

(Established under Gujarat Private Universities Act, 2009)

Shroff S.R. Rotary Institute of Chemical Technology

Ref: UPL University/SRICT/BOS/EST/2021-22/02

Date: 15-03-2022

Teaching Scheme for Second Year Bachelor of Environmental Science & Technology

Semester-III (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	Humanities & Social Science	MH2201	Communication Skills in English	2	0	2	4	3	70	30	20	30	150
2	Basic Science	ET2201	Analytical & Instrumentation Techniques	3	1	2	6	5	70	30	20	30	150
3	Engineering Science	ET2202	Basics of Unit Operations	3	0	2	5	4	70	30	20	30	150
4	Professional Core Course	ET2203	Environmental Management - I	3	0	0	3	3	70	30	0	0	100
5	Professional Core Course	ET2204	Wastewater Treatment - I	3	1	2	6	5	70	30	20	30	150
6	Professional Core Course	ET2205	Solid Waste Management	3	1	2	6	5	70	30	20	30	150
7	Internship	MH2205	In plant Training	0	0	0	0	1	0	0	50	0	50
Total				17	3	10	30	26	420	180	150	150	900

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Semester-IV ((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	Humanities & Social Science	MH2204	Universal Human Values	3	0	0	3	3	70	30	0	0	100
2	Basic Science	ET2206	Organic Chemistry & Industrial Process	3	0	2	5	4	70	30	20	30	150
3	Professional Core Course	ET2207	Environmental Management - II	3	0	0	3	3	70	30	0	0	100
4	Professional Core Course	ET2208	Air Pollution Control - I	3	0	2	5	4	70	30	20	30	150
5	Professional Core Course	ET2209	Hazardous & Other Waste Management	3	0	0	3	3	70	30	0	0	100
6	Professional Core Course	ET2210	Wastewater Treatment - II	3	0	2	5	4	70	30	20	30	150
7	Professional Elective	ET2211	Fundamentals of Stoichiometry	3	0	0	3	3	70	30	0	0	100
8	Professional Elective	ET2212	Environmental Resource Management	3	0	0	3	3	70	30	0	0	100
Total				21	0	6	27	24	490	210	60	90	850

Course code and definition:

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

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: MH2201
Subject Name: Communication Skills in English

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Language and Communication

Prerequisite: Zeal to learn the Language

Rationale: The rationale of the curriculum is to help students to express their original ideas in English and also develop interest in language and literature with a focus on comprehension, and reading, speaking and writing 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	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Dynamics of Communication: Definition and process Kinesics Proxemics Paralinguistic features Importance of Interpersonal and Intercultural Communication in today's organizations	6
2	Technical Writing: Report writing Technical proposal Technical description Business letters(sales, order, complaint, adjustment, inquiry, recommendation, appreciation, apology, acknowledgement, cover letter) Agenda of meeting, Minutes of meeting Resume writing	7
3	Technical Communication: Public speaking, Group discussion, Presentation strategies, Interview skills, Negotiation skills ,Critical and Creative thinking in communication	7
SECTION-B		
4	T Ethics in Engineering: Scope of engineering ethics, Accepting and sharing responsibility , Resolving ethical dilemmas, Making moral choices	6

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: MH2201
Subject Name: Communication Skills in English

5	Etiquettes: Telephone etiquettes for foreign business trips, Etiquettes for small talks, Respecting privacy ,Learning to say NO, Time management, Scope of engineering ethics, Accepting and sharing responsibility ,Resolving ethical dilemmas ,Making moral choices	7
6	Self-development and Assessment: Change, Grow, Persist, Prioritize, Read, Learn, Listen, Record, Remember, Asses, Think, Communicate, Relate, Dream.	6

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	15	5	5

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

Language Laboratory Activities:

Sr. no	Practical/ Exercise	Apprx. Hours required
1	Role Play	02
2	Letter writing: Formal	02
3	Group Discussion	02
4	Presentations	02
5	Book Review(Preferably related to self-development)	04
6	Mock Interview	02
7	Report writing	02
8	Case studies related to unit 4, 5 and 6	02
9	Conducting meeting with Agenda	02
10	Minutes of Meeting	02

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Bachelor of Engineering
Subject Code: MH2201
Subject Name: Communication Skills in English

Reference Books:

1. Raman and Sharma, Technical Communications, OUP, New Delhi, 2017
2. Lata and Kumar, Communication Skills, OUP, New Delhi, 2018
3. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw Hill, New York, 2014
4. Mohapatra and Sreejesh S., Case Studies in Business Ethics and Corporate Governance, Pearson, UP, 2013
5. Ramesh and Ramesh, The Ace of Soft Skills, Pearson, UP, 2019
6. Sherfield, Montgomery and Moody, Cornerstone: Developing Soft Skills, UP, 2009
7. Open Sources: <https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases>

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

Sr. No.	CO statement
CO-1	Define and describe dynamics of verbal and non-verbal aspects of communication.
CO-2	Associate with various formal documents of technical and professional communication
CO-3	Interpret communication of diverse formal situations taking place in organizations.
CO-4	Illustrate and examine the knowledge of ethical aspects of engineering
CO-5	Establish and explain social and professional etiquettes.
CO-6	Recommend self -development and self - assessment.

List of Open Source Software/learning website:

Open Sources: <https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases>

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2201

Subject Name: Analytical & Instrumentation Techniques

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Basic Science

Prerequisite: Fundamental knowledge of instrumentation

Rationale: To provide knowledge related to various analytical technique and instruments used.

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	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction to instrumental method of analysis, Scope of Analytical Instrumentation, Introduction to Laboratory Techniques and Instrumentation, Portable versus stationary analytical instrument, remote calibrations for OCMS.	04
2	Spectrophotometry: Spectral methods of analysis, Electromagnetic spectrum, Beer-Lambert law, UV-Visible spectrophotometry, Single and double beam instruments, IR Spectroscopy, Atomic absorption Spectroscopy, FTIR spectrophotometry, Flame emission Spectroscopy , Mass Spectroscopy	10
3	Chromatography: Different techniques, Techniques by chromatographic bed shape: Column chromatography, Paper Chromatography, Thin layer Chromatography and its Applications, Techniques by physical state of mobile phase: Gas chromatography, Liquid chromatography and its Applications, High-pressure liquid chromatography and its Applications, Techniques by separation mechanism: Ion exchange chromatography and its Applications	10

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2201

Subject Name: Analytical & Instrumentation Techniques

SECTION-B		
4	<p>pH Meters And Dissolved Component Analyzers: Selective ion electrodes, Principle of pH measurement and conductivity measurements, dissolved oxygen analyzer, Water quality Analyzer.</p> <p>Instrumentation for Field Observations: Remote Sensing Related Equipment's, Principles of Quadrat Survey</p>	05
5	<p>Industrial Gas Analyzers And Pollution Monitoring Instruments: Types of gas analyzers: Oxygen, NO₂ and H₂S types, thermal conductivity analyzers, analysis based on ionization of gases, Dust and smoke measurements.</p>	05
6	<p>Miscellaneous Methods: Dissolved oxygen sensors, TOC analyzer, Visual method and instrumental method of turbidity measurement, On line sensors, Electronic Direct Reading Instrumentation</p>	05

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	15	10	-

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

Recommended Books:

1. Braun, R.D., Introduction to Instrumental Analysis, Mc Graw – Hill, Singapore, 2006.
2. H.H.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, Instrumental methods of analysis, CBS publishing & distribution, 1995.
3. James keeler; Understanding NMR Spectroscopy, Second Edition John Wiley & Sons, 2010.
4. Frank G. Kerry Industrial Gas Handbook: Gas Separation and Purification, Taylor and Francis group, 2007.
5. Standard methods for the examination of water and wastewater; published by American public Health Association, American water works Association, Water pollution control federation (21st Edition & later).
6. Chemistry for Environmental Engineering by Sawyer and M C Carty (4th Edition- McGraw-Hill Publishing Company Ltd.)

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2201

Subject Name: Analytical & Instrumentation Techniques

7. NPTEL Lecture Notes on, “Modern Instrumental Methods of Analysis” by Dr.J.R.Mudakavi, IISC, Bangalore.

List of Practical:

1. To demonstrate the working principle of pH meter.
2. To demonstrate the working principle of electrical conductivity meter
3. To demonstrate the working principle of Nephelo turbidity meter.
4. Separation of mixture of dyes using thin layer chromatography.
5. To demonstrate the working principle of Respirable Dust Sampler (RDS) which is used for analysis of ambient air.
6. To demonstrate the working principle of Fine Dust Sampler which is used for analysis of ambient air.
7. To demonstrate the working principle of TOC analyzer.
8. Demonstrate the Noise level meter for measuring sound at given location.
9. Colorimetric analysis using UV-Vis spectrophotometer.
10. To demonstrate the working principle of Flame Photometer.

List of Tutorials:

1. Scope of analytical instrumentation in the Environmental Science & Technology field.
2. Describe remote calibrations for OCMS.
3. Principles of Spectrophotometry.
4. Describe the classification of Chromatography.
5. Role of remote sensing in instrumentation which is used for field observation.
6. Describe the process of FTIR Spectrometer using Block diagram.
7. Describe the different types of HPLC.
8. Non Dispersive Infrared Gas Analyzer (NDIR).
9. Describe Electronic Direct Reading Instrumentation.
10. Single and double beam instruments used in spectrophotometry.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2201

Subject Name: Analytical & Instrumentation Techniques

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	List various techniques and methods of Spectral analysis.
CO-2	Extend the adequate knowledge about Gas sensor and pollution monitoring instruments.
CO-3	Apply the knowledge of chromatography to separate the constituents from a complex mixture.
CO-4	Examine the selection of appropriate analyzer for an Industrial requirement.
CO-5	Explain the working of instruments as well as development of new technologies
CO-6	Justify to carry out statistical analysis of the data.

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Engineering Science

Prerequisite: Basic knowledge of unit and dimension, theoretical knowledge of mass fraction, mole fraction, material balance.

Rationale: The objective of this course is to study various unit operations used in effluent treatment involving solid-solid and solid-liquid handling, mixing and 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	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Particulate Solids: Characterization of solid particles, particle shape, particle size, mixed particle sizes and size analysis, specific surface of mixture, average particle size, screen analysis: standard screen series. Cumulative and differential analysis. Screening and screening equipment: stationary screens and grizzlies, gyrating screens, vibrating screens, comparison of ideal and actual screens, material balances over screen, screen effectiveness, capacity and effectiveness of screens.	05
2	Size Reduction: Principles of comminution, energy and power requirements in comminution, crushing efficiency, empirical relationships: Rittinger's and Kick's laws. Bond's crushing law and work index. Types of size-reduction equipment. Crushers: jaw crushers, gyratory crushers. Grinders: hammer mills and impactors, tumbling mills, action in tumbling mills. Ultrafine grinders: fluid energy mills. Cutting machines: knife cutters.	06

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2202
Subject Name: Basics of Unit Operations

	Open-circuit and closed circuit operation.	
3	Separations based on motion of particles through Fluid: Gravity settling processes, gravity classifiers, sorting classifiers: sink-and-float methods, differential settling methods. Batch sedimentation, various sedimentation zones, rate of sedimentation. Concept of Reynold's number, drag force and drag coefficient. Various settling regimes. Equipment for sedimentation: thickeners and clarifiers.	07
SECTION-B		
4	Filtration: Introduction, principles and mechanisms of filtration. Filter media and filter aids. Types of filtration: constant rate filtration and constant pressure filtration, pressure drop through filter cake. Compressible and incompressible filter cakes, resistance due to filter media and filter cake. Mechanism and working principle of discontinuous pressure filter: plate and frame filter press, continuous vacuum filters: vacuum leaf filter, rotary drum filter. Bag filters. Application of filtration in wastewater treatment.	07
5	Centrifugal Separations: Introduction and principle of centrifugal separations. Separation of liquids in a centrifuge: tubular bowl centrifuge. Centrifugal sedimentation: tubular centrifuge, disk bowl centrifuge. Working principle and mechanism of cyclones and hydrocyclones.	07
6	Agitation and Mixing: Principles of agitation, agitation equipment, flow patterns: prevention of swirling, baffles and draft tubes. Agitation equipment design. Dimensional analysis: Buckingham's π theorem. Power correlation in an agitated vessel, calculation of power consumption in agitation. Scale up of agitated vessels.	07

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
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)

Recommended Books:

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2202
Subject Name: Basics of Unit Operations

1. Foust A. S. & associates, "Principles of Unit Operations" John Wiley and Sons (1980).
2. McCabe Smith, "Unit Operation in Chemical Engineering" 5th ed. McGraw Hill (1985).
3. Perry R.H. & Chilton C.H., "Chemical Engineers Hand Book", 7th ed. McGraw hill.
4. Badger and Bencharo, "Introduction to Chemical Engineering". Tata McGraw hill.
5. S. K. Gupta, "Momentum Transfer Operation". Tata McGraw Hill (1979)
6. Davidson J.F. & Harrison D. "Fluidization" Academic press (1985)
7. Kunni & Levenspiel "Fluidization engineering" Wiley (1962)
8. Brown, G.G. and associates, "Unit operations" Wiley, New York, (1950).
9. Coulson and Richardson: Chemical Engineering, Vol. 2. Butterworth Heinemann Pub
10. Welty, Wicks, Wilson & Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th ed. Wiley,
11. Narayanan C.M. & Bhattacharya B.C. "Mechanical Operations for Chemical engineers", Khanna Publishers. 3rd Ed. 1999

List of Practical:

1. Determination of average particle size of the given mixture by cumulative and differential analysis.
2. Determination of screen effectiveness of the given screen.
3. Determination of average particle size and size reduction ratio of the given mixture of particles using Jaw Crusher.
4. Determination of efficiency and constants for Kick's law, Rittinger's law and Bond's law using a Jaw Crusher.
5. Determination of average particle size and size reduction ratio of the given mixture of particles using Roll Crusher.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2202
Subject Name: Basics of Unit Operations

6. Determination of efficiency and constants for Kick's law, Rittinger's law and Bond's law using a Roll Crusher.
7. Determination of average particle size and size reduction ratio of the given mixture of particles using Ball Mill.
8. Determination of optimum, critical speed and constants for Kick's law, Rittinger's law and Bond's law using a Ball Mill.
9. Determination of settling characteristics of dilute slurry and hence to calculate its critical velocity and area of the thickener.
10. Determination of efficiency of a cyclone separator.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define and enumerate properties of solid and solid mixtures
CO-2	Classify and discuss size reduction and screening equipment with their applications
CO-3	Develop and illustrate the principles of filtration and its application in environmental science and technology
CO-4	Analyze and categorize sedimentation and centrifugal separation equipment with their application in treating waste
CO-5	Summarize different solid – fluid and solid – solid separation equipment
CO-6	Interpret and evaluate the applications of all unit operation equipment in the field of environmental science and technology

List of Open-Source Software/learning website:

- NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Professional Core Course

Prerequisite: Students shall have basic knowledge of Ecosystem, Ecology and towards managing Environment

Rationale: To provide knowledge related to different aspects of 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	00	00	100

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Ecology: Objective of Ecology and its Importance, Classification of Ecology, Ecological Factors, Ecological Balance, Ecosystem Stability & Instability, Industrial Ecology: A new Horizon of Management. Ecosystem: Concept and Structure, Kinds of Ecosystem, Components of Ecosystem, Major Ecosystems, Biogeochemical Cycles, Energy Flow in Ecosystem, Food chain, Ecological Pyramids, Artificial Ecosystems, Characteristic of an Ideal Ecosystems, Humans and the Ecosystem	07
2	Importance of Natural Resource, Types of Resources, Increasing Pressure on Natural Resources, Water Resources and Land Degradation, Watershed Management, Wasteland Development and Role of National Wastelands Development Board (NWDB), Voluntary Agencies and Non-Government Organizations (NGOs), River Valley Projects, Water Resource Scenario in India	07
3	Soil Resource Degradation (Soil Erosion) and its kinds, Agents of Soil Erosion, Soil Conservation: Principles and its Methods, Land Use in India, Forest Resource including Forest Cover, Forest Survey of India,	06

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Bachelor of Engineering
Subject Code: ET2203
Subject Name: Environmental Management-I

	Deforestation, Desertification, Afforestation: Strategy to Demands, Chipko Movement and its significance	
SECTION-B		
4	Autecology of Species: Biological Rocks, Liebig's Law of the Minimum, Shelford's law of Tolerance, Combined Concept of the Limiting Factors. Population: The Impact Equation, The root cause of Pollution, The Population Dynamics and the application of Exponential Growth Equation, Population Forecasting, Population Explosion	05
5	Bioremediation: A promising Technology for Pollution Cleanup Importance of Bioremediation, Needs, Merits and Scope of Bioremediation, Approaches to Bioremediation, Ecology of Bioremediation, Technology of Bioremediation, Phytoremediation: Concept and Importance, Field Scale Applications of Phytoremediation, Introduction to Biotechnology, Applications of Biotechnology in Industries and Environmental Engineering	07
6	Current Environmental Issues and Case Studies: Increasing Sea Level, Polyethylene: An Environmental Disaster, Lead Pollution and its Control, Pesticide Pollution and its control, Santa Babara Oil Slick, Deterioration of Taj Mahal, Construction of Tehri dam, Ganga Pollution, Bhopal Gas Leak Disaster, Minamata Tragedy, Oleum Gas Leak, Environmental Consideration in Rural Development, Environmental Friendly Approaches for Generation of Energy, Landfill Issue of Ghaziabad, Bangalore Lake Fire	07

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
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)

Recommended Books:

1. Environment and Ecology by Gourkrishna Dasmohapatra, 3rd Edition.
2. Environmental Management, National and Global Perspectives by Swapan C. Deb

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Bachelor of Engineering
Subject Code: ET2203
Subject Name: Environmental Management-I

3. Ecology and Environment, 11th Edition by P.D. Sharma
4. Environmental Engineering and Management by Dr. Suresh k. Dhameja
5. Basics of Environmental Studies by Prof. Dr. N.S.Varandani, Books India Publications
6. Handbook of Bioremediation Edited by Norris et al, Robert S. Kerr;
7. Bioremediation Principles: Ewies, Ergas, Chang and Schroeder

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Describe the concept of Ecology and Ecosystem
CO-2	Explain the importance of Natural Resources and Its management.
CO-3	Interpret different and current environmental issues
CO-4	Determine Significance of Biotechnology and Bioremediation
CO-5	Evaluate Autecology of Species
CO-6	Establish awareness on Natural Resource Degradation

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Professional Core Course

Prerequisite: Students shall basic knowledge regarding the concept of solid waste, its importance, collection, transportation and proper disposal facilities.

Rationale: To understand the planning, management, technical and sustainable aspects of handling MSW.

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	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction: Waste- The Business of exclusions; Waste concept; Sources, Composition and Classification of solid waste; Physical, Chemical and Biological characteristics of solid waste; Hierarchy of waste management - 5 Rs (Reduce, Reuse, Recycle, Recover and Remove); SWM- Indian scenario; Key issues of solid waste management; Municipal Solid Waste Management Rules, 2016.	06
2	Management Aspects: Planning, Institutional and Financial Aspects Guiding Principles of Municipal Solid Waste Management; Overview of developing a MSW plan in an urban local body- a seven step approach for developing a plan; Establishment of Institutional mechanisms; Sustainable financing for MSW; Centralized Vs. Decentralized MSWM system; Role of the informal sector.	06
3	Municipal Solid Waste Management: Waste minimization: ISWM hierarchy; Need and benefits of waste	08

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2205

Subject Name: Solid Waste Management

	<p>minimization; Strategies for waste minimization. Source Segregation: Segregation of MSW at source; Storage of MSW at source; Public participation and awareness. Collection and Transportation: Waste collection; Collection systems and equipments; Layout of collection routes; Means of transport; Need and Design requirements of transfer station.</p>	
SECTION-B		
4	<p>Municipal Sanitary Landfill Terminologies; Classification; Essential components; Landfill siting considerations- Locational criteria, Identification of search area, Data collection; Planning and design- Design life, Waste volume and landfill capacity, Landfill layout, Landfill section, phased operation, Landfill liner system, Leachate management, Landfill gas management, Final cover; Closure and Post closure care; Landfill mining.</p>	07
5	<p>Municipal Solid Waste Management Plan: Implementation Components of MSW Plan; Statutory clearances for MSWM facilities- clause 15, clause 21, statutory clearances, non-statutory approvals, identification of land for MSW, EIA requirements for MSWM facilities, roles and responsibilities of stakeholders involved in EIA; Preparation of action plans- action plans for specific services; Tendering- steps in preparing tender documents; Operationalizing the financial plan.</p>	07
6	<p>Construction and Demolition Waste Management: Salient features of Construction and Demolition Waste Management Rules, 2016. Plastic Waste Management: Salient features of Plastic Waste Management Rules, 2016; Composition of Plastics; Recycling of Plastic waste and Sustainable disposal of Plastic Waste.</p>	05

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	05

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

Recommended Books:

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Bachelor of Engineering

Subject Code: ET2205

Subject Name: Solid Waste Management

1. Solid & Hazardous waste Management by PM Cherry.
2. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management”, the McGraw- Hill, New York, 3rd Ed., 1993.
3. M.S. Bhatt, “Solid Waste Management-An Indian Perspective”, 2020.
4. Kiely G., “Environmental Engineering”, McGraw Hill Book Company, 1998.
5. Rao C.S., “Environmental Pollution Control and Engineering”, New Age International (P) Limited, 1991.
6. Manual on Municipal Solid waste management by Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.

List of Practicals:

1. To determine the Calorific value of a given solid waste using Bomb Calorimeter.
2. To determine the concentration of Potassium in given solid waste sample by Flame photometer.
3. To determine the concentration of Sodium in given solid waste sample by Flame photometer.
4. To determine the moisture content in given solid waste sample.
5. To demonstrate the sanitary landfill model.
6. To determine the pH of a given sample of solid waste.
7. To carry out Paint Filter Liquid Test (PFLT) for a given sample of solid waste to check the availability free moisture content.
8. To Determine Loss on ignition (% organic matter) of given sample of solid waste.
9. To analyze the collection route analysis.
10. To develop a solid waste management system for a smart city.

Course Outcomes:

After learning this course, students will be able to:

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2205

Subject Name: Solid Waste Management

Sr. No.	CO statement
CO-1	Understand the basic concept of solid waste along with the characteristics, issues and challenges.
CO-2	Interpret the importance of planning and financing for the sustainable waste management.
CO-3	Describe the significance of waste minimization, segregation, collection and transportation of MSW.
CO-4	Illustrate the design criteria for designing the sanitary landfill site.
CO-5	Elaborate the implementation phase regarding the MSWM.
CO-6	Explain the strategies to deal with the Plastic and C&D waste.

List of Open-Source Software/learning website:

NPTEL

MOEF&CC

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Bachelor of Engineering
Subject Code: ET2204
Subject Name: Wastewater Treatment - I

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Semester: - III

Type of course: Professional Core Course

Prerequisite: Fundamental knowledge of water pollution.

Rationale: The main objective of this subject is to make students aware about different types of impurities present in wastewater along with the different treatments used to remove these impurities.

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	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction to wastewater treatment: Wastewater Constituents, Characteristics of wastewater: Physical, chemical, biological. Sources of water & generation of wastewater. Standard wastewater discharge limits as prescribed by competent authority. Drinking water standards.	06
2	Analysis and selection of wastewater flow rates: Components of wastewater flows, Wastewater Sources and flowrates: Domestic, Residential areas, Commercial areas, Institutional, Recreational facilities, Variations in wastewater flow rate: Diurnal variations, Seasonal Variations, Industrial Variations.	06
3	Introduction to Sewage Treatment plant and Effluent Treatment Plant: Sampling & preservation of wastewater samples (Objective, Selection of sample containers, Selection of type of sampling, Selection of sampling points, Selection of type of filling the container, In – situ measurements, Sample labeling, Collection and preservation of samples	07

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2204

Subject Name: Wastewater Treatment - I

	for organics and trace metals, Sampling and Handling Requirements).	
SECTION-B		
4	Theory and measurement of physical, chemical and biological parameters: pH, Color, Turbidity, TDS, TSS, Alkalinity, Acidity, Hardness, COD, BOD, Nitrogen, Sulphates and Oil & Grease.	07
5	Preliminary Treatment of wastewater: Screening: Classification of Screens, Hand cleaned screens, Mechanically cleaned screens, Purpose, Head loss in screens, Screenings handling, processing & disposal. Flow Equalization: Concept, Description of flow equalization, Design Considerations, Location of equalization facilities, In line and Off line equalization, Strength & Flow Equalization, Determination of capacity of equalization tank.	07
6	Preliminary Treatment of wastewater: Grit Chamber: Concept, Grit Removal, Types of Grit chamber: Rectangular horizontal flow, Aerated grit chamber, Vortex type grit chamber, Grit characteristics, Grit Quantities, Grit Processing, Grit Disposal. Oil & grease removal, Dissolved air flotation.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
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)

Recommended Books:

1. Wastewater Engineering: Treatment and Reuse, Metcalf & eddy; McGraw Hill Book Company, 4th Ed, 2002.
2. Environmental Pollution and Control engineering, Rao C. S. - Wiley Eastern Limited, India, 1993

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2204

Subject Name: Wastewater Treatment - I

3. Water Treatment Plants: Planning, Design & Control, S R Qasim, Technomic Pub. Co., 1999.
4. Industrial Water Pollution Control, Eckenfelder W.W.; McGraw Hill Book Company, 3rd Ed, 2000.
5. Environmental Engineering, Kiely G.; McGraw Hill Book Company, 1998
6. Pollution control in process industries, S.P. Mahajan TMH., 1985.
7. Waste water treatment, M.Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.
8. Industrial Pollution Control and Engineering, Swamy AVN, Galgotia publications, 2005.
9. Environmental Engineering (Vol. II) - Sewage disposal and Air pollution, S.K Garg & Rajeshwari Garg, Khanna Publishers, 27th Edition, 2013.
10. Environmental Engineering and Sanitation: Joseph A. Salvato, John Wiley & Sons, 4th Ed. 2003
11. Water Supply and Sanitary Engineering, Birdie and Birdie, Dhanpatrai and Sons, 1996.
12. Environmental engineering (Vol. I) - Water Supply Engineering S.K Garg & Rajeshwari Garg, Khanna Publishers, 23rd Edition, 2013.

List of Practical:

1. To determine pH of wastewater sample.
2. To determine Alkalinity of wastewater sample.
3. To determine Acidity of wastewater sample.
4. To determine Turbidity of wastewater sample.
5. To determine Conductivity of wastewater sample.
6. To determine Ammonical Nitrogen of wastewater sample.
7. To determine Chlorides of wastewater sample.
8. To determine Residual Chlorine of wastewater sample.
9. To determine Sulphates of wastewater sample.

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Bachelor of Engineering

Subject Code: ET2204

Subject Name: Wastewater Treatment - I

10. To determine iron of wastewater sample.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Describe different characteristic of water and wastewater.
CO-2	Explain physical unit operations used for treatment of wastewater.
CO-3	Interpret the difference between physical and chemical treatment of wastewater.
CO-4	Identify the degree of treatment required for a particular stream of wastewater.
CO-5	Understand the concept of various wastewater parameters.
CO-6	Compare different preliminary treatment used for removal of inorganic pollutants.

List of Open-Source Software/learning website:

- NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: MH2204
Subject Name: Universal Human Values

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Humanities, Social Science including Management courses (HSMC)

Prerequisite: None. Basics of Universal Human Values (desirable)

Rationale: Course helps the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings

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	-	-	100

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction to Value Education : Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity–the Basic Human Aspirations, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity–Current Scenario, Method to Fulfill the Basic Human Aspirations.	8
2	Harmony in the Family: Harmony in the Family – the Basic Unit of Human Interaction, Values in Human-to-Human Relationship, Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation.	5
3	Harmony in the Nature/ Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at all levels, The Holistic perception of Harmony in Existence.	7
SECTION-B		

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: MH2204

Subject Name: Universal Human Values

4	Harmony in the Human Being :Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health	8
5	Harmony in the Society: Understanding Harmony in the Society: Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive human goals, Visualizing a universal harmonious order in society.	4
6	Implications of the Holistic Understanding – A Look at Professional Ethics :Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	20	10	10	0

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

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, “A Foundation Course in Human Values and Professional Ethics”, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93- 87034-47-1.
2. R R Gaur, R Asthana, G P Bagaria, “Teachers’ Manual for A Foundation Course in Human Values and Professional Ethics”, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: MH2204
Subject Name: Universal Human Values

Reference Books:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. A.N. Tripathi,, Human Values, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book)
4. Mohandas Karamchand Gandhi “The Story of My Experiments with Truth”
5. E. F Schumacher, “Small is Beautiful”.
6. Cecile Andrews, “Slow is Beautiful”.
7. J C Kumarappa, “Economy of Permanence”
8. PanditSunderlal, “Bharat Mein Angreji Raj”
9. Dharampal , “Rediscovering India”
10. Mohandas K. Gandhi, “Hind Swaraj or Indian Home Rule”
11. Maulana Abdul Kalam Azad , “India Wins Freedom”
12. Romain Rolland, “Vivekananda” (English)
13. Romain Rolland, “Gandhi” (English)

Course Outcomes:

After learning this course students will be able to:

Sr. No.	CO statement
CO-1	Relate themselves with the surroundings (family, society, nature)
CO-2	Explain sustainable solutions with respect to problems, keeping in mind the correlation between human relationships and human nature.
CO-3	Apply what they have learnt, into various day to day schedule.
CO-4	Distinguish between ethical and unethical practices and start working out the strategy in order to materialize a harmonious environment in the work place.
CO-5	Justify their commitment with respect to their understanding regarding human values, relationship and society.
CO-6	Develop the understanding of the intricacy of the problem and design appropriate solution.



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OF
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Bachelor of Engineering
Subject Code: MH2204
Subject Name: Universal Human Values

List of Open Source Software/learning website:

- <https://www.uhv.org.in>
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXE
kQw

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Bachelor of Engineering

Subject Code: ET2206

Subject Name: Organic Chemistry & Industrial Process

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Basic Science

Prerequisite: Students shall have basic knowledge regarding concepts of Organic Chemistry.

Rationale: The main objective of this subject is to make students aware about the basics of organic chemistry and their synthesis. It also emphasize the contribution of synthetic organic compounds towards environment. Importance of Unit process & utilities also need to be detailed to students.

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	Organic functional groups & their applications : IUPAC nomenclature Basic reactions in chart format for following functional groups : Phenols, Amines, Carboxylic acids, Nitro compounds, Aldehydes, Ketones, Organo halo compounds	07
2	Sources and types of Organic pollutants : Aerosol, agrochemicals, Chemical wastes, Coal & coal products, Crude oil & crude oil products, Refinery wastes, flame retardants, Industrial chemicals, Natural gas & VOC Synthesis & Environmental footprint of Synthetic Organic Compounds: Five compounds from Dyes/Drugs/Perfumes/Agrochemicals/Polymers	08
3	Fundamentals of Industrial Processes: Reduction, Hydrolysis, Oxidation, Polymerization	06

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2206

Subject Name: Organic Chemistry & Industrial Process

SECTION-B		
4	Introduction to various Industrial Processes involving emissions: Nitration, Sulphonation, Halogenation, Alkylation, Acylation	05
5	Importance of degradation in fate of toxic organic compounds in environment: Organophosphates, Organochloro and carbamate insecticides; herbicides: atrazines .Dioxins, Furans, and PCBs, PAH, phthalates; fire retardants and perfluorinated compounds.	06
6	Utilities in Industrial Process: Efficient use of Utilities, Various utilities – Fuel, Compressed air, Inert Gases, Boiler, Steam distribution, Pumps & Compressors.	07

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. Organic Chemistry, Volumes I & II, I L Finar, ELBS & Longman Ltd., 5th Ed.,1996
2. Industrial Aromatic Chemistry: Raw materials, processes, products, H. G. Franck & J. W. Stadehofer, Berlin Springer Verlag, 1st Ed., 1988
3. Organic Chemistry, Morrison & Boyd, Pearson, 7th Ed, 2011
4. Organic Building Blocks of the Chemical Industry, H HSzmant, John Wiley and Sons, 1989
5. Organic chemistry : Bahl and Bahl
6. Fundamentals of Organic chemistry : Puri & Sharma
7. Anastas & Warner, Green Chemistry: Theory & Practice ,Oxford Univ. Press,New York,1998
8. Baird, C.; Cann, M. Environmental Chemistry, Fifth Edition;
9. W. H. Freeman and Company, New York; 2012. ISBN-13: 978-1-4292-7704-4.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2206

Subject Name: Organic Chemistry & Industrial Process

10. Unit Process in Organic Synthesis By P H Groggins, Tata Mc Graw Hill, New Delhi.
11. B. Koumanova, E. Mehmetli, The Fate of Persistent Organic Pollutants in the Environment, Springer Netherlands, ISBN 9781402066429, 1402066422
12. A. H. Neilson, A. S. Allard, Organic Chemicals in the Environment - Mechanisms of Degradation and Transformation, CRC Press, Second Edition 2013, ISBN - 9781439826386, 1439826382.
13. Process Utility Systems – Introduction to Design Operation and maintenance: Jack Broughton, Institution of Chem. Engineers, U.K.

List of Practical:

1. Organic qualitative analysis for solid binary mixture (Acid + Base)
2. Organic qualitative analysis for solid binary mixture (Acid + Phenol)
3. Organic qualitative analysis for solid binary mixture (Acid + neutral)
4. Organic qualitative analysis for solid binary mixture (Phenol + Base)
5. Organic qualitative analysis for solid binary mixture (Phenol + neutral)
6. Organic qualitative analysis for liquid binary mixture (Base + neutral)
7. Organic qualitative analysis for solid binary mixture (neutral + neutral).
8. Synthesis of m-dinitrobenzene from Benzene.
9. Calorific value of different fuels and their comparisons.
10. Estimation of purity of Asprin.
11. Synthesis of Azo Dyes.
12. Estimation of Saponification value.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Review the fundamentals of organic chemistry with illustrative problems.
CO-2	Explain sources, types, synthesis and environmental footprint of synthetic organic compounds.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2206

Subject Name: Organic Chemistry & Industrial Process

CO-3	Demonstrate different unit process based on various reactions carried out in Industry.
CO-4	Analyze industrial unit process based on emissions.
CO-5	Describe the importance of degradation in fate of toxic organic compounds in environment.
CO-6	Recognize the various utilities used in Industrial Process

List of Open-Source Software/learning website:

- NPTEL
- WRPLOT

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2207
Subject Name: Environmental Management-II

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Professional Core

Prerequisite: Students shall have basic knowledge of different concepts leading to Environmental Management

Rationale: To provide knowledge related to various efforts taken to manage Environment

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	Remote Sensing, Image Interpretation & Analysis, Photogrammetry Geoinformatics, Application of Remote Sensing in Environmental Assessment and Monitoring. GIS Definitions and Terminology, GIS categories, Levels/scales of Measurement, spatial data modelling, GIS data management, GIS in EIA (Topography Sheet), Application of GIS.	07
2	ISO14000: Introduction, Evolution of ISO 14000:Background, Step by Step Preparation for EMS Certification, ISO 14001:Environmental Management System, Certain Clarification and Regarding ISO 140001 standard, Basic ISO 14004 Guidance Document, ISO 14010 Audit Standards, ISO 14020 Labelling Standards.	07
3	Life Cycle Assessment, Life Cycle Analysis, Clean Development Mechanism, International Efforts to Mitigate Climate Change and India's Effort to Tackle Climate Change, Concept of Green Business, Carbon Credit, Carbon Foot Print, Green Productivity, Responsible Care: Its Importance, Guiding Principles and Codes of Practice.	06
SECTION-B		

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2207

Subject Name: Environmental Management-II

4	Biodiversity: Concept and its Importance, Keystone Species in Conservation Strategy, Measuring Biodiversity, Bioethics and Conservation, Causes of Extinction, Biodiversity of India, Indian Biodiversity under Serious Threat, Biodiversity Conservation Strategies, Present Scenario and Status of Biodiversity Conservation in India.	07
5	Radiation and Chemical Toxicology: Radiation, Units of Radioactivity, Kinds of Radiation, Sources of Radiation Exposure, Nuclear Power, Biological Effects of Radiation, Nuclear Pollution, Control of Radioactive Pollution and Disposal of Radioactive Waste, Chernobyl Disaster.	05
6	National and International Efforts at Environment Protection: The 42 nd Constitutional Amendment, National Committee on Environment Planning ,Other national efforts in the direction of Environmental Protection, UN Conference on Human Environment,1972, Environmental Education Conference, Montreal Protocol, Climate or Green House control convention, Concept and Significance of Paris Agreement, The Rio Summit Follow up, Sustainable Development in India :Perspectives and Strategies, Responsible care.	07

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
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)

Recommended Books:

1. Environmental Management, National and Global Perspectives by Swapan C. Deb
2. Ecology and Environment, by P.D. Sharma, 11th Edition
3. Environmental Engineering and Management by Dr. Suresh k. Dhameja
4. "Responsible Care Manual" Second Edition
5. Environment and Ecology by Gourkrishna Dasmohapatra, 3rd Edition.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2207

Subject Name: Environmental Management-II

6. Environmental Management by S.K. Agarwal, APH Publishing Corporation
7. Textbook of Remote Sensing and GIS, M. Anji Reddy, B.S. Publications

Course Outcomes:

After learning this course, students will be able to:

Sr. No	CO statement
CO-1	Examine the significance of Remote Sensing and GIS
CO-2	Discuss the concept of ISO 14000
CO-3	Assess different steps taken towards Green Environment
CO-4	Analyse the role of Biodiversity and its Conservation
CO-5	Evaluate the importance of Radiation and Chemical Toxicology
CO-6	Organize Life Cycle Analysis and Life Cycle Assessment

Bachelor of Engineering
Subject Code: ET2208
Subject Name: Air Pollution Control – I

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Program Core

Prerequisite: Students shall have basic understanding of air pollution along with some basic information of pollutant dispersion.

Rationale: This subject is intended to make students aware about the noise and air pollution, degradation of air quality through various sources of air pollution, assessment of air quality through air quality index, and 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	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction to Air Pollution: Air and its composition, Air Pollution, Sources of air pollution and its classification, Major air Pollutants and their characteristics, Specific group pollutants such as CFC, GHG etc. Effects of air pollution on human health and vegetation, animals and materials.	04
2	Meteorology and Air Pollution: Temperature lapse rate and stability, wind velocity and turbulence, plume behavior, dispersion of air pollutants, maximum mixing depth and its calculations, heat island effect, stack height, Indoor air pollution, Odors and their controls. Various types of Fuels and pollution issues, Greenbelt requirement and the role of trees in air pollution control.	08

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2208
Subject Name: Air Pollution Control – I

3	Air Pollution Sampling and Measurement: Ambient Air Sampling and Analysis of air pollutants: SO ₂ , NO _x CO, O ₃ , HC, particulate matter, Introduction to Stack Sampling, Isokinetic sampling, CEMS for various process industries as per CPCB guidelines	08
SECTION-B		
4	Control methods and equipment: Introduction to control methods and equipment for Particulate matter and gases. Construction and working of scrubbers, Electrostatic Precipitator, Gravity settlers, Cyclone separator, Filter bags etc.	12
5	Air Quality and Emission Standards: NAAQS, Air Quality index, CEPI, Salient features of Air pollution Control Act and rules 1981. Salient features of ODS Rules 2000.	03
6	Introduction to noise: Sound Pressure, Sound Pressure level (Decibel), Difference between sound and noise, Pitch and Frequency, Leq, and sources of noise and harmful effects of noise, noise measurement and noise control measures.	04

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	20	15	05	00	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. Environmental Pollution Control and Engineering, Rao C.S., New Age International (P) Limited, 2nd Ed., 2006.
2. Air Pollution, Perkin, H.G. McGraw Hill 1974.
3. Air Pollution – by Wark & Warner
4. Air Pollution. Physical and Chemical Fundamentals, Sainfeld, J.H. McGraw Hill, N.Y. 1975.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2208

Subject Name: Air Pollution Control – I

5. Air Pollution: Measurement, Modeling and Mitigation, A Tiwari and J Colls, Taylor & Francis, 2010
6. Sources and Control of Air Pollution, R J Heinsohn and R L Kabel, Prentice Hall, 1999
7. Air Pollution Control Equipment Calculations, L Theodore, John Wiley and Sons, 2008
8. Catalytic Air Pollution Control, Hack, Furraoto and Gulati, John Wiley and Sons, 2009

List of Practical:

1. Determination of SPM in ambient air.
2. Determination of PM_{2.5} in ambient air.
3. Determination of PM₁₀ in ambient air.
4. Sampling of SO₂ in ambient air.
5. Analysis of SO₂ sampled in ambient air.
6. Sampling of NO_x in ambient air.
7. Analysis of NO_x sampled in ambient air.
8. Sampling of NH₃ in ambient air.
9. Analysis of NH₃ sampled in ambient air
10. Measurement of Noise using Sound Level meter

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Recall the concept of air pollution including its sources and effects.
CO-2	Interpret the impact of various meteorological parameters on air pollutants.
CO-3	Experiment sampling and analysis of various air pollutants.
CO-4	Compare and contrast various air pollution control methods and equipment.
CO-5	Explain air quality standards and understand the quality of air using various indices.



UPL UNIVERSITY
OF
SUSTAINABLE TECHNOLOGY



(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2208

Subject Name: Air Pollution Control – I

CO-6	Revise the concept of noise pollution and implement its control measures.
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List of Open-Source Software/learning website:

- NPTEL

Bachelor of Engineering

Subject Code: ET2209

Subject Name: Hazardous & Other Waste Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Professional Core Course

Prerequisite: Students shall have basic information regarding the current hazardous waste generation, its characteristics, types and overall impact on environment if not managed properly.

Rationale: To study the hazardous 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	00	00	100

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction of Hazardous waste: Definition and sources; classification; Hazardous waste & Other Waste (Management and Transboundary) rules, 2016; Hazardous Waste Management Strategy; Waste utilization and Rule-9; TCLP test; Environmental monitoring for industrial hazardous waste treatment; Waste management and circular economy.	06
2	Hazardous waste Landfills: Siting and locational criteria; Planning and design criteria- Essential components, Design life, Landfill layout, Landfill section, Phased operation, Liner system, Leachate management, Gaseous emissions management, Final cover system, Surface water drainage system, Environmental monitoring system, Closure and Post closure maintenance plan; Waste Acceptance criteria for direct landfill.	06
3	Markets and Products for recycled material: Advantages of recycling; Stages of material recovery; Material recovery facility (MRF)- Types of MRF and unit processes in MRF; Need for	07

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2209

Subject Name: Hazardous & Other Waste Management

	<p>establishing market linkages and Extended producer responsibility; Informal sector involvement in recycling. Factors influencing recycling markets; Sustainable recycling; Recycling markets- market analysis, materials for recycling, commodity prices and identifying markets.</p>	
SECTION-B		
4	<p>Treatment methods of solid waste: Hierarchy of sustainable waste management; Overview of Physico-chemical, biological and thermal methods; Concept of Co – Processing; Hazardous Waste co processing in Cement industry. Composting- Basic concept; Benefits of composting; Constraints faced by the composting sector in India; Composting process- phases and critical parameters; Composting technologies- windrow composting, in-vessel composting, decentralized composting (bin and box composting), vermi composting.</p>	08
5	<p>Tyre Waste Management: Storage of used tyres; Reuse of used tyres; Processing of used tyres; Co-processing of used tyres. Legacy Waste management: Present status of legacy waste and its impact on environment; Provisions of SWM rules 2016- duties and responsibilities of local authorities and village panchayats of census towns and urban agglomerations, closure and rehabilitation of old dumps; Methodology- Bioremediation and Bio-mining of old municipal dumpsites; Clearing vs. Capping of legacy waste; Case studies.</p>	07
6	<p>Biomedical Waste Management: Definition; Sources; Generation; Classification; Storage; Transportation; Treatment techniques; Disposal. E-Waste Management: Definition; Sources; Generation; Categories Recovery & Recycling technologies; Disposal.</p>	05

Suggested Specification table with Marks (Theory):

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

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2209

Subject Name: Hazardous & Other 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. Hazardous Waste Management by M LaGrega and others, McGraw-Hill Publication.
2. Solid & Hazardous waste Management by PM Cherry.
3. Kiely G., "Environmental Engineering", McGraw Hill Book Company, 1998.
4. Rao C.S., "Environmental Pollution Control and Engineering", New Age International (P) Limited, 1991.
5. Manual on Municipal Solid waste management by Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.
6. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management", the McGraw- Hill, New York, 3rd Ed., 1993.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Understand the characteristics of different types of hazardous Waste, its toxicity and impact on environment.
CO-2	Illustrate about the significance and design criteria for hazardous waste landfill.
CO-3	Describe about the various recycling trends of waste, factors affecting and the market analysis of the recycled material.
CO-4	Elaborate the various patterns observed in case of treating the solid waste.
CO-5	Demonstrate the gaps in identifying the issues related to tyre and legacy waste.
CO-6	Explain the methods to deal with Bio-medical waste and E-waste.

List of Open-Source Software/learning website:

**NPTEL
MOEF&CC**

Bachelor of Engineering

Subject Code: ET2210

Subject Name: Wastewater Treatment – II

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Professional Core Course

Prerequisite: Fundamental of wastewater treatment.

Rationale: The main objective of this subject is to make students aware about designing aspects of preliminary and primary treatment units along with sludge handling and tertiary treatment of wastewater.

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	Designing of preliminary units for wastewater treatment: Design of bars screen and bar screen chamber, Design of grit chamber: Horizontal Flow & Aerated grit chamber, Design of Dissolved air flotation (DAF), Design of oil & grease removal, Introduction to Corrugated Plates inceptor, operational excellence of preliminary treatment units	06
2	Coagulation: Coagulation tank, feeding devices for coagulation, mixing device of coagulants, types of coagulants, dry feeding and wet feeding of coagulants. Mixing and Flocculation: Continuous rapid mixing in wastewater treatment, Continuous mixing in wastewater treatment, Flocculation in wastewater treatment, Energy dissipation in mixing and flocculation. Primary Sedimentation: Description, Rectangular tanks, Circular Tanks, Types of settling, Functions of Primary sedimentation tanks.	06
3	Designing of primary units for wastewater treatment: Design of Equalization tank, Design of Clarifier, Design of Flocculator, Design of Neutralization tank, Design of Primary Sedimentation tank,	07

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Bachelor of Engineering

Subject Code: ET2210

Subject Name: Wastewater Treatment – II

	Operational excellence of primary treatment units.	
SECTION-B		
4	Tertiary treatment of wastewater: Design of Rapid Sand Filter, Design of Slow sand Filter, Disinfection: Definition, Factors affecting disinfection, methods of disinfection, Chlorination: Definition, Application of chlorine, Forms of chlorination, tests for residual chlorine, mixing device of chlorine, design examples,	07
5	Tertiary treatment of wastewater: Reverse Osmosis: Definition, Working, RO membranes, Advantages & disadvantages, MEE: Working, operational Problems, Ultrafiltration, Microfiltration, MVRA, Disposal of concentrated waste, ATFD: Working and applications, Introduction to activated carbon filter, Feasibility study of ZLD, Operational Excellence of Tertiary Treatment.	07
6	Sludge handling and management: Sludge Bulking, Sludge Composting, Sludge Thickening, Sludge Composting, Sludge volume index. Introduction & Brief description of Centrifuge, Belt filters press, Neutsch Filter, Filter Press, Decanter, Sludge Drying beds, Double drum dryer. Operational excellence of sludge handling system.	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. Wastewater Engineering: Treatment and Reuse, Metcalf & eddy; McGraw Hill Book Company, 4th Ed, 2002.
2. Environmental Pollution and Control engineering, Rao C. S. - Wiley Eastern Limited, India, 1993

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2210

Subject Name: Wastewater Treatment – II

3. Water Treatment Plants: Planning, Design & Control, S R Qasim, Technomic Pub. Co., 1999.
4. Industrial Water Pollution Control, Eckenfelder W.W.; McGraw Hill Book Company, 3rd Ed, 2000.
5. Environmental Engineering, Kiely G.; McGraw Hill Book Company, 1998.
6. Pollution control in process industries, S.P. Mahajan TMH., 1985.
7. Waste water treatment, M.Narayana Rao and A.K.Datta, Oxford and IHB publ. New Delhi.
8. Industrial Pollution Control and Engineering, Swamy AVN, Galgotia publications, 2005.
9. Environmental Engineering (Vol. II) - Sewage disposal and Air pollution, S.K Garg & Rajeshwari Garg, Khanna Publishers, 27th Edition, 2013.
10. Environmental Engineering and Sanitation: Joseph A. Salvato, John Wiley & Sons, 4th Ed. 2003
11. Water Supply and Sanitary Engineering, Birdie and Birdie, Dhanpatrai and Sons, 1996.
12. Environmental engineering (Vol. I) - Water Supply Engineering S.K Garg & Rajeshwari Garg, Khanna Publishers, 23rd Edition, 2013.
13. Wastewater treatment concepts and design approach: GL Karia & R.A Christian.

List of Practical:

1. To determine Total Dissolved Solids of wastewater sample.
2. To determine Total Suspended Solids of wastewater sample.
3. To determine Chemical Oxygen Demand of wastewater sample.
4. To determine Biochemical Oxygen Demand of wastewater sample.
5. To determine Dissolved Oxygen of wastewater sample.
6. To determine Coagulant Dose using Jar test Apparatus by varying coagulant dose.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2210

Subject Name: Wastewater Treatment – II

7. To determine Coagulant Dose using Jar test Apparatus by varying pH of sample.
8. To determine Oil & Grease of wastewater sample.
9. To determine Ammonical Nitrogen of wastewater sample.
10. To determine Most Probable Number (MPN) in wastewater sample

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Outline design specifications of preliminary wastewater treatment unit.
CO-2	Explain the design and working of primary wastewater treatment unit
CO-3	Assess the process parameters of tertiary wastewater treatment unit.
CO-4	Distinguish the concept of disinfection and chlorination
CO-5	Summaries the concept of RO, MEE, & ATFD.
CO-6	Compare different techniques used for management and handling of sludge.

List of Open-Source Software/learning website:

- NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Professional Elective

Prerequisite: Students shall have basic knowledge regarding Mathematics and Chemistry

Rationale: The main objective of this subject is to make students to have a conceptualized knowledge regarding various unit operations in Chemical Engineering. This will emphasize on need of having a background for the solution of Industrial problems.

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	Units & Dimensions: Dimensions & system of units, Fundamental and derived units, Unit conversion and its significance.	03
2	Basic Chemical Calculations: Concepts of Atomic weight, equivalent weight and mole. Composition of Solids, Liquids and Solutions (weight percent, mole percent, molarity, normality etc) other expressions for concentration, Average molecular weight and density, Gaseous mixtures, Ideal gas law, Real gas laws and their applications, Raoult's law and their applications, Henry's law, Amagat's law and Dalton's law	07
3	Material Balances without Chemical Reactions: Process Flow sheet, Material balance with and without recycle, Bypass, Purge Streams, Material balance around equipments related to unit operations like absorber and stripper, Distillation towers, Extractors, Dryers, Evaporators, Crystallizer, Humidification and Dehumidification towers,	07

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Bachelor of Engineering
Subject Code: ET2211
Subject Name: Fundamentals of Stoichiometry

	Material balance of unsteady state operations.	
SECTION-B		
4	Material balances with Chemical Reactions: Concept of limiting and excess reactants, percentage conversion and yield. Material balance involving reactions with reference to fertilizer, petrochemicals, petrochemicals and dyestuff industries.	08
5	Energy balances: Heat capacity of gases and gaseous mixtures, liquids and solids, Sensible heat change in liquids and gases, Enthalpy changes during phase transformation, Enthalpy changes accompanied by chemical reactions, standard heat of reaction, Hess's law, Theoretical flame temperature	08
6	Fuels & Combustion: Types of fuels, calorific value of fuels, gaseous fuel, Proximate and ultimate analysis, combustion calculations, Air requirement and flue gases	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	20	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. Basic Principles & Calculations in Chemical Engineering, D.M.Himmelblau. 6th Ed., 2004
2. Stoichiometry, B.I.Bhatt &Thakore, Tata McGraw Hill Book Company, 5th Ed, 2010
3. Chemical Process Principles, Vol.1, O.A.Hougen, K.M.Watson, R.A.Ragatz., Indian print, CBS Publishers, 2nd Ed., 1995
4. Stoichiometry & Process Calculations, Narayanan K.V., &Lakshmikutti B., Prentice Hall, 2006

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2211

Subject Name: Fundamentals of Stoichiometry

5. Process Calculations, V Venkataramani and N Anantharaman, PHI Learning, 2004
6. Chemical Process Calculations Manual, David Carr Igbinoehene, McGraw Hill Professional, 2004
7. 7. Optimization of Chemical Processes, T F Edgar, D M Himmelblau and L S Lasden, Tata McGraw Hill, 2001

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify different system of units and dimensions with conversion
CO-2	Distinguish concepts for expressing compositions and behavior of different gases and solutions
CO-3	Demonstrate material balance in steady state and unsteady state unit operation with and without recycle.
CO-4	Analyze the material balance involving chemical reactions in a fertilizer, petrochemical, dyestuff and electrochemical industries.
CO-5	Describe energy changes in liquid and gases accompanying various chemical reactions with terms used to associate energy changes in different phases.
CO-6	Evaluate fuel quality and to device requirement of gases in combustion.

List of Open-Source Software/learning website:

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

Bachelor of Engineering

Subject Code: ET2212

Subject Name: Environmental Resource Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - IV

Type of course: Professional Elective

Prerequisite: A good fundamental backup of basics of energy sources for environmental science and technology.

Rationale: The main objective of this subject is to make students aware about the basics of energy resources and its management for environmental science and technology.

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 Energy sources and their availability, Solar Radiation and its measurement. Introduction, Solar radiation at the Earth's surface, Solar radiation measurement, Solar Energy collectors and its type, Solar energy storage and systems, Application of solar energy.	07
2	Wind Energy – Introduction, basic principle of wind energy conversion, classification Wind energy conversion systems, Types of Wind machines, Environmental aspects	06
3	Energy from Biomass: Introduction, Biomass conversion technologies, Biogas generation, Biomass as a source of Energy, Thermal gasification of Biomass, Pyrolysis.	07
SECTION-B		
4	Geothermal energy: Introduction, Estimation of thermal power, Geothermal sources, Prime movers for geothermal energy conversion, advantages and disadvantages of geothermal energy, Energy from Oceans: Introduction, Ocean Thermal Electric conversion, Energy from	07

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Bachelor of Engineering

Subject Code: ET2212

Subject Name: Environmental Resource Management

	tides, Ocean waves.	
5	Energy Management: Introduction, Energy planning, Energy staffing, Energy organization, Energy requirement, Energy costing, Energy Budgeting, Energy Monitoring, Environmental pollution due to energy use, Categories of energy audit, Types of Energy audit, Measuring and detection instruments for energy survey.	06
6	ENVIRONMENTAL RESOURCE MANAGEMENT TOOLS: Sustainable development concept, need, principles & challenges, National & international steps for resource conservation, GNP & Quality of Life, Clean Development Mechanisms (CDM), Carbon footprint.	06

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	15	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. Non-conventional Energy sources, G.D Rai, Khanna Publishers.
2. Energy Engineering and Management, Amlan Chakrabarti, PHI Publication.
3. Energy Technology, S.Rao and Dr BB Parulekar, Khanna Publishers.
4. Alternate Energy, Dr NK Giri, Khanna Publishers.
5. Eco science, Population, resources, environment By Ehrlich and Ehrlich (W.H. Free man & Company San Fransico 1977).
6. Essentials of Environment by Gilbert Master (3rd Edition- Prentice hall, New Jersey.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
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Bachelor of Engineering

Subject Code: ET2212

Subject Name: Environmental Resource Management

CO-1	List the different sources of energy.
CO-2	Classify the energy systems.
CO-3	Apply the basic fundamentals of science for energy calculation.
CO-4	Outline the system of energy management.
CO-5	Explain the energy conservation in industries.
CO-6	Summarize the application of various energy sources

List of Open-Source Software/learning website:

- NPTEL