

(Established under Gujarat Private Universities Act, 2009)

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

Ref: UPL University/SRICT/BOS/EST/2021-22/03

Date: 15-03-2022

### Teaching Scheme for Second Year Master of Environmental Management

#### Semester-III (Environmental Management) 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	Program Elective V	EM3201	Environmental Monitoring & Assessment	3	0	0	3	3	70	30	0	0	100
2	Program Elective V	EM3202	Industrial Wastewater Treatment	3	0	0	3	3	70	30	0	0	100
3	Open Elective-II	EM3203	Sustainable Development & Waste Valorization	3	0	0	3	3	70	30	0	0	100
4	Open Elective-II	EM3204	Design of Pollution Control Systems	3	0	0	3	3	70	30	0	0	100
5	Open Elective-III	EM3205	Risk Assessment & Safety Management	3	0	0	3	3	70	30	0	0	100
6	Open Elective-III	EM3206	Novel Separation Techniques	3	0	0	3	3	70	30	0	0	100
7	Seminar	MH3201	Seminar	0	0	4	4	2	0	0	20	30	50
8	Dissertation-I/Industrial Project	MH3202	Project	0	0	14	14	7	0	0	50	100	150
<b>Total</b>							<b>27</b>	<b>18</b>					<b>500</b>

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**Semester-IV ((Environmental Management) 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	Dissertation II	MH3203	Project	0	0	36	36	18	0	0	100	200	300
<b>Total</b>				<b>0</b>	<b>0</b>	<b>36</b>	<b>36</b>	<b>18</b>	<b>0</b>	<b>0</b>	<b>100</b>	<b>200</b>	<b>300</b>

**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

(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3201**

**Subject Name: Environmental Monitoring and Assessment**

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

**Semester: - III**

**Type of course: Program Elective**

**Prerequisite:** Students shall have basic knowledge of environmental quality particularly air, water and soil.

**Rationale:** To provide knowledge related to various air pollution control methods and equipment.

**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>Environmental Monitoring:</b> 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.	<b>06</b>
<b>2</b>	<b>Water Quality Monitoring</b> Sampling techniques, Collection and Preservation of samples, types of samples, Chain-of-Custody Procedures, Sampling Methods, Sample Containers, Number of Samples, Sample Volumes, Sample Storage and Preservation. <b>Surface Water and Ground Water Monitoring</b> Surface Water Monitoring: -Water Quality parameters, sampling the waters, Water sampling equipment. Ground Water Monitoring: - Objectives, Location of monitor wells, well construction, Design and Execution of ground water sampling programs.	<b>07</b>

(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3201**

**Subject Name: Environmental Monitoring and Assessment**

<b>3</b>	<b>Air Quality Monitoring</b> Type of Air Quality monitoring - Ambient Air Quality monitoring, Source Air Quality monitoring, Selection of monitoring sites, Sampling time, Frequency & mode of sampling, Source Air Quality Monitoring – Type of Monitoring procedure.	<b>05</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Environmental Modelling with GIS and Remote Sensing:</b> Taxonomy of Environmental Models in the Spatial Sciences, New Environmental Remote Sensing Systems, Geographic Data for Environmental Modeling and Assessment, Vegetation Mapping and Monitoring, Remote Sensing and Geographic Information Systems for Natural Disaster Management, Land Use Planning and Environmental Impact Assessment Using Geographic Information Systems, 2D & 3D Modelling.	<b>07</b>
<b>5</b>	<b>Environmental Compensation:</b> Theory and calculations on: Environment Compensation to be levied on Industrial Units, Environmental Compensation to be levied in case of failure of preventing the pollutants being discharged in water bodies and failure to implement waste management rules, Environment Compensation to be Levied on Concerned Individual/Authority for Improper Solid Waste Management, Environmental Compensation in Case of Illegal Extraction of Ground Water. Case studies related to Environmental Compensation.	<b>07</b>
<b>6</b>	<b>Statistics in Environmental Monitoring:</b> Samples & Population: Random Sampling, Sample support, Frequency Distribution & Probability Density Function: Mean, Variance, Standard Deviation, Gaussian Variable, Sample size & Confidence interval, Co-variance & Correlation, Liner Regression, Interpolation & Spatial Distribution.	<b>07</b>

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

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

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**Master of Engineering**

**Subject Code: EM3201**

**Subject Name: Environmental Monitoring and Assessment**

**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 by S. K. Agarwal, APH Publishing Corporation.
2. Environmental Monitoring and Analysis by Dr. Aaradhana Salpekar and Mohd. Azharul Haque, Jnanada Prakashan [P&D] (1 January 2010)
3. Environmental monitoring and characterization by Janick F Artiola, Ian L Pepper, Mark Brusseau
4. Environmental Modelling with GIS and Remote Sensing by Andrew Skidmore, Taylor and Francis Group, 2002
5. Environmental Chemistry by Sawyer & McCarty.

**Course Outcomes:**

After learning this course, students will be able to:

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Recollect the concept of environmental characteristics and environmental monitoring.
CO-2	Identify various water sampling and analysis techniques for water quality monitoring.
CO-3	Illustrate various types of air quality monitoring.
CO-4	Distinguish between various physical, chemical and microbiological contaminants.
CO-5	Explain various environmental compensation.
CO-6	Appraise the use of statistics in environmental monitoring.

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

- NPTEL
- Guide Manual Water and Wastewater Analysis by CPCB (<https://cpcb.nic.in/>).
- Report of the CPCB In-house Committee on Methodology for Assessing Environmental Compensation and Action Plan to Utilize the Fund. (<https://cpcb.nic.in/uploads/report-15.07.2019.pdf>).

(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3202**

**Subject Name: Industrial Wastewater Treatment**

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

**Semester: - III**

**Type of course:** Program Elective V

**Prerequisite:** Basic knowledge of wastewater parameter and basic concepts regarding wastewater treatment units.

**Rationale:** The main objective of this subject is to provide knowledge related to requirement of industrial wastewater treatment technologies and its 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	0	3	70	30	0	0	100

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Introduction:</b> Sources and characteristics of Industrial wastewater, Differences between industrial and municipal wastewaters, Industrial wastewater and environmental impacts, Toxicity of industrial effluents, Quality and quantity of industrial wastes.	07
2	<b>Standards for disposal into different Sinks:</b> Difference between criteria & standards, Stream standards, effluent standards, relevant Indian standards for disposal in to different sinks, costs of pollution control	07
3	<b>Industrial Waste survey-</b> Process flow charts, condition of waste stream, Material balance, Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Bio-monitoring.	05
<b>SECTION-B</b>		

(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3202**

**Subject Name: Industrial Wastewater Treatment**

<b>4</b>	<b>Waste Reduction:</b> Methods of volume reduction, Strength reduction, Neutralization, Equalization and proportioning as related to Industrial waste treatment.	<b>07</b>
<b>5</b>	<b>Pollution Control in Industries:</b> Manufacturing process, Identification & characterization of sources of wastewater, treatment of wastewater including recycling & reuse concepts in Pulp & paper industry, Tannery, Distillery, Textile industry, Dairy industry, Fertilize industry, Sugar industry, Petrochemical industry, Pharmaceutical industry, Corn starch industry.	<b>07</b>
<b>6</b>	<b>CETP:</b> Concept of Common Effluent Treatment Plant (CETP), pros and cons of CETP, case studies; Liquid toxic wastes: identification and quantification of toxic wastes, physico-chemical, bio-physical treatment processes for toxic wastes.	<b>06</b>

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

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

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

**Reference Books:**

1. Industrial water pollution by W. Wesley Eckenfelder –Mcgraw-Hill International edition.
2. Wastewater Engineering, Treatment & Reuse by Metcalf & edition Tata – Mcraw –Hill edition.
3. Wastewater Treatment by M.N. Rao & A.K. Datta.
4. Industrial Water pollution by Nelson L. Nemerow.
5. A Handbook of Effluent Treatment Plants by Mehjabin Shaikh, Enviro Media.
6. Relevant Indian Standards.



(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3202**

**Subject Name: Industrial Wastewater Treatment**

**Course Outcomes:**

After Learning this Course Students will be able to:

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Recognize, define and understand the quality parameters typically used to characterize industrial wastewater.
CO-2	Describe various types of process units used for various types of industries water and wastewater treatment
CO-3	Explain the different methods of wastewater sampling and continuous industrial wastewater monitoring.
CO-4	Acquire the knowledge of different industrial process, water utilization and wastewater generation.
CO-5	Categorize the strength and volume reduction techniques in industrial wastewater.
CO-6	Appraise the concept of Common Effluent Treatment Plant.



(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3203**

**Subject Name: Sustainable Development & Waste Valorization**

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

**Semester: - III**

**Type of course: Open Elective**

**Prerequisite:** Fundamental of sustainable development and waste valorization routes.

**Rationale:** To gain the knowledge regarding basics of environmental economics and also to study the recovery of energy and fuel from the waste.

**Teaching and Examination Scheme:**

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

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	Introduction to Sustainable Development, Sustainable Development: Definition and Principles, Challenges of the Global World, Production and Consumption, Protecting and Managing the Natural Resource Base of Economic and Social Development, Sustainable Development Goals, Sustainability disclosure for industries, ESG Domain.	<b>06</b>
<b>2</b>	Sustainable Business, Environmental Ethics, Environmental Justice, Natural Capital, Eco-Efficiency, Product Greening and Design for Environment, Green Marketing, Green Value Chain/Value Group, Corporate Sustainability Reporting (Environmental Reporting). Environmental Social Governance: Concept, Criteria, Importance, Types, BRSR Guidelines, Global reporting initiative National Guidelines on Responsible Business Conduct.	<b>06</b>
<b>3</b>	Environmental Economics: Introduction, Environmental Costs and Benefits, Environmental Taxes, Environmental Accounting, Techniques of Environmental Valuation, Valuing Environmental Amenities,	<b>06</b>

(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3203**

**Subject Name: Sustainable Development & Waste Valorization**

	Economics of Natural resources, Cleaner production concept, Theory of cleaner production, Effect of CP on Industrial economy. Cleaner Methodology, Six steps methodology for CP, Designation of cleaner production team, Analyze process steps, CP tools, Barriers and Drivers of CP.	
<b>SECTION-B</b>		
<b>4</b>	Introduction to waste valorization: Energy supply and waste management, Recycling and Waste To Energy (WTE), SWM Rules, 2016: Guidance on Waste to energy- Clause 15, 18 and 21, Integrated planning for WTE plants; Future trends. Thermal analysis-TGA/DSC Alternative fuel resources- Algae, Transesterification etc. Waste valorization of agricultural waste (liquids), Plastic waste to paver block, Fly ash utilization, Sludge to bricks. Resource recovery from waste.	<b>05</b>
<b>5</b>	Waste valorization routes: Torrefaction, Liquefaction and Pyrolysis Objectives of torrefaction, Liquefaction of biomass and algae. Pyrolysis: Basic concept, Feed stock for pyrolysis, Plasma pyrolysis vitrification, Pyrolysis of MSW, Plastic waste, Biomass, E-waste, Types of pyrolysis- Slow, fast and flash pyrolysis, Effect of operating parameters, Product characterization and applications, Charcoal production and gas utilization, Environmental effects of pyrolysis, Case studies.	<b>08</b>
<b>6</b>	Waste valorization routes: Gasification, Combustion and Anaerobic conversion Basic concept of Gasification, Gasification reactions, Different types of reactors used for gasification, Cogeneration of renewable energy, Landfill minimization and material recovery via waste gasification, Environmental effects of gasification. Combustion: Types of Combustion systems- Mass Fired combustion system, Fluidized bed combustion system, RDF-Fired combustion system. Anaerobic conversion, Biogas, Effect of operating parameters, Biogas compositions, Biogas cleaning and up-gradation to bio methane, Bio CNG, benefits, drawbacks and applicability of biogas systems.	<b>08</b>

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

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level

(Established under Gujarat Private Universities Act, 2009)

Master of Engineering

Subject Code: EM3203

Subject Name: Sustainable Development & Waste Valorization

15	20	15	10	10	00
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**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Recommended Books:**

1. An Introduction to Sustainable Development by Peter P. Rogers, Kazi F. Jalal and John A. Boyd, Earth Scan.
2. Environment and Sustainable Development by M. H. Fulekar, Bhawana Pathak and R. K Kale, Springer.
3. Green Energy Technology, Economics and Policy, Aswathanarayana U., Harikrishnan T., and Kadher-Mohien S. T., CRC Press
4. GCPC manual
5. Biogas Technology by B.T. Nijaguna, New age international Ltd, New Delhi, 2009.
6. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management", the McGraw- Hill, New York, 3rd Ed., 1993.
7. Manual on Municipal Solid waste management by Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.
8. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983
9. Environmental Engineering by Peavy, H.S., Rowe, D.R., Tchobanoglous, G. McGraw Hills, New York 1985.
10. Waste to Energy by N. B. Klinghoffer and N. J. Themelis.

(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3203**

**Subject Name: Sustainable Development & Waste Valorization**

**Course Outcomes:**

After learning this course, students will be able to:

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Understanding of sustainable development and environmental ethics.
CO-2	Apply C.P. tools for Cleaner production.
CO-3	Apply C.P. methodology.
CO-4	Recollect the concept of waste and study the guidelines of waste to energy.
CO-5	Study about the various thermal processes that helps to convert solid waste into gaseous, liquid and solid products in absence of air.
CO-6	Describe the gasification, combustion and biogas technology along with its drawbacks and applicability.

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

- NPTEL

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

### Semester: - III

**Type of course: Open Elective**

**Prerequisite:** Knowledge of fundamentals of environmental and chemical engineering.

**Rationale:** Design, operation and maintenance of pollution control systems related to gaseous emissions, waste water and solid waste, design of equipments and understanding about environment management 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	0	3	70	30	0	0	100

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Introduction to air pollution control equipments:</b> Introduction, air quality standards, process parameters, operating conditions, gas characteristics, dust characteristics, performance required, different types of pollution control equipments, criteria for selection, Auxiliary equipments.	06
2	<b>Design of various air pollution control equipments:</b> Design of Absorbers: Introduction, principle and theory, types of Absorption towers, design of packed tower, venture scrubber, falling film absorber. Design of Cyclone separators: Introduction, principle and theory, terminology, design and performance equations, Design of cyclone separator, design of multi cyclones. Design of Fabric Filters: Introduction, principle and theory, performance equations, design of fabric/bag filter, operation and maintenance. Design of Electrostatic Precipitator: Introduction, principle and theory, performance equations, design of ESP, operation and maintenance. Design of Wet scrubbers:	07

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**Master of Engineering**

**Subject Code: EM3204**

**Subject Name: Design of Pollution Control Systems**

	Spray towers: Introduction, principle and theory, design of spray towers. Cyclone spray chamber: Introduction, principle and theory, design of Venturi scrubbers: Introduction, principle and theory, design and performance equations.	
<b>3</b>	<b>Introduction to waste water treatment:</b> Introduction, sources of effluent, water quality standards, waste water characteristics, different stages of waste water treatment plant, performance required.	<b>07</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Design of waste water treatment plant:</b> Primary treatment methods: Screening, Equalization, Oil Separation, Sedimentation and clarification. Secondary treatment methods: Biological process, aerobic and anaerobic process. Tertiary treatment methods: Ion Exchange-processes, Membrane Processes, Biological treatment for strong industrial waste: Design of Incinerators, multiple effect evaporators Common Effluent Treatment Plants (CETPs): Location, Need, Design, and Operation & Maintenance Problems and Economical aspects.	<b>07</b>
<b>5</b>	<b>Design of solid waste management systems:</b> Sources of solid waste, hazardous solid waste, characterization of waste, resource recovery from solid waste, solid and hazardous waste disposal and transport, land disposal of solid waste. Design of Secured landfills – site selection, design and operation of landfills, Landfill liners, leachate collection and removal, advance methods for treatment of landfill leachate, design of solid waste incinerators.	<b>07</b>
<b>6</b>	<b>NOISE POLLUTION AND ITS CONTROL:</b> Sources of noise, units and measurements of noise, effects of noise pollution, prevention and control of noise pollution.	<b>05</b>

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

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
15	10	15	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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**Master of Engineering**

**Subject Code: EM3204**

**Subject Name: Design of Pollution Control Systems**

**Recommended Books:**

1. Perry's Chemical Engineers Handbook, McGraw-Hill Education.
2. Coulson & Richardson's Chemical Engineering Design: Vol. 6 by R. K. Sinott, CBS.
3. Wastewater Engineering, Treatment and Reuse, Metcalf and Eddy, Tata McGraw Hill.
4. Handbook of Solid Waste Management by George Tchobanoglous, Frank Kreith, McGraw-Hill Education.
5. Introduction to Process Engineering and Design by Thakore & Bhatt, McGraw-Hill Education.

**Course Outcomes:**

After learning this course, students will be able to:

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Understand fundamentals of pollution control systems
CO-2	Design key air pollution control equipments
CO-3	Design liquid effluent treatment plants
CO-4	Design solid waste management systems
CO-5	Explain various methods for control of gaseous pollutants
CO-6	Appraise the use of air quality monitoring

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

- NPTEL
- WRPLOT



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**Master of Engineering**

**Subject Code: EM3205**

**Subject Name: Risk Assessment & Safety Management**

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

**Semester: - III**

**Type of course: Open Elective**

**Prerequisite:** Fundamental of safety management

**Rationale:** The main objective of this subject is to make students aware about the importance of instrumentation in Environmental Management.

**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	Sources of Environmental hazards, Environmental and ecological risks, Environmental risk assessment framework, Regulatory perspectives and requirements, Social benefit Vs. technological risks; Path to risk analysis; Perception of risk, risk assessment in different disciplines and offsite and onsite emergency plan.	07
2	Hazard identification and accounting , Fate and behavior of toxics and persistent substances in the environment , Properties, processes and parameters that control fate and transport of contaminants, Receptor exposure to Environmental Contaminants, Dose Response Evaluation, Exposure Assessment , Exposure Factors, Slope Factors, Risk Characterization and consequence determination , Vulnerability assessment , Uncertainty analysis.	07
3	HAZOP and FMEA methods, Cause failure analysis , Event tree and fault tree modeling and analysis , Multimedia and multipath way exposure modeling of contaminant migration for estimation of contaminant concentrations in air, water, soils, vegetation and animal products ,	06

(Established under Gujarat Private Universities Act, 2009)

**Master of Engineering**

**Subject Code: EM3205**

**Subject Name: Risk Assessment & Safety Management**

	Methods in Ecological risk assessment Probabilistic risk assessments, radiation risk assessment. Fire triangle.	
<b>SECTION-B</b>		
<b>4</b>	Introduction to Ventilation & General Principal of Ventilation, General Industrial Ventilation, Local Exhaust Ventilation (LEV) Systems, Heat, Ventilation & Air Conditioning (HVAC), Testing of Ventilation System, Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision, safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Classification of Health Hazards, Hierarchy of Control, Substitutions, Engineering Control, Administrative Control, Personal Protective Equipments (PPE)	<b>05</b>
<b>5</b>	Introduction to Material Safety Data Sheet (MSDS), Sources of exposure, exposure evaluation, exposure-hazard control, Fire and explosion: types of fire, detonation and deflagration, UVCE and BLEVE, Regulatory bodies and regulations; Safety by specific devices such as, safety release valves, vents, flare systems; Instrumentation for safety - specific devices such as alarms, interlocks, shutdown systems, Hazard Identification Checklist procedure, Preliminary hazard analysis, What if analysis.	<b>07</b>
<b>6</b>	Route Of Entry Of Toxic Substance Into Human Body, Occupational diseases, ways to reduce risk of occupational diseases, measures for occupational health and safety, Occupational diseases due to Chemical Agents, Physical Agents, Biological Agent, Psychological Agents, and Physiological Agents. Ergonomical Agents Etc., Occupational Health and Hygiene Services At Work Place: Occupational Health and Hygiene Centre at Workplace.	<b>07</b>

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

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
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)**

**Reference Books:**

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**Master of Engineering**

**Subject Code: EM3205**

**Subject Name: Risk Assessment & Safety Management**

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
3. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
4. Industrial Safety by K.U Mistry

**Course Outcomes:** After learning this course, students will be able to,

Sr. No.	CO statement
CO-1	Identify major process and health hazards and apply hazard analysis techniques for risk assessment
CO-2	Understand the importance of Environment Health & Safety
CO-3	Identify industrial & occupational health problems from safety point of view
CO-4	Interpret sources of Environmental hazards.
CO-5	Apply knowledge of risk assessment.
CO-6	Define the use of engineering control in industries.

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

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

(Established under Gujarat Private Universities Act, 2009)

**Masters in Engineering**  
**Subject Code: EM3206**  
**Subject Name: Novel Separation Techniques**

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

**Semester: - III**

**Type of course: Open Elective**

**Prerequisite:** Fundamental knowledge of separation process and basic concepts of Fluid mechanics.

**Rationale:** The main objective of this subject is to identify multiple factors influencing the choice of separation technologies. Upon the completion of this course students will be able to quantitatively and qualitatively address regarding choice of separation process for effecting particular separation.

**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> Fundamentals of separation process – Basic concepts in mass transfer and mechanical operations, Concept of driving forces, Case studies of separation techniques	06
2	<b>Adsorptive Separations:</b> Definition, Types of adsorption, Adsorbent types, Preparation and properties, Types of adsorption isotherms and their importance, Breakthrough curves, Adsorption Capacity estimations, Cases such as thermal swing, pressure swing, and moving bed adsorption, Desorption. Gas separation with PSA and TSA.	08
3	<b>Membrane Separations:</b> Synthesis and characterization of membranes, Transport processes in membrane, Modeling of reverse osmosis (RO), Ultrafiltration (UF) and gaseous separations, Dialysis, Nanofiltration, Ultrafiltration, Microfiltration, Principles, mechanisms, cross flow, membrane materials and various membrane modules.	08

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**Masters in Engineering**  
**Subject Code: EM3206**  
**Subject Name: Novel Separation Techniques**

<b>SECTION-B</b>		
<b>4</b>	<b>Distillation:</b> Concept and working of Short path distillation, Molecular distillation, Reactive and catalytic distillation, Pressure swing distillation, Advantage & Disadvantages of PSD over azeotropic and Extractive Distillation, Osmotic distillation – working principle, Comparison of various distillations process and relevant applications.	<b>10</b>
<b>5</b>	<b>Ionic Separations:</b> Electrophoresis, Di-electrophoresis, Controlling factors, Applications, Equipment employed for electrophoresis, Di-electrophoresis, Ion exchange chromatography and electro dialysis, Affinity chromatography, Immune chromatography	<b>10</b>
<b>6</b>	<b>Mechanical – Physical Separation Process:</b> Introduction, Classification, Filtration in solid liquid separation. Settling & sedimentation in particle fluid separation. Other Separations: Separation by thermal diffusion, Electrophoresis, Crystallization – Melt crystallization, Supercritical fluid extraction, Pervaporation, Freeze drying. Industrial effluent treatment by modern techniques.	<b>10</b>

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

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
14	21	21	7	7	0

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

**Recommended Reference Books:**

1. D. M. Ruthven, Principles of Adsorption and Adsorption Processes, John Wiley (1984).
2. Ghoshal S.K, Sanyal Shyamal K, Dutta S, Introduction to Chemical Engineering, Tata Mc Graw Hill Publications.
3. King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd., 1982.
4. Marcel Mulder, Basic Principles of Membrane Technology, Springer, 1991.
5. “Introduction to process Engineering & Design” by S.B. Thakore & B.I Bhatt, Tata McGraw-Hill Ltd.,2007

(Established under Gujarat Private Universities Act, 2009)

**Masters in Engineering**

**Subject Code: EM3206**

**Subject Name: Novel Separation Techniques**

6. Schoew, H.M. - "New Chemical Engineering Separation Techniques ", Interscience Publishers, 1972.
7. Large Scale Adsorption Chromatography, P C Wankat, CRC Press, 1986.
8. Ronald W.Rousseu - "Handbook of Separation Process Technology ", John Wiley, New York, 1987
9. Rate Controlled Separations, Phillip C Wankat, Kluwer Academic Pub, 1990.
10. Reverse Osmosis and Ultra Filtration Process Principle, S. Sourirajan& T. Matsura, NRC Publication, Ottawa, 1985.
11. Supercritical Fluid Extraction, M A McHugh & V. J. Krukonis, Butterworth, 1987.

**Course Outcomes:**

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify the importance of separation process in various in downstream operations in industry.
CO-2	Explain the concepts of adsorption and industrial importance of this unit operation in gaseous separations.
CO-3	Apply the membrane separation for understanding transport process through different membrane modules.
CO-4	Differentiate unit operations carried out in Industry for separation of components present in a mixture through distillation.
CO-5	Describe ionic separations carried out for components based on size, molecular weight and diffusional effects.
CO-6	Explain physical separation process based on size fractions of components and through thermal pathways.

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

- Reference to NPTEL lectures can be made for a better understanding regarding various unit operations.