

(Established under Gujarat Private Universities Act, 2009)

Shroff S.R.Rotary Institute of Chemical Technology

Ref: UPL University/SRICT/BOS/EST/2023-24/02

Date: 07-02-2024

Teaching Scheme for Fourth Year Bachelor of Environmental Science & Technology

Semester-VII (Environmental Science & Technology) 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	ET2401	Groundwater & Soil Contamination & Remediation	3	0	0	3	3	70	30	0	0	100
2	Professional Core Course	ET2402	Environmental Monitoring	3	0	2	4	4	70	30	20	30	150
3	Professional Elective Course	ET2403	Cleaner Production & Sustainable Development	3	0	0	3	3	70	30	0	0	100
4	Professional Elective Course	ET2404	Global Warming & Climate Change	3	0	0	3	3	70	30	0	0	100
5	Professional Elective Course	ET2405	Energy Technology	3	1	0	4	4	70	30	20	30	150
6	Professional Elective Course	ET2406	Environmental Risk Management	3	1	0	4	4	70	30	20	30	150
7	Open Elective	ET2407	Basics of Reaction Engineering	2	0	2	4	3	70	30	20	30	150
8	Open Elective	ET2408	Petroleum Refining and Petrochemicals	2	1	0	3	3	70	30	20	30	150
9	Summer Internship	MH2401	Inplant Training	0	0	6	6	3	0	0	20	80	100

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	Total	14	2	8	24	20	350	150	80	170	750
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Semester-VIII (Environmental Science & Technology) 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	ET2409	GHG Emission Accounting & Sustainability Reporting	4	0	0	4	4	70	30	0	0	100
2	Professional Elective Course	ET2410	Water Supply & Sanitary Engineering	3	0	0	3	3	70	0	0	0	100
3	Professional Elective Course	ET2411	Sustainable Waste Management	3	0	0	3	3	70	30	0	0	100
4	Open Elective	ET2412	Occupational Health & Safety	3	0	0	3	3	70	30	0	0	100
5	Open Elective	ET2413	Pollution Control & Safety Management	3	0	0	3	3	70	30	0	0	100
6	Project	MH2402	Project	0	0	18	18	9	0	0	100	100	200
	Total			10	0	18	28	19	210	90	100	100	500

A. 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

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VII

Type of course: Professional Core Course

Prerequisite: Fundamental Knowledge of ground water contamination and their preventive measures.

Rationale: Students shall have basic knowledge of Ground water and soil contamination and different remedial measures.

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.
SECTION-A		
1	Introduction and occurrence of ground water: Definition of ground water, aquifers, vertical distribution of subsurface water, ground water in hydrologic cycle, ground water budget, ground water level fluctuations & environmental influence, connection between groundwater and soil contamination, Origin & age of ground water, rock properties affecting groundwater, groundwater basins & springs	05
2	Movement of ground water: Darcy's Law, its range of validity, Dupuit's assumptions, Applications of Darcy's law for simple flow systems, Governing differential equations for confined and unconfined aquifers, steady and unsteady flow solutions for fully penetrating wells, partially penetrating wells, interference of wells, test pumping analysis with steady and unsteady flows, delayed yield	07

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Bachelor of Engineering

Subject Code: ET2401

Subject Name: Groundwater & Soil Contamination & Remediation

3	Ground water pollution and quality analysis: Types and sources of contamination, causes of pollution, physical /chemical /biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity.	06
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Bachelor of Engineering

Subject Code: ET2401

Subject Name: Groundwater & Soil Contamination & Remediation

	Ground water remediation: Source control strategies, Treatment technologies, In situ treatment methods, Pump and treat method, Bioremediation and artificial recharge.	
SECTION-B		
4	Monitoring of ground water: Surface Investigations of Groundwater, Subsurface Investigations of Groundwater, Piezometers, Use of remote sensing in groundwater monitoring CGWA 2020 guidelines: Exemptions from seeking No Objection Certificate, Groundwater use in Agriculture Sector, Commercial Use, Industrial Use, Mining Projects, Infrastructure projects, Ground water abstraction/ restoration charges, Ground Water Level Monitoring, Environmental Compensation,	05
5	Soil contamination: Definition of soil pollution, Sources of Soil pollution, causes of soil pollution, soil pollution due to natural and biological factor, Negative consequence of soil pollution Soil monitoring: Soil sampling strategies, Equipment for soil classification, soil samplers, soil sample storage and preservation.	07
6	Soil remediation: Soil contamination and chemical and biological remediation techniques, Remediation of soils contaminated with metals and organics, Land use planning methods to prevent soil pollution, Prevention of contaminate spreading, Phyto-remediation	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	15	15	10	10	00

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

Recommended Books:

1. Ground water hydrology and contamination by Nicholas Cheremenisoff
2. Ground Water : by Raghunath
3. Ground Water Hydrology: By D K Todd

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Bachelor of Engineering

Subject Code: ET2401

Subject Name: Groundwater & Soil Contamination & Remediation

4. Groundwater Resources Education by W C Walton
5. Environmental soil chemistry by Sparks (Academic Press)
6. Soils and Environmental Quality by Pierzynski, Sims, and Vance (CRC)
7. Biodegradation and Bioremediation by Alexander (Academic Press)
8. Environmental monitoring and characterization by Janick F Artiola, Ian L Pepper, Mark Brusseau
9. "Soil Science: Principles and Practices" by Edward Plaster

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify the sources of ground water contamination
CO-2	Apply the laws of ground water hydraulics to solve the differential equations for different types of aquifers.
CO-3	Employ the ground water survey work to check the quantity and quality of ground water.
CO-4	Outline the monitoring measures to overcome ground water contamination.
CO-5	Summaries the various technique for soil monitoring.
CO-6	Decide the remediation measures for soil contamination.

List of Open-Source Software/learning website:

- NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VII

Type of course: Professional Core Course

Prerequisite: Knowledge of subjects Environmental Sciences.

Rationale: Analysis of water, wastewater and air samples is the first step towards designing treatment technologies for water, waste water and air pollution control. Much information can be obtained by statistical analysis of the data on environmental parameters. This subject aims at equipping the student with methods of monitoring and managing the data generated.

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.
SECTION-A		
1	Environmental Monitoring: Purpose of monitoring, Scales of observation, Environmental characteristics, Representative units, Sampling Location, Types of environmental monitoring, Sampling plan, Analytical data quality requirements: Precision and Accuracy, Detection limits, Reporting data.	7
2	Water Quality Monitoring Sampling techniques, Preservation of water sample, Physical Properties of water & its monitoring: Temperature, Conductivity, Turbidity etc., Chemical Properties of water & its monitoring 1. Electrometric method: pH 2. Colorimetric method 3. Spectroscopy method, Standardization & calibration of monitoring instruments, Biological Properties of water: coliform presence, types of bacteria, theory of staining procedures, introduction to lab equipment: Laminar air flow equipment, autoclave, microscope.	9

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Bachelor of Engineering

Subject Code: ET2402

Subject Name: Environmental Monitoring

3	Air Quality Monitoring Type of Air Quality monitoring - Ambient Air Quality Monitoring- Selection of monitoring sites, Sampling time, Frequency & mode of sampling, Source Air Quality Monitoring – Type of Monitoring procedure	5
SECTION-B		
4	Physical, Chemical and Microbial contaminants Physical contaminants – Naturally occurring particulates, Human made particulates, Mechanisms and control of particulate, Chemical contaminant: - Type of contaminants, Sources of Contaminants, contaminant transport and fate, Microbial contaminants: - Environmentally transmitted pathogens, concept of indicator organisms, sample processing and storage	8
5	Surface Water Monitoring: - Water Quality parameters (drinking water standards, national recommended water quality criteria), sampling the waters (spatial water composition, temporal water composition), sampling techniques for surface waters (direct in situ field measurements, particulate-sediment measurements, in situ sample analysis), water sampling equipment, bio monitoring, criteria for categorization of river monitoring location as per CPCB guidelines.	5
6	Ground Water Monitoring: - Objectives, Location of monitor wells (hydraulic gradient, geological conditions), well construction (monitor well drilling methods, monitor well construction materials), Design and Execution of ground water sampling programs (sampling objectives, groundwater sampling devices, sample collection and processing)	5

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	15	20	10	05	05

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

Recommended Books:

1. Environmental monitoring and characterization by Janick F Artiola, Ian L Pepper, Mark Brusseau

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Bachelor of Engineering

Subject Code: ET2402

Subject Name: Environmental Monitoring

2. Environmental Chemistry by Sawyer & McCarty

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Recognize the concept of environmental monitoring
CO-2	Classify various waste quality monitoring equipment
CO-3	Illustrate air quality monitoring program
CO-4	Examine various physical, chemical and microbial properties of contaminants
CO-5	Explain surface waste monitoring program
CO-6	Summarize ground waste monitoring program

List of Practical:

1. Sampling and preservation of groundwater sample followed by analysis of chemical organic parameters for sampled groundwater
2. Analysis of preserved groundwater sample.
3. Grab sampling and preservation of surface water sample followed by analysis of physical parameters for sampled surface water
4. Analysis of preserved surface water sample.
5. Isolation and enumeration of bacteria from soil sample
6. To perform simple staining procedures to study morphological features of bacteria.
7. To perform gram staining procedures to differentiate two principal groups of bacteria.
8. To assess the microorganism present in the air environment.
9. To study the presence of E. Coli in the given sample.
10. To prepare an air monitoring program for a given location using given windrows diagram.

List of Open-Source Software/learning website:

- NPTEL

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Bachelor of Engineering

Subject Code: ET2403

Subject Name: Cleaner Production & Sustainable Development

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VII

Type of course: Professional Elective Course

Prerequisite: Students shall have basic knowledge regarding Cleaner Production, Good Housekeeping & Sustainable Development

Rationale: To understand the concepts of Cleaner Production & Sustainable Development

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.
SECTION-A		
1	Introduction to Cleaner Production: Theory of Cleaner Production: concepts, principles and significance in industrial settings. Cleaner Production Methodology: Analyzing process steps, identifying opportunities, selecting solutions, and implementing cleaner production practices. Role of International Organizations: Contributions and initiatives of organizations like UNIDO, IFC, GEF, ILO, UNEP, WBCSD, and CII-ITC Centre of Excellence for Sustainable Development in promoting cleaner production globally. The Ten Principles of the UN Global Compact: Introduction to the principles and their application in fostering corporate sustainability and responsible business practices.	06
2	Good Housekeeping and End-of-Pipe Solutions: Implementing effective housekeeping practices for pollution prevention and resource conservation. Difference between Cleaner Production and End-of-Pipe Solutions: Comparative analysis and advantages of cleaner production approaches. Barriers and Drivers in Cleaner Production: Identifying factors influencing the adoption and implementation of cleaner	06

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Bachelor of Engineering

Subject Code: ET2403

Subject Name: Cleaner Production & Sustainable Development

	production practices.	
3	Applications of Cleaner Production in Industries: Case Studies: Examining real-world applications of cleaner production principles in various industries. Sustainable Industrial Practices: Introduction to eco-friendly manufacturing methods, waste management strategies, and product life cycle assessment. Enhanced Oil Recovery (EOR), Enhanced Coal Bed Methane Recovery and recovery of Shale Gas.	07
SECTION-B		
4	Principles of Sustainable Development: Introduction to Sustainable Development: Historical perspective, core principles, and objectives. Sustainable Development Goals (SDGs): Overview of SDGs, their significance, and relevance to environmental engineering. SDG Indicators: Incorporating relevant SDG indicators to measure progress towards sustainable development goals. 2030 Agenda for Sustainable Development: Understanding the global agenda and its implications for environmental sustainability. Conference of the Parties, Concept of carbon capture and storage, Carbon Capture in Cement manufacture and Petrochemical Industries.	07
5	Sustainable Supply Chains: .Sustainable Supply Chain Management: Integrating sustainability principles into supply chain practices, stakeholder engagement, and sustainability reporting. Corporate Social Responsibility (CSR): Principles, practices, and reporting frameworks for promoting social and environmental responsibility.	07
6	Triple Bottom Line and Sustainable Business Practices: Triple Bottom Line Concept: Understanding the three pillars of sustainability (economic, social, and environmental) and their integration into business practices. Role of Innovation and Technology: Harnessing innovation and technology for sustainable development and business growth. Global Initiatives and Partnerships: Examining global initiatives, partnerships, and collaborative efforts towards advancing sustainability goals.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	10	10	5	5

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Bachelor of Engineering

Subject Code: ET2403

Subject Name: Cleaner Production & Sustainable Development

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

Recommended Books:

1. GCPC manual
2. The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R., New Society Publishers, 2005
3. Cleaner Production and its implementation in Industries , Dr Bharat Jain, GCPC
4. Environmental Sustainability Using Green Technologies, By V. Sivasubramanian
5. Green Technologies and Environmental Sustainability, Editors: Singh, Ritu, Kumar, Sanjeev
6. Green Technology : SS Purohit

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Manage CP Methodology.
CO-2	Describe the check lists for Good House Keeping.
CO-3	Identify applications of cleaner production in industries.
CO-4	Explain Principles of Sustainable Development
CO-5	Evaluate concept of Sustainable Supply Chains
CO-6	Understand Sustainable Business Practices

List of Open-Source Software/learning website:

- NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VII

Type of course: Professional Elective Course

Prerequisite: Fundamental of greenhouse effects and greenhouse gas emission.

Rationale: The main objective of this subject is to make students aware about the consequences of greenhouse gas emission and its effects on global climate change.

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.
SECTION-A		
1	<p>Basics of Global Warming: Global warming and climate change, Way and means, Carbon emission, stabilizing Atmospheric Carbon Dioxide Concentrations, Global Carbon Cycle.</p> <p>Green House Gases: Carbon dioxide & climate change, Methane & climate change, Nitrous oxide & climate change, CFCs & climate change.</p>	06
2	<p>Basics of Climate Change: Science of climate change, Natural climatic variability Global warming, Natural and enhanced greenhouse effect, Greenhouse gases & Carbon emissions</p>	06
3	<p>Climate Change Modeling: Elements of weather and climate modeling, Basic equation and dynamics of atmosphere, Climate variability and climate change, Elementary idea of Global climate models, Comparison of various IPCC reports, important findings of IPCC AR5, Impacts of climate change – Global and India.</p>	07

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Bachelor of Engineering

Subject Code: ET2404

Subject Name: Global Warming & Climate Change

SECTION-B		
4	Carbon Capture and Sequestration (CCS): Projects, Carbon Capture in Cement manufacture, Petrochemical Industries. Modalities and Procedures. Fossil Power Generation with CCS: Policy, Development for Technology and Deployment	07
5	Geological Storage of Carbon Dioxide: CO ₂ Properties and Geological Storage, CO ₂ Storage through Enhanced Hydrocarbon Recovery, Enhanced Oil Recovery (EOR), Enhanced Coal Bed Methane Recovery, Shale Gas, storage Options	07
6	Climate change mitigation: GHG emission trends, Climate change mitigation policies, Mitigation technologies for transport, infrastructure, industry, waste, energy sector , Renewable and alternative energy, Green building.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	10	10	5	5

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

Recommended Books:

1. Climate Change: Science, strategies & solutions by Eileen Clausen, Vicki Arroyo Cochran.
2. Climate change: a multidisciplinary approach by William Kininmouth.
3. Climate Change and the Kyoto Protocol: The Role of Institutions and Instruments to Control Global Change by Michael Faure Joyeeta Gupta Andries and Nentje.
4. Carbon Capture and Sequestration Integrating Technology, Monitoring, Regulation by Elizabeth Wilson and David Gerard.
5. Climate change: Critical Concepts in the environment by Frank Chambers, Michael Ogle.

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Bachelor of Engineering

Subject Code: ET2404

Subject Name: Global Warming & Climate Change

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Understand the connection between climate change and human activities and the physical basis of the natural greenhouse effect.
CO-2	Examine the relationship between climate and weather.
CO-3	Identify individual carbon footprints and identify ways to lessen them.
CO-4	Discuss the policies and legislation of international and national legislative frameworks.
CO-5	Explain different methods of capturing atmospheric carbon.
CO-6	Calculate greenhouse gas emissions.

List of Open-Source Software/learning website:

- NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VII

Type of course: Professional Elective Course

Prerequisite: Students shall have basic knowledge of various Energy generation technologies.

Rationale: To provide knowledge related to various Renewable Energy 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	1	0	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction to Energy Systems: Basic Concepts, Different forms of energy, Energy conversion processes and principles. Conventional Energy Sources: fossil fuels (coal, oil, natural gas), extraction, processing, and utilization. Non-Conventional Energy Sources: Introduction to renewable energy sources (solar, wind, hydro, biomass, geothermal), their potential, and applications. Waste-to-Energy Technologies: gasification, pyrolysis, incineration, and biogas production. Global Energy Scene: analysis of global energy consumption patterns, future projections, and challenges. Current Indian Scenario of Renewable Energy: Examination of renewable energy deployment, policies, and initiatives. MNRE Policies Towards Renewable Energy	06
2	Solar Energy: Conversion of Solar energy into Electricity - Photovoltaic Effect, Photovoltaic system design, calculation of solar efficiency, Solar concentrating collectors, Solar air heater, Solar water heating system,	06

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Bachelor of Engineering
Subject Code: ET2405
Subject Name: Energy Technology

	Solar ponds, Solar Thermal Power Plant, Solar refrigeration and air conditioning, recent developments in Solar Cells, Solar energy program in India	
3	<p>Wind Energy: Wind characteristics and analysis of wind regime, measurement of wind, Wind turbine energy production estimation, Wind energy converters, application of wind turbines, Environmental benefits and impact of wind energy systems, Wind energy Program in India</p> <p>Ocean Energy: Ocean Tidal Energy Conversion, Ocean Thermal Energy Conversion (OTEC), Ocean Wave Energy Conversion, applications, development of OTEC plants.</p>	07
SECTION-B		
4	<p>Nuclear Energy: Basic concepts, Neutrons and their interaction with matter, Biological effects of radiation, Fusion Energy, Fission Energy, Nuclear Power Plants, Nuclear fuel processing, safety considerations.</p> <p>Geothermal Energy: Geothermal resources, power plant technologies, applications in electricity generation and heating.</p>	06
5	<p>Energy Efficiency and Conservation: Energy Conservation Opportunities, Strategies for energy efficiency improvement in various sectors.</p> <p>Energy Management & Audit: Principles of energy management, audit methodologies, and implementation</p>	07
6	<p>Alternative Energy Technologies:</p> <p>Hydrogen energy systems: Properties of hydrogen, production methods, Blue Hydrogen, Green Hydrogen, transportation, storage, applications, and recent developments</p> <p>Other Clean energy sources:</p> <p>Microbial Fuel Cells: Working principle, types, applications, and future prospects in energy generation and wastewater treatment.</p> <p>Energy from Algae: Algae Cultivation, Photo-bioreactors, Harvesting, Sewage and Waste water growth conditions, algae biomass, Integration of CO₂ emitting industries for growth of Algae</p> <p>Fuel Cells: History, Working principle of fuel cells, Types of fuel cells, Fuel cell power plants, Fuel cell applications, Future trends in fuel cells</p>	07



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Bachelor of Engineering
Subject Code: ET2405
Subject Name: Energy Technology

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Bachelor of Engineering
Subject Code: ET2405
Subject Name: Energy Technology

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	10	10	5	5

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

Recommended Books:

1. Alternate Energy Sources, Applications and Technologies by Dr. N.K Giri, Khanna publishers
2. Non- Conventional Energy Sources by G.D Rai
3. S. Rao, B.B. Parulekar, "Energy Technology", Khanna Publishers, 3rd Edition, 2018.
4. Waste to Energy Conversion Technology by Naomi B. Klinghoffer and Marco J. Castaldi
5. Wind Energy Systems by Gary L Johnson
6. Fundamentals of Solar Cells: PV Solar Energy Conversion by AL Fahrenbruch and RH Bube, Academic Press, New York.
7. Waste to Energy Technologies and Global Applications by Efstratios N. Kalogirou.
8. Waste to Energy: Recent Developments and Future Perspectives towards Circular economy by Abd El-Fatah Abomohra Qingyuan Wang Jin Huang.
9. Principles of Solar Engineering by F Kreith and JF Kreider, McGraw-Hill.
10. Bio-fuels: biotechnology, chemistry, and sustainable development by DM Mousdale, CRC Press.

List of Tutorials:

1. Non- Conventional Energy sources
2. Waste to Energy conversion technologies
3. Solar Energy design criteria
4. Wind Energy production estimation
5. Ocean Thermal energy conversion

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Bachelor of Engineering
Subject Code: ET2405
Subject Name: Energy Technology

6. Nuclear fuel processing technology
7. Application of Geothermal in electricity generation and heating.
8. Energy management and Audit
9. Hydrogen Energy production technology
10. Microbial fuel cell

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Understand various energy sources and their trends at Global level and India
CO-2	Describe Solar Energy Technology
CO-3	Analyze Wind and Ocean Energy Technology
CO-4	Explain Nuclear Energy and Geothermal Energy
CO-5	Analyze energy conservation strategies
CO-6	Evaluate new technologies like Hydrogen, Algae, microbial fuel cell as a potential source of fuel

List of Open-Source Software/learning website:

- NPTEL
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Bachelor of Engineering

Subject Code: ET2406

Subject Name: Environmental Risk Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VII

Type of course: Professional Elective Course

Prerequisite: Basic knowledge of occupational health.

Rationale: The main objective of this subject is to make students aware about safety health & environment department of industry which requires knowledge of matters relating to human health risks and their mitigation.

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	1	0	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	<p>Introduction: Environment Risk assessment and Management: The what's, whys and how's. Sources of Environmental hazards, Environmental and ecological risks, Environmental risk assessment framework, Regulatory perspectives and requirements.</p> <p>Risk Assessment: Assessing risk to human health and ecological systems from chemicals.</p>	06
2	Risk assessment and management for waste treatment and disposal. Risk Communication. Economics of risk and valuing risk, Dose Response Evaluation, Exposure Assessment, Exposure Factors, Slope Factors, Risk Characterization.	06
3	<p>Risk Assessment Process: Conceptual frame work, Hazard identification, Hazard assessment, Risk estimation, Risk evaluation, Risk mitigation, Risk assessment in option evaluation, Risk assessment during operation of risk Assessment.</p>	07
SECTION-B		

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Bachelor of Engineering

Subject Code: ET2406

Subject Name: Environmental Risk Management

4	Maximum Credible accidents (MCA) analysis: Hazard indices viz. Dow’s fire and explosion. Index (FEI) and MOND index – degree of hazard – toxicity index	07
5	Consequence analysis: Development and assessment of various scenarios, determination of extent of damage. Hazard identification and accounting, Fate and behavior of toxics and persistent substances in the environment	07
6	Introduction to Material Safety Data Sheet (MSDS), Sources of exposure, exposure evaluation, exposure-hazard control, Fire and explosion: types of fire, detonation and deflagration. Disaster Management Plan (DMP) and Emergency preparedness plan (EDP)	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	10	10	5	5

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

Recommended Books:

1. Hand book of Environmental Impact Assessment vol –1: By Judith petts.
2. The Risk Assessment of Environmental and Human Health Hazards (Text book of case studies): by Paustenbach, D.ceds
3. Hand book of Env Risk Assessment and Management Edited: By Peter Callow.
4. Environmental Risks and Hazards: By Cutter and Susan.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, “Risk Assessment and Management Handbook”, McGraw Hill Inc., New York, 1996.

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Bachelor of Engineering

Subject Code: ET2406

Subject Name: Environmental Risk Management

List of Tutorials:

1. Environmental risk assessment
2. Assessing risk to human health
3. HAZAN Analysis
4. HAZOP Analysis
5. Fault tree analysis
6. Event tree analysis
7. Dow's fire and explosion. Index
8. MOND index & toxicity index
9. Fate and behavior of toxics
10. Material Safety Data Sheet

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify the diseases associated with occupation
CO-2	List out the hazards in industrial operation and propose prevention measures
CO-3	Carry out HAZOP and HAZAN analysis
CO-4	Apply knowledge of risk assessment.
CO-5	Define the use of engineering control in industries.
CO-6	Interpret sources of Environmental hazards.

List of Open-Source Software/learning website:

- NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VII

Type of course: Open Elective

Prerequisite: The subject of reactor design uses information regarding the physical properties of reactants in different phases for conversion of raw materials into products. Prior knowledge regarding fluid flow, heat transfer, mass transfer and mathematics are essential in this regard.

Rationale: This subject Reaction Engineering encompasses a process in terms of speed at which any process will occur. At an industrial scale, this subject takes into account reactor design of different types and product distribution obtained in different reactor systems with catalysts.

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)	
2	0	2	3	70	30	30	20	150

L-Lectures; T-Tutorial/Teacher Guided Student Activity; P-Practical; C-Credit; ESE-End Semester Examination; PA-Progressive Assessment

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Kinetics of homogenous reactions: Classification of reactions, Definitions of reactions rate, Temperature dependent term of rate equations from Arrhenius theory and comparison with collision and transition state theory, Temperature dependency from thermodynamics, Comparison of theories.	05
2	Interpretation of batch reactor data: Constant volume batch reactor, Differential method of analysis, Integral Method, Method of Half-lives, Method of initial rates. Variable volume batch reactor.	04
3	Introduction to Reactor Design: Batch Reactor, Semi batch reactor, Batch reactor design equations, Design equation of flow reactors: CSTR, PFR. , Space-time and space velocity Application of design equations for continuous flow reactors, Reactors in series, combination of CSTRs and	04

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2407

Subject Name: Basics of Reaction Engineering

	PFRs in series, Comparing the CSTR and PFR reactor volumes and reactor sequencing.	
SECTION-B		
4	Multiple Reactions: Types of reaction, series – parallel reactions, Concept of instantaneous and overall yield, Reactor/reactors selection based on yield of the desired product. Maximizing the desired product in series reactions.	05
5	Basic Aspects of Non-ideal flow: RTD function, E C and F curves, RTD in a PFR & CSTR, Conversion in non-ideal reactors, States of aggregation in flowing stream, RTD application in Wastewater treatment.	04
6	Catalysis and Catalytic Reactors: Activity & selectivity, Mechanism of Solid Catalyzed reactions, Fixed bed and Fluidized Bed reactors, Catalyst deactivation, Methods of Catalyst deactivation.	04

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	15	15	10	10	5

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

Recommended Books:

1. Octave Levenspiel, "Chemical Reaction Engineering", 3rd Edition, John Wiley & Sons (Asia) Pvt. Ltd.
2. H. Scott Fogler, "Elements of Chemical Reaction Engineering" 3rd Edition November, Prentice Hall

List of Practical's:

1. Calculation of Activation Energy and Frequency factor
2. Integral Method of Analysis
3. Differential method of Analysis
4. Kinetics by Half-life method
5. Reaction Kinetic studies in CSTR

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2407

Subject Name: Basics of Reaction Engineering

6. Reaction Kinetic studies in PFR
7. Reaction Kinetic studies in semi batch reactor
8. RTD studies in Continuous Stirred Tank Reactor (CSTR).
9. RTD studies in Plug Flow Reactor (PFR).
10. Experiments on catalyst particle on Shrinking core model

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define the kinetics and rate law for homogeneous reactions, temperature dependency and prediction of mechanism.
CO-2	Illustrate various methods available for collection and analysis of rate data
CO-3	Correlate the reaction kinetics with reactor design equations for performance of reactors and reactor sequences.
CO-4	Identify various steps involved in multiple reactions for reactor design based on yield of desired product
CO-5	Differentiate ideal flow from non-ideal flow in case of
CO-6	Recognize the various utilities used in Industrial Process

List of Open-Source Software/learning website:

- NPTEL
- Swayam

Bachelor of Engineering

Subject Code: ET2408

Subject Name: Petroleum Refining and Petrochemicals

Shroff S.R. Rotary Institute of Chemical Technology

Type of course: Open Elective

Prerequisite: Basics of Unit Operations & Unit process.

Rationale: Petroleum refining as well as petrochemical industries constitute a major part of chemical sector. Every chemical engineer has to invariably handle the enormous consumption of petroleum products, their diversity and increasing applications. Chemical engineer has to apply the relevant concepts for operating petroleum refinery or petrochemical plant in a safe manner. Beside this, a chemical engineer must be aware about the various properties of petroleum fractions as well as petrochemicals. Hence, this course has been designed to develop such expertise and skills.

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)	
2	1	0	3	70	30	30	20	150

L-Lectures; T-Tutorial/Teacher Guided Student Activity; P-Practical; C-Credit; ESE-End Semester Examination; PA-Progressive Assessment.

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Basics of Petroleum: Origin and formation of petroleum, reserves and deposits, Indian petroleum industry, composition of crude oils, classification of petroleum, evaluation of crude oil, benchmark crudes.	04
2	Types of Gases and their Composition: Types of gasoline & its important properties and tests such as ASTM distillation, RVP, octane number, oxidation stability, sulphur content, various types of naphtha and their important properties and application, important tests and properties of kerosene such as flash & fire point, smoke point, aniline point, ASTM, TBP, EFV distillation curves.	05
3	Processing of Petroleum: Distillation- Pretreatment, Electric desalting, atmospheric and vacuum distillation. Thermal & Catalytic Cracking: Necessity and types of cracking, thermal cracking, FCC, catalytic reforming	04
SECTION-B		

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2408

Subject Name: Petroleum Refining and Petrochemicals

4	Manufacturing Processes for Petrochemicals (C1): Properties, uses, manufacturing processes, flow-sheets and manufacturing problems of methanol, formaldehyde, chloromethane, ethylene, ethylene dichloride	04
5	Manufacturing Processes for Petrochemicals (C2): Properties, uses, Manufacturing processes, flow-sheets and manufacturing problems of vinyl chloride, ethylene oxide, ethylene glycol, ethanol amines.	05
6	Manufacturing Processes for polymers: Properties, uses, manufacturing processes, flow-sheets and manufacturing problems of BTX separation, p-xylene, styrene, LDPE, LLDPE, HDPE, SBR, polyesters.	04

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	15	15	10	5	5

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

Recommended Books:

1. B. K. Bhaskara Rao, A textbook on Petrochemicals, 2nd edition, Khanna Publishers, Delhi, 1998.

Reference Books:

1. B. K. Bhaskara Rao, Modern Petroleum Refining Processes, 4th edition, Oxford & IBH Co. Pvt. Ltd., 2002.
2. R. Prasad, Petroleum Refining Technology, Khanna Publishers, 2000.
3. J. C. Speight, The Chemistry and Technology of Petroleum, 3rd edition, Marcel Dekker, 1999.
4. A. G. Lucas, Modern Petroleum Technology, Vol. 2, 6th edition, John Wiley & Sons Limited, 2000.
5. R. N. Watkins, Petroleum Refinery Distillation, 2nd edition, Gulf Pub. Co., 1979.
6. G. N. Sarkar, Advance Petroleum Refining, Khanna Publishers, 1998.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2408

Subject Name: Petroleum Refining and Petrochemicals

List of Tutorials:

1. Estimation of Flash & Fire point of fuel sample.
2. Estimation of cloud point and pour point of fuel sample.
3. Estimation of Anline point for the given sample.
4. Characterization of petroleum fuel sample by A.S.T.M distillation – Plotting ASTM curve.
5. Determination of smoke point of fuel sample using smoke point apparatus.
6. Estimation of carbon residue of given sample by rams bottom apparatus.
7. Determination of viscosity of given sample using say bolt viscometer at different temperatures.
8. Determination of Reid vapour pressure of a given petroleum fraction.
9. Determination of the carbon residue of given sample by Conradson apparatus.
10. Determination of the softening point and penetration index of Bitumen.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	State the composition of crude oil and its exploration.
CO-2	Describe the various test properties of crude oil and petroleum products and also explain their physical significance.
CO-3	Explain crude oil processing, pre-treatment techniques.
CO-4	Discuss the treatment techniques for crude oil.
CO-5	Compare the relationship between the types of cracking operations.
CO-6	Formulate the pathways for the manufacture of various petrochemicals.

List of Open-Source Software/learning website:

- NPTEL
- Swayam

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2409

Subject Name: GHG Emission Accounting & Sustainability Reporting

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VIII

Type of course: Professional Core Course

Prerequisite: Knowledge of subjects Environmental Sciences, Carbon footprint, GHG Emissions.

Rationale: This book provides an introduction to the importance, relevance, and benefits of business sustainability and accountability reporting in all areas of economic, governance, social, ethical, and environmental performance

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)	
4	0	0	4	70	30	00	00	100

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	<p>Green House Gases: Carbon dioxide & climate change, methane & climate change, Nitrous oxide & climate change, CFCs & climate change.</p> <p>GHG Accounting Principles: Relevance, Completeness, Consistency, Transparency, Accuracy, Conservativeness. Corporate GHG Accounting overview, Voluntary Carbon Standards, overview on ISO 14064-1</p>	7
2	<p>GHG Emissions & Inventorization: GHG Protocol, Standards under the GHG Protocol, Organizational Boundaries, GHG Tools and their application</p> <p>Net Zero Emission v/s Carbon Neutrality: Net Zero Goals, Approach to Net Zero, Approach for Scope-1 Emission, Approach to Scope-2 Emission, Carbon Neutral Approach, New and Emerging Technologies</p>	10

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2409

Subject Name: GHG Emission Accounting & Sustainability Reporting

3	Operational Boundaries (Unit level GHG emissions): Scope I Emissions, Scope II Emissions, Scope III Emissions, Emission Sources, Typical GHG Emission Profile, Components of an Emission Calculation, Emission Factors, classes of emission factor: Tier 1, Tier 2, Tier 3.	10
SECTION-B		
4	ESG/Sustainability Reporting: - Importance of Sustainability Reporting, Guideline on Sustainability Reporting, Materiality Assessment and Sustainability Reporting, Role of Gatekeepers in Sustainability Reporting, Mandatory Sustainability Reporting. ESG corporate reporting ecosystem	9
5	Different Reporting standards: GRI sustainability reporting process. GRI Standards. Different reporting framework, BRR, BRSR, Integrated report (IR), TCFD, SASB, Financial Reporting/Annual Reporting as per Indian law.	8
6	Sustainability Ratings: Significance of rating systems, Criteria for ratings, ESG rating methodology, ESG rating agencies – Overview, Case study of ESG raters.	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	15	20	15	05	00

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

Recommended Books:

1. The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard by World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD)
2. Corporate Sustainability: Integrating Performance and Reporting by Ann Brockett, William P. Mott

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Bachelor of Engineering

Subject Code: ET2409

Subject Name: GHG Emission Accounting & Sustainability Reporting

3. GHG Accounting in the Supply Chain by Daniel S. Turner and Subramanian Sivaramakrishnan
4. Sustainable Business: An Executive's Primer by Peter A. Soyka
5. Sustainability Reporting: Managing for Wealth and Corporate Health by Jyoti Prasad Mukhopadhyay

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Recognize the principles of GHG emission accounting
CO-2	Classify various baseline candidates for GHG accounting
CO-3	Illustrate GHG reduction reporting
CO-4	Examine sustainability reporting procedures
CO-5	Explain ESG sustainability
CO-6	Summarize GRI standards and BRSR in line with sustainability reporting

List of Open-Source Software/learning website:

- NPTEL

Bachelor of Engineering

Subject Code: ET2410

Subject Name: Water Supply & Sanitary Engineering

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VIII

Type of course: Professional Elective Course

Prerequisite: Fundamental Knowledge of water supply and sanitation.

Rationale: To understand the water supply and sewage collection systems in cities

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.
SECTION-A		
1	Water supply scheme: Importance & necessity of water supply scheme, importance and reliability of water works, flow chart of water supply scheme, essentials of water supply engineering and its history, duties of water works engineers.	04
2	Quantity of water: Type of water demand, per capita demand, design period, different types of population forecasting methods, fluctuation in demand of water, factors affecting demand of water Collection and conveyance: Intakes, type of intake, conveyance of water, different type of pipes used in water supply, pipe-joint, laying of pipe, hydrostatic test.	07
3	Distribution System: Type of distribution system, different layout of distribution system, methods of supplying water, pressures in distribution system, distribution resources and its capacity, type of reservoirs & accessories, design of distribution system, design of pipelines and analysis of complex pipe networks-Hard cross method, basics of WaterGEMS.	09

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2410

Subject Name: Water Supply & Sanitary Engineering

SECTION-B		
4	<p>Sanitary works: Definitions, sanitary works, objectives of sewage disposal</p> <p>Systems of sanitation: Methods of collection: conservancy systems and water-carriage system, sewerage system: Combined system, separate system and partially separate system</p>	05
5	<p>Quantity of sanitary and storm sewage: Sources of sanitary sewage, factors affecting sanitary sewage, determination of quantity of sanitary sewage, peak rates of flow, factor affecting storm sewage and determination of quantity of storm sewage</p>	07
6	<p>Design of sewers: Estimate of sanitary sewage, design period, per capita sewage flow, ground water infiltration, estimation of storm runoff, flow assumption, determination of velocity of flow by Empirical formulae, Velocity of flow, velocity at minimum flow, minimum sewer size, sewer grades, method of design of sewers, basics of SewerGEMS.</p>	07

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	20	15	10	10	00

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

Recommended Books:

1. "Water supply and Sanitary Engineering" by G. S. Birdie
2. "Elements of Water Resources Engineering" by K.N. Duggal
3. "Water Supply Engineering" by S. K. Garg
4. "Water Supply and Sanitary Engineering" by Rangwala
5. "Water Supply Engineering" by B. C. Punamia, Laxmi Publication New Delhi.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2410

Subject Name: Water Supply & Sanitary Engineering

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Understand the necessity of water supply scheme.
CO-2	Evaluate the water demand considering the future population growth.
CO-3	Develop the water distribution system for the cities.
CO-4	Illustrate the concept of sewers and sewer systems.
CO-5	Estimate the quantity of sewage including storm water.
CO-6	Design construction and maintenance of the sewers considering the quantity of storm water and sewage using software.

List of Open-Source Software/learning website:

- NPTEL
- SewerCAD/ WaterCAD/ SeweGEMS/ WaterGEMS

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2411
Subject Name: Sustainable Waste Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VIII

Type of course: Professional Elective Course

Prerequisite: Fundamental of waste management.

Rationale: The main objective of this subject is to make students understand about sustainable development and how it can be applied in waste management practices.

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.
SECTION-A		
1	Sustainable Development: Scope and definition, goals, Principles of sustainability, Sustainability indicators, Framework for sustainability assessment, Population stabilization, Integrated land use planning, control of pollution, development of non-polluting renewable energy systems. Recycling of wastes, environmental education and awareness	06
2	Solid waste generation and GHG emissions: Solid waste types, sources and characteristics. Per capita waste generation, prediction of GHG emissions from disposal site and calculation of carbon credits. Emissions from composting, incineration, landfilling, recycling. Emission factors, Direct emission measurements. Risk assessment in waste management, Life cycle assessment for waste management, carbon-footprint-based solid waste management	06
3	Land-use planning: Definition and concept, land use policy for India. Urban and rural planning for India. Land use and land cover planning.	07

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2411

Subject Name: Sustainable Waste Management

	Arable lands in India. Environmental priorities in India. Sustainable development in practice: sustainable urban and industrial development. Sustainable agriculture and rural development, Sustainable resource management. Sustainable MSW dump yards, Secure Sanitary landfill sites, Hazardous waste disposal sites and injection wells.	
SECTION-B		
4	Bioremediation - Biotransformation, Biodegradation, Bioaugmentation, biostimulation, application of bioremediation on solid waste management: In-situ, Ex-situ Bioremediation, Bioremediation of rubber waste, agriculture waste, Bio indicators of soil contamination, Role of microbes in solid waste management.	07
5	Plastic waste management practices: Plastic waste management by new technologies, Co-processing, Plasma pyrolysis, Waste conversion into liquid fuel, Fly ash as a potential by-product waste. Waste management to sustainable waste management: Waste management Hierarchy, Sustainable waste management paradigm, Role of NGOs/CBOs, Participation of private sector, Support of national governments, Role of international agencies, Waste management authorities, Improvement in waste management system	07
6	Integrated solid waste management based on the 3 R Approach: Current state of waste generation, Current state of waste management in developing countries, Implementing ISWM: Waste Characterization and Quantification, Assessment of Waste Management Systems, Identification of Stakeholders' Concerns, ISWM Plan, Clean development mechanisms. Carbon credits and carbon trading. Policy towards a sustainable waste management	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	10	10	5	5

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2411

Subject Name: Sustainable Waste Management

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

Recommended Books:

1. Bayley, A., & Strange, T. (2010). Sustainable Development: Linking Economy, Society, Environment, Academic Foundation Publishers.
2. Sundar, I. (2006). Environment and Sustainable Development, 1st Edition, APH Publishing Corporations Publishers.
3. Sustainable solid waste management issues policies and structures by Urvashi Dhamija
4. Sustainable solid waste management by Syeda Azeem Unnisa, S. Bhupatthi Rav CRC Press
5. Solid waste management policy and planning for a sustainable society by Elena Rada
6. Zero Waste Management Practices for Environmental Sustainability by Ashok K. Rathoure
7. Sustainable solid waste management A Systems Engineering Approach by Ni-Bin Chang Ana Pires

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Understand sustainable development
CO-2	Estimate the GHG emissions
CO-3	Analyze sustainable land management practices
CO-4	Explain bioremediation techniques
CO-5	Evaluate the role of different sectors in waste management
CO-6	Explain the Integrated solid waste management

List of Open-Source Software/learning website:

- NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2412

Subject Name: Occupational Health & Safety

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VIII

Type of course: Open Elective

Prerequisite: Students shall have basic knowledge of Occupational Health, Hazards & Risk identification.

Rationale: To provide knowledge related to occupational health, personal protective equipment, accident causes and prevention.

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.
SECTION-A		
1	Occupational Health: Classification of occupational health hazards, dangerous properties of chemical and their health effects, routes of entry of toxic material into human body, permissible exposure limits, Threshold limit value, lethal dose and lethal concentration, ergonomics, constituents of ergonomics, application of ergonomics for safety & health, occupational diseases due to metals & dusts, legal requirement of OHC as per factory act.	06
2	Concept, Philosophy & Psychology of safety: Concept of safety, nature of concept of safety, safety terminology, philosophy of total safety concept, safety psychology, accident causative factors, general psychological factors, awareness on safety management system.	06
3	Accident Causes and prevention: Causation, accident problem, reasons for prevention, factors impending safety, accident prevention, role of leading indicator like unsafe act/condition/near miss in accident prevention. Assessing risk to human health and ecological systems from chemicals.	07

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2412

Subject Name: Occupational Health & Safety

SECTION-B		
4	Fire and Explosion: Fire phenomena, classification of fire and extinguishers, statutory and other standards, fire prevention & protection system, explosion phenomena, explosion control devices, fire awareness, fundamentals of fire hydrant system design and their adequacy, maintenance of firefighting equipment and system and various/latest type of firefighting equipment's. Disaster Management Plan & Emergency preparedness plan	07
5	Hazards & Risk identification, Assessment and control techniques: Hazards, risks & detection techniques, preliminary hazard analysis (PHA) & hazard analysis (HAZAN), failure mode effect analysis (FMEA), Hazard and operability (HAZOP) study, hazard ranking (DOW & MOND index), fault tree analysis, event tree analysis (ETA), major accident hazard control, on-site and off-site emergency plans, hazard analysis risk assessment calculation and their mitigation methods.	07
6	Personal Protective Equipment: Need of PPE, factors for selection of PPE, non-respiratory equipment, respiratory equipment, effective use of PPEs, inspection and maintenance of PPEs, specification of safety PPEs,	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	10	10	5	5

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

Recommended Books:

1. Fundamentals of Industrial safety & health by Dr. K. U. Mistry.
2. Industrial & occupational Safety, Health & Hygein - by AHommadi.
3. Occupational Health, a Practical Guide for Managers -by Ann Fingret & Akin Smith.
4. Environmental Health & Technology - by Y P Kudesia & Ritu Kudesia.
5. Environment & Health by Norman M Triff

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2412

Subject Name: Occupational Health & Safety

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify the diseases associated with occupation.
CO-2	Describe the concept of safety.
CO-3	Analyze accident causes and prevention.
CO-4	Knowledge about fire and explosion.
CO-5	Carry out HAZAN and HAZOP analysis.
CO-6	Manage safety in industries by suggesting safety measures and PPE.

List of Open-Source Software/learning website:

- NPTEL

Bachelor of Engineering

Subject Code: ET2413

Subject Name: Pollution Control & Safety Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VIII

Type of course: Open Elective

Prerequisite: Fundamental knowledge of chemistry and environmental science.

Rationale: The main emphasis of this course is to acquaint students with different traditional and modern techniques used for pollution control. Additionally, it emphasizes to recognize different types of pollutants and understand the relevant industrial laws and regulations concerning safety, health, and the environment in the Indian context. By taking this course, students will develop the ability to identify and evaluate hazards at any stage of operation and effectively measure and handle them.

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.
SECTION-A		
1	Impact of man on the environment; ecological systems and pollution, hydrologic and nutrient cycles, Energy consumption and demand, Pollution of air, water and soil and its effect on environment.	5
2	Air pollution: Definition and scale of concentration, classification and properties of air pollutants, emission sources, behavior and fate of air pollutants, effect of air pollution, Temperature lapse rate and stability, plume behavior, air pollution control methods, source correction methods, particulate emission control, control of gaseous emissions. Water pollution: sources and classification of water pollutants, Physico-chemical characterization of wastewater, water quality standards, Industrial water pollution management: Wastewater treatment processes; Pretreatment, primary and secondary treatment processes. Advanced wastewater treatment processes.	10

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2413

Subject Name: Pollution Control & Safety Management

	Solid waste management: sources and classification, public health aspects, methods of collection, potential methods of disposal: sanitary landfill, incineration, composting, recovery and recycling.	
3	Rules, regulations, laws etc. regarding environmental protection, pollution prevention and control, waste disposal etc. Standards and legislation EIA, EIS and EMP. Air and water pollution management through waste minimization. Industrial air pollution management, Role of government, semi/quasi govt. and voluntary organizations, environment audit.	5
SECTION-B		
4	The Concept of Safety; Philosophy of Safety, Accident Causation and Prevention, Safety Management: concept, definitions, nature and importance of management, management principals, safety management and its responsibilities.	4
5	Hazards, Classification of hazards, Personal Protective Equipment, Safety in Engineering Industry, Hazard identification methods: a) Hazard Operability study (HAZOP), b) Hazard Analysis (HAZAN), and Risk Assessment methods: a) Failure mode and effect analysis (FMEA) b) Fault Tree analysis (FTA) c) Event Tree analysis (ETA).	10
6	Safety in Engineering Industry, Safety standards in Indian context, Factories Act and Case Law, Specific Safety Laws, Social Security Legislation.	5

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
26	20	17	7	0	0

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

Recommended Books:

1. Fundamentals of Industrial Safety and Health by Dr. K. U. Mistry.
2. Frank P Lees, "Loss Prevention in Process Industries" Volume 1, 2 & 3.
3. Industrial Organization and Economics by T.R. Banga & S.C. Sharma.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2413

Subject Name: Pollution Control & Safety Management

4. “Chemical Process Safety, Fundamentals with Applications”, Second Edition by Daniel A. Crowl & Joseph F. Louvar Published by Prentice Hall, Inc. ISBN 0-13-018176-5.
5. Environmental Pollution Control Engineering by C.S.Rao, New Age International Publishers, New Delhi.
6. Wastewater Engineering: Treatment & Reuse by Metcalf and Eddy, McGraw Hill Publication.
7. Pollution control in process industries, S P Mahajan, Tata McGraw Hill Publishing Company, New Delhi.
8. Safety and Accident Management in the Chemical Process Industries Ed. by H. Heinmann, M. Dekker3Instrumental Methods of Analysis, B. K. Sharma, Goel Publishing house.
9. HAZOP and HAZAN by Trevor Kletz, 4th Edition, Institution of Chemical Engineers, IChemE, UK.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Recollect the basic knowledge of environmental studies.
CO-2	Discuss about various environmental pollutions and pollution control methods and equipments.
CO-3	Relate to various laws and regulations regarding environmental protection.
CO-4	Outline the concept of safety and safety management.
CO-5	Recognize classification of hazards and hazard and risk assessment methods.
CO-6	Explain various laws and regulations regarding safety.

List of Open-Source Software/learning website:

- NPTEL