer machine, automated transfer line, auto-storage and retrieval system, automated guided vehicles, automated material handling system, automated inspection system and CMM.	<b>07</b>
<b>SECTION-B</b>		

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME 2414**

**Subject Name: Industrial Automation and Control**

<b>4</b>	<b>Industrial Robotics and Mechatronics System:</b> Introduction, Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Sensors in Robotics, Industrial Robot Applications, Robot Programming overview. Transducers, Sensors and Actuators: Classification, Principle of Operation, Selection Criteria, Signal Conditioning, Calibration	<b>07</b>
<b>5</b>	<b>Pneumatic and Hydraulic Control System:</b> Introduction, pneumatics and hydraulic system components, pneumatics and hydraulic actuators, application of pneumatics and hydraulic system in automation, pneumatics and hydraulic circuit design for automation, limitations of pneumatics and hydraulic system.	<b>06</b>
<b>6</b>	<b>Economic analysis for Industrial Automation:</b> Plant Economy, feasibility of automation on economical sense, effect of automation on economy, feasibility of automation in Indian market, Scope of automation in Indian industries, Break Even point analysis for automation.	<b>05</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
10%	20%	25%	20%	15%	10%

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

**Reference Books:**

1. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P. Groover, P.H.I. Learning Private Limited.
2. Hydraulics and Pneumatics by Andrew Parr, JAICO Publishing Home, Ahmedabad
3. Industrial Automation and Robotics by Er. A. K. Gupta and S. K. Arora, University Science Press, Laxmi Publishing Pvt. Ltd.
4. Robotics and Control by R. K. Mittal and I. J. Nagrath, McGraw Hill Education (India) Private Limited.
5. Programmable Logic Controller by Vijay R. Jadhav, Khanna Publishers, New Delhi
6. Programmable Logic Controllers: Programming Methods and Applications, by John R. Hackworth, Fredrick D. Hackworth Jr., Pearson
7. Handbook of industrial automation, by Richard L. Shell and Ernest L. Hall, CRC press 2000.

**List of Practical/ Tutorials: NA**

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME 2414**

**Subject Name: Industrial Automation and Control**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Categorize</b> concept of automation , its elements and levels used in industries
CO-2	<b>Describe</b> components of PLC system and <b>Evaluate</b> various function and applications in automation
CO-3	<b>Interpret</b> various automated machineries used in industries for material handling as well as storage and inspection
CO-4	<b>Select</b> appropriate Robot and sensors, transducers and programming method for robot based on applications
CO-5	<b>Compare and select</b> proper control system suitable with specific application in automation
CO-6	<b>Estimate</b> different obstacles and financial aspects associated with industrial automation and control systems

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2415**

**Subject Name: Precision Engineering and Metrology**

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

**Semester: VIII**

**Type of course:** Professional Elective Courses

**Prerequisite:** Basic knowledge of Mechanical Measurement

**Rationale:** Precision engineering is involved with the design, manufacturing and measurement of highly specified parts for the medical, aerospace, automotive, oil and gas exploration and related industry. Metrology will expose the students to various modern metrological instruments and the procedure used to operate these instruments.

**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	<p><b>Introduction to Precision Engineering:</b> Introduction, Precision, Accuracy &amp; Smoothness, Need, Development of overall Machining, Precision Classes of Achievable Machining Accuracy.</p> <p><b>Precision Machining:</b> High Precision Machining, Ultra Precision Machining, Application of Precision Machining.</p>	06
2	<p><b>Materials for Precision Machining:</b> Materials for Tools and Machine Elements, Coated and Laminated Carbides, Ceramics, Diamonds, Cubic Boron Nitride (CBN), Tool and Work Material Compatibility.</p> <p><b>Precision Machine Elements:</b> Guide-ways, Drive Systems, Friction Drive, Linear Motor Drive, Spindle Drive. Hydrodynamic and Hydrostatic Bearings.</p>	06

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2415**

**Subject Name: Precision Engineering and Metrology**

<b>3</b>	<p><b>Precision Manufacturing:</b> Micro Machining Processes, Diamond Machining, Micro Engraving, Micro Replication Techniques, Micro Forming, Micro Casting, Micro Injection Moulding, Micro Embossing.</p> <p><b>Energy Assisted Processes:</b> LBM, EBM, FIB, Micro Electro Discharge Machining, Photolithography, LIGA Process, Silicon Micro Machining, Wet and Dry Etching, Thin Film Deposition.</p>	<b>06</b>
<b>SECTION-B</b>		
<b>4</b>	<p><b>Introduction to Metrology:</b> Definition of Metrology, Objectives of Metrology, Categories of Metrology, Scientific Metrology, Industrial Metrology, Legal Metrology.</p> <p><b>General Metrological Terms:</b> Precision, Accuracy, Repeatability, Reproducibility, Sensitivity, Resolution, Stability, Readability, Calibration.</p>	<b>06</b>
<b>5</b>	<p><b>Machine Tool Metrology:</b> Parallelism, Straightness, Squareness, Coaxiality, Roundness, Run out, Alignment Testing of Machine Tools such as Lathe, Milling Machine and Drilling Machine as per IS Standard Procedure.</p> <p><b>Coordinate Measuring Machine (CMM):</b> Definition, Different Configurations of CMM, Principle, Error involved, Calibration, Probing System.</p>	<b>06</b>
<b>6</b>	<p><b>Quality Control (QC):</b> Meaning, Objectives, Quality Characteristics, Relationship between Various Quality Concepts, Principles of Six-Sigma Techniques, Six-Sigma Certification.</p> <p><b>Statistical Quality Control (SQC):</b> Meaning, Advantages, Different SQC Tools - Central Tendency, Dispersion, Various Control Charts.</p>	<b>06</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
15%	30%	25%	10%	10%	10%

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2415**  
**Subject Name: Precision Engineering and Metrology**

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

**Reference Books:**

1. Precision Engineering by V. C. Venkatesh, Sudin Izman, McGraw Hill.
2. Principles of Precision Engineering by H. Nakazawa, Oxford University Press.
3. Precision Engineering in Manufacturing by R. L. Murty, New Age International.
4. Manufacturing Engineering & Technology by S. Kalpakjian, S. R. Schmid, Pearson.
5. Engineering Metrology by R. K. Jain, Khanna Publishers.
6. Engineering Metrology and Instrumentation by R. K. Rajput, S. K. Kataria and Sons.

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Understand</b> the fundamentals of precision engineering and machining.
CO-2	<b>Identify</b> appropriate materials for tools and machine elements.
CO-3	<b>Analyze</b> the various manufacturing process for precision machining.
CO-4	<b>Understand</b> the fundamentals of metrology and associated terms.
CO-5	<b>Validation</b> of machine tools and work piece.
CO-6	<b>Explain</b> the quality concepts and tools for quality control.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>



(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2416**

**Subject Name: Nanoengineering in Mechanical Systems**

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

### Semester: VIII

**Type of course:** Open Elective Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** To make students understand the use of concept of nanotechnology and nanoscience in the industries and in consumer products. It will be useful to attain a broad range of the knowledge required to flourish in the rapidly developing field of Nanotechnology.

**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>		
1	<b>Basic Elements of Nano-science and Nanotechnology:</b> Engineering scale of nanotechnology, different classes of nano-materials, synthesis of nano-materials, fabrication and characterization of nanostructures,	06
2	<b>Science of Nano Materials</b> Classification of nano structures – effect of the nanometer length scale effects of nano scale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties – effect of nanoscale dimensions on biological systems. Fabrication methods – Top down processes – bottom up process.	06
3	<b>Nanotechnology Methods :</b> Introduction, Vapor Condensation Methods, Sputtering, Laser Method, Spray Pyrolysis, Thermo Chemical /Flame Decomposition of metal organic Precursors methods	06
<b>SECTION-B</b>		
4	<b>Tools to characterize Nanomaterials:</b> X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy, UV/Visible Spectroscopy	06

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2416**

**Subject Name: Nanoengineering in Mechanical Systems**

<b>5</b>	<b>Nanotechnology in Surface Engineering:</b> Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings	<b>06</b>
<b>6</b>	<b>Engineering applications-</b> Cosmetics and Consumer Goods, Nano Sensor, Nano catalysts, Water Treatment and the Environment, Paints, Food and Agriculture Industry, Medicines.	<b>06</b>

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

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
15%	30%	25%	10%	10%	10%

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

**Reference Books:**

1. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by G. Cao, Imperial College Press, 2004.
2. Nanoscale Science and technology by Robert Kelsall (editor), Ian W. Hamley (co-editor), Mark Geoghegan (co-editor) , ISBN: 978-0-470-85086-2
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications by C. N. R. Rao, A. Muller, A. K. Cheetham, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN: 3-527-30686-2.
4. Nanoscale Materials in Chemistry Edited by Kenneth J. Klabunde, John Wiley & Sons, Inc., ISBNs: 0-471-38395-3 (Hardback); 0-471-22062-0.
5. Textbook of Nanoscience and Nanotechnology, B.S. Muty, P. Shankar, Baldev Raj, B.B Rath and James Murday, University Press, IIM ( ISBN-978 81 7371 738 3).
6. Introduction to Nanotechnology by Charles P. Poole Jr and. Frank J. Owens, Wiley-Inter science, 2003.
7. James A. Murphy- Surface Preparation and Finishes for Metal, McGraw-Hill, New York 1971

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2416**  
**Subject Name: Nanoengineering in Mechanical Systems**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Attain</b> a broad range of the knowledge required to flourish in the rapidly developing field of Nanotechnology.
CO-2	<b>Understand</b> the science behind nanotechnology
CO-3	<b>Distinguish</b> different methods of Nanotechnology
CO-4	<b>Describe</b> various characterization techniques of nanomaterials.
CO-5	<b>Understand</b> the effect of process parameters on the properties & microstructure of the surface coating processes.
CO-6	<b>Find</b> the different application of nanotechnology

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2417**

**Subject Name: Composite Materials in Engineering**

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

**Semester: VIII**

**Type of course:** Open Elective Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** This course provides an in-depth understanding of composite materials used in engineering applications. It covers the fundamentals of composite materials, their types, properties, manufacturing processes, design considerations, and applications in various engineering fields.

**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>Introduction to Composite Materials:</b> Definition and classification of composite materials, Advantages and limitations of composite materials, Applications of composite materials.	05
2	<b>Constituents of Composite Materials:</b> Matrix materials, Reinforcement materials, Fiber reinforcements: glass, carbon, aramid, etc.	05
3	<b>Mechanical Behavior of Composite Materials:</b> Stress-strain behavior, Elastic constants of composite materials, Strength and failure criteria Fatigue behavior, Creep behavior.	08
<b>SECTION-B</b>		
4	<b>Manufacturing Processes of Composite Materials:</b> Hand lay-up, Spray-up, Filament winding, Compression molding, Resin transfer molding (RTM), Vacuum bag molding, Autoclave molding, Injection molding.	07
5	<b>Design Considerations for Composite Materials:</b> Laminate theory, Design for stiffness and strength, Environmental considerations, Joining and bonding of composite materials.	07

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2417**

**Subject Name: Composite Materials in Engineering**

<b>6</b>	<b>Applications of Composite Materials:</b> Aerospace applications, Marine applications, Automotive applications, Other engineering applications.	<b>04</b>
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**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
20%	30%	25%	05%	10%	10%

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

**Reference Books:**

1. Composite Materials and Structures by R.K. Rajput (Published by S. Chand & Company Ltd.)
2. Introduction to Composite Materials by K.S. Pandey (Published by PHI Learning Pvt. Ltd.)
3. Introduction to Composite Materials Design by Ever J. Barbero (Published by McGraw Hill Education (India) Private Limited)
4. Advanced Mechanics of Composite Materials and Structural Elements by Valery V. Vasiliev and Evgeny V. Morozov (Published by Wiley India Pvt Ltd)
5. Composite Materials: Processing, Fabrication, and Applications by K.K. Chawla and V.K. Kothari (Published by Prentice-Hall of India Pvt. Ltd.)

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**Bachelor of Engineering**  
**Subject Code: ME2417**  
**Subject Name: Composite Materials in Engineering**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Understand</b> the fundamental concepts of composite materials.
CO-2	<b>Identify</b> different types of composite materials.
CO-3	<b>Describe</b> the constituents of composite materials.
CO-4	<b>Analyze</b> the mechanical behavior of composite materials.
CO-5	<b>Comprehend</b> the manufacturing processes of composite materials.
CO-6	<b>Apply</b> composite materials in engineering design and applications.

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2418**  
**Subject Name: Industry 4.0**

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

### Semester: VIII

**Type of course:** Open elective course

**Prerequisite:** Zeal to learn the subject

**Rationale:** Industry 4.0 allows for smart manufacturing and the creation of intelligent factories. It aims to enhance productivity, efficiency, and flexibility while enabling more intelligent decision-making and customization in manufacturing and supply chain operations. Students can understand the concept, basic framework and obstacles for implementation of industry 4.0 .

#### 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 Industry 4.0:</b> Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0	<b>06</b>
<b>2</b>	<b>A Conceptual Framework for Industry 4.0:</b> Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.	<b>06</b>
<b>3</b>	<b>Technology Roadmap for Industry 4.0:</b> Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.	<b>06</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Advances in Robotics in the Era of Industry 4.0:</b> Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive	<b>07</b>

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**Bachelor of Engineering**  
**Subject Code: ME2418**  
**Subject Name: Industry 4.0**

	Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly.	
<b>5</b>	<b>The Role of Augmented Reality in the Age of Industry 4.0:</b> Introduction, AR Hardware and Software Technology, Industrial Applications of AR.	<b>05</b>
<b>6</b>	<b>Obstacles and Framework Conditions for Industry 4.0 :</b> Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data.	<b>06</b>

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

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10%	20%	25%	25%	10%	10%

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

**Reference Books:**

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing the Digital Transformation".
2. Bartodziej, Christoph Jan, "The Concept Industry 4.0".
3. Klaus Schwab, "The Fourth Industrial Revolution".
4. Christian Schröder , "The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".

**List of Practical/ Tutorials: NA**

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	<b>Interpret</b> concept of Industry 4.0 and current technologies
CO-2	<b>Describe</b> components and supportive technologies of Industry 4.0.
CO-3	<b>Propose</b> framework and strategy for new product development with linkage to Industry <b>4.0</b>



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**Bachelor of Engineering**  
**Subject Code: ME2418**  
**Subject Name: Industry 4.0**

CO-4	<b>Select</b> appropriate sensors and advance technologies in Robotics and their applications
CO-5	<b>Understand</b> Industrial Applications of AR
CO-6	<b>Classify</b> different obstacles and financial aspects associated for implementation of Industry 4.0

**List of Open-Source Software/Learning Website**

<https://nptel.ac.in>