Ref: UPL University /SRICT/BOS/CH/2023-24/02 **Date:** 13/02/2024

Proposed Teaching Scheme for Final Year Bachelor of Chemical Engineering

Semester-VII (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	Professional Core Course	CH2401	Process Equipment Design	3	0	2	5	4	70	30	20	30	150
2	Professional Core Course	CH2402	Process Optimization	3	0	0	3	3	70	30	00	00	100
3	Professional Elective -V	CH2403/04	Professional Elective -V	3	0	2	5	4	70	30	20	30	150
4	Professional Elective -VI	CH2405/06	Professional Elective - VI	3	0	0	3	3	70	30	00	00	100
5	Open Elective-V	CH2407/08	Open Elective-V	3	0	0	3	3	50	30	20	0	100
6	Project work, seminar and internship in industry or elsewhere	MH2401	In Plant Training	0	0	6	6	3	0	0	20	80	100
	Total						**25**	**20**					**700**

Semester-VIII (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	Professional Core Course	CH2409	Transport Phenomena	3	1	0	4	4	70	30	20	30	150
2	Professional Elective - VII	CH2410/11	Professional Elective -VII	3	0	0	3	3	70	30	00	00	100
3	Open Elective-VI	CH2412/13	Open Elective-VI	3	0	0	3	3	70	30	00	00	100
4	Project work, seminar and internship in industry or elsewhere	MH2402	Project	0	0	18	18	9	00	00	100	100	200
	Total						**28**	**19**					**550**

A. Course Code and Definition:

Abbreviations	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 Courses Sem-VII and VIII

BE Sem -VII			
Sr. No.	**Category of Course**	**Code No.**	**Course Title**
1.	Professional Elective -V	CH2403	Computer Aided Process Synthesis
2.		CH2404	Process Modeling and Simulation
3.	Professional Elective -VI	CH2405	Process Intensification
4.		CH2406	Biochemical Engineering
5.	Open Elective-V	CH2407	Artificial Intelligence in Chemical Engineering
6.		CH2408	Entrepreneurship Development

BE Sem -VIII			
Sr. No.	**Category of Course**	**Code No.**	**Course Title**
1.	Professional Elective -VII	CH2410	Mechanical Design of Process Equipment
2.		CH2411	Piping Design
3.	Open Elective-VI	CH2412	Industrial Organization and Management
4.		CH2413	Project Management

Bachelor of Engineering
Subject Code: CH2401
Subject Name: Process Equipment Design

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Professional Core Course

Prerequisite: Learning process equipment design requires a foundation in engineering fundamentals like thermodynamics, fluid mechanics, and mass transfer, along with chemical engineering principles and mathematics.

Rationale: The objective of this course is to explore the design principles of significant chemical engineering equipment like distillation tower, absorbers, and heat exchangers. Additionally, the subject covers the design of piping systems. Students will gain proficiency in simulating these equipment designs using simulators, enabling them to practically apply their knowledge in designing such Equipment.

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

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction to process equipment design:** Role of process engineer, generalizes approach to the chemical plant design, importance of process diagrams	**2**
2.	**Process design of Piping and Pumps**: Process design of piping, NPSHA & NPSHR, Power required by pump, Power required in Fan, Blower and adiabatic compressor, Flow meters, Process design of Orifice meter & Rota meter.	**8**
3.	**Process design of Heat Exchangers:** Shell & Tube heat exchangers, Functions of various parts of shell & Tube Heat exchanger, General design method of shell & tube heat exchanger, Criteria of selection among Fixed Tube sheet, U Tube & Floating Head heat exchanger, Process design of without phase change heat exchanger, Process design of condenser, Criteria of selection for Horizontal and vertical condenser, Process design of Kettle type & Thermosyphon Reboilers and vaporizes, Tinker's flow model.	**8**
	SECTION-B	

4.	**Process design of Distillation Column:** **Multicomponent distillation:** Introduction, Criteria of selection, Selection of equipment for distillation, Distillation column design, Selection of key components for multi- component distillation, Determination of operating pressure for distillation column, Advantages & disadvantages of vacuum distillation, Determination of nos. of theoretical stages for multi-component distillation by Fenskey- Underwood-Gilliland's method.	**6**
5.	**Tray tower sizing:** Selection of trays, Calculations for tower diameter & pressure drop of sieve tray tower, Checking of conditions for weeping, down comer flooding, liquid entrainment, etc, tray efficiency, Jet Flooding & down comer Flooding, Different types of weirs & down comers of tray tower, their selection criteria	**6**
6.	**Process design of Absorbers:** Introduction, Criteria for selection among different types of absorption equipment, Process Design of packed tower type absorber: Determination of actual amount of solvent, Selection of packing, Determination of tower diameter & pressure drop, Determination of NtoG, HtoG & height of packing, Process design & selection criteria of liquid distributors, redistributors & packing support, Process design of spray tower type absorber, Venturi Scrubber	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
0	10	25	30	20	15

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

Textbooks:

1. S B Thakore and B I Bhatt, Introduction to Process Engineering and Design, 2nd Edition, McGraw Hill, 2015.

Reference Books:

1. Coulson, J. M., & Richardson, J. F., Chemical engineering design (4th ed., Vol. 6). Butterworth-Heinemann, 1999.
2. Ludwig, E. E., Applied process design for chemical and petrochemical plants, 3rd ed., Vols. 1-3. Butterworth-Heinemann, 1997.
3. Don W. Green, Marylee Z. Southard, Perry's Chemical Engineers' Handbook, 9th Edition, McGraw Hill Professional, 2018.

Bachelor of Engineering
Subject Code: CH2401
Subject Name: Process Equipment Design

Shroff S.R. Rotary Institute of Chemical Technology

List of Practicals:

Sr. No.	Practical	Approx. Hours required
1.	Basic symbols of process equipment, piping and instrumentation	02
2.	Drawing of Process flow diagram in simulator.	02
3.	Pressure drop study in piping.	02
4.	Pumping design	02
5.	Heat exchanger designing.	02
6.	Sensitivity analysis of heat exchangers.	02
7.	Distillation designing for Binary system.	02
8.	Distillation designing for multi component distillation	02
9.	Absorption packed tower designing	02
10.	Sensitivity analysis of Packed tower.	02

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Identify key concepts and techniques to design process equipment in a process plant and to understand sizing of fluid moving devices such as pumps, blowers and fans.
CO-2	Understand working of flow measuring instruments and to design orifice and rotameters.
CO-3	Compare and contrast different types of heat exchanger used in industry and design heat exchanger equipment.
CO-4	Apply knowledge of distillation column design to modify the design of existing equipment to new process conditions or new required capacity
CO-5	Design the distillation tower sizing and down comer designing.
CO-6	Classify various absorption equipment used in chemical industry and determine tower diameter & pressure drop.

List of Open Source Software/learning website:

- https://archive.nptel.ac.in/courses/103/107/103107207/

Bachelor of Engineering
Subject Code: CH2402
Subject Name: Process Optimization

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Professional Core Course

Prerequisite: Basic knowledge of differential calculus and basic mathematics.

Rationale: The objective of this subject is to study concepts of optimization in chemical engineering. In design, construction and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. In this course, the optimization problem formulation, Linear Programming and Non Linear Programming are briefly introduced.

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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction to optimization:** Historical development, Engineering applications of optimization, Statement of an optimization problem: Design vector, Design constraint, Constraint surface, Objective function, Obstacles in optimization.	**6**
2.	**Developing Models for Optimization:** Classification of Models, How to Build a Model, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Examples of Inequality and Equality Constraints in Models, Basic formulation of objective function.	**6**
3.	**Basic concept of optimization:** Continuity of function, NLP problem statement, convexity and its applications, interpretation of the objective function in terms of its quadratic approximation, Economic Objective Functions.	**6**
	SECTION-B	
4.	**Optimization of Unconstrained Functions: One-Dimensional Search:** NLP Problem, Convexity, Necessary and Sufficient Conditions, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods, Polynomial Approximation Methods.	**6**

5.	**Linear Programming (LP):** Geometry of Linear Programs, Simplex Algorithm, Sensitivity Analysis, Linear Mixed Integer Programs, LP Software.	**5**
6.	**Mixed Integer Programming:** Branch-and-Bound Methods Using LP Relaxations, Solving MINLP Problems Using Branch-and-Bound Method, Solving MINLPs Using Outer Approximation. Applications of Optimization: Optimal Pipe Diameter, Plant wide Management and Optimization.	**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	20	20	10

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

Textbooks:

1. Singiresu S. Rao, Engineering Optimization: Theory and Practice, 3rd Edition, New Age International Publishers, 2013.
2. Thomas F. Edgar, David Mautner Himmelblau, Leon S. Lasdon, Optimization of Chemical Processes, 2nd Edition, McGraw Hill, 2001.

Reference Books:

1. Dutta Suman, Optimization in Chemical Engineering, 3rd Edition, Cambridge University Press, 2016
2. Edwin K.P. Chong, Stanislaw H. Zak, Introduction to Optimization, 4th Edition, Wiley India, 2017.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	**CO statement**
CO-1	Comprehend the techniques and applications of Engineering optimization.
CO-2	Understand characteristics of a general linear programming problem
CO-3	Apply basic concepts of mathematics to formulate an optimization problem
CO-4	Analyze various methods of solving the unconstrained minimization problem
CO-5	Comprehend and appreciate variety of performance measures for various

	optimization problems.
CO-6	Understand Integer programming problems with its applications.

List of Open Source Software/learning website:

- https://archive.nptel.ac.in/courses/103/105/103105139/

Bachelor of Engineering
Subject Code: CH2403
Subject Name: Computer Aided Process Synthesis

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Professional Elective-V

Prerequisite: Understanding chemical engineering fundamentals including basics of unit operations

Rationale: Learning CAPS provides students with a practical understanding of computational tools, enhances their problem-solving abilities, and prepares them for the role of process engineer. The knowledge of CAPS is essential for addressing complex engineering challenges, improving process efficiency, and ensuring sustainable and cost-effective solutions in the field.

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

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**The Design Process:** Design Opportunities, Steps in Product Process Design, Environmental Protection, Safety Considerations, Engineering Ethics, Role of Computers, Simulation to assist in process creation	5
2	**Reactor Design and Reactor Network Synthesis:** Objectives, Reactor Models, Reactor Design for complex configurations, Reactor Network Design using the Attainable Region	4
3	**Synthesis of Separation Trains:** Introduction, Criteria for Selection of Separation Methods, Selection of Equipment, Sequencing of Ordinary Distillation for the Separation of Nearly Ideal Fluid Mixtures, Heuristics for Determining Favourable Sequences, Marginal Vapour Rate Method, Complex and thermally coupled distillation, Sequencing of Ordinary Distillation for the Separation of Nearly Non-Ideal Fluid Mixtures, Sequencing of Ordinary Distillation for the Separation of nearly Non-Ideal fluid mixtures	9
	SECTION-B	
4	**Heat Integration:** Basic Heat Exchanger Network Synthesis (HENS), Minimum Utility Targets, Temperature Interval Method, Hohmann / Lochart Composite Curves (HCC), Grand Composite Curves (GCC), Pinch Design Approach to Inventing a Network, Networks for Maximum Energy Recovery, Minimum Number of Exchangers, Stream Splitting, Threshold and Optimum Approach Temperature, Derivation of Network Superstructures for	9

	Minimization of Annual Costs, Multiple Utility Design Problems, Heat integrated distillation trains	
5	**Optimal Design and Scheduling of Batch Processes:** Introduction, Design of Batch Process Units, Design of Reactor-Separator Processes, Design of Single Product Processing Sequences, Design of Multi-Product Processing Sequencing	**6**
6	**Heuristics in Process Synthesis:** Raw materials, chemical reactions, separations, heat exchangers, pumping, compression, conveying of solids	**3**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**25**	**30**	**15**	**10**	**05**

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

Textbooks:

1. Warren D. Seider, J. D. Seader, Daniel R. Lewin, Product and Process Design Principles: Synthesis, Analysis, and Evaluation, 2nd Edition, Wiley.

Reference Books:

1. James M. Douglas, Conceptual Design of Chemical Processes, McGraw Hill International, 1988.
2. Robin Smith, Chemical Process: Design and Integration, Wiley.
3. Lorens T. Biegler, E. Ignacio Grossmann, Arthur W. Westerberg, Systematic Methods of Chemical, Process Design, Prentice Hall International.
4. Uday V Shenoy, Heat Exchanger Network Synthesis: Process Optimization by Energy and Resource Analysis, Gulf Professional Publishing, 1995.

List of Practicals:

Sr. No.	**Practical**	**Approx. Hours required**
1.	Non-linear regression analysis to determine optimum Antoine equation constants	02
2.	Introduction to process simulator	02
3.	Estimation of minimum utility target and pinch point using HINT	02
4.	Estimation of threshold approach temperature using HINT	02

5.	Estimation of the minimum utility target and pinch point using LPP with GAMS	02
6.	Material balance over multicomponent separation columns using array calculation in MS excel	02
7.	Simulation studies on reactors using process simulator for the production of ethyl acetate	02
8.	Simulation of short cut distillation using process simulator for the separation of multicomponent	02
9.	Residue curve mapping using process simulator	02
10.	Design and scheduling of batch process using Gantt charts	02

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	State various heuristics in process synthesis.
CO-2	Describe various steps in process design.
CO-3	Analysis energy targets to design HEN using pinch technology.
CO-4	Select an appropriate separation method for synthesizing separation trains.
CO-5	Develop reactor network synthesis using attainable region.
CO-6	Design batch processes using cycle time for a single/multi product plants.

List of Open-Source Software/learning website:

COFE, DWSIM, HINT, SciLAB and GAMS

Bachelor of Engineering
Subject Code: CH2404
Subject Name: Process Modeling and Simulation

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Professional Elective-V

Prerequisite: Understanding chemical engineering fundamentals including basics of unit operations.

Rationale: Process Modeling and Simulation in chemical engineering offer an essential framework for understanding and designing chemical processes through parameters estimation, network decomposition, numerical methods, data regression, convergence promotion, specific-purpose simulation, and dynamic simulation.

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

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction to Process Modeling:** General Aspects of Modeling, Introduction to Regression Analysis, physical and mathematical modeling, deterministic and stochastic process, classification of models, model building, black-box model, white box model, gray model.	5
2	**Fundamental Laws for Modeling:** Introduction, uses of mathematical models, scope of coverage, principles of formulation, fundamental laws, continuity equations, energy equations, equation of motion, transport equation, equation of state	4
3	**Mathematical Models of Chemical Engineering Systems**: Introduction, series of isothermal, constant-hold up CSTR, CSTR with variable holds up, two heated tanks, gas-phase, pressurized CSTR, non-isothermal CSTR, single-component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.	9
	SECTION-B	
4	**Introduction to Process Simulation:** Introduction, process design and simulation, steps in solving simulation problems, Basic architectures for commercial software, Degrees of freedom analysis, limitations, and applications of process simulation, good habits for process simulation.	9
5	**Modes of simulation:** Modular and Equation Solving Approaches, sequential modular approach to Process Simulation, decomposition of network, tearing	6

	algorithm, tips in handling recycle streams, Simultaneous modular simulation approach, Equation-Solving Approach	
6	**Registration of new components and exercises:** Steady state and dynamic simulation, Types of process simulators, open source and commercial simulators, Registration of hypothetical components	**3**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**25**	**30**	**15**	**10**	**05**

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

Textbooks:

1. William L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill International Editions.

Reference Books:

1. B V Babu, Process Plant Simulations, Gulf Publications.
2. B Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall International Inc.
3. Foo D. C. Y. Foo, Chemical Engineering Process Simulation, 2nd Edition, Elsevier, 2003.

List of Practicals:

Sr. No.	**Practical**	**Approx. Hours required**
1.	Modeling of semi empirical equation	02
2.	Introduction to process simulator	02
3.	Modeling MILP and MINLP using GAMS	02
4.	Simulation of ammonia production process	02
5.	Simulation studies on reactors using process simulator for the production of ethyl acetate	02
6.	Write simple codes for solving chemical engineering models using MATLAB	02
7.	To familiarize students with various logical operators of CHEMCAD	02
8.	Simulation of short cut distillation using process simulator for the separation of multicomponent	02
9.	Perform steady-state simulations of some simple flow sheet	02

10.	Perform Recycle Operations in a flowsheet	02

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Relate various types of models.
CO-2	Discuss various fundamental laws of chemical engineering.
CO-3	Illustrate various mathematical models of chemical engineering systems.
CO-4	Explain the basics of chemical process simulation.
CO-5	Design and develop various process flow diagram using process simulation.
CO-6	Solve process flow diagram problems using an appropriate mode of simulation

List of Open-Source Software/learning website:

COFE, DWSIM, HINT, SciLAB and GAMS

Bachelor of Engineering
Subject Code: CH2405
Subject Name: Process Intensification

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Professional Elective Course-VI

Prerequisite: Basic knowledge of heat, mass transfer and chemical reaction engineering.

Rationale: Process intensification does not address catalyst composition modifications or the development of novel chemical routes; it solely addresses engineering tools and methodologies. Process intensification is the process of developing new instruments and techniques to improve processing and output while drastically lowering energy usage, waste generation, equipment size/production-capacity ratio, and other variables. Process intensification produces technology that is much safer, cleaner, more energy-efficient, and smaller.

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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Overview of the Intensification Process:** The Process Intensification History Process Intensification Definitions and Interpretations The Principles, Approaches, Domains, and Scales of Process Intensification Applications of Process Intensification (PI) Techniques, advantages of process intensification, equipment for process intensification, toolkit for process intensification, and PI application techniques.	**6**
2.	**Novel Reactors:** Overview of the Spinning Disc Reactor The Taylor-Couette reactor, the STT reactor, and other rotor stator reactors Rotating reactors with packed beds, Oscillatory baffled reactors (OBRs), Hydrodynamic Cavitation Reactors, HEX-reactors, and Micro-reactors (The Catalytic Plate Reactor (CPR)).	**7**
3.	**Intensive Mixers:** Chemical processing in high-gravity fields, mixing in intensified equipment, ultrasonic atomization, nebulizers, high intensity inline mixer reactors, Static mixers, ejectors, tee mixers, impinging jets, rotor stator mixers.	**5**
	SECTION-B	
4.	**Structured Catalysts and Reactors:** Three-Levels-of-Porosity (TLP) Reactors, Membrane-Enclosed Catalytic Reactors (MECR), Environmental Catalysis,	**5**

	Hydrodynamics and Mass Transfer in Monoliths, Gauzes, Structured Packings, and Foams will all be covered in this overview of structured reactors.	
5.	**Hybrid Separation:** Membrane extraction, extractive distillation, short path distillation, adsorbent distillation, membrane absorption/stripping, adsorbent membranes (membrane chromatography), membrane distillation, Supercritical dissociation. **Integration of reaction and separation:** Heat Integrated Distillation Trains, Reactive distillation, Reactive extraction, Reactive absorption, Fundamentals of process modeling in integrated systems, Case studied such as Absorption of NOx, Coke Gas Purification, Methyl Acetate Synthesis, Synthesis of Methyl Tertiary Butyl Ether.	**8**
6.	**New Heat Exchangers:** Plate heat exchangers, Graphite plate heat exchangers, Spiral heat exchangers, Printed circuit heat exchangers, The Chart-flow heat exchanger, Flat tube-and-fin heat exchangers, Microchannel heat exchangers, Polymer film heat exchanger, Foam heat exchangers, Mesh heat exchangers, Selection of heat exchanger technology, Integrated heat exchangers in separation processes	**5**

Suggested Specification table with Marks (Theory):

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

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

Textbooks:

1. David Reay, Colin Ramshaw, Adam Harvey, Process Intensification Engineering for Efficiency, Sustainability and Flexibility, 3rd Edition, Elsevier Science, 2013.

Reference Books:

1. Stankiewicz, A., Moulijn, Reengineering the Chemical Process Plants, Process Intensification, Marcel Dekker, 2003.
2. Kamelia Boodhoo, Adam Harvey, Process Intensification for Green Chemistry, Engineering Solutions for Sustainable Chemical Processing, Willey, 2013.

Bachelor of Engineering
Subject Code: CH2405
Subject Name: Process Intensification

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Demonstrate the importance of process intensification.
CO-2	Illustrate fundamentals of various novel reactors.
CO-3	Apply fundamentals of process intensification in chemical industry.
CO-4	Explain structured catalytic reactors.
CO-5	Assess various integration opportunity.
CO-6	Compare various heat exchangers.

List of Open Source Software/learning website:

- https: nptel.ac.in/courses/103/103/103103152/

Bachelor of Engineering
Subject Code: CH2406
Subject Name: Biochemical Engineering

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Professional Elective Course-VI

Prerequisite: Basic knowledge of unit operations, chemical reaction engineering.

Rationale: The objective of this subject is to study different biochemical processes, concepts of biochemical reaction, factors affecting rate of biochemical reactions kinetics of enzyme catalyzed reactions design of reactors to perform biochemical reactions along with their applications in various industry.

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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction to Bioscience:** Types of microorganisms, structure and function of microbial cells, fundamentals of microbial growth, batch and continuous culture, sterilization methods, isolation and purification of enzymes from cells. Downstream processing and product recovery in bioprocesses, assay of enzymes, cell growth measurement.	**6**
2.	**Stoichiometry:** Stoichiometry of microbial growth and product formation, elemental balances, degree of reduction, yield coefficient, respiratory quotients. Oxygen uptake rate, Biomass production in cell cultures, phases of microbial growth, measurement of microbial growth by various methods.	**6**
3.	**Kinetics of enzyme catalyzed reactions:** Properties of enzymatic reactions, Various models for enzyme-substrate complex formation, factors affecting enzyme activity, Michaelis-Menten equation: derivation and graphical evaluation of kinetic parameters, Enzyme inhibition, Enzyme immobilization, different methods of immobilization. Environmental factors affecting microbial growth.	**6**
	SECTION-B	
4.	**Design of reactors for enzyme catalyzed reactions:** Growth of organisms in batch reactor, continuous culture of organism, comparison between batch and continuous biomass culture, Stirred tank reactor in series and stirred tank reactor with recycle of	**6**

	biomass. Fed batch reactor, plug flow reactor.	
5.	**Design of Fermentor:** Basic Functions, Body construction, Maintenance of aseptic conditions, Control of parameters, Valves and steam traps, Variants of fermentation vessels, Oxygen requirement in fermentations, Aeration and Agitation, Determination of kLa values, Fluid rheology, Factors affecting kLa values.	**6**
6.	**Applications:** Applications of enzymes in industry and medicine, carbohydrates, starch conversion and cellulose conversion, food industry, biofuel production, waste water treatment.	**6**

Suggested Specification table with Marks (Theory):

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

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

Textbooks:

1. Michael L Shuler & Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, PHI, New Delhi.

Reference Books:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, John Wiley and Sons, 2006.
2. James Bailey & David F Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill Publications.
3. Whitaker, Peter F Stanbury, S. Hall and A. Whitaker, Principles of Fermentation Technology, 2nd Edition, Butterworth-Heinemann Publications.
4. Shuichi Aiba, Arthur Earl Humphrey, Nancy F. Millis, Biochemical Engineering, 2nd edition, Academic Press, 1973.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	**CO statement**
CO-1	Demonstrate the cell cultivation and enzymatic processes and downstream processing.
CO-2	Understand basic features of a biochemical reaction and its stoichiometry
CO-3	Know enzyme kinetics and cell kinetics.

CO-4	Derive the performance equation of bioreactor.
CO-5	Design aspects of the fermentor system.
CO-6	Identify application of enzyme in various industry.

List of Open Source Software/learning website:

- https: nptel.ac.in/courses/103/105/103105054/
- https: nptel.ac.in/courses/102/105/102105064/

Bachelor of Engineering
Subject Code: CH2407
Subject Name: Artificial Intelligence in Chemical Engineering
Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Open Elective-V

Prerequisite: Basic knowledge of mathematics & chemical engineering principles.

Rationale: The objective of this subject is to study fundamentals of artificial intelligence, understand different machine learning methods and their applications in chemical engineering.

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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction:** History of AI, Need of AI in Chemical Engineering, Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation.	**6**
2.	**Approaches to Artificial Intelligence:** Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical, Supervised learning, Unsupervised learning, Reinforcement learning.	**6**
3.	**Artificial Neural Networks:** Introduction to Artificial **Neural** Networks, Network architecture, ANN terminologies, selection of hidden layers, Normalizing the input and output data sets, Initializing the Learning Rate, Selecting of Transfer Function, Generating a Network Learning curve.	**6**
	SECTION-B	
4.	**Clustering:** Distance measures, Different clustering methods (Distance, Density, Hierarchical), Iterative distance-based clustering, Dealing with continuous, categorical values in K-Means, Constructing a hierarchical cluster, K-Mode and density-based clustering, Measures of quality of clustering	**7**
5.	**Classification:** Naive Bayes classifier, Decision tree, Random forest, Support vector machine	**7**
6.	**Applications of AI in Chemical Engineering :** Control system, property prediction, elucidation of kinetics and thermodynamic parameters, chemical product distribution, fault detection, process safety etc.	**4**

Bachelor of Engineering
Subject Code: CH2407
Subject Name: Artificial Intelligence in Chemical Engineering
Shroff S.R. Rotary Institute of Chemical Technology

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	10	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. S. N. Sivanandam, S. Sumathi and S. N. Deepa, Introduction to Neural Networks Using Matlab 6.0, Tata McGraw Hill Education, 2012.
2. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," 3rd edition, Pearson, 2003.

Reference Books:

1. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
2. Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence, McGraw Hill, 3rd ed., 2009
3. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
4. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
5. P Kulkarni and P Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015.
6. S S. Tambe, B. D. Kulkarni, P. B. Deshpande, Elements of Artificial Neural Networks with Selected Applications in Chemical Engineering, and Chemical and Biological Sciences, Simulation & Advanced Controls, Incorporated, 1996.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Demonstrate fundamentals of artificial intelligence and machine learning.
CO-2	Understand artificial neural network architecture
CO-3	Apply machine learning algorithms for classification problems.
CO-4	Apply machine learning algorithms for regression problems.
CO-5	Develop a machine learning models

CO-6	Simulate machine learning model in chemical engineering problems.

List of Open Source Software/learning website:

- http://nptel.ac.in/courses/111101003/
- https://nptel.ac.in/courses/106/106/106106202/
- https://nptel.ac.in/courses/112/103/112103280/ents/

Bachelor of Engineering
Subject Code: CH2408
Subject Name: Entrepreneurship Development

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VII

Type of course: Open Elective-V

Prerequisite: None

Rationale: This subject equips chemical engineering students with the entrepreneurial mindset and innovation skills crucial for addressing industry challenges.

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	0	3	70	30	00	00	100

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction to Entrepreneurship –** Who Is an entrepreneur? Entrepreneurial Dreams and Their Outcomes, Challenging Assumptions—Entrepreneurship Is for all, Types of entrepreneurs, Entrepreneurs: Made or Born, The Entrepreneurial Personality and mindset, Opportunity Recognition	**8**
2	**Business Models and Planning & Lean Startups:** Introduction to Understanding different business models, Win-Win model, Double Whammy, Fractional Ownership, Perceived Shortage business models, business model innovation framework, Lean canvas model and business model canvas	**6**
3	**Intellectual Property and Legal Considerations:** Intellectual Property Rights, Copyrights, Trade Secrets Trademarks, Patents, Intellectual Property Rights in India, Legal Issues to Consider when Starting Your Business	**4**
	SECTION-B	
4	**Funding and Financing:** Factors Influencing Entrepreneurship, financial analysis (ratio, breakeven, investment process, profitability analysis, Social Cost-Benefit Analysis), budget and planning, Source of finance (Project Financing, Institutional Finance to Entrepreneurs, Financial Institutions)	**4**
5	**New-age Entrepreneurship:** Technology Transfer and Commercialization: Challenges, Creating User Experience Design, Humanizing Technology and Success stories	**8**
6	**Ethical and Sustainable Entrepreneurship:** Sustainable Entrepreneurship, Challenges to Sustainable Entrepreneurs, Business ethics, Corporate Social Responsibility, Case studies	**6**

Bachelor of Engineering
Subject Code: CH2408
Subject Name: Entrepreneurship Development

Shroff S.R. Rotary Institute of Chemical Technology

Suggested Specification table with Marks (Theory):

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

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

Textbooks:

1. Brannback, M. and Carsrud, A. Fundamentals for becoming a successful Entrepreneur, Old Tappan, New Jersey, Pearson Education, Inc

Reference Books:

1. Chakravarthy, B.K., Krishnamoorthi, J. Innovation by Design: Lessons from Post Box Design & Development, Springer, 2013.
2. Gurmeet Naroola, The Entrepreneurial Connection: East Meets West in the Silicon Valley.
3. Desai, V, The dynamics of entrepreneurial development and management, 6th Edition, Himalaya Publishing house.
4. Dr. S. S. Khanka, Entrepreneurship Development, 1st edition, S. Chand & Company Ltd., 1999.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define Entrepreneurships and its types.
CO-2	Describe various business models for entrepreneurship.
CO-3	Infer various intellectual property.
CO-4	Explore various source of finance for entrepreneurship.
CO-5	Plan on converting idea to a successful entrepreneurial firm.
CO-6	Develop an entrepreneurial mind-set and awareness about successful entrepreneurs.

List of Open-Source Software/learning website:

www.onlinecourses.nptel.ac.in/noc23_de04/course

Bachelor of Engineering
Subject Code: CH2409
Subject Name: Transport Phenomena

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VIII

Type of course: Professional Core Course

Prerequisite: Basic knowledge of Mass Transfer, Process Heat Transfer, Fluid Mechanics and Mathematics.

Rationale: The objective of this subject is to study the concept of mass, momentum and heat transfer in different geometrical regimes in different condition by shell balance equations and to understand the mathematical structure of the three phenomena. It is also focused to solve the problems by deducing equation of motion.

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

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction to Transport Phenomena**: Classification of Transport Processes, Conservation Laws, Vector and Tensor Calculus.	**2**
2.	**Momentum Transport:** Newton's Law of Viscosity and viscosity estimation, Shell Momentum Balance, Application of Shell Momentum Balance for Flow of Falling Film, Flow Through Circular Pipe, Flow Through annulus, Flow Over Moving Plate, Flow of adjacent immiscible fluids	**10**
3.	**Equation of Changes and Time Dependent Flow of Newtonian Fluids:** Continuity Equation, Equation Motion, Navier-Stokes Equation. Use of equation of change to solve flow problems.	**6**
	SECTION-B	
4.	**Steady State Heat Transport:** Fourier's Law of heat conduction and estimation of thermal conductivity, Shell Energy Balance.	**2**
5.	**Applications of Shell Energy Balance:** Heat Conduction with Electrical Source, Heat conduction with Nuclear heat source, Heat conduction viscous heat source, Heat Conduction with Chemical Heat Source, Heat Conduction in a Cooling Fin, Forced Convection, Energy Equation.	**8**

6.	**Mass Transport:** Fick's law of binary diffusion and estimation of diffusivity, Mass and Molar Concentrations, Mass Average and Molar Average Velocity, Mass and Molar Fluxes, Convective Mass and Molar Fluxes, Shell mass balance, Applications of Shell mass balance for Diffusion Through a Stagnant Gas Film, Diffusion with Heterogeneous Chemical Reaction, Diffusion With Homogeneous Chemical Reaction, Diffusion Into a Falling Liquid Film	**8**

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	10	10	-

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

Textbooks:

1. R. B. Bird, W. E. Stewart, E. N. Lightfoot. "Transport Phenomena", 2nd Edition, John Wiley & Sons (Asia) pvt. Ltd., 2002.

Reference Books:

1. C. J. Geankoplis, "Transport Processes and Separation Process Principles", 4th Edition, PHI Learning Private Limited., New Delhi 3.
2. W. J. Thomson, "Introduction to Transport Phenomena", Prentice Hall, 2000.
3. Don W. Green, Marylee Z. Southard, Perry's Chemical Engineers' Handbook, 9th Edition, McGraw Hill Professional, 2018.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Illustrate transport equations using vector and tensor calculus
CO-2	Estimate transport properties such as viscosity, conductivity and diffusivity
CO-3	Solve transport problems using shell balance methods
CO-4	Develop equation of changes from conservation laws for momentum, energy and mass transport
CO-5	Compare the mechanisms of transport processes

Bachelor of Engineering
Subject Code: CH2409
Subject Name: Transport Phenomena

CO-6	Apply transport laws in chemical processes.

List of Open Source Software/learning website:

https://archive.nptel.ac.in/courses/103/102/103102024/

Bachelor of Engineering
Subject Code: CH2410
Subject Name: Mechanical Design of Process Equipment

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VIII

Type of course: Professional Elective -VII

Prerequisite: Learning Mechanical equipment design requires a foundation in engineering fundamentals like Process equipment design, material science and mathematics.

Rationale: This course focuses on imparting in-depth knowledge of mechanical design principles for chemical engineering equipment. The course addresses key components' mechanical design, including shells, heads, nozzles, agitators, jackets, trays, and supports, using both graphical and analytical methods for pressure analysis. Selection and designing components like flanges and support structures are highlighted, preparing students for diverse chemical process equipment design challenges.

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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction:** Design pressure and temperature, design and allowable stress, Static and rotary equipments, Different types of welding joints, joint efficiency and methods of fabrication of equipment, Radiography, Codes, standard and specification for pressure vessel, Mechanical properties of material.	**2**
2.	**Design of Pressure vessel**: Mechanical design of shell and head subjected to internal and external pressure, Graphical & analytical method for shell and head subjected to external pressure, Shell design for external pressure with & without stiffening ring, Different types of Nozzles and design of reinforcement pad for nozzle by area for area method, Different types of flanges, flange facings, gaskets and their selection criteria. Different types of agitators & their selection criteria, Determination of power required for agitation, shaft diameter, blade thickness, etc., Various types of jackets and coils for reactors	**12**
3.	**Design of Storage Tank:** Types of storage tanks, Capacity of storage tank, its diameter & height, Design of fixed roof storage tank, Design of structural supported conical roof.	**4**

SECTION-B		
4.	**Design of Shell & Tube Heat Exchangers:** Mechanical design of Shell, tube, tube sheet, head, channel shell, etc. of shell & tube heat exchanger	**4**
5.	**Design of tall vessels:** Mechanical design of shell, head, tray support for Vertical tall tower, Determination of shell thicknesses at various heights for tray tower & packed tower in case of internal & external pressure, Different types of tray support.	**8**
6.	**Supports for vessels** Design consideration for supports for process equipments, Design of brackets support, leg support skirt, support, saddle support.	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
07	21	21	07	14	00

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

Textbooks:

1. Bhattacharyya, B. C., Introduction to chemical equipment design: Mechanical aspects, 5th edition, CBS Publishers, 2008.

Reference Books:

1. Joshi, M. V., & Mahajani, V. V., Process equipment design 3rd edition. MacMillan, 1996.
2. Brownell, L. E., & Young, E. H., Process equipment design, Wiley Eastern, 1977.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Define various process equipments according to various design codes and standards
CO-2	Perform design of process equipments subjected to internal pressure and external pressure.

CO-3	Solve the mechanical design related problem for different types of roofs.
CO-4	Design the shell & tube heat exchangers
CO-5	Evaluate stress & thickness calculation for tall vessels.
CO-6	Design different supports for pressure vessel.

List of Open Source Software/learning website:

- https://archive.nptel.ac.in/courses/103/107/103107143/

Bachelor of Chemical Engineering
Subject Code: CH2411
Subject Name: Piping Design

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VIII

Type of course: Professional Elective-VII

Prerequisite: Students should have a basic knowledge about the engineering principles such as mechanics, thermodynamics, and fluid mechanics. Proficiency in engineering graphics and computer-aided design (CAD) tools is essential, along with knowledge in fluid mechanics, materials science, and thermodynamics. Familiarity with mechanical design principles, stress analysis, and structural integrity is necessary.

Rationale: The present course serves a crucial purpose in your engineering program, laying the foundation for students to understand and apply essential skills in designing and analyzing safe, efficient, and compliant piping systems for chemical and process plants. It is also intended to familiarize undergraduate students about the fundamental design aspects of piping components and their applications in 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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction to Piping:** Overview of piping systems in chemical process plants, Piping classifications and applications, difference between pipe and tube Pipe materials and their properties. Selection of pipe materials based on process requirements, Joining methods, Determination of pipe size and flow velocity considerations.	**5**
2.	**Piping Components and Design:** Types of pipe fittings and their selection, Valves, flanges and fittings, Pressure relief devices (safety valves, rupture discs) and their selection, Expansion joints and bellows, Pipe supports and hangers, design considerations for condensable and non-condensable gases.	**6**
3.	**Pipe Stress Analysis:** Introduction to stress and strain in piping systems Internal and external pressure stresses, Thermal expansion and contraction stresses, Types of loads on piping systems (dead weight, pressure, thermal, etc.). Failure theories and allowable stresses. Stiffness matrix formulation for pipe segments.	**7**

SECTION-B		
4.	**Codes and Standards:** Introduction to piping codes and standards (ANSI/ASME B31.3, B31.4, etc.), Code Structure and Interpretation, Design pressure and temperature considerations, Material qualifications and corrosion resistance, Fabrication and inspection requirements.	**5**
5.	**PFD and P& ID, its software and Plant layout:** Difference between a PFD and P&ID, Typical P&ID diagrams for pumps, distillation column, Reactors and Shell and tube heat exchanger. Importance of piping layout in process plant design. Basic concepts of piping systems and their components. Key considerations in piping layout design (flow optimization, space constraints, safety, maintainability). Introduction to Plant design & Management software (PDMS) developed by AVEVA PLANT	**7**
6.	**Case Studies and Applications:** Analyzing and designing piping systems for specific chemical processes (reactor feed, product lines, cooling water systems, etc.), Troubleshooting and optimizing existing piping systems based on PFD and P&ID data, Integrating piping design with other process equipment and plant layout. Preparing piping design documentation for construction and fabrication.	**6**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	25	15	10	-

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

Textbooks:

1. M. Nayyar, Piping Handbook, 7th Edition, McGraw-Hill(1992).
2. C. Geankoplis, Codes and Standards for Process Piping.

Reference Books:

1. R.H.Perry., "Chemical Engineers' Handbook", McGraw-Hill, 2009.
2. S.B. Thakore, B.I. Bhatt, Introduction to Process Engineering and Design", 2nd Edition, Tata McGraw Hill Publication, 2017.
3. J.M. Coulson, J.F. Richardson and R.K. Sinnott, "Coulson and Richardson's Chemical Engineering", Vol. 6, 4th Edition, Elesevier, New Delhi, 2006.
4. W.L. McCabe, J.C. Smith P. Harriott "Unit Operations of Chemical Engineering", McGraw

Hill Publication.
5. M. W. "Kellogg, Design of Piping Systems", Pullman Power Products, New York, 1976.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	CO statement
CO-1	Understand the fundamental principles of piping design in chemical and process plants.
CO-2	Apply hydraulic principles (flow rate, pressure, velocity) to size pipes and analyze flow in piping systems.
CO-3	Identify appropriate pipe materials, components, and fittings based on process requirements and codes.
CO-4	Comply with relevant piping codes and standards.
CO-5	Interpret Process Flow Diagrams (PFDs) and Piping & Instrumentation Diagrams (P&IDs) to extract key design information.
CO-6	Analyze the case studies related to the piping design system.

List of Open Source Software/learning website:

1. Students can refer to the video lectures available on the websites including NPTEL lecture series.
2. Literature available for Process design of equipment in plant/ industry.
3. "Open-Source Piping Design Handbook" by The Piping Design Library: This online resource offers a comprehensive guide to piping design using open-source software like Free CAD and Open FOAM.

Bachelor of Engineering
Subject Code: CH2412
Subject Name: Industrial Organization and Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VIII

Type of course: Open Elective-VI

Prerequisite: NA

Rationale: An engineer has to work in industry with human, capital and machines. Therefore, managerial skills are essential for enhancing their employability and career growth. This course is therefore designed to provide the basic concepts in management principles and industrial legislation.

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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Principles of Management:** Principles, thoughts and contributions of FW Taylor, Henry Fayol and Elton Mayo. Responsibilities of management: society and development	**4**
2.	**Decision-Making and Leadership:** Decision-making process, Types of decisions (programmed and non-programmed), Decision-making tools and techniques, Leadership styles (autocratic, democratic, laissez-faire, etc.) Leadership theories (trait theory, behavioral theory, contingency theory), Role of leadership in organizational success	**8**
3.	**Quality Management:** Total Quality Management (TQM), Six Sigma principles, Quality control and improvement techniques. ISO 9001 for quality management systems, Lean Manufacturing	**6**
	SECTION-B	
4.	**Human Resource Management:** Recruitment and Selection, Training and Development, Performance Management, Compensation and Benefits, Employee Relations, Legal Compliance, Workforce Planning, Human Resource Information Systems (HRIS).	**4**
5.	**Operations Management:** Process Design and Improvement, Inventory Management, Supply Chain Management, Forecasting, Technology Integration	**8**

6.	**Industrial Legislation:** Indian Factory Act 1948, Industrial Dispute Act, Workman Compensation Act, Minimum Wages Act, Occupational Safety, Health and Working Conditions Code, 2020, Contract Labor (Regulation and Abolition) Act, 1970.	**6**

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	10	10	-

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

Text Books:

1. O. P. Khanna, Industrial Engineering and Management, Dhanpathrai and Sons, 1980.

Reference Books:

1. Veerabhadrappa, Havinal, Management and entrepreneurship, New Age International Publishers, 2014.
2. O P. Chaudvary, Principles of Management, New Age international publishers, 2012,
3. T.R. Banga and S.C.Sharma, Industrial Engineering and Management, Khanna Publication, 2017.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	**CO statement**
CO-1	Comprehend the basic principles of management.
CO-2	Understand the significance of decision making
CO-3	Appraise the need of quality management
CO-4	Comprehend the process of recruitment
CO-5	Understand the significance of operation management
CO-6	Know the various provisions of Industrial acts

Bachelor of Engineering
Subject Code: CH2412
Subject Name: Industrial Organization and Management

List of Open Source Software/learning website:

1. https://labour.gov.in/industrial-relations
2. https://nptel.ac.in/courses/122106031

Bachelor of Engineering
Subject Code: CH2413
Subject Name: Project Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: VIII

Type of course: Open Elective-VI

Prerequisite:

Rationale: A course in project engineering typically aims to provide students with a comprehensive understanding of the principles and practices involved in managing engineering projects effectively. The rationale for such a course can be justified by several key factors like risk management etc.

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	0	3	70	30	00	00	100

Sr. No	Content	Total Hrs.
	SECTION-A	
1.	**Introduction:** An Overview, Pre-project Activities, Types of Projects, Chemical Project Classification, Prices of a Product, Project: Conception to commissioning.	**4**
2.	**Project Cost** Elements of Project Cost, Land and Site Development, Building and Civil Works, Plant and Machinery, Know-how and Engineering, Expenses on Foreign Technicians and Training of Indian Technicians Abroad Miscellaneous, Fixed Assets, Contingencies, Pre-operative Expenses, Preliminary and Capital Issue Expenses, Margin Money (Working Capital), The Project Cost Schedule	**8**
3.	**Project Planning and Scheduling :** Concept of Project Planning and its Importance, Project scheduling methods Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Gantt Charts, Resource Leveling, Monte Carlo Simulation	**6**
	SECTION-B	
4.	**Project Implementation and Controlling:** Introduction to Monitoring, Evaluation and Controlling, Project Control, Project Control Cycle, Elements of Project Control (time, cost and quality). Project Schedule Control Project Cost Control: Methods and procedure (Earned value analysis) Project Quality Control, Introduction to Project Management	**4**

	Information System (PMIS)	
5.	**Project Risk Analysis and Management:** Introduction to Project Risk. Types of Project Risk. Analysis of Major Sources of Risk, Effective Management of Project Risk. Risk Management planning, Risk Identification, Qualitative and Quantitative Risk Analysis, Risk Response Planning, Risk Monitoring and Controlling.	**8**
6.	**Introduction to Project Financing:** Introduction to Project finance structures, Project funding alternatives, Investor Profiles, Investor criteria, Terms and conditions of investment agreements, Financing strategies	**6**

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	10	10	-

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

Text Books:

1. K. Nagarajan, "Project Management", ISBN: 81-224-1340-4, New Age International (P) Limited, New Delhi, India, 2001

Reference Books:

1. H. Kerzner "Project Management: A Systems Approach to Planning, Scheduling, and Controlling" ISBN: 9780471225775/0471225770, Wiley New Jersey, USA, 2003
2. S. A. Burtonshaw-Gunn, "Risk Management for Project Driven Organizations". Palgrave Macmillan, 2004.
3. D.L. Cleland, L. R. Ireland "Project Management: Strategic Design and Implementation". McGraw-Hill Education. 2006.

Course Outcomes:

After Learning this course, students will be able to:

Sr. No.	**CO statement**
CO-1	Understand the process of converting idea into reality.
CO-2	Comprehend the factors affecting the cost of project.

CO-3	Understand the methods of project scheduling.
CO-4	Provide the sound knowledge of project planning, implementation and controlling.
CO-5	Analyze the on risk associated with the project
CO-6	Understand the various methods of project finance

List of Open Source Software/learning website:

- https://nptel.ac.in/courses/110104073