Ref: UPL University /SRICT/BOS/CH/2021-22/01
Date: 23-03-2022

Proposed Teaching Scheme for Second Year Bachelor of Chemical Engineering

Semester-III (Chemical Engineering) 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 and Social Sciences including Management courses	MH2201	Communication Skills in English	2	0	2	4	3	70	30	20	30	150
2	Basic Science courses	MH2202	Mathematics-III	3	2	0	5	5	70	30	20	30	150
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	CH2201	Engineering Thermodynamics	3	1	0	4	4	70	30	20	30	150
4	Professional core course-I	CH2202	Material and Energy Balance calculation	3	1	0	4	4	70	30	20	30	150
5	Professional core course-II	CH2203	Fluid Flow Operations	4	0	2	6	5	70	30	20	30	150
6	Professional core course-III	CH2204	Mechanical Operations	3	0	2	5	4	70	30	20	30	150
7	Project work, seminar and internship in industry or elsewhere Mandatory Courses	MH2205	In Plant Training	0	0	0	0	1	0	0	50	0	50
	Total						28	26					950

Semester-IV (Chemical Engineering) 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 and Social Sciences including Management courses	MH2204	Universal Human Values	3	0	0	3	3	70	30	0	0	100
2	Basic Science courses	CH2206	Chemical Process Industries	3	0	2	5	4	70	30	20	30	150
3	Professional core course-IV	CH2207	Chemical Engineering Mathematics	3	2	0	5	5	70	30	20	30	150
4	Professional core course-V	CH2208	Process Heat Transfer	3	0	2	5	4	70	30	20	30	150
5	Professional core course-VI	CH2209	Chemical Engineering Thermodynamics	3	2	0	5	5	70	30	20	30	150
6	Professional Elective courses-I	CH2210/11	Professional Elective-I	3	0	0	3	3	70	30	0	0	100
	Total						26	24					800

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

B. List of Professional and Open Electives

Program Elective -I
Air Pollution Control
Wastewater Engineering

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

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Language and Communication

Prerequisite: Zeal to learn the Language

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

Teaching and Examination Scheme:

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

Content:

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

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

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

Suggested Specification table with Marks (Theory):

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

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

Language Laboratory Activities:

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

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

Reference Books:

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

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

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

List of Open Source Software/learning website:

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

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: MH2202
Subject Name: Mathematics-III

Shroff S.R. Rotary Institute of Chemical Technology

Semester: - III

Type of course: Engineering Science

Prerequisite: Algebra, Trigonometry, Geometry, Differentiation, Integration

Rationale: The study to compute area, volume and Transformation of functions

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	2	0	5	70	30	0	50	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Fourier Series:** Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion.	5
2	**Laplace Transforms**: Definition of the Laplace transform, Linearity, Shifting theorems, Laplace transformation of elementary function, basic properties of Laplace transformation, Differentiation of Laplace transformation(multiplication by t), Integration of Laplace transformation(division by t), Laplace transformation of derivatives and integrals, unit step function. Evaluation of integrals using Laplace transformation.	10
3	**Curve Sketching**: Curve sketching in Cartesian Co-ordinates and Polar co-ordinates, Relation between Polar and Cartesian Co-ordinates.	5
	SECTION-B	
4	**Double integral and it's applications of:** over rectangular and general regions, properties of double integrals, Change of order, in polar coordinates, change of variables, Area by double Integrals	5

Bachelor of Engineering
Subject Code: MH2202
Subject Name: Mathematics-III

5	**Inverse Laplace transformation and its application:** Properties of inverse Laplace transformation, shifting theorem, multiplication and division by differentiation and integration of Laplace transformation. Convolution theorem, inverse Laplace transformation using partial fraction, solution of linear differential equation.	10
6	**Fourier integral:** Sine and cosine integral, even and odd functions	4

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**20**	**30**	**10**	**0**	**0**

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

Text Books:

1. Advanced Engineering Matheamtics by Ravish Singh and Mukul Bhatt.MC Graw Hill Education Pvt Ltd.

2. Engineering Mathematics Vol 2, by Baburam, Pearson

Reference Books:

1. Thomas' Calculus, Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.
2. Advanced Engineering Mathematics (8th Edition), by E. Kreyszig, Wiley-India (2007).
3. R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).

List of Tutorial:

1. Tutorial-1 (Fourier Series)

2. Tutorial-2 (Fourier Series)
3. Tutorial-3 (Laplace Transform)
4. Tutorial-4 (Laplace Transform)
5. Tutorial-5 (Curve sketching)
6. Tutorial-6 (Double Integral and its application)
7. Tutorial-7 (Double Integral and its application)
8. Tutorial-8 (Fourier Integral)
9. Tutorial-9 (Inverse Laplace Transformation)
10. Tutorial-10 (Inverse Laplace Transformation)

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

Sr. No.	CO statement
CO-1	**Define** Laplace and Inverse Laplace transformation, Fourier Series and Integral.
CO-2	**Solve** differential equations Using Laplace transform and inverse Laplace Transformation.
CO-3	**Sketch** the Cartesian and Polar graphs.
CO-4	**Calculate** the area using Double integrals
CO-5	**Construct** a Fourier integral to evaluate the Integral.
CO-6	**Evaluate** the sum of series using Fourier series

List of Open Source Software/learning website:

- https://nptel.ac.in/
- http://www.sosmath.com/

Bachelor of Engineering

Subject Code: CH2201

Subject Name: Engineering Thermodynamics

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Engineering Science

Prerequisite: Basics of Physics and Mathematics

Rationale: Knowledge of thermodynamics from a chemical engineering viewpoint 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	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction and First Law of Thermodynamics:** The scope & Limitations of thermodynamics, Definition and fundamental concepts, Force, pressure, and energy, Equilibrium state and Phase rule, Temperature & Zeroth law of Thermodynamics, Reversible & Irreversible process, Closed System & Open system, Heat capacity, Internal Energy, Enthalpy, First law of thermodynamics for cyclic process, Internal energy concept, first law of thermodynamics for Non-flow process, Enthalpy concept, The first law of thermodynamics for Flow process, Heat capacity concept, Problems on Application of first law of thermodynamics to steady state flow process.	9
2	**Volumetric Properties Of Pure Fluids:** PVT behaviour of pure substances, Ideal and non-ideal gas processes, Equation of states, Vander Waals EOS, Redlich/Kwong (RK) EOS, Calculation of constants in terms of Pc, Tc, Vc. Virial equation - principle of corresponding states, Compressibility charts.	7

3	**Second Law of Thermodynamics:** Limitations of 1st law of thermodynamics, Concept and real life examples of heat source, heat sink (reservoir), heat engine, heat pump and refrigerator, Second law of thermodynamics: Kelvin-Plank statement, Clausius statement, Equivalence of above two statements, Concept importance and examples of entropy, entropy changes-Carnot's principle, Thermodynamic Temperature Scales, Ideal gas temperature scale, Entropy changes of an Ideal Gas, Clausius inequality.	**9**
	SECTION-B	
4	**Application of Laws Of Thermodynamics:** Third law of thermodynamics, Thermodynamics of flow Process: Fundamental equations and relationships, flow in pipes, Maximum velocity in pipe flow, Nozzles, Ejectors, Throttling Process, Single and Multistage compressors.	**8**
5	**Refrigeration and Liquefaction:** Choice of refrigerant, Heat Pumps, Refrigerator capacity, Carnot refrigerator, Carnot cycle, Coefficient of Performance (COP), Vapor compression cycle, Absorption refrigeration, Air refrigeration. Liquefaction: Vaporization of Liquid, Free expansion, Isentropic expansion, Claude Cycle, Linde Cycle, Power cycles - Steam-Power Plant cycles - Internal Combustion Engine Cycles.	**9**
6	**Heat Effects Accompanying Chemical Reactions:** Latent heats of pure substances, Sensible heat effects, Temperature dependence of the heat capacity, Approximate methods for the estimation of the latent heat of vaporization, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Temperature Dependence of ΔH^o.	**6**

Suggested Specification table with Marks (Theory):

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

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

Bachelor of Engineering

Subject Code: CH2201

Subject Name: Engineering Thermodynamics

Textbooks:

1. Smith, J. M., Vanness H. C., Abbott, M. M., Swihart, M. T., "Introduction to Chemical Engineering Thermodynamics", McGraw-Hill Companies, Inc. 8th Ed., 2018.
2. Stanley, M. W., "Phase Equilibria in Chemical Engineering", new edition, Butterworth-Heinemann Ltd, 1991.
3. Sandler, S. I., "Chemical, Biochemical and Engineering Thermodynamics", 4th Ed., Wiley India Edition, 2007.
4. Rao, Y. V. C., "Introduction to Thermodynamics", 2nd Ed., Wiley Eastern Limited, 2004.

Reference Books:

1. Narayanan, K. V., "A textbook of Chemical Engineering Thermodynamics", 2nd Ed., Prentice-Hall of India Pvt. Ltd., 2013.
2. Kyle, B.G., "Chemical and Process Thermodynamics"; Prentice-Hall Inc. 1992.

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	Develop fundamental understanding of the basic principles of thermodynamics and related calculations.
CO-2	Demonstrate the use and applications of the first and second laws of thermodynamics
CO-3	Evaluate changes in different thermodynamic properties for pure fluids using equations of state (EOS).
CO-4	Understanding the concept of entropy, evaluating mass and energy balance to closed and open systems.
CO-5	Apply thermodynamic principles to the analysis of chemical processes and equipment such as turbines, compressors, heat pumps etc.
CO-6	Theoretical understanding of refrigeration and liquefaction processes, Problem solving.

List of Open-Source Software/learning website:

1. Students can refer to video lectures available on the websites including NPTEL
2. Students can refer to the CDs which are available with some reference books for the solution of problems using softwares. Students can develop their own programs for the solutions of problems.
3. XSEOS–an Open Software for Chemical Engineering Thermodynamics

Bachelor of Engineering
Subject Code: CH2202
Subject Name: Material and Energy Balance Calculation

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core-I

Prerequisite: Basics Mathematics, Applied Sciences

Rationale:

Chemical engineering is all about transformation of species of material by a chemical process and the subject stoichiometry (chemical process calculations) forms one of the core subjects of the course. It mainly deals with the qualitative and quantitative aspects of material and energy transformations during a chemical process, the knowledge of which is very essential in the design of chemical reactors, equipment's and the chemical process as a whole.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	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	**Mathematical Principles:** System of units, Units and dimensions: basic and derived units, Unit processes and operations, Process flow sheet, Block diagram, Steady and unsteady state operations	**04**
2	**Gases, Gas mixtures & Gas liquid mixtures:** Ideal gas law, Dalton's law, Amagat's law, Vander Waals equation of state Avg. molecular wt. of a gas mixture, density of a gas mixture, composition of gas a mixture, Raoult's law, Henry's law – statement and simple problems	**06**
3	**Material Balance for Physical Systems:**	

Bachelor of Engineering
Subject Code: CH2202
Subject Name: Material and Energy Balance Calculation

	Law of conservation of mass. Definition & block diagram of various unit operations such as drying, evaporation, crystallization, extraction, distillation, absorption, filtration, etc. Solving material balance problem in distillation, drying, evaporation operations, Solving material balance problem in crystallization, extraction, absorption, filtration, mixing & blending. Recycle, by-pass and Purging.	**06**
	SECTION-B	
4	**Material Balance for Reacting Systems:** Definition & terms, Stoichiometric equation, stoichiometric co-efficient, stoichiometric ratio, limiting component, excess component, conversion, yield, selectivity & % excess, solving material balance problems with chemical reactions for calculating % conversion, % yield, and % excess, of raw materials or products, Introduction to unsteady-state material balance.	**06**
5	**Energy Balance:** Law of conservation of energy, different forms of energy, heat/thermal energy & its units. Sensible heat, latent heat, specific heat, heat capacity, heat capacity at constant volume, and at constant pressure, variation of heat capacity with temp. Equation for calculating the sensible heat requirement using heat capacity data Standard states for gas, liquid & solid. Heat of formation, heat of combustion, heat of reaction, Hess's law of constant heat summation and its application. Heat of dilution & dissolution. Effect of temperature on heat of reaction, relationship for calculating the heat of reaction at any temp. Heat effects associated with chemical reactions (endothermic and exothermic). Adiabatic oprations, adiabatic reaction & adiabatic reaction temp.	**08**
6	**Fuels and Combustion:** Calorific values, types of fuels, air requirement and flue gases, combustion calculations. Proximate and ultimate analysis of coal. Solving material balance problems with fuels & combustion reaction for calculating percent excess air.	**06**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**30**	**20**	**-**	**-**

Bachelor of Engineering
Subject Code: CH2202
Subject Name: Material and Energy Balance Calculation

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

Textbooks: NA

Reference Books:

1. Bhatt, B. I. Vora, S. M., "Stoichiometry", Tata McGraw Hill, NewDelhi, 2nd Ed., 2004.
2. Hougen, O. A., Watson R. M., Ragatz R.A., "Chemical ProcessPrinciples Part I", CBS Publications, 2nd Ed., 1976.
3. Himmelblau, D. M., "Basic Principles and Calculations in ChemicalEngineering", Prentice Hall of India, New Delhi, 8th Ed., 2012.
4. Narayanan. K.V., Lakshmikutty. B., "Stoichiometry and ProcessCalculations", Prentice Hall of India, New Delhi, 2nd Ed., 2009.
5. Venkatramani, V., Ananatharaman, N., Begum, S., "Process Calculations", Prentice Hall of India, 2nd ed., 2011.
6. Felder, R. M., Rousseau, R. W., "Elementary Principles of ChemicalProcesses", John Wiley and Sons, 3rd Ed., 2005.

List of Practical/Tutorials: NA

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	Identify the various units and conversion
CO-2	Differentiate the behavior of gases, mixtures and solutions
CO-3	Analyze the material balance on physical systems
CO-4	Analyze the material balance on reacting systems
CO-5	Describe the energy balance in reacting and non-reacting systems with phase change.
CO-6	Evaluate the calorific values of fuel

List of Open-Source Software/learning website:

NPTEL video lectures

Bachelor of Engineering

Subject Code: CH2203

Subject Name: Fluid Flow Operations

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core - II

Prerequisite: Basic Concepts of Engineering Mathematics and Physics.

Rationale: Chemical Engineers are converting raw material into valuable product. Process stream moves through different unit operations and pipe network. Fluid flow operations plays an important role in chemical plants.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Properties of Fluid:** Pressure, density, specific weight, viscosity, dynamic and kinematic viscosity, Newton's law of viscosity and its applications. **Fluid Statics:** Pascal's Law and Hydrostatic equation, absolute and gauge pressures - pressure measurements by manometers, Hydrostatic equilibrium, decanters like continuous gravity, centrifugal etc. **Fluid Flow Phenomena:** Velocity fluid, Velocity gradient and rate of shear, Newtonian and Non Newtonian fluids, Viscosity and momentum flux, Reynolds number and its significance, laminar and turbulent flow; Laminar and Turbulent flow in boundary layers, boundary layer formation in straight tubes, boundary separation and wake formation.	**10**
2	**Basic equations of Fluid Flow:** Mass velocity; average velocity; potential flow; streamlines, stream tubes, macroscopic momentum balance, momentum correction factor, Equation of continuity, Bernoulli's equation, corrections for fluid friction, pump work in Bernoulli's equations, angular momentum equations.	**6**

3	**Flow Through Pipes:** Critical Reynolds number, velocity distribution in pipes, friction factor, Moody's chart, Laminar flow through pipe, Hagen-Poiseulli's equation, Turbulent flow through pipe, Hydraulic gradient line and Total energy line. Minor head losses in pipes.	**8**
SECTION-B		
4	**Boundary Layer Theory:** Development of Boundary layer over flat plate and pipe, boundary layer thickness.	**6**
5	**Measurement of Flowing Fluids:** Full bore meter like venturimeter, orifice meter, coefficient of discharge of venturimeter, orifice meter, area meters like Rotameter, target meters, vortex-shedding meters, coriolis meters, magnetic meters, Notches etc., insertion meters like pitot tubes etc. Pipe and tubing, joint and fittings selection of pipe sizes, prevention of leakage around moving parts, stuffing boxes, mechanical seals, valves like Gate, Globe, Plug cocks, Ball, Check valves. **Pumps:** definition and classifications - Centrifugal pump: classifications, working principles, , specific speed, efficiency and performance curves - Reciprocating pump: classification, working principles, indicator diagram, work saved by air vessels and performance curves - cavitations in pumps - rotary pumps: working principles of gear and vane pumps	**10**
6	**Dimensional Analysis:** Different methods of dimensional analysis applied to fluid flow problems.	**8**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	**30**	**30**	**10**	**5**	**-**

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

Textbooks:

1. McCabe, W., Smith, J. C., Harriott P., "Unit Operations of Chemical Engineering", McGraw Hill International, 7th Ed., 2005.

Reference Books:

1. Munson, B. R., Young, D. F., Okiishi T. H., "Fundamentals of Fluid Mechanics", John Wiley & Sons, 8th Ed., 2018.
2. Gupta, S., Gupta, V., "Fluid Mechanics and its applications", New Age International Publishers, 3rd Ed., 2013.
3. Richardson, J., Coulson, J., Harker, J., Backhurst, J. R. "Chemical Engineering, Volume I, – Fluid flow, Heat Transfer and Mass Transfer", Butterworth – Heinemann Publication, 6th Ed., 2017.

List of Practical:

1. To study and verify Bernoulli's Theorem.
2. To calibrate an Orifice meter and obtain it's coefficient of discharge.
3. To study Reynolds's Experiment Apparatus.
4. Reciprocating Pump testing and characteristic curves
5. Friction vs. Re losses in Pipe Friction using water.
6. Study of Pressure measurement devices.
7. To Study Notched Weirs Apparatus and obtain its discharge coefficient.
8. To calibrate the given Rota meter.
9. Calibration of Triangular Notch and find the value of discharge co-efficient.
10. Study of Pressure Drop in packed bed.

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	State the Newton's law of viscosity and explain the mechanics of fluids at rest and in motion.
CO-2	Derive Euler's equation of motion and deduce Bernoulli's equation.
CO-3	Evaluate pressure drop in pipe flow using Hagen-Poiseuille's equation for laminar flow in a pipe.
CO-4	Examine energy losses in pipe transitions.
CO-5	Discuss the flow over immersed bodies.
CO-6	Classify the various types of pumps and their working principles.

List of Open-Source Software/learning website:

- Reference to NPTEL lectures can be made for a better understanding.

Bachelor of Engineering
Subject Code: CH2204
Subject Name: Mechanical Operations

Shroff S.R. Rotary Institute of Chemical Technology

Semester: III

Type of course: Professional Core-III

Prerequisite:

Chemical engineering consists of several unit operations and unit processes. Thus, unit operations are a very essential part of chemical engineering; and hence, basic knowledge about the principles and equipment of solid-solid unit operations and solid-liquid unit operations is mandatory for any professional chemical engineer.

Rationale:

The main objective of this subject is to study the basic mechanical operation (crushing, grinding, filtration, etc.) takes place during the process in chemical industry. This subject provides the fundamental knowledge regarding to particle size reduction, conveying and also deals with the construction & working of equipment's used for mechanical operations. It also covers other unit operations such as filtration and sedimentation.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	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	**Solid Particle and its Characterization**: Solid Particle: Shape and size of particle, Sphericity, Mixed Particle Size, Average Particle Size, Specific surface area of the mixture, No. of particles in the mixture, Differential and Cumulative Analysis, Capacity and Effectiveness of Screens, Ideal and Actual Screens, Screening Equipments: Grizzly, gyrating, trommels, vibrating and oscillating screens.	6

Bachelor of Engineering

Subject Code: CH2204

Subject Name: Mechanical Operations

2	**Size Reduction:** Principle of size reduction, Kicks law, Rittinger's law, Bonds Law, Crushing efficiency, work index, (crushing, grinding), Open and closed circuit grinding, Types of Crushers, Grinders, Ultra-fine grinders, cutters. Critical speed of ball mill, Angle of Nip.	**5**
3	**Flow Of Fluid Past Immersed Bodies:** Mechanics of particle motion, Equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field, Terminal velocity, Drag coefficient, Motion of spherical particles in Stoke's region, and Newton's region, Pressure drop calculations– Kozeny-Carman equation, Burke-Plummer, Ergun equation, Fluidization, conditions for fluidization, Minimum fluidization velocity, Pneumatic conveying.	**7**
	SECTION-B	
4	**Solid-Liquid Separation:** Sedimentation: Concept, free and hindered settling, factors affecting the rate of sedimentation, Sedimentation Equipment: thickener, clarifier and settling tank: Principle, construction (different zones), working, Cyclones, Hydrocyclones. Principle, Construction and Working of Basket centrifuge, Filtration: Principles, types, factors affecting filtration rate, use of filter aid (example of filter aid). Plate and frame filter press, rotary vacuum drum filter.	**6**
5	**Mixing and Agitation:** Principle of mixing (solid-solid, solid-liquid, Liquid-Liquid), mixing index. Sigma Mixer, Ribbon blender, Muller mixer: Principle, construction, working. Agitators (anchor type, paddle, turbine), flow patterns (radial and axial flow patterns),Concept of vortexing.	**6**
6	**Sampling, Storage and Conveying Of Solids:** Sampling of solids, Storage of solids, Open and closed storage, Bulk and bin storage, Conveyors-Belt conveyers, Chain conveyor, Apron conveyor, Bucket conveyor, Screw conveyor.	**6**

Suggested Specification table with Marks (Theory):

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

Bachelor of Engineering
Subject Code: CH2204
Subject Name: Mechanical Operations

Textbooks:

1. McCabe, W. L., Smith J. C., Harriott P., "Unit Operation in Chemical Engineering" 7th Ed., McGraw Hill, 2014.
2. Narayan, C. M., Bhattacharya, R. C., "Mechanical Operations for Chemical Engineers", Khanna Publications, 2010.

Reference Books:

1. Perry, R. H., Chilton, C.H., "Chemical Engineers Handbook", McGraw hill., 7th Ed. 2018.
2. Patil, K.D., "Mechanical Operations Fundamental Principles and Applications", Nirali Prakashan, 2016.
3. Richardson, J. F., Harker, J. H., "Coulson and Richardson's Chemical Engineering", Vol. 2. Butterworth-Heinemann Pub, 5th Ed., 2002.

List of Practical:

1. To determine the screen efficiency for the given sample by sieve analysis.
2. To determine the screen efficiency for the given sample by vibrating screen.
3. To determine nip angle, Reduction Ratio, Ribbon Factor, Rittinger's constant, Bond's constant, Kick's constant, Work Index as well as Theoretical & Actual Capacity using roll crusher.
4. To determine Rittinger's constant, Bond's constant, Kick's constant and Work Index using jaw Crusher.
5. To calculate the overall efficiency of the cyclone separator.
6. To carry out the batch sedimentation tests.
7. To carry out gravity filtration test.
8. To determine Rittinger's constant, Bond's constant, Kick's constant and Work Index for ball mill.
9. To study filter press.
10. To study size reduction of material by drop weight crusher.

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	To characterize particles and study the size analysis of particles to meet the need of chemical industries.
CO-2	Describe the size reduction equipments for solid-solid operations.
CO-3	To understand the flow of particles through fluids.
CO-4	To evaluate the parameters of sedimentation and filtration.
CO-5	To identify the different types of mixing equipments
CO-6	To elaborate the concept of conveying of solids.

List of Open-Source Software/learning website:

Reference to NPTEL lectures can be made for a better understanding regarding mechanical operation done in industries under different conditions.

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

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

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

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

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

Teaching and Examination Scheme:

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

Content:

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

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

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

Suggested Specification table with Marks (Theory):

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

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

Text Books:

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

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

Reference Books:

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

Course Outcomes:

After learning this course students will be able to:

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

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

List of Open Source Software/learning website:

- **https://www.uhv.org.in**
- **https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw**

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering

Subject Code: CH2206

Subject Name: Chemical Process Industries

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Basic Science

Prerequisite: Basic Organic and Inorganic Chemistry

Rationale: In order to combat the problem of industry the first step is to understand the various chemical unit processes taking place in an industry. Chemical Unit Processes is essential for chemical engineering as it gives an overview of all chemical process industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	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	**Mechanisms and Recent Advances of Following Unit Processes:** Alkylation and Acylation, e.g. alkylation of benzene, phenols, etc. Halogenation, e.g. chlorination of toluene, Nitration and Sulfonation, e.g. nitration, sulfonation of benzene, etc. Hydrogenation and Reductive Alkylations, e.g. hydrogenation of nitrobenzene, reductive alkylation reactions of anilines, Oxidation, e.g. oxidation of xylenes, etc.	6
2	**Sulphur, Sulphuric Acid Fertilizer Industries:** Mining and manufacturing of Sulphur, Manufacture of Sulphuric acid by DCDA process and its applications. Sulphur trioxide, Sodium Sulphate, Sodium Thiosulphate, Manufacturing technologies & associated Engineering problems. Introduction to Fertilizer industries, manufacturing processes of Ammonia, Urea, Nitric acid, Phosphoric acid their uses and applications, major engineering problems, NPK fertilizer.	8
3	**Chlor-Alkali and Heavy Inorganic Industry:** Manufacturing of Caustic Soda and Chlorine by membrane cell, mercury & diaphragm process, Manufacturing of Sodium Bicarbonate.	4

Bachelor of Engineering
Subject Code: CH2206
Subject Name: Chemical Process Industries

	SECTION-B	
4	**Drugs and Pharmaceuticals:** Classification of various drugs and pharmaceuticals, Introduction of Antibiotics, Manufacturing of penicillin, Introduction of vitamins, Manufacturing processes of Aspirin, Vitamin-D, B-12, & C (Ascorbic acid), Introduction to Barbital & Phenol Barbital.	**6**
5	**Introduction to Biotechnology:** Introduction, Old and New Biotechnology, an Interdisciplinary Activity, Scope and Importance, Commercial Potential, Biotechnology in India. Introduction to DNA technology and genetic engineering, basic techniques and tools. Applications of DNA technology.	**7**
6	**Sugar & Fermentation Industries:** Manufacturing of Sugar. Fermentation, Industrial Alcohol, Absolute Alcohol, Beers, Wines and Liquors, Manufacturing of Butyl Alcohol & Citric acid by fermentation. **Introduction to pulp and paper industries:** Pulp manufacturing by Kraft process, Difference between sulphate & sulphite process, Manufacturing of Paper.	**5**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	20	30	05	05	10

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

Textbooks:

1. Dryden, C. E., "Outlines of Chemical Technology", East West Press. Pvt. Ltd., New Delhi, 3rd Ed.,1997.
2. Austin, G. T., "Shreve's Chemical Process Industries", McGraw Hill, 5th Ed., 1984.

Reference Books:

1. Sharma, B. K., "Industrial Chemistry", Krishna Publishing House, 2016
2. Kent, J. A., "Riegel's Handbook of Industrial Chemistry", Springer Publication, 1992.
3. Patel, A. H., "Industrial Microbiology", Trinity Press, Laxmi Publication Pvt Ltd., 2nd Ed., 2015.

4. Rao, M. G., Sittig, M., "Outlines of Chemical Technology", Affiliated East West Press. Pvt. Ltd., 3rd Ed., 2005.
5. Ratledge, C., Kristiansen, B., "Basic Biotechnology", Cambridge University Press, 3rd Ed., 2006.

List of Practical:

1. To prepare soap in the laboratory and carry out its cost analysis.
2. To determine saponification value of oil sample.
3. To prepare detergent in the laboratory and to carry out its cost analysis.
4. To determine the acid value of the given sample of oil.
5. To prepare hydrated lime from the given calcium carbonate powder.
6. To prepare caustic soda by chemical method.
7. Preparation of nitro benzene from benzene.
8. Development of Inoculum.
9. Production of bioethanol through fermentative method.
10. Production of biomass in laboratory.

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	Develop fundamental understanding of the process carried out in chemical industry.
CO-2	Explain the basic reaction steps involved in the production of various grades of products.
CO-3	Construct process flow diagrams for different chemical manufacturing plants.
CO-4	Predict all possible trouble shootings arise in chemical plants.
CO-5	To review the practical importance and relevance of process takes place in chemical industry.
CO-6	Resolve all technological and economic problems arise in the chemical manufacturing plants.

List of Open-Source Software/learning website:

NPTEL, World Wide Web, etc.

Bachelor of Engineering

Subject Code: CH2207

Subject Name: Chemical Engineering Mathematics

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core -IV

Prerequisite: Linear Algebra

Rationale:

It is necessary for Chemical Engineering students to solve complex mathematical problems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	2	0	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Approximation and Errors:** Approximation in numerical computation, Truncation and rounding errors, Propagation of errors, Accuracy and Precision.	4
2	**Numerical Solution of System of linear equations & non-linear equations:** Solution of transcendental and non-linear equations by Bisection, Regular Falsi, Newton's Raphson and Secant method, Solution of a system of linear simultaneous equations by LU Decomposition, Cholesky Decomposition, Jacobi and Gauss Seidel methods, Concept of Ill conditioned system.	7
3	**Finite Differences and Interpolation:** Introduction of Finite differences, Operators, Newton Gregory Forward Interpolation Formula, Newton Gregory Backward Interpolation Formula, Gauss's Forward and Backward Interpolation Formula, Stirling's Central Difference Formula, Lagrange's Interpolation Formula for unevenly spaced data, Inverse Interpolation, Divided Differences, Newton's Divided Difference Formula, Relation between Divided Differences and Ordinary Differences.	7
	SECTION-B	

4	**Curve Fitting:** Introduction, The Method of Least Squares, Fitting of a Straight Line, Fitting of a Second-Degree Curve, Fitting of an Exponential Curve, Fitting of a Geometric (Power) Curve.	**6**
5	**Numerical Integration:** Trapezoidal rule, Simpson's one-third rule, Simpson's Three-Eighth rule, Weddle's rule, Romberg's method, Double Integration.	**5**
6	**Numerical Solution of Ordinary Differential Equations**: Taylor's Series and Euler's Method, Modifications and Improvements in Euler's Method, Runge-Kutta 2nd Order & 4th Order Methods, Milne's Predictor-Corrector Methods.	**7**

Suggested Specification table with Marks (Theory):

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

Textbooks:

1. Kreyszig, E., "Advanced Engineering Mathematics", Wiley India Pvt. Ltd., 2020.
2. Bali, N., Goyal, M., "A Textbook of Engineering Mathematics", Laxmi Publications, 2010.
3. Chapra, S.C., Canale, R.P., Numerical Methods for Engineers, McGraw Hill International 6th Ed., 2012.

Reference Books:

1. Ramana, B., "Higher Engineering Mathematics", McGraw Hill, 2008.
2. Jain, R. K., Iyengar, S. R. K, "Advanced Engineering Mathematics", Taylor & Francis, 2004.
3. Grewal, B. S., "Higher Engineering Mathematics", 42nd Ed., Khanna Publications, 2005.
4. Davis, P.W., "Differential Equations for Mathematics, Science, and Engineering", Prentice Hall, 1992.

5. Press, W. H., Vetterling, W. T., "Numerical Recipes", Cambridge University Press, 3rd Ed., 2007.

Course Outcomes:

Students should be able to:

Sr. No.	CO statement
CO-1	Interpret the accuracy of numbers, errors, and propagation of errors
CO-2	Evaluate the system of linear and non-linear equations
CO-3	Solve the finite and infinite differences
CO-4	Analyze the principles of complex integration
CO-5	Assess the concept of probability distribution
CO-6	Compare the methods of numerical integration

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CH2208
Subject Name: Process Heat Transfer

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core -V

Prerequisite: Basic knowledge of mathematics. Fundamentals of material & Energy balance and fluid flow operations.

Rationale: The main objective of this subject is to study the basics of heat transfer takes place in the Chemical industries. This subject provides knowledge regarding the basic modes and aspects of heat transfer process as well as it also provides an idea about various equipment used for heat transfer.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	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:** Modes of Heat Transfer, Heat transfer equipment, Systems of measurement, Units and dimensions.	1
2	**Conduction:** Fourier's law, Thermal conductivity, Steady state conduction of heat through a composite solid, Steady state heat conduction through a Variable area, Thermal Insulation, Optimum thickness, Critical radius of insulation. Unsteady state heat transfer, Lumped heat capacity analysis, Biot and Fourier's number significance.	7
3	**Convection:** Classification of convection, Concept of heat transfer coefficient, Overall heat transfer coefficient, Fouling factor, resistance in overall heat transfer coefficients, Flow arrangement in heat exchangers, LMTD, Boundary layers theory, Heat transfer correlations for free convection from different shapes like flat surface, cylinder, Sphere. Correlations for the heat transfer coefficient: Internal flows and External flows, Momentum and heat transfer analogies.	10
	SECTION-B	
4	**Boiling, Condensation and Radiation:** The boiling phenomenon, Hysteresis in the Boiling Curve, The mechanism of nucleate Boiling,	7

Bachelor of Engineering
Subject Code: CH2208
Subject Name: Process Heat Transfer

	Correlations for pool boiling heat transfer, The condensation phenomenon, Film condensation on vertical surface, Effect of non-condensable gases, Dropwise condensation, Basic laws like Planck's, Wein displacement, Stefen-Boltzmann, Kirchhoff's law. Grey body, Transmissivity, Absorptivity, Reflectivity, Emissivity of black bodies and gray bodies. Application of thermal radiation: Radiation Transfer between surfaces. Radiation through semi-transparent materials.	
5	**Evaporation:** Performance of tubular evaporator. Individual & overall Coefficients, Capacity & economy of evaporators. Boiling point elevation, Durhing's rule, Effect of liquid head and friction on pressure drop, Types of evaporators, Multiple effect evaporators, Vapor recompression.	**5**
6	**Heat exchangers:** Classification of Heat exchangers, Construction of Shell & Tube heat exchangers, Double pipe heat exchangers, Plate Heat exchangers. Effectiveness-NTU method of heat exchanger analysis, Design procedure of Shell & tube heat exchanger and Double pipe heat exchanger.	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	25	25	10	20	0

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

Textbooks:

1. Dutta, B. K., "Heat Transfer-Principles & Applications", PHI Learning Pvt. Ltd., 1st Ed., 2006.
2. Kern, D. Q., "Process Heat Transfer", McGraw Hill, 1950.

Reference Books:

1. McCabe, W. L, Smith, J. C., Harriott, P., "Unit Operations of Chemical Engineering", 7th Ed., McGraw-Hill Book Co, 2005.
2. Holman, J. P., "Heat Transfer", McGraw-Hill, 10th Ed., 2010.

Bachelor of Engineering
Subject Code: CH2208
Subject Name: Process Heat Transfer

List of Practical:

Sr. No.	Experiment name
1	To determine the Overall Thermal Conductivity of Composite Wall.
2	To determine the Thermal Conductivity of metal rod.
3	To study about the critical flux in a pool boiling apparatus & determine the critical heat flux of a given wire.
4	To study the heat transfer from a pin fin under forced and natural convection and calculate the heat transfer co-efficient and effectiveness of the fin.
5	To compare overall heat transfer coefficient for Parallel and Counter flow in a Double Pipe Heat Exchanger and also compare practical overall heat transfer coefficient value with the theoretical value.
6	Study of radiation heat transfer by black plate and test plate & calculate the emissivity of test plate.
7	To analyze the performance of an existing Shell & Tube Heat Exchanger and also calculate the Overall Heat Transfer Coefficient for Shell & Tube Heat Exchanger.
8	(i) To analyze the performance of an existing plate type Heat Exchanger (ii) To calculate Overall Heat Transfer Coefficient & effectiveness for plate type Heat Exchanger.(iii) To analyze effects of changing the flow rate for hot water & cold water fluids.
9	To determine the Overall heat transfer Coefficient (U) for Bare pipe, Longitudinal fins and Transverse fins and to study the operation of heat exchanger.
10	To study the radiation heat transfer by black body and to study the effect of hemisphere temperature on it & calculate the stefan boltzmann constant.

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	Identify the different modes of heat transfer.
CO-2	Determine the rate of heat transfer by conduction.
CO-3	Apply the concept of convection to operate heat exchangers.
CO-4	Determine the amount of heat transfer by radiation.
CO-5	Choose proper heat transfer equipment for various applications.
CO-6	Calculate energy associated with evaporators.

List of Open-Source Software/learning website:

NPTEL videos/ MIT videos

Bachelor of Engineering
Subject Code: CH2209
Subject Name: Chemical Engineering Thermodynamics

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Core-VI

Prerequisite: Engineering Thermodynamics

Rationale: This subject introduces the concepts of fugacity, activity coefficient and other important thermodynamic properties and its evolution for pure components and solutions. Starting with ideal gas mixtures and ideal solutions, the concepts of bubble and dew points are introduced to enable flash calculations and design of process components. Subsequently, various levels of non-ideality and complexity are introduced. The course also provides fundamental insight into the underlying thermodynamic principles of phase equilibria and reaction equilibria to solve complex problems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	2	0	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Thermodynamic Properties of Pure Fluids:** Classification of Thermodynamic Properties, Helmholtz free energy, Gibbs free energy. Relation among thermodynamic properties: Exact differential equation, fundamental property relation, Thermodynamic diagrams, Maxwell's equation.	5
2	**Equilibrium and Stability** Criteria of equilibrium, Chemical potential, Application of equilibrium criteria, Clausius Equation, Problems.	2
3	**Phase Equilibria: Vapour/Liquid Equilibrium (VLE)** Introduction, Phase Rule, Duhem's Theorem, VLE- Qualitative behaviour, Simple Models for VLE, Raoult's Law, Dew point and Bubble point	6

	calculations with Raoult's Law , Henry's law, VLE by Modified Raoult's Law, VLE from K-Value Correlations, The Gamma/Phi Formulation of VLE.	
	SECTION-B	
4	**Solution Thermodynamics:** Fundamental Property Relation, The Chemical Potential as a Criterion for Phase Equilibria, Fugacity, Standard state for fugacity, fugacity coefficient, Effect of Temperature and Pressure on Fugacity, Fugacity for pure gases, solids, liquids, Concept of activity, Effect of Temperature and Pressure on activity, The Partial Molar Properties, Chemical Potential, Effect of Temperature and Pressure on chemical potential.	**9**
5	**Model Equations: Applications Of Solution Thermodynamics** Fugacity in solutions, fugacity in Gaseous solutions, Lewis/Randall Rule, Ideal solutions & Rault's law, Henry's law & dilute solutions, activity in solutions, activity coefficient, Gibbs-Duhem Equationin terms of activity coefficients for two component system, relating activity coefficient with composition, theoretical calculation of activity coefficient, relation for excess free energy, Thermodynamic Consistency by Integral or Area Test Method, Models for the Excess Gibbs Energy, Margules Equations, VanLaar Equations, Local Composition Models such as NRTL Equation, UNIQUAC Equation, UNIFAC Method.	**9**
6	**Chemical Reaction Equilibria:** Reaction ordinate for single & multiple reactions, condition of equilibrium for a chemical reaction, The standard Gibbs free energy change and the equilibrium constant, Effect of temperature on equilibrium constant, Estimation of equilibrium rate constant, Homogeneous gas phase reactions, Heterogeneous chemical equilibrium.	**5**

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	15	20	5

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

Bachelor of Engineering

Subject Code: CH2209

Subject Name: Chemical Engineering Thermodynamics

Textbooks:

1. Smith, J. M., Vanness, H. C., Abbott, M. M., Swihart, M. T., "Introduction to Chemical Engineering Thermodynamics", McGraw-Hill Companies, Inc. 8th Ed., 2018.
2. Stanley, M. W., "Phase Equilibria in Chemical Engineering", new edition, Butterworth-Heinemann Ltd, 1991.
3. Sandler, S. I., "Chemical, Biochemical and Engineering Thermodynamics", 4th Ed., Wiley India Edition, 2007.
4. Rao, Y.V.C., "Introduction to Thermodynamics", 2nd Ed., Wiley Eastern Limited, 2004.

Reference Books:

1. Narayanan, K. V., "A textbook of Chemical Engineering Thermodynamics", 2nd Ed., Prentice-Hall of India Pvt. Ltd., 2013.
2. Kyle, B.G., "Chemical and Process Thermodynamics"; Prentice-Hall Inc. 1992.

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	Develop fundamental understanding of the basic principles of thermodynamics and related calculations.
CO-2	Demonstrate the use and applications of the first and second laws of thermodynamics
CO-3	Evaluate changes in different thermodynamic properties for pure fluids using equations of state (EOS).
CO-4	Apply mass and energy balance to closed and open systems.
CO-5	Apply thermodynamic principles to the analysis of chemical processes and equipment such as turbines, compressors, heat pumps etc.
CO-6	Solve problems of refrigeration and liquefaction processes.

List of Open-Source Software/learning website:

1. Students can refer to video lectures available on the websites including NPTEL.

2. Students can refer to the CDs which are available with some reference books for the solution of problems using softwares. Students can develop their own programs for the solutions of problems.
3. XSEOS–an Open Software for Chemical Engineering Thermodynamics.

(Established under Gujarat Private Universities Act, 2009)

Bachelor of Engineering
Subject Code: CH2210
Subject Name: Air Pollution Control

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Elective-I

Prerequisite: Understanding some basic information of pollutant dispersion.

Rationale: The main objective of this subject is to make students aware of air pollution and the control mechanism of pollutants. And also, to focus on the control technologies for specific pollutants

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction To Air Pollution:** Air Pollution, Sources of air pollution and its classification, Major air Pollutants and their characteristics, Specific group pollutants such as CFC, GHG etc. Effects of air pollution on human health and vegetation, animals and materials, brief introduction to air pollution sampling and measurement.	7
2	**Air Pollution Control:** Various mechanisms to control gaseous pollutants and particulate matter, Wet Collection of Particulate, Dry Collection, Gas Absorption, and Hybrid Systems	5
3	**Air Quality and Emission Standards:** National Ambient Air Quality Standards, Air Quality index, Salient features of Air pollution Control Act and rules, and Salient features of Ozone Depleting Substances Rules.	6
	SECTION-B	

Bachelor of Engineering
Subject Code: CH2210
Subject Name: Air Pollution Control

4	**Control Technologies for Specific Pollutants:** Control of Sulphur dioxide emission, nitrogen oxides, control of carbon monoxide, VOCs, ammonia, hydrogen chloride, and hydrogen sulfide	**5**
5	**Air Pollution Control Equipment Selection:** Introduction to control methods and equipment for Particulate matter and gases. Scrubbers (tray, vane type, and venturi), Electrostatic Precipitator, Gravity settlers, Cyclone separator, Filter bags etc.	**8**
6	**Mobile Source Air Pollution:** A/F ratio, engine design, fuel pre-treatment, use of alternative fuels, fuel additives, exhaust treatment or better tuning of the combustion process, catalytic converter, types of catalytic convertor, limitation of catalytic convertor and also achievements of catalytic convertor.	**5**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
40	30	15	10	05	00

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

Textbooks:

1. Rao, C.S., "Environmental Pollution Control and Engineering", New Age International (P) Limited, 2nd Ed., 2006.

Reference Books:

1. Tiwary, A., Williams, I., "Air Pollution: Measurement, Modeling and Mitigation", Taylor & Francis, 4th Ed., 2010.
2. Seinfeld, J.H., "Air Pollution. Physical and Chemical Fundamentals" McGraw Hill, N.Y., 1975.
3. Schifftner, K. C., "Air pollution control equipment selectin guide", Taylor & Francis Group, LLC, CRC Press, Broken Sound Parkway NW, 3rd Ed., 2014.

List of Practical/Tutorials: NIL

Bachelor of Engineering
Subject Code: CH2210
Subject Name: Air Pollution Control

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	Identify the major class of air pollutants.
CO-2	Describe various mechanisms to air pollution control.
CO-3	State various emission standards and rules of air pollution.
CO-4	Explain various control technologies for pollutants.
CO-5	Differentiate various air pollution control equipments.
CO-6	Describe various technologies to curb mobile source air pollution.

List of Open-Source Software/learning website: NIL

Bachelor of Engineering

Subject Code: CH2211

Subject Name: Wastewater Engineering

Shroff S.R. Rotary Institute of Chemical Technology

Semester: IV

Type of course: Professional Elective - I

Prerequisite: Basic Concepts of Chemistry.

Rationale: The objectives of this course are to help the students develop the ability to apply the basic understanding of physical, chemical and biological phenomena for successful design, operation and maintenance of wastewater treatment plant.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Characterization and Treatment of Wastewater:** Wastewater flow and its characteristics, Sources of Wastewater, types of collection systems, Wastewater Properties and constituents, constituents of concern,Sampling and Analytical procedures, recoverable resources in wastewater. Classification of Wastewater treatment methods: Physical Unit Processes, Chemical Unit Processes, Biological Unit Processes. Reactors used in Wastewater treatment: Batch Reactor, Complete-mix Reactor, Plug Flow Reactor, Fluidized-bed Reactor. Hydraulic Characteristics of Reactors: Ideal Flow in complete-mix and plug flow reactors, and Nonideal flow in complete-mix and plug flow reactors. Application of reactors.	8
2	**Physical Unit Processes:** Screening, Coarse Solids Reduction, Mixing and Flocculation, Gravity Separation Theory, Grit Removal, Primary sedimentation, High-Rate Clarification, Flotation. **Chemical Unit Processes:** Role of Chemical Unit Processes, Fundamentals of Chemical Coagulation, Chemical Precipitation for Improved Plant Performance, Chemical Phosphorus Removal, Chemical	4

	Precipitation for removal of Heavy Metals and Dissolved Substances. Conventional Chemical Oxidation, Chemical Neutralization, Scale control.	
3	**Biological Treatment:** Objectives of Biological Treatment, Role of Microorganisms in wastewater Treatment, Types of Biological Processes for wastewater Treatment, Composition and Classification of Microorganisms , Environmental factors, Bacterial Growth, Energetics, and Decay.	**6**
SECTION-B		
4	**Suspended Growth Biological Treatment Processes:** Introduction to the Activated-Sludge Process, Basic Process Description, Evolution of the conventional activated sludge Processes, Nutrient Removal Processes, Fundamentals of Process Selection, Design and Control, Activated Sludge Process Design, Aeration Tank Design for Activated-Sludge Processes.	**5**
5	**Attached Growth Biological Treatment Processes:** Introduction to the Attached Growth Process, Types of Attached Growth Processes, Nonsubmerged Attached Growth Processes, Trickling Filter Classification and Applications, Advantages and Disadvantages of Trickling Filters.	**5**
6	**Anaerobic and Advanced Treatment Processes:** The Rationale for Anaerobic Treatment, Advantages and disadvantages of Anaerobic Treatment Processes, Types of Anaerobic Technologies, Application of Anaerobic Technologies, Water Oxidation, Membrane filtration, Reverse osmosis.	**8**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	35	25	5	5	-

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

Textbooks:

1. Metcalf, Eddy, "Wastewater Engineering: Treatment and Resource Recovery", McGraw-Hill, 5th Ed., 2013.

Reference Books:

1. James, L. D., and Lee, R.R, "Economics of Water Resources Planning", McGraw-Hill, Newyork, 1971.
2. Mays, L.W., "Water Resources Handbook", McGraw-Hill, 1996.
3. Maass, A., Hufschmidt, M. M., Dorfman, R., Thomas, H. A., Marglin, S. A., Fair, G. M, "Design of Water-Resource Systems", Harvard University Press, 1962.
4. Garg, S. K., "Environmental Engineering, Volume I Water Supply Engineering", Khanna Publishers, 1977.
5. Raju, B. S. N., "Water Supply and Wastewater Engineering", Tata McGraw-Hill, New Delhi, 1995.

Course Outcomes:

Students should be able to

Sr. No.	CO statement
CO-1	Memorize Characterization of wastewater.
CO-2	Interpret the activated sludge process for the treatment of wastewater
CO-3	Compare the suspended and attached growth process for the treatment of wastewater
CO-4	Illustrate the advantages and disadvantages of anaerobic process.
CO-5	Compare aerobic and anaerobic processes.
CO-6	Relate anaerobic process for wastewater treatment.

List of Open-Source Software/learning website:

- Reference to NPTEL lectures can be made for a betterunderstanding.