

(Established under Gujarat Private Universities Act, 2009)

Shroff S.R. Rotary Institute of Chemical Technology

Ref: UPL University/SRICT/BOS/EST/2022-23/02

Date: 28-01-2023

Proposed Teaching Scheme for Third Year Bachelor of Environmental Science & Technology

Semester-V (Environmental Science & Technology) Proposed 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	ET2301	Principles of Economics & Management	3	0	0	3	3	70	30	0	0	100
2	Professional Core Course	ET2302	Wastewater Treatment - III	3	0	2	5	4	70	30	20	30	150
3	Professional Core Course	ET2303	Air pollution Control - II	3	0	2	5	4	70	30	20	30	150
4	Professional Core Course	ET2304	Environmental management - III	3	1	0	4	4	70	30	20	30	150
5	Professional Elective Course / Professional Elective Course – (NPTEL)	ET2305/2306	Legislation for Environmental Protection / Municipal Solid Waste Management	3	0	0	3	3	70	30	0	0	100
6	Open Elective	ET2307/2308	Basics of Thermodynamics/ Advanced Separation Techniques	2	1	0	3	3	70	30	20	30	150
7	Mandatory Course	MH2301	Contributor Personality Development Program - I	1	1	0	2	2	50	30	20	0	100
8	In Plant Training	MH2303	Industrial Internship	0	0	0	0	1	0	0	50	0	50

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	Total	18	3	4	25	24	470	210	150	120	950
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Semester-VI (Environmental Science & Technology) Proposed Structure

Sl. No	Category of Course	Code No.	Course Title	Hours per week			Total contact hrs/ week	Total Credits	E	M	I	V	Total Marks
				L	T	P							
1	Professional Core Course	ET2309	Waste Valorization	3	0	0	3	3	70	30	0	0	100
2	Professional Core Course	ET2310	Advanced Technologies for Wastewater Treatment	3	0	2	5	4	70	30	20	30	150
3	Professional Elective Course	ET2311/2312	GIS & Remote Sensing / Estimation & Specifications for Project Management	3	1	0	4	4	70	30	20	30	150
4	Professional Elective Course / Professional Elective Course – (NPTEL)	ET2313/2314	Environmental Impact Assessment & Audit / Aquatic Biodiversity and Environmental Pollution	3	0	0	3	3	70	30	0	0	100
5	Open Elective	ET2315/2316	Elements of Fluid Flow / Instrumentation & Process Control	3	0	2	5	4	70	30	20	30	150
6	Open Elective	ET2317/2318	Basics of Heat & Mass Transfer / Fuels & Combustion	3	0	2	5	4	70	30	20	30	150
7	Mandatory Course	MH2302	Contributor Personality Development Program - II	1	1	0	2	2	50	30	20	0	100
	Total			19	2	6	27	24	470	210	100	120	900

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A. Course code and definition:

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

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Humanities & Social Science

Prerequisite: Basic computational skills with rational decision making along with knowledge of mathematics.

Rationale: The course focuses on economic and cost analysis of engineering projects, giving insights on modern techniques and methods used on economic feasibility studies relating to design and implementation of projects. The basic purpose of this course is to provide a sound understanding of concepts and principles of engineering economy and to develop proficiency with methods for making rational decisions regarding problems likely to be encountered in professional practice.

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

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

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Economic Decisions Making – Overview, Problems, Role, Decision making process Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits. Case Study - Price and Income Elasticity of Demand in the real world	05
2	Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value of Money, Debt repayment, Nominal & Effective Interest. Inflation And Price Change – Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite	10

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Bachelor of Engineering

Subject Code: ET2301

Subject Name: Principles of Economics & Management

	vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.	
3	Cash Flow & Rate Of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks	07
SECTION-B		
4	Introduction to Management; Definitions, Nature, Management Difference between Management & administration, skill, types and roles of managers Management Principles; Scientific principles, Administrative principles, Maslow’s Hierarchy of needs theory	08
5	Functions of Management; Planning, Organizing, Staffing, Directing, Controlling (meaning, nature and importance) Organizational Structures; meaning, principles of organization, types-formal and informal, line, line & staff, matrix, hybrid (explanation with merits and demerits), span of control, departmentalization, chain of command, centralization and decentralization.	06
6	Organizational culture: Concept of culture and its importance, Attributes, Relationship of organizational culture with managers and employees, Corporate Social Responsibility; meaning, importance Business Ethics; meaning, importance.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	15	15	10	10	0

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

Recommended Books:

1. Engineering Economics, R.Paneerselvam, PHI publication
2. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P and Decenzo David A.
3. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
4. Principles and Practices of Management by L.M.Prasad

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Bachelor of Engineering

Subject Code: ET2301

Subject Name: Principles of Economics & Management

5. Principles of Management by Tripathy and Reddy
6. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications
7. James L.Riggs, David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill
8. Donald Newnan, Ted Eschembach, Jerome Lavelle : Engineering Economics Analysis, OUP
9. John A. White, Kenneth E. Case, David B. Pratt : Principle of Engineering Economic Analysis, John Wiley
10. Sullivan and Wicks: Engineering Economy, Pearson
11. R. Paneer Seelvan: Engineering Economics, PHI
12. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Describe the principles of economics that govern the operation of any organization under diverse market conditions
CO-2	Explain various terminologies in economics – Cash flow, Interest, Inflation, and Indexes.
CO-3	Demonstrate methods available for estimating Cash Flow & Rate of return analysis.
CO-4	Identify different management principles along with understanding the difference between administrative and management principles.
CO-5	Brief functions of management along with detailing organizational structures.
CO-6	Summarize the concept of organizational structure along with stressing the need of CSR and Business ethics.

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Bachelor of Engineering
Subject Code: ET2302
Subject Name: Wastewater Treatment – III

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Semester: - V

Type of course: Professional Core

Prerequisite: Fundamental of wastewater treatment.

Rationale: The main objective of this subject is to make students aware about the biological 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	Fundamentals of Biological Treatment: Overview of biological wastewater treatment, objectives of biological treatment, removal mechanism, objectives of biological treatment, Classification of treatment process, role of microorganisms in wastewater treatment, types of biological process in wastewater treatment, composition and classification of microorganism.	06
2	Microbial Growth Kinetics: Introduction to microbial metabolism, Bio kinetic coefficients, significant bio kinetic coefficient: specific growth rate, yield coefficient, maximum substrate utilization rate constant, half velocity constant, endogenous decay coefficient, determination of bio kinetic coefficient, Determination of bio kinetic coefficients, MCRT, F/M ratio.	06
3	Aerobic suspended growth biological treatment systems: Aerobic Biological oxidation, Process description, environmental factors, Modification in ASP: Complete Mix activated sludge, Extended Aeration system, Oxidation Ditch systems, Intermittently aerated and decanted systems, Oxygen activated sludge, Oxidation ponds, stabilization ponds,	07

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Bachelor of Engineering

Subject Code: ET2302

Subject Name: Wastewater Treatment – III

	Secondary settling tank, Design examples for activated sludge process, oxidation ditch, secondary settling tank	
SECTION-B		
4	Aerobic attached Growth Biological Treatment systems: Introduction to attached growth systems, Trickling Filter, Oxygen transfer and utilization, Applications rotating biological contactors, Bio-Towers, Design Examples for rotating biological contactor, trickling filter, Membrane bio reactor, Sequencing batch reactor. Operational excellence of activated sludge process	07
5	Anaerobic Biological Wastewater Treatment: Introduction, Removal Concept, System concept, design considerations, design procedure and criteria, anaerobic reactors (attached growth reactors): Packed bed reactor, extended bed reactor, fluidized bed reactor, up-flow anaerobic sludge blanket reactor, anaerobic reactors (suspended growth reactors): complete mix reactor, contact reactor, design examples.	07
6	Anaerobic biological wastewater treatment: Introduction, Removal Concept, Design Considerations, Anaerobic reactors, Packed bed reactor, Fluidized bed reactor, Up flow Anaerobic sludge blanket reactor, high rate and multi stage anaerobic digesters. Operational excellence of UASB.	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
3. Water Treatment Plants: Planning, Design & Control, S R Qasim, Technomic Pub. Co., 1999.

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Bachelor of Engineering

Subject Code: ET2302

Subject Name: Wastewater Treatment – III

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 Mix Liquor Suspended Solids of wastewater sample.
2. To determine Mix Liquor Volatile Suspended Solids of wastewater sample.
3. To determine Sludge Volume Index of wastewater sample.
4. To determine colour of wastewater sample.
5. To design Aeration tank using ETPSOFT
6. To design Trickling filter using ETPSOFT
7. To design USAB using ETPSOFT
8. To design Secondary Sedimentation tank using ETPSOFT

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Bachelor of Engineering

Subject Code: ET2302

Subject Name: Wastewater Treatment – III

9. To design Sludge drying bed using ETPSOFT

10. To design Sand filter using ETPSOFT

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Describe biological treatment based on the role of microorganism for removal of organics from wastewater.
CO-2	Identify microbial growth kinetics responsible for the growth of microorganism in wastewater.
CO-3	Choose suspended aerobic biological treatment process according to the characteristics of wastewater.
CO-4	Analyze attached aerobic biological treatment process according to the characteristics of wastewater.
CO-5	Differentiate aerobic and anaerobic biological treatment process.
CO-6	Compare different anaerobic biological treatment used for wastewater.

List of Open-Source Software/learning website:

- NPTEL

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Bachelor of Engineering
Subject Code: ET2303
Subject Name: Air Pollution Control - II

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Professional Core Course

Prerequisite: Fundamentals of Air pollution and its control

Rationale: The main objective of this subject is to make students aware about the control mechanism of air pollutants and control technologies for specific pollutants along with air quality modelling.

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 Control Equipment: Various mechanisms to control gaseous pollutants and particulate matter.	2
2	Design of Air Pollution Control Equipment: a) Gravity chamber b) Cyclone separator c) Electrostatic precipitator d) fabric filter e) absorption towers, f) Dry Scrubber	12
3	Mobile Sources: IC engine and cycle, A/F ratio, sources of air pollutants, control by process change, engine design change, Stratified charge engines, Rotary combustion engines, control by fuel change, catalytic converters	4
SECTION-B		

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Bachelor of Engineering

Subject Code: ET2303

Subject Name: Air Pollution Control - II

4	Control technologies for Sulphur dioxide emission extraction from fuel, sulphur reduction during combustion, desulphurization, Processes using metal oxides and activated carbon, wet scrubbing	6
5	Control technologies for nitrogen oxides emission Modification of operating condition, modification of design condition, treatment of effluent gas	7
6	Air Quality Modeling: Introduction to Air Quality Modeling. Necessity, application and limitation of air quality modelling. Introduction to Dispersion Modeling, Photochemical Modeling and Receptor Modeling. Different air quality Dispersion models and their limitations. Introduction to Gaussian Plume modelling, its assumption and limitation. GLC determination. Introduction to commonly used software-based models such as AERMOD, CALPUFF, ISCST3 and CALINE4 etc.	8

Suggested Specification table with Marks (Theory):

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

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

Recommended Books:

1. Environmental Pollution Control and Engineering, Rao C.S., New Age International (P) Limited, 2nd Ed., 2006.
2. Air Pollution Control – by Wark & Warner
3. Air Pollution Control equipment calculations by Louis Theodore.
4. Air Pollution – by M N Rao
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

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Bachelor of Engineering

Subject Code: ET2303

Subject Name: Air Pollution Control - II

List of Practical:

1. Determine the concentration of pollutant using Handy Air Sampler.
2. Demonstrate Stack monitoring kit.
3. Air quality modelling for a point source using AERMOD software.
4. GLC determination for a receptor using AERMOD software.
5. Plot wind rose for a given location using WRPLOT software.
6. Study the working of Gravity Settling Chamber and determination of pollutant removal efficiency.
7. Study the working of Cyclone Separator and determination of pollutant removal efficiency.
8. Study the working of Bag Filter and determination of pollutant removal efficiency.
9. Study the working of Scrubber and determination of pollutant removal efficiency.
10. Study the working of Adsorption Tower and determination of pollutant removal efficiency.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Recollect various mechanisms to control gaseous pollutants and particulate matter.
CO-2	Explain the working and designing of various air pollution control equipment.
CO-3	Discover the control measures for mobile source of air pollution.
CO-4	Compare various control technologies for control of SO ₂ .
CO-5	Categorize various control technologies for control of NO _x .
CO-6	Appraise various air quality models.

List of Open-Source Software/learning website:

- NPTEL

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Bachelor of Engineering

Subject Code: ET2304

Subject Name: Environmental management - III

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - 5

Type of course: Professional Core Course

Prerequisite: Fundamental of environmental management

Rationale: The main objective of this subject is to make students aware about the concept 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	1	0	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Definition and scope of environmental management, Process and goals of environmental management, The concept of 'limits' to development, The 'polluter-pays' principle, The precautionary principle, Environmental management challenges.	4
2	Environmentalism, social sciences, economics and environmental management, Corporate environmental management, Approaches adopted to promote environmental management in business	4
3	Concept of Carbon neutrality and Emission Trading, Rate Analysis: Prerequisites, factors affecting rate analysis, procedure for rate analysis. Various International Conventions: Stockholm convention, Montreal protocol, Paris Agreement, UNFCCC and its Role.	4
SECTION-B		
4	Preventive Environmental Management Initiatives: Principles of Green chemistry and cleaner technologies, Green choices in process Industries, Recycle and Reuse of waste water, Benefits of Corporate Environmental Responsibility.	4
5	Preventive Environmental Management Tools: Environmental Audit,	4

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Bachelor of Engineering

Subject Code: ET2304

Subject Name: Environmental management - III

	Objectives and Scope, Need of Environmental Audit, General Approach of Environmental Auditing, Audit Procedures: Pre-Audit Activities, Activities at site and Post audit activities Environmental Impact Assessment, EIA Methodologies.	
6	Green Building: Green Ammonia, Energy recovery. Design of Green Belt, Green Building Principles and Components, Advantage of Green Belt Development, Rain Water harvesting, Sustainable Development Goals and status of India.	4

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)

Reference Books:

1. C.J Barrow, Second Edition, Environmental Management for sustainable development
2. C.J Barrow , Environmental Management and Development
3. Environmental audits: evaluating and responding to environmental concerns, L Leo Motiuk Practising Law Insitute, 1991.
4. Environmental Management, Agarwal, APH Publishing, 2005
5. Environmental Impact Assessment, Canter, L.W., 1977, McGraw Hills, New York.
6. Preventive Environmental Management: An Indian Perspective by Dr. Shyam R. Asolekar & Dr. R.Gopichandran

List of Practical/ tutorials:

1. Process and goals of environmental management.
2. The 'polluter-pays' principle, The precautionary principle, Environmental management challenges.

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Bachelor of Engineering

Subject Code: ET2304

Subject Name: Environmental management - III

3. Environmentalism, social sciences, economics and environmental management
4. Concept of carbon footprint and carbon credit
5. Various International Conventions: Stockholm convention, Montreal protocol, Paris Agreement.
6. Rate Analysis: Prerequisites, factors affecting rate analysis, procedure for rate analysis.
7. UNFCCC and its Role
8. Recycle and Reuse of waste water
9. Environmental Impact Assessment, Life Cycle Analysis
10. CDM as preventive Environmental management initiative

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Classify environmental management principle.	20
CO-2	Knowledge of Environmentalism, social sciences, economics and environmental management.	15
CO-3	Carry out Carbon footprint.	15
CO-4	Identify Environmental Management Initiatives	15
CO-5	Evaluation and characterization of Preventive Environmental Management Tools	20
CO-6	Proper understanding of green business.	15

List of Open Source Software/learning website:

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

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Bachelor of Engineering

Subject Code: ET2305

Subject Name: Legislation for Environmental Protection

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Professional Elective

Prerequisite: Students shall have basic knowledge of legislation.

Rationale: To provide knowledge related to various environmental protection laws, Acts, Rules, and Notifications etc.

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	Origin of Environmental Law, concept of law & policy- Precautionary Principle and Polluter Pays Principle, Environment & Governance, Environmental Law and the Indian Constitution, Other major law and Environment (CrPC, IPC), Institutional framework (SPCB/CPCB/MOEF)	05
2	Legislation for Water and Air Pollution: Water (Prevention & Control of Pollution) Act; 1974, Water (Prevention & Control of Pollution) Rules; 1975, Air (Prevention & Control of Pollution) Act; 1981, Air (Prevention & Control of Pollution) Rules; 1981	07
3	Environmental Protection Act; 1986 Improvement over previous acts; limitations; Important Sections; Environmental Protection Rules; 1986	05
SECTION-B		

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Subject Code: ET2305

Subject Name: Legislation for Environmental Protection

4	Waste Management Rules: Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 Hazardous & other wastes (Management & trans boundary movement) Rules, 2016, Management and Handling rules for bio medical waste, E-waste Management Rules, Silent features of Battery Waste Management Rules 2020.	07
5	National Green Tribunal: The National Green Tribunal Act, 2010 The National Green Tribunal (Manner of Appointment of Judicial and Expert Members, Salaries, Allowances and other Terms and Conditions of Service of Chairperson and other Members and Procedure for Inquiry) Rules, 2010 The National Green Tribunal (Removal of Difficulties) Order, 2010 The National Green Tribunal (Practices and Procedure) Rules, 2011	07
6	Miscellaneous Regulations: The Noise Pollution (Regulation & Control) Rules, 2000 & its amendments, The Public Liability & Insurance Act; 1991 & amendments, Public Interest Litigation Act; 1991; EIA Notification & Environmental clearance procedures; CRZ notification; Bio-diversity Rules; ODS Rules; ISO 14000; EC notification and EC procedure.	05

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. Environment and pollution Laws containing Acts & Rules, S.K Mohanty

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Bachelor of Engineering

Subject Code: ET2305

Subject Name: Legislation for Environmental Protection

2. Publications/ Website of MoEFCC/ CPCB on Environmental Regulations
3. Environmental Law and Policy in India by Armin Rozencaranz; Shyam Divan and Marhta L. Noble; Tripathi Publications ISO 14000
4. Water (Prevention & Control of Pollution) Act; 1974 & its amendments 1978; 1988.
5. Air (Prevention & Control of Pollution) Act; 1981 & its amendments.
6. Environmental Protection Act; 1986 & its amendments.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Relate different Constitutional provision for Environmental Protection.
CO-2	Identify major Acts and Rules for preventing and controlling the pollution.
CO-3	Assess the importance of Environmental Protection Act.
CO-4	Analyze various waste management rule.
CO-5	Summarize role of National Green Tribunal in Environmental Protection
CO-6	Appraise various rules and notifications for Environment Protection

List of Open-Source Software/learning website:

- NPTEL
- Website of GPCB, MoEFCC & CPCB.

Municipal Solid Waste Management - Web course

COURSE OUTLINE

Due to rapid increase in the production and consumption processes, societies generate as well as reject solid materials regularly from various sectors - agricultural, commercial, domestic, industrial and institutional.

The considerable volume of wastes thus generated and rejected is called solid wastes.

In other words, solid wastes are the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted.

This inevitably places an enormous strain on natural resources and seriously undermines efficient and sustainable development.

One of the ways to salvage the situation is through efficient management of solid wastes, and this is the focus of this Course, Management of Municipal Solid Waste.

In the 10 Units that constitute this Course, we will discuss the processes involved in the management of solid wastes - from waste generation to final disposal.

In Unit 1, we will describe solid wastes and introduce you to the classification of solid wastes and the functional elements, such as waste generation, storage, collection, transport, processing, recovery and disposal, in the management of solid wastes.

In Units 2 to 7, we will explain with the support of case studies each of these functional elements.

In Unit 8, we will explain the treatment of solid wastes by incineration and energy recovery from the incineration process.

Subsequently, in Unit 9, we will deal with the treatment and management of hazardous (biomedical) wastes.

Finally, in Unit 10, we will discuss the concept of integrated waste management.

COURSE DETAIL

Lectures (each topic – 2 hours duration: 20*2= 40 hours).

S.No	Topics
1	Municipal Solid Waste Management.
2	Generation and Characteristics of Waste.
3	Health and Environmental Effects.
4	Waste Collection, Storage and Transport.



NPTEL

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

Environmental Science

Pre-requisites:

Basic knowledge in science and mathematics.

Additional Reading:

- Ramachandra T.V., 2006. Management of Municipal Solid Waste, Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore.
- Ramachandra T.V., 2006. Soil and Groundwater Pollution from Agricultural Activities, Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore.
- Vijay Kulkarni and Ramachandra T.V., 2006. Environmental Management, Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore.

Hyperlinks:

- www.ces.iisc.ernet.in/energy
- www.wgbis.ces.iisc.ernet.in
- www.ces.iisc.ernet.in/biodiversity
- www.astra.iisc.ernet.in

Coordinators:

Prof. T.V. Ramachandra
Centre for Ecological Sciences IISc
Bangalore

5	Record Keeping, Control, Inventory and Monitoring.
6	Implementing Collection and Transfer System.
7	Case Study-Waste Storage, Collection and Transport.
8	Waste Disposal - Key issues and features.
9	Sanitary Landfill.
10	Waste Processing Techniques.
11	Volume, size and Chemical reduction techniques.
12	Source Reduction, Product Recovery and Recycling.
13	Planning of a Recycling Programme.
14	Recycling Programme Elements.
15	Recovery of Biological Conversion Products: Composts and Biogas.
16	Composting and Biogasification: Technology.
17	Environmental Effects of Composting and Biogasification.
18	Incineration and Energy Recovery.
19	Hazardous Waste: Management and Treatment.
20	Integrated Waste Management (IWM).

References:

Ramachandra T.V., 2006. Management of Municipal Solid Waste, Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2307

Subject Name: Basics of Thermodynamics

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Open Elective

Prerequisite: A good understanding regarding different physical modes of heat transfer is needed for a deep understanding in this subject. Mathematical background is also essential in this respect

Rationale: Knowledge of thermodynamics is essential to study principles and applications of laws of thermodynamics to real systems. This subject is also useful to calculate thermodynamic properties of any chemical species and their mixtures

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	1	0	3	70	30	30	20	150

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

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction and First law of Thermodynamics: The scope of thermodynamics, Dimensions and units, Force, temperature, pressure, work, energy, heat, etc. Internal Energy, Enthalpy, The first law of thermodynamics, Thermodynamic state, state functions, Energy balance for closed systems, Equilibrium, The Phase rule, The reversible process, Heat capacity, Application of first law of thermodynamics to steady state flow process	05
2	Volumetric properties of pure fluids & Second law of thermodynamics: PVT behavior of pure substances, Ideal and non-ideal gases, Equation of states, Virial, Cubic, Vanderwaals EOS, Redlich/Kwong (RK) EOS etc., Statements of second law of thermodynamics, Heat engines and Carnot cycle, Thermodynamic Temperature Scales, Concept of entropy, Entropy changes of an Ideal	09

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Bachelor of Engineering

Subject Code: ET2307

Subject Name: Basics of Thermodynamics

	Gas, Third law of thermodynamics.	
3	Thermodynamic properties of fluids: Network of thermodynamic equations, mathematical relations among thermodynamic functions, Maxwell relations, Clayperon & Clausius Clayperon equations, Types of thermodynamic diagrams, Partial Molar properties, Chemical potential, Ideal and non-ideal solutions, Fugacity, Fugacity coefficient and its evaluation, Effect of Pressure and Temperature on Fugacity.	06
SECTION-B		
4	Solution Thermodynamics: Fugacity & Fugacity coefficient of species in mixtures, Relationship between residual property and fugacity coefficient, Lewis Randall rule, Ideal solution & Raoult's law, Henry's law & dilute solutions, Activity & Activity coefficients, Gibbs Duhem's equation and Gibbs Duhem Margules equation.	07
5	Phase Equilibrium: Criteria of phase equilibrium, Clausius Clapeyron equation and Antoine's equation, Vapor liquid Equilibrium, Boiling point diagram, Bubble point & Dew point temperature and pressure calculations, Azeotropes.	06
6	Chemical Reaction Equilibrium: Reaction Stoichiometry and extent of reaction, Criterion of Chemical Reaction equilibrium, Equilibrium constant, Standard Gibb's Free Energy change and equilibrium constant, Effect of temperature on equilibrium constant, Standard Gibb's Free Energy Change as a function of temperature.	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	15	15	10	10	0

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

Recommended Books:

1. "A text book of Chemical Engineering Thermodynamics"; K. V. Narayanan, Prentice-Hall of India Pvt. Ltd.

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Bachelor of Engineering

Subject Code: ET2307

Subject Name: Basics of Thermodynamics

2. "Introduction to Chemical Engineering Thermodynamics"; J. M. Smith, H. C. Vanness, M. M. Abbott, The McGraw-Hill Companies, Inc.
3. "Chemical and Process Thermodynamics"; B.G. Kyle, Prentice-Hall Inc
4. "Introduction to Thermodynamics"; Y.V.C. Rao, 2nd Edition, Wiley Eastern Limited
5. Elliot J. R. and Lira C.T., "Introductory Chemical Engineering Thermodynamics", Prentice Hall, 1999.
6. Hougen O.A., Watson K.M., and Ragatz R.A., "Chemical Process Principles Part,II"

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Describe fundamental understanding regarding basic principles and first law of thermodynamics and its relevance to Environmental applications.
CO-2	Explain the PVT behavior of pure fluids with various equations of state demonstrating second and third law of thermodynamics.
CO-3	Demonstrate thermodynamic property relation of fluids, Maxwell equation and partial molar properties signifying their importance.
CO-4	Identify fundamental property relations to find thermodynamic properties of solutions
CO-5	Interpret fundamentals of Solution thermodynamics, phase equilibria for the separation of components in a mixture.
CO-6	Summarize the criteria of Chemical Reaction Equilibrium to determine the feasibility of various Industrial Process.

List of Tutorials: Numericals/problems based on topics of each theme of content.

List of Open-Source Software/learning website:

- NPTEL
- XSEOS—an Open Software for Chemical Engineering Thermodynamics

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2308

Subject Name: Advanced Separation Techniques

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - V

Type of course: Open Elective

Prerequisite: Basic knowledge of stoichiometry, units and dimensions, unit operations, mass and energy balance. Mathematical background is also essential in this respect.

Rationale: The course is intended to familiarize the students of chemical engineering with the new, emerging and nontraditional separation techniques and their potential applications in chemical and allied process industries. The course will provide exposure to membrane based techniques, chromatographic separation, super critical fluid extraction and various other technologies.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	1	0	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction to Separation Processes Fundamentals of separation processes, separation factor, chemical potential in interface mass transfer, equilibrium and rate governed separation, drawbacks of the conventional separation processes, need for advanced separation processes. Major areas of applications of advanced separation processes.	06
2	Membrane Separation Processes Membrane Separation Processes: Membrane types, materials, synthesis and characterization; Different membrane modules; Working principle, operating parameters, membranes used, transport processes/mechanisms and industrial applications for individual membrane processes such as (i) Reverse osmosis, (ii) nanofiltration, (iii) ultrafiltration, (iv) microfiltration (v) dialysis	06

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Bachelor of Engineering

Subject Code: ET2308

Subject Name: Advanced Separation Techniques

3	<p>Supercritical fluid extraction and Separation Supercritical extraction: Working Principal, unique properties and solubility behavior of supercritical fluids, Advantages of supercritical extraction, Decaffeination, ROSE process for purification of crude oil, hydrothermal oxidation, and Commercial applications of supercritical extraction.</p>	07
SECTION-B		
4	<p>Chromatographic Separations Chromatographic separation: Principle and operation, Chromatographic column Ion exchange chromatography, Gel filtration and affinity chromatography; Thin layer and paper chromatography Liquid chromatography, Advantages and disadvantages of chromatographic separations.</p>	07
5	<p>Electrophoretic Separations Electrophoretic separations: Principle of electrophoresis, Factors affecting electrophoresis, Gel membrane and paper electrophoresis, applications of electrophoresis.</p>	07
6	<p>Novel Separation Processes Introduction to pervaporation: principle, membranes used and application. Hybrid distillation-pervaporation system, Membrane Reactor: Concept & working, Various types of membrane used for membrane reactor, Membrane bioreactor. Reactive and catalytic distillation Concept, advantage & disadvantages, BALE & KATMAX packing Manufacturing of MTBE and ETBE and its comparison with conventional techniques, Concept & working of short path Distillation Unit (SPDU)</p>	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)

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Bachelor of Engineering

Subject Code: ET2308

Subject Name: Advanced Separation Techniques

Recommended Books:

1. Transport Processes and Separation Process principles, Christie J Geankoplis Prentice-Hall of India Private Ltd, New Delhi, 4th Edition 2006.
2. Membrane Separation Processes, Second Edition, by Kaushik Nath, PHI Learning Pvt. Ltd, New Delhi, 2017.
3. Munir Cheryan, UF Applications Handbook, Technique Publishing Co, Lancaster, USA (1986).
4. Separation Process Engineering, Philip C. Wankat, Prentice-Hall, 4th Edition, 2016.
5. Introduction to process Engineering & Design” by S.B. Thakore & B.I Bhatt,Tata McGraw-Hill Ltd.,2007.
6. Separation Process Principles, J.D. Seader and E.J.Henley, Wiley, 2nd Edition 2004.
7. Perry Chemical Engineers Handbook’ 7thEdition by R.H Perry and D. Green.
8. Ullman’s Encyclopedia of Industrial Chemistry, 7th edition, Wiley-VCH.
9. Natural Extracts using supercritical carbon dioxide, M. Mukhopadhyay, CRC Press.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify an appropriate separation technique for an intended problem.
CO-2	Discuss and understand the principle of membrane separation for various aqueous systems.
CO-3	Develop and illustrate various techniques related to supercritical fluid extraction.
CO-4	Analyze and categorize principles of chromatography and its equipments.
CO-5	Summarize the principles of electrophoretic separations.
CO-6	Interpret and evaluate the principles and applications of various novel separation techniques.

List of Open-Source Software/learning website:

- NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: MH2301

Subject Name: Contributor Personality Development Program – 1

Shroff S.R. Rotary Institute of Chemical Technology

Type of course: Work-Personality Development

Prerequisite: To keep open mind and will to learn humanity for oneself and society.

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

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Subject Code: MH2301

Subject Name: Contributor Personality Development Program – 1

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)	
1	1	0	2	50	30	00	20	100

Note:

- Weekly 2 hours of Classroom facilitated sessions are planned which include Solutioning and Self- discovery sessions.
- In addition, there will be individual/ team projects as part of Practical's. Students can do this on their own, with faculty as guide.

Note:

It is the responsibility of the institute heads that marks for PA of theory & ESE and PA of practical for each Students are entered online into the UPL University Portal at the end of each semester within the dates Specified by UPL University.

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	<p>The Contributor Work Ideal</p> <p>In this topic, students explore what is their “ideal” of work - is the ideal to be a “worker” or to be a “contributor”? For example, an employee who has the ideal of a “worker” goes to work to pass time, earn a living, get benefits; in contrast to an employee with the ideal of a “contributor” who wants to make a difference, get things done well, create value for the company. This enables students to transform their expectation of themselves in work</p>	<p>04 hrs Classroom engagement (including self- discovery/ solutioning sessions)</p>

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Subject Code: MH2301

Subject Name: Contributor Personality Development Program – 1

2	<p>Identity & Self-esteem</p> <p>In this topic, students engage with the question “who am I?” or on what basis they define themselves. Is their identity defined by what others think of them (extrinsic self-esteem) or by what they think of themselves (intrinsic self-esteem)? Further, they discover positive identities that lead to intrinsic self-esteem, such as an I-can identity based on one’s capacity and inner strength. This enables them to build confidence and self-esteem.</p>	<p>04 hrs Classroom engagement (including self-discovery/solutioning sessions)</p>
3	<p>Become a Creator of one’s destiny</p> <p>In a “victim stance”, we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the “creator of destiny stance” to challenges and situations. This stance frees them to try out new things, open up new possibilities, take on responsibility, and see the opportunity hidden in their environment.</p>	<p>04 hrs Classroom engagement (including self-discovery/solutioning sessions)</p>
SECTION-B		
4	<p>Achieving Sustainable Success</p> <p>In this topic, students discover how to achieve sustainable or lasting success, by building one’s “engine of success”, making them success-worthy. Where their focus shifts to building one’s “engine of success” rather than being on chasing the “fruits of success”. This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success, fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don’t come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not. And with a strong engine of success, fruits come to them in time.</p>	<p>04 hrs Classroom engagement (including self-discovery/solutioning sessions)</p>

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Subject Name: Contributor Personality Development Program – 1

5	<p>Career Development Models</p> <p>In this topic, students explore a range of diverse “career development models” and the possibilities for contribution each opens up to them (e.g. start-up career model, change-maker career model, etc.). This opens their mind to different and even unconventional career models possible, beyond the usual (such as “stable large company career model” where one gets an engineering degree, then MBA, then get a job in a large company). This frees them from a herd mentality when making career choices.</p>	<p>04 hrs Classroom engagement (including self- discovery/ solutioning sessions)</p>
6	<p>Expanding contribution in every role</p> <p>In this topic, students explore the many roles they can play in their life & discover the power they have to expand the contribution possible in any role. (E.g. role of student, role of manager, role of a project site engineer). So, the potential of a role is in the individual’s hands. This opens their mind to an alternative way of career growth.</p>	<p>04 hrs Classroom engagement (including self- discovery/ solutioning sessions)</p>

Suggested Specification table with Marks (Theory):

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

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

Reference resources:

- A. Basic reference for both students and teachers
 1. Contributor Personality Program textbook cum workbook developed by Illumine

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Subject Code: MH2301

Subject Name: Contributor Personality Development Program – 1

2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

B. Advanced reference for teachers

1. On Contributors, Srinivas V.; Illumine Ideas, 2011
2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007
9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca, R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 200



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Bachelor of Engineering

Subject Code: MH2301

Subject Name: Contributor Personality Development Program – 1

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Students will be able to recognize & appreciate two alternative ideals of work – “worker” and “contributor”.
CO-2	Students will be able to recognize & appreciate alternative ways in which they could define themselves & their identity – that will lead to building intrinsic self-esteem and confidence in oneself.
CO-3	Students will be able to recognize & appreciate the way people approach challenges and situations; and how it frees individuals to take on challenges and open up Opportunities.
CO-4	Students will be able to differentiate between two alternative approaches to success - ‘building one’s engine of success’ and ‘chasing the fruits of success’Lead to sustainable or lasting success in the long run.
CO-5	Students will be able to recognize & appreciate different career models and their Value; to help them make more informed career-related choices.
CO-6	Students will be able to recognize & appreciate how one can expand the contribution possible in any role, thereby opening up an alternative way of career Growth to them.

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Core

Prerequisite: Students shall have basic understanding regarding the recovery of energy and fuel from the waste.

Rationale: To understand the treatment technologies to overcome with the issues related to waste generation.

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 Overview of waste valorization concept, Trends towards waste valorization, Development of Biochemical process for utilization of waste as a bioresource, Process integration for waste-based biorefinery, Closed loop recirculation in a bio-based economy, Circular economy and waste valorization.	06
2	Waste as a Bioresource Introduction, Waste streams and their suitability as feedstock for valorization, Variability of waste feedstock, Drivers, policies and markets for value added waste derived products, Future trends.	06
3	Waste Treatment Biochemical treatment, thermal treatment and mechanical treatment for solid waste, Factors influencing selection of an appropriate valorization technique for specific waste types, Case studies. Pyrolysis: Basic concept, Feed stock for pyrolysis, Types of pyrolysis- slow, fast and flash pyrolysis, Environmental applications of pyrolysis,	07

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Bachelor of Engineering

Subject Code: ET2309

Subject Name: Waste Valorization

	Advantages of pyrolysis.	
SECTION-B		
4	<p>Waste Treatment Gasification: Introduction, Reactor design and different types of reactors used for gasification, Environmental effects of gasification. Combustion: Types of Combustion systems- Mass Fired combustion system, Fluidized bed combustion system, RDF-Fired combustion system.</p>	06
5	<p>Valorization of certain wastes Agricultural waste residues- Introduction, Conventional techniques: Anaerobic digestion, Pyrolysis and Gasification. Municipal/Domestic Food waste- Recovery of valuable products from anaerobic digestion of food waste, Novel approaches- Biotechnological processes and chemical transformations, fly ash utilization & ETP sludge co processing. Biomass waste- Introduction, Handling of emerging biomass wastes by newly developed techniques- catalytic chemistry, thermochemical and biochemical technologies.</p>	09
6	<p>Environmental Control System Environmental considerations and challenges in waste valorization- Air emissions (Nitrogen oxides, Sulphur Dioxide, Carbon Monoxide, Particulate matter), Metals, Acid gases, Dioxins and Furans, Life Cycle Assessment and its application to sustainable waste management.</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

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

Recommended Books:

1. Waste valorization: Waste streams in Circular Economy by Carol Sze Ki Lin, Guneet Kaur, Chong Li and Xiaofeng Yang- Wiley.
2. Waste to Energy Conversion Technology by Naomi B. Klinghoffer and Marco J. Castaldi.

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Subject Code: ET2309

Subject Name: Waste Valorization

3. Waste to Energy Technologies and Global Applications by Efstratios N. Kalogirou.
4. Waste to Energy: Recent Developments and Future Perspectives towards Circular economy by Abd El-Fatah Abomohra Qingyuan Wang Jin Huang.
5. Biogas Technology by B.T. Nijaguna, New age international Ltd, New Delhi, 2009.
6. Emerging Technologies for Waste valorization and Environmental Protection by Sadhan Kumar Ghosh, Chiranjib Bhattacharya, Suggala V. Satyanarayana, S. Varadarajan.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Recollect the concept of waste valorization and correlate it with circular economy.
CO-2	Understand the suitability of waste feedstock for valorization.
CO-3	Rethink in selecting appropriate waste valorization techniques.
CO-4	Study the different types of Gasifiers and Combustion system used for thermal conversion.
CO-5	Explain the waste valorization for certain waste.
CO-6	Rectify the environmental challenges and sustainable approaches for waste valorization.

List of Open-Source Software/learning website:

NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2310

Subject Name: Advanced Technologies for Wastewater Treatment

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Core

Prerequisite: Fundamental of wastewater treatment.

Rationale: The main objective of this subject is to make students aware about various advanced technologies used for reuse of wastewater after primary and secondary treatment.

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	Overview of Advanced Wastewater Treatment: Need of Advanced Wastewater Treatment, Applications of Advanced Wastewater Treatment, Operational difference between STP & ETP, Characteristics, Sewage treatment and disposal, dry weather and wet weather flow, factors affecting dry weather flow and wet weather flow, Variations in flow rate, Overall design of Sewage treatment and Effluent treatment plant.	06
2	Membrane Filtration: Membrane Process Classification and operation: Microfiltration, Ultrafiltration, Nano filtration, Reverse Osmosis, Electro dialysis Membrane Configurations: Plate-and-frame module, Spiral-wound module, Tubular module, Hollow-fiber module, Membrane Fouling: Modes of membrane fouling, Control of membrane fouling. Application of membrane processes.	06
3	Membrane Bio Reactor: MBR Process Description, Types of Membrane Bioreactors, MBR	07

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Bachelor of Engineering

Subject Code: ET2310

Subject Name: Advanced Technologies for Wastewater Treatment

	System Features, Membrane Module Design Considerations, Process Applications: Industrial Wastewater Treatment, Municipal Wastewater.	
SECTION-B		
4	Ion Exchange: Fundamentals of Ion Exchange, Types of Ion Exchange Resins for wastewater treatment, Theory of Ion Exchange Applications : Removal and recovery of heavy metals, Removal of nitrogen, Removal of phosphorus , Organic chemical removal.	07
5	Electrochemical Wastewater Treatment Processes: Introduction, Electro-coagulation: Factors affecting Electrocoagulation, Electrode materials , Reactor configurations; Electro floatation: Factors affecting electro floatation Comparison with other technology, Reactor configurations; Electro-oxidation : Electro oxidation process, Reactor configurations	07
6	Advanced Oxidation Processes: Theory of advanced oxidation, Types of oxidizing agents, ozone based and non-ozone based processes, Fenton and photo-Fenton Oxidation, Solar Photo Catalytic Treatment Systems, Chlorination.	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
3. Water Treatment Plants: Planning, Design & Control, S R Qasim, Technomic Pub. Co., 1999.

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Bachelor of Engineering

Subject Code: ET2310

Subject Name: Advanced Technologies for Wastewater Treatment

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 design Screen chamber using ETPSOFT.
2. To design Grit chamber using ETPSOFT.
3. To design Oil & grease trap using ETPSOFT
4. To design Primary Sedimentation tank using ETPSOFT
5. To determine Mercury concentration of wastewater sample.
6. To determine Lead concentration of wastewater sample.

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Subject Code: ET2310

Subject Name: Advanced Technologies for Wastewater Treatment

7. To determine Chromium concentration of wastewater sample.
8. To determine Chlorine Dose of a wastewater sample using chlorinator.
9. To determine Ozone Dose of a wastewater sample using Ozonator.
10. To determine disinfection property using UV chamber of a wastewater sample

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify different advanced technologies used for wastewater treatment.
CO-2	Differentiate various membrane technologies used to treat wastewater.
CO-3	Analyze membrane bioreactors used for wastewater treatment.
CO-4	Understand the importance of ion exchange process for removal of salts from wastewater.
CO-5	Explain the concept of electrochemical treatment processes.
CO-6	Recommend advanced oxidation processes to treat concentrated wastewater.

List of Open-Source Software/learning website:

- NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2311
Subject Name: GIS & Remote Sensing

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Elective

Prerequisite: None

Rationale: To impart the knowledge of applications of Remote sensing in Environmental Engineering field

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Concept of remote sensing Definition of remote sensing, remote sensing process, source of energy, energy interaction in atmosphere, energy interaction with earth surface, interpretation and analysis, analog (visual) image interpretation, digital image processing, process of remote sensing data analysis.	7
2	Sensors and platforms Passive sensors, Active sensors, Orbits and swaths, Sensor characteristics, Spatial resolution, Temporal resolution, Spectral resolution, Platforms, Common satellites, Online emission monitoring system.	7
3	Ground truth data and GPS (Global positioning system) Introduction, requirements of ground truth data, instruments for ground truthing, parameters of ground truthing, factors of spectral measurement, working principle of GPS.	7

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2311
Subject Name: GIS & Remote Sensing

SECTION-B		
4	Digitizing of images Image enhancement, Image classification, Image interpretation, Vegetation indices. Pixel, images and colors: Color composite images, False color composite, Natural color composite, Image processing and analysis.	6
5	Current applications of remote sensing Forestry, Greenhouse gases, Vegetation health, Biodiversity, Change detection, Geology, Land degradation, Oceanography, Meteorology.	6
6	GIS Definition of GIS, key components of GIS, Data in GIS, function of GIS, advantages of GIS	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	20	10	05	05

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

Recommended Books:

1. Introduction To Remote Sensing by Dr Robert Sanderson from New Mexico State University.
2. Introduction to Geographic Information System by Prachi Misra Sahoo. I.A.S.R.I., New Delhi-110012

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Recognize the concept of remote sensing

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2311
Subject Name: GIS & Remote Sensing

CO-2	Classify various sensors and platforms used in remote sensing
CO-3	Assess the usage of GPS for remote sensing
CO-4	Examine the application of image digitization to interpret the data obtained from remote sensing
CO-5	Integrate various applications of remote sensing in environment
CO-6	Summarize in importance of GIS

List of Tutorials

1. Tutorial on remote sensing concept
2. Tutorial on various sensors used in remote sensing
3. Tutorial on various platforms used in remote sensing
4. Tutorial on usage of ground truth data in remote sensing
5. Tutorial on usage of GPS in remote sensing
6. Tutorial on image digitization
7. Tutorial on pixel, color and image
8. Tutorial on various application of remote sensing
9. Tutorial on components of GIS
10. Tutorial on GIS functionality

List of Open-Source Software/learning website:

- NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2312

Subject Name: Estimation & Specifications for Project Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Elective

Prerequisite: Knowledge of Civil Engineering Drawing

Rationale: Estimating the cost for construction of treatment plant structures and the project management techniques

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Construction Technology: a. Subsurface investigation b. Foundations c. Masonry Construction d. Plain and Reinforced Concrete construction e. Plastering	04
2	Elements of Estimating and Costing: (a) Types of estimate: Detailed estimate and approximate estimate, Methods of estimate: Long wall short wall method and centre line method, Units of measurement: Modes and units of measurements, Uses of estimates. (b) Rate Analysis: Purpose and importance of rate analysis, Schedule of Rates; task work	22

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2312

Subject Name: Estimation & Specifications for Project Management

	per day; procedure for rate analysis for Excavation, P.C.C. work, 2Cement-concrete work, Brick work, R.C.C. work, plastering, flooring work, painting work. (c) Estimation of Various types of works: Detailed estimation of Two Rooms building, Column structure, Retaining wall, Water storage tank (only in bricks), Underground water storage tank (Brick cum R.C.C.), Overhead R.C.C. storage tank, Septic tank, Sludge drying beds, Clarifier and aeration tank	
3	Specifications: Objectives and importance of specifications, Uses of Specifications, Types of specifications, Classification of specifications; Specifications of excavation, DPC, Brick work, Cement-concrete work, R.C.C work, plastering work, Finishing, Flooring work.	02
SECTION-B		
4	Contracts and Tenders: (a) Contracts: Essential requirements of contract, Types of contract (b) Classification of tenders, Tender notice, Advertisement, Tender form.	02
5	Conditions of Contract: Importance and general provisions, typical clauses of conditions of contract	02
6	Project Management with Network Technique: Project planning, scheduling, controlling, bar chart and mile stone charts, elements of network, development of network, time estimates, time computation, network analysis-PERT and CPM, Determination of critical path using PERT and CPM	09

Suggested Specification table with Marks (Theory):

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

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

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2312

Subject Name: Estimation & Specifications for Project Management

Recommended Books:

1. Estimation & Costing in civil Engineering - B.N. Dutta.
2. Project Planning and Control with PERT & CPM- Dr. B.C. Punamia.
3. Elements of Estimation & Costing – Rangwala.
4. Estimation, costing, specification & valuation in Civil Engg. By M.Chakroborti.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define the applications of construction technology
CO-2	Estimate the quantities and cost of environmental structures
CO-3	Frame the specifications, contracts and tender documents
CO-4	Use the concepts of project management

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>).

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Professional Elective

Prerequisite: Students shall have basic knowledge of environmental impact assessment and audit.

Rationale: To provide knowledge related to Environmental Impact Assessment studies for making decision for better environmental management. The major components and processes of EIA systems will be dealt in the course. The course will also introduce different aspects and methodologies of planning and managing an EIA study.

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	Concepts of Environmental Impact Assessment: Environment; Environmental Impacts; Environmental Impact Analysis; Environmental Impact Assessment And Environmental Impact Statement; EIA- As An Integral Part of The Planning Process	06
2	EIA Notification and Project categorization: EIA Notification September 2006 and amendments: Categorization of projects, Procedure for getting environmental clearance, Public participation in environmental decision making process	04
3	Environmental Monitoring: Detailed Contents of EIA: Introduction; Project Description; Description of the Environment; Anticipated Environmental Impacts And Mitigation Measures: Analysis of Alternatives; Environmental Monitoring Program (EMP), Quality risk assessment, Environmental Management Plan.	08

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2313

Subject Name: Environmental Impact Assessment & Audit

SECTION-B		
4	EIA Methodologies : EIA as a four step methodology, Criteria for selection of EIA methodology ; Checklist methodology and its types, Matrix and its types, Networks methodology , Overlay method , Cost Benefit analysis	08
5	Case Studies: EIA for chemical industry, EIA for construction project, EIA for mining project, EIA for Dairy industry	06
6	Environmental Audit: Definitions, objectives and benefits; Audit procedures: Pre audit activities; activities of site and post audit activities; Environmental Audit Scheme as implemented by GPCB under the instructions of Hon. Gujarat High Court.	07

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 Impact Assessment – by A. K. Shrivastava
2. Environmental Impact Assessment – by R. R. Barthwal; New Age International publishers.
3. Environmental Impact Analysis Handbook – by Rau Whooten; McGraw Hill publications
4. Environmental Impact Assessment – by Larry Canter; McGraw Hill publications
5. Environmental Impact Analysis – A Decision Making Tool by R K Jain
6. Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications
7. Environmental Auditing – CPCB Publication

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2313

Subject Name: Environmental Impact Assessment & Audit

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Appreciate the importance of EIA as an integral part of planning process.
CO-2	Execute EIA Process as prescribed in EIA Notification
CO-3	Enumerate the role of public participation in environmental decision making process.
CO-4	Apply the different methodologies to predict and assess the impacts of project on various aspects of environment.
CO-5	Carry out EIA studies including description of environment using environmental attributes and prepare the EIA report.
CO-6	Organize the Environmental audit of industries

List of Open-Source Software/learning website:

- NPTEL
- Website of GPCB, MoEFCC & CPCB.

Aquatic Biodiversity and Environmental Pollution - Web course

COURSE OUTLINE

This course is focused on how biodiversity represents the very foundation of human existence in India.

The loss of biodiversity has serious economic and social costs due to human influence.

The genes, species, ecosystems and human knowledge which are being lost represent a living library of options available for adapting to local and global change.

Biodiversity is part of our daily lives and livelihood and constitutes the resources upon which families, communities, nations and future generations depend in India.

This course also focused on conservation and management of biodiversity, remedial options and rejuvenation of lakes in India.

The course discusses the

1. A systematic examination of the full array of organisms.
2. A study of the methods by which diversity can be maintained and used for the benefit of mankind in India.

COURSE DETAIL

Lecture number	Lecture title	No. of Hours
1	Introduction to freshwater ecology.	2
2	Human impacts on fisheries.	1
3	Fish diversity and status.	2
4	Fish sampling methods in rivers, lakes, reservoirs etc.	2
5	Over fishing and mitigation.	1
6	Management and conservation of aquatic biodiversity.	2
7	Human impacts on biodiversity of aquatic ecosystem.	2
8	Capture of fisheries.	1



NP-TEL

NPTEL

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

Environmental Science

Pre-requisites:

Basic Biology.

Coordinators:

Dr. D.S. Durgappa
Centre for Sustainable Technologies
(formerly known as ASTRA)IISc
Bangalore

9	Processing and fish preservation.	1
10	Electro fishing.	2
11	Fish sampling techniques.	1
12	Fishing net and fishing gears.	1
13	Socioeconomic status of fisheries.	1
14	Introduced and invasive fish species.	1
15	Fisheries and economic development.	3
16	Aquaculture.	2
17	Sampling techniques in freshwater fish catch.	2
18	Fish stock assessment.	2
19	Ecology of plankton.	2
20	Freshwater biotic components.	2
21	Environmental toxicology.	2
22	Assessment of freshwater pollution.	2
23	Coral taxonomy, Coral bleaching, Scuba diving and intertidal and underwater coral transplantation.	3
TOTAL		40

References:

1. E.P. Odum 1971, Principles of Environmental Science and Technology.
2. Talwar, P.K. and A.G. Jhingran. 1991. Inland fishes of India.
3. K.C. Jayaram 2002, Fundamentals of Fish Taxonomy.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2315
Subject Name: Elements of Fluid Flow

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Open Elective

Prerequisite: Basic knowledge of physics and units and dimensions. Mathematical background is also essential in this respect.

Rationale: This subject is intended to make students aware about types and behaviour of fluid with the fundamentals underlying the operation of fluid for Environmental Science & Technology students. Apparently, the subject aims at measurement techniques involved for the pressure concepts, fluid flow and equipments used for the transportation of fluids.

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	Properties of fluids and Fluid flow phenomena Unite and dimensions. Properties of fluids. Nature of fluids: incompressible and compressible. Hydrostatic equilibrium. Manometers, types of manometers. Potential flow, the velocity field, laminar flow. Newtonian and non-Newtonian fluids, Newton's-law of viscosity, turbulence, Reynolds number. Rheological classification of fluids. Eddy viscosity, flow in boundary layers, laminar and turbulent flow in boundary. Boundary-layer formation in straight tubes	05
2	Kinematics of Fluid flow Bernoulli equation, pump work in Bernoulli equation. Flow of incompressible fluids. Shear stress distribution in pipes. Velocity distribution in pies. Friction factor, relationships between skin-friction parameters. Hagen-Poiseuille equation. Hydraulically smooth pipe, von	07

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2315

Subject Name: Elements of Fluid Flow

	Karman equation, roughness parameter. Equivalent diameter, form friction losses in Bernoulli equation, Couette flow.	
3	Flow past immersed objects Drag, drag coefficients and drag coefficients of typical shapes. Ergun equation for packed bed. Terminal settling velocity, free and hindered settlings. Stokes' law, Newton's law. Criterion for settling regime. Fluidization, and its types. Conditions for fluidization, minimum fluidization velocity	07
SECTION-B		
4	Transportation of fluids Introduction to: pipe and tubing, joint and fittings, stuffing boxes, mechanical seals. Gate valves and globe valves, plug cocks and ball valves, check valves. Classification and selection of pumps, blowers and compressors. Pumps: developed head, power requirement, suction lift and cavitation, NPSH. Constructional features and working principle of single suction volute centrifugal pump. Constructional features and working principle of reciprocating pump. Characteristic curves of a centrifugal pump.	07
5	Flow Metering Constructional features and working principles of venturimeter. Constructional features and working principles of orificemeter. Rotameters, pitot tube, pitot tube, target meters. Discharge coefficients. Application of Bernoulli equation to venturi meter and orifice meter, flow rate calculations from the readings of venturi meter, orifice meter and pitot tube.	07
6	Agitation and Mixing Principles of agitation, agitation equipment, flow patterns: prevention of swirling, baffles and draft tubes. Types of agitated vessels. Dimensional analysis: Buckingham's π -theorem, significance of dimensionless groups-effect of system geometry. Calculation of power consumption in Newtonian liquids.	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)

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2315
Subject Name: Elements of Fluid Flow

List of Practical:

1. Discharge coefficient of orificemeter.
2. Discharge coefficient of rotameter.
3. Verification of Bernoulli's equation.
4. Frictional pressure drop in circular pipe.
5. Frictional pressure drop in annular pipe.
6. Equivalent length of straight pipe.
7. Discharge coefficient of V-notch.
8. Discharge coefficient of rectangular weir.
9. Viscosity by Stoke's law.
10. Characteristic curves of centrifugal pump.

Recommended Books:

1. Gavhane K.A.. "Unit Operations – I" Nirali Publications (2017).
2. Foust A. S. & associates, "Principles of Unit Operations" John Wiley and Sons (1980).
3. McCabe Smith, "Unit Operation in Chemical Engineering" 5th ed. McGraw Hill (1985).
4. S. K. Gupta, "Momentum Transfer Operation". Tata McGraw Hill (1979)
5. Coulson and Richardson: Chemical Engineering, Vol. 2. Butterworth Heinemann Pub.
6. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 3rd Edn., McGraw Hill International Editions, 2011.
7. Narayanan.C.L& Bhattacharya, "Mechanical Operatiосn for ChemicalEngineering", 1993.
8. White.F.M, "Fluid Mechanics", 7thEdn, McGraw-Hill Inc, 2011.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2315
Subject Name: Elements of Fluid Flow

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify and classify fluids based on their physical properties.
CO-2	Discuss and classify various flow situations with forces acting on fluid element
CO-3	Develop and illustrate the principle of flow past immersed bodies.
CO-4	Analyze various fluid moving machineries.
CO-5	Summarize the different practical applications of metering of fluids.
CO-6	Interpret the equipments used for agitation and mixing of fluids.

List of Open-Source Software/learning website:

- NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Open Elective

Prerequisite: A good understanding regarding material and energy balance for unit operations are needed. Sound knowledge with differential equations are also needed in this respect.

Rationale: The course is designed to introduce the fundamentals of process control along with instrumentation and its applications. The course will teach the students about mathematical models based on transfer function approach for single loop systems, how to obtain dynamic response of open loop and closed loop systems, stability analysis in transient and frequency domains, and controller tuning methods. The course introduces P, PI, and PID controllers and their applications. The instrumentation segment is focused on instruments used for measuring temperature, pressure, composition, and level measurements in process Industries.

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

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

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	<p>Introduction to Process Control & Laplace Transforms: Need for Process control and automation, servo and regulatory, control, block diagrams, control structures (feedback vs. feedforward), Laplace Transforms: Definition & Need, Transforms of simple functions, Solutions of differential equations. Inversions of transform function by partial fractions, qualitative nature of solutions, Final value and initial value theorems, Translation of transforms, Transforms of unit impulse functions, Transforms of integral.</p>	05

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2316

Subject Name: Instrumentation & Process Control

2	Response of first order and second order systems: Mercury thermometer, Transient response of step functions, Sinusoidal input, Impulse functions. Physical Examples of First Order Systems: Liquid level, Mixing process, linearization. First Order System in Series: Noninteracting system of liquid level, Generalization of several non-interacting systems in series, Interacting systems. Development of transfer functions, Damped vibrator, Liquid manometer, Thermometer in thermo-pocket, Step response & impulse response, Overshoot, Decay ratio, Rise time, Response time, Period of oscillation, Natural period of oscillation, Sinusoidal response, Transportation lag.	08
3	Control system and Response of Control Systems: Block diagram & parts of a control system, Negative and positive feedback, Servo problem v/s regulator problem, Development of block diagrams with various components, Closed Loop Transfer Functions: Block diagram reduction, PID diagrams, Controllers - P, PI, PD, PID, Transfer functions for controllers, Transient Response of simple control systems, Stability & Frequency response analysis.	07
SECTION-B		
4	Introduction to Instrumentation & temperature measurement: Elements of instruments, Parts of instruments, Static and dynamic characteristics, Temperature measurement scales, Constant volume gas thermometer, Mercury in glass thermometer, Bimetallic, Pressure spring thermometer, Static accuracy and error temperature measurement, Methods of compensation, Thermo-electric temperature measurement, Thermocouples, RTD, Pyrometers, Radiation & Optical pyrometers.	06
5	Pressure and level measurement: Liquid column manometer, Enlarged leg manometer, Inclined tube manometer, Ring manometer, Tilting U tube manometer, Bourdon gauge, Bellows, Differential pressure gauge, Vacuum Measurement: Ionization gauge, Pirani vacuum gauge, Thermocouple vacuum gauge, McLeod gauge Direct measurement, Float and tap, Float and shaft, Hydraulic remote transmission, Bubbler system, Diaphragm & air trap system, Differential pressure manometer, Float and spring pneumatic balance, Displacement float, Magnetic float gauge.	07
6	Flow measurement: Head flow meter, Orifice plate, Flow nozzle, Venturi tube, Pitot tube, Differential pressure meter, Electric type head flow meter, Bellows type meter, Rotameter, Piston type area meter and Positive displacement meter, Flow control actuators: different types of valves.	06

Suggested Specification table with Marks (Theory):

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2316

Subject Name: Instrumentation & Process Control

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)

Recommended Books:

1. Coughanowr, D. R., LeBlanc, S. "Process Systems Analysis and Control", 3rd edition, McGraw-Hill (2008).
2. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984)
3. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, John Wiley (2003)
4. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGrawHill (2005).
5. S.K. Singh, Industrial Instrumentation and Control, 3rd edition, McGraw-Hill (2008).
6. R. P. Vyas, "Process Control and Instrumentation", Denett & Co.
7. Donald .P. Eckman, "Industrial Instrumentation", John Wiley & Sons Inc, New York.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define the need of process control and substantiate the need of laplace transform in Process Control.
CO-2	Summarize the response of first order and second order and various parameters affecting the response of these systems.
CO-3	Predicting the transient response of P, PI, PD and PID controllers for servo & regulator problems
CO-4	Analyze the static and dynamic characteristics of Instruments introducing different levels of temperature measurements.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2316

Subject Name: Instrumentation & Process Control

CO-5	Describe the various instruments for measuring pressure and level in process Industries.
CO-6	Explain various instruments used for flow measurement in Industries.

List of Experiments:

1. Temperature measurement using RTD & Thermistors.
2. Response of first order system: thermometer
3. Response of first order liquid level system
4. Responses of second order system: U-tube manometer
5. Response of Interacting tanks
6. Response of Non-interacting tanks
7. Characteristics of flow control valves
8. Temperature measurement using Thermocouples.
9. Temperature, level, flow, and pressure control trainers
10. Study of P, PI, PD and PID controllers for measurement of flow and level.

List of Open-Source Software/learning website:

- Scilab Xcos open source software can be used for process control modelling and analysis
- Students can refer to video lectures available on the websites including NPTEL

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Open Elective

Prerequisite: A good understanding regarding basic states of matter along with fluid flow phenomena. Mathematical background is also essential in this respect in addition to basic heat transfer modes

Rationale: Heat transfer is a necessary process in virtually all forms of energy generation and use; from coal fired to nuclear power stations, from automobile engines to rocket motors, from refrigerating cold stores to air conditioning space vehicles. This subject is intended to make students aware about mechanisms involved in heat and mass transfer process. Mass transfer is also presented through analogy of heat transfer by diffusion and forced convection.

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

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

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	<p>Introduction to Heat Transfer & Heat Transfer Process: Conduction – Fourier’s law, Variation of Thermal conductivity with temperature, Boundary conditions, Formulation of heat transfer problems through plane wall, cylinder, sphere & composite slab. Critical and Optimum thickness of Insulation. Convection: Mechanism, Thermal and velocity boundary layers, Convective heat transfer coefficient, thermal boundary layers for the cases of flow over a flat plate and flow through pipe, dimensionless numbers in heat transfer and their significance. Correlations for heat transfer in laminar and turbulent flow for external and internal flows for constant heat flux and wall temperature conditions, Analogy between momentum and heat transfer. Radiation: Introduction, Theories of radiation, electromagnetic</p>	05

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2317

Subject Name: Basics of Heat & Mass Transfer

	spectrum, thermal radiation, spectral emissive power, surface emission, - total emissive power, and emissivity. Radiative properties, Emission, irradiation, absorptivity, reflectivity and transmissivity. Concept of black and grey body, radiation intensity, Laws of black body radiation	
2	Heat Exchangers: Classification of heat exchangers, Fouling, concept of overall heat transfer coefficient, LMTD and its correction factor, Sizing and rating problem using LMTD method in parallel flow, counter flow exchanger, cross flow and multi -pass heat exchangers, Temperature profile for single & multipass heat exchangers, Shell and tube heat exchanger, Important parts, Double pipe heat exchangers.	09
3	Heat Transfer with Phase Change: Boiling, Pool boiling - Boiling curve, hysteresis in the boiling curve, Forced convection boiling – boiling regimes, Condensation: Physical mechanisms, types of condensation, factors affecting condensation. Evaporators- Different types, Capacity & Economy, Boiling point elevation, Overall heat transfer coefficient, Material & Energy balance in Single Effect & Multi effect evaporators, Agitated thin film dryer, MVR Evaporators.	06
SECTION-B		
4	Introduction to Mass Transfer: Molecular diffusion, Mass flux, Fick's law, Steady state molecular diffusion in Gases and liquids, Mass transfer coefficient and its correlations, Interphase Mass transfer and Overall mass transfer coefficient, Gas liquid Contacting Equipments.	06
5	Absorption & Distillation: Gas Absorption and Stripping, Design of packed tower, Applications of Gas Absorption & Stripping, Distillation – Vapor Liquid Equilibrium, Steam distillation, Batch distillation, Azeotropic distillation, Fractional distillation, McCabe Thiele method. Extraction – Solvent selection, Material balance over extractors,	06
6	Adsorption & Drying: Adsorption – Adsorbent properties & selection, Adsorption Isotherms, Batch adsorption and Fixed bed adsorption, Regeneration of adsorbents. Drying – Drying Equilibria, Rate of Drying and drying calculations. Crystallization – Crystal growth, Batch crystallization.	07

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	0

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: ET2317

Subject Name: Basics of Heat & Mass Transfer

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

Recommended Books:

1. Özisik M. N, "Heat Transfer—A Basic Approach", McGraw-Hill.
2. Binay. K. Dutta, "Heat Transfer Principles and applications" Prentice Hall of India.
3. Robert. E. Treybal, "Mass Transfer Operations", McGraw-Hill.
4. Binay. K. Dutta, "Principles of Mass Transfer and Separation Process" Prentice Hall of India.
5. Coulson J M and Richardson J F, Chemical Engineering Volume 1 & 2, Pergamon Press (1999).
6. Incropera F. P. and DeWitt D. P, "Introduction to Heat Transfer". John Wiley & Sons.
7. K. V. Narayanan and B Lakshmikutty, Mass Transfer – Theory and Applications, CBS Publishers
8. Holman J. P, "Heat Transfer", McGrawHill.
9. Sachdeva R.C, "Fundamentals of Engineering Heat and Mass transfer", New Age International, India
10. Rao Y.V.C, "Heat Transfer", University Press, India
11. Cengel A. Yunnus. "Heat Transfer – A Practical Approach", McGraw Hill
12. Geankopolis C J, Transport Processes and Separation Process Principles, Prentice Hall of India, 4thEdition, Eastern Economy Edition (2004)
13. Kothandaraman C.P, "Heat and Mass Transfer Data Book" New Age International, India
14. Ramesh K. Shah and Dušan P. Sekulic, Fundamentals of Heat Exchanger Design, John Wiley & Sons, Inc. 2003

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define heat transfer mechanism of conduction, convection and radiation with its relevant industrial applications.
CO-2	Summarize heat transfer mechanisms for construction and operation of heat exchangers.
CO-3	Application of fundamental heat transfer process for studying heat transfer with phase change.
CO-4	Analyze the phenomena of diffusion for mass transfer in laminar and turbulent flow
CO-5	Describe the mechanisms involved in multiphase mass transfer operations involving Distillation, Absorption and Extraction.
CO-6	Explain the various mass transfer operations practiced in Industry viz. Distillation, Extraction, Adsorption, Crystallization and Drying

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Bachelor of Engineering

Subject Code: ET2317

Subject Name: Basics of Heat & Mass Transfer

List of Experiments:

1. Determination of thermal conductivity of solids
2. Determination of heat transfer coefficient by natural convection
3. Determination of heat transfer coefficient by forced convection: Determination of Forced convection heat transfer coefficients for flow of fluids through heated ducts
4. Determination of overall heat transfer coefficient for counter flow in laminar regime in double pipe heat exchanger
5. Determination of overall heat transfer coefficient and efficiency in shell and tube heat exchanger
6. Heat Transfer in Composite walls- Determination of effective thermal conductivity and overall resistance.
7. Determination of overall heat transfer coefficient and efficiency in finned tube heat exchanger
8. Determination of overall heat transfer coefficient and efficiency in plate type heat exchanger
9. Estimation of diffusivity of a component in a solution
10. Estimation of rate of drying of sand in a tray.

List of Open-Source Software/learning website:

- NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: ET2318
Subject Name: Fuels & Combustion

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - VI

Type of course: Open Elective

Prerequisite: Basic knowledge of units and dimensions, stoichiometric calculations, mass and energy balance calculations.

Rationale: This course deals with different types of fuels and technology involved in the production of energy from them. Also gives an introduction to conventional energy systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	Introduction Introduction and classification of fuels, fundamental definitions. Units and their conversions. Proximate and ultimate analysis. Calorific value, specific heats, latent heats, theoretical flame temperature, ignition temperature, octane number, cetane number. Pour and flash point.	066
2	Solid Fuels Introduction — Solid fuels - Origin of Coal - Rank of coal – Composition – Analysis and Properties. Storage of Coal. Washing of coal. Pulverization – Briquetting. Carbonization of coal -Low Temperature and High Temperature. Hydrogenation and liquefaction of coal - Applications of coal	06
3	Liquid Fuels Introduction – Liquid fuels - Origin of Petroleum – Composition - Classification of crude oil. Processing of crude oil – Distillation. Cracking – Thermal and catalytic. Reforming – Thermal and catalytic. Polymerization, alkylation and isomerization. Coal tar fuels, Properties	07

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Bachelor of Engineering
Subject Code: ET2318
Subject Name: Fuels & Combustion

	and purification of petroleum products. Storage and handling of liquid fuels.	
SECTION-B		
4	Gaseous Fuels Introduction – Gaseous fuels –Wood gas, Gobar gas, Sewage Gas, Natural gas – LPG, refinery gases and gas from underground gasification of coal. Producer gas and water gas. Water gas shift reaction. Coal gas from coal gasification. Oil gas from oil gasification.	07
5	Combustions General principles of combustions. Types of combustion processes. Heat and mass balance in combustion processes. Gas analysis and calorific value determinations. Excess air calculations. Fuel and flue gas compositions.	07
6	Combustion Equipments Grate firing and Pulverized fuel firing system. Burners for liquid fuel combustion –Vaporizing oil burners, atomizing oil burners. Burners used for gaseous fuels firing. Fluidized bed combustion of solid fuels.	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)

List of Practical:

1. Proximate analysis of the given coal sample.
2. Ultimate analysis of the given sample of coal.
3. Calorific value of the given coal sample.
4. Pour point determination of the fuel.
5. Flash point determination of the given liquid fuel.

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6. Determination of octane number of the given sample of liquid fuel.
7. Determination of cetane number of the given sample of liquid fuel.
8. Determination of loss of ignition of the given fuel sample.
9. Determination of energy content of fuel.
10. Determination of ignition temperature of the given fuel sample.

Recommended Books:

1. O.P. Gupta, "Fuels, Furnaces and Refractories", Khanna Publishers, 6th Edition, 2014.
2. S.P. Sharma and Chandramohan, "Fuels and Combustion", Tata McGraw-Hill, 1987.
3. Perry R.H. & Chilton C.H., "Chemical Engineers Hand Book", 7th ed. McGraw hill.
4. Civil Davies, Calculation in Furnace Technology, Pergamon Press.
5. Samir Sarkar, "Fuels and Combustion", Orient Longman, 3rd Edition.

Course Outcomes:

After learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define and enumerate various types of fuels and their terminologies.
CO-2	Classify and discuss various types of solid, liquid and gaseous fuels.
CO-3	Develop and illustrate the principles of various fuel processing technologies.
CO-4	Analyze and categorize various types of combustion processes.
CO-5	Summarize various combustion equipments.
CO-6	Interpret and evaluate combustion calculations.

List of Open-Source Software/learning website:

- NPTEL

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: MH2302

Subject Name: Contributor Personality Development Program – II

Shroff S.R. Rotary Institute of Chemical Technology

Type of course: Work-Personality Development

Prerequisite: To keep open mind and will to learn humanity for oneself and society.

Rationale: The Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them to recognize how they, as technical professionals, can participate and make a positive contribution to their communities and to their state.

Towards this goal, the Contributor Program has been designed to awaken and strengthen students from within, in terms of building positive self-esteem, increasing their confidence level and I-can attitude, improving their aspirations, giving them new methods of thinking, building their cognitive capacities, exposing them to the skills and practices associated with being contributors in the workplace (not mere employees).

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Gujarat.

The Contributor Program syllabus has been evolved and fine-tuned over several years, (a) to address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire and (b) by working extensively with universities and students building an appreciation of their challenges and concerns. At the core, the program is guided by the higher ideas and principles of practical Vedanta in work.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: MH2302

Subject Name: Contributor Personality Development Program – II

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)	
1	1	0	2	50	30	00	20	100

Content:

Sr. No.	Content	Total Hrs.
SECTION-A		
1	<p>Finding Solutions</p> <p>The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of “finding solutions” rather than “seeing problems or roadblocks”.</p> <p>Students learn how to build this way of thinking, in this topic.</p>	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
2	<p>Creating Value</p> <p>Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.</p>	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)

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3	<p>Engaging deeply</p> <p>The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student’s ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is important. Engaging deeply is a core way of thinking that can help them in this. In this topic, students learn how to engage deeply.</p>	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
SECTION-B		
4	<p>Enlightened self-interest & collaboration at work</p> <p>The changing nature of work in organizations and in the global environment is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved is “thinking in enlightened self-interest”. In this topic, students learn how to develop this way of thinking (going beyond “narrow self-interest”).</p>	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
5	<p>Human-centered thinking & Empathy</p> <p>In this topic, students explore a human-centric approach to work – where the ability to recognize and respond to other people (whether they are users or customers or team members) as a human being with human needs and difficulties, is essential. This is at the heart of user-centric design of products and solutions, at the heart of genuine customer- centricity in services, and of any successful interaction with other people.</p>	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)
6	<p>Trust Conduct</p> <p>The biggest currency in a sustainable career is “trust” i.e. being trusted by team members, bosses, and customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make</p>	04 hrs Classroom engagement (including self-discovery/ solutioning sessions)

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	mistakes, and work seamlessly with each other without always having to “prove ourselves”. In this topic, students learn how to demonstrate conduct that builds the trust of people.	
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Suggested Specification table with Marks (Theory):

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

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

Reference resources:

- A. Basic reference for both students and teachers
 1. Contributor Personality Program textbook cum workbook developed by Illumine
 2. Web-based ActivGuide™ for self-exploration of rich media resources to vividly understand many of the ideas, watch role models, learn from industry people, get reference readings – that help them enrich the understanding they gained in the class published by Illumine Foundation

- B. Advanced reference for teachers
 1. On Contributors, Srinivas V.; Illumine Ideas, 2011
 2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989
 3. Eternal Values for a Changing Society – Vol I-IV, Swami Ranganathananda; Bharatiya Vidya Bhavan
 4. Karma Yoga, Swami Vivekananda; Advaita Ashrama
 5. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama
 6. Six Pillars of Self Esteem, Nathaniel Branden; Bantam, 1995
 7. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
 8. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007

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9. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003
10. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 & 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004
11. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003
12. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2
13. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008
14. The Courage to Meet the Demands of Reality, Henry Cloud; HarperCollins, 2009
15. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Students will be able to recognize & appreciate the thinking required to find solutions in the face of any challenge.
CO-2	Students will be able to recognize & appreciate different types of value that can be created and the different ways to create value for others.
CO-3	Students will be able to recognize & appreciate how to engage deeply, and its need, value, payoffs and consequences in different contexts.
CO-4	Students will be able to differentiate between 'enlightened self-interest' and 'narrow self-interest' & appreciate the payoffs/ consequences of both when working with multiple stakeholders.
CO-5	Students will be able to recognize & appreciate the human side of situations or interactions or projects that will help them develop a more human-centric approach/ response to work.
CO-6	Students will be able to recognize & appreciate conduct which builds trust of people in contrast to conduct which breaks trust of people - in teams / organization & the value of trust conduct in various situations.