Chemical Engineering

Academic Book

S.E. Chemical

(Semester-II)

Content:

Vision and Mission of the institute

Vision

Enrich the youth with skills and values to enable them to contribute in the development of society; nationally and globally.

Mission

To provide quality technical education through effective teaching-learning and research to foster the youth with skills and values to make them capable of delivering significant contribution in local to global development.

Vision and Mission of the Department

Vision

The department is committed to provide quality technical education to students in the field of Chemical engineering to meet the global expectations of industry and society.

Mission

To prepare the students to hold authority in Chemical Engineering, pursue their education through advanced study & endow to the betterment of society.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Apply the knowledge of basic science and basic courses of the Chemical Engineering In industry.
PSO2: Acquire the skills of design and analysis of the Chemical process or system to meet the desired needs within the practical limits.
PSO3: Ability to use the innovative techniques, skills and modern engineering tools necessary to industry and society.

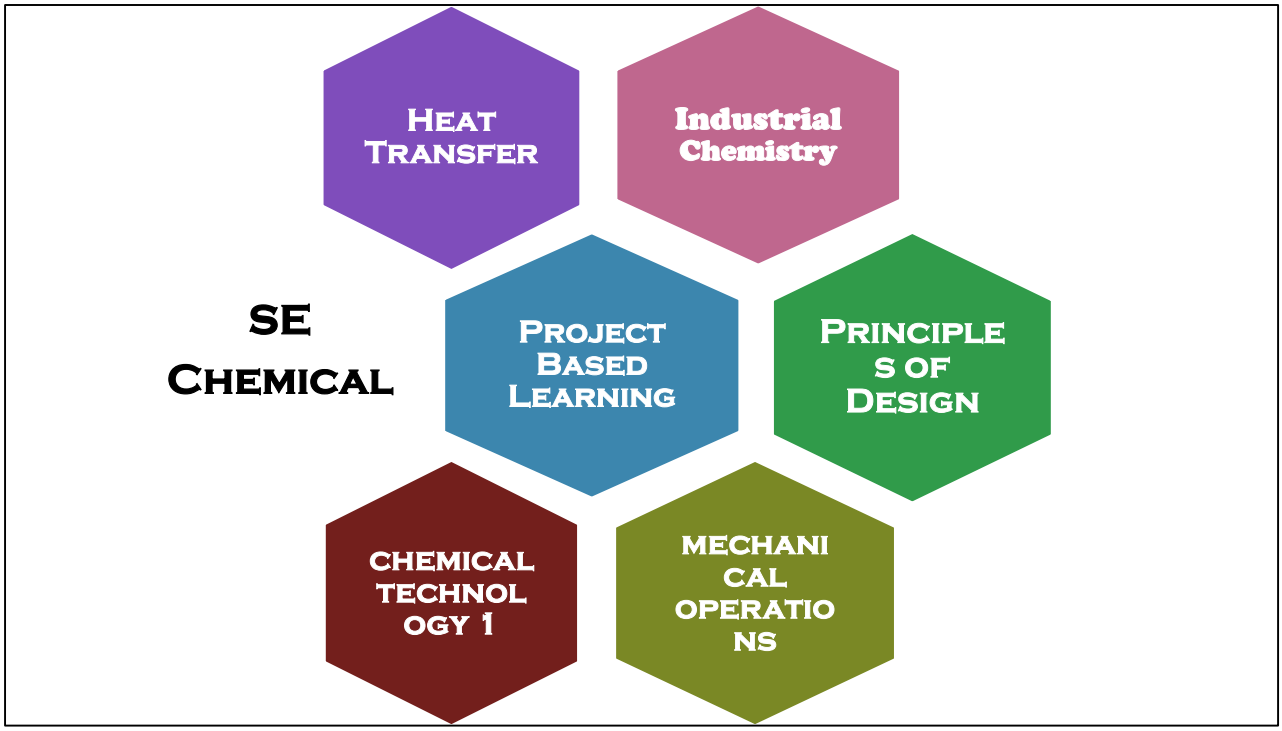
Program Educational Objectives (PEOs)

Graduates would demonstrate ability to,

- **PEO1:** To impart strong knowledge of fundamentals to the students so that they can be good practicing engineers in Chemical Engineering.
- **PEO2:** To teach basic concepts, knowledge through experimentation, scientific literature & prediction of system behavior by models & simulations.
- **PEO3:** To develop overall personality, inculcate team spirit & capability of shouldering responsibility of nation building

Syllabus Structure

Course code	Course Title	Total number of contact hours				Total Credits
		Lecture (L)	Tutorial (T)	Practical (p)	Total	
Second Year						
209347	Industrial Chemistry II	03	--	04	07	05
209348	Heat Transfer	03	--	02	05	04
209349	Principles of Design	03	--	02	05	04
2093509	Chemical Technology I	03	--	--	03	03
209351	Mechanical Operations	03	--	02	05	04
209352	Project Based Learning	--	--	04	04	02
209353	Audit Course 4	--	--	--	--	--



Academic Calendar

Regular Activity

- HOD, Staff meeting – Twice Every Month 2nd and 4th Saturday
- Submission of monthly student Class Attendance and list of defaulter students to Dean Academic on first working day of every month
- Conduction of Test I,II and III (FE TO BE)

  Test – I - After 40 Days of Commencement of Teaching
  Test –II - After 70 Day of Commencement of Teaching
  Test – III - Before Conclusion of Semester
- Students feedback Report (FE,SE,TE and BE) submission to Principal (Twice in semester – 1st at mid semester and 2nd before the end of semester)
- Parent meets report submission by department to Principal at the mid semester.
- One week Soft skill training programme (FE,SE,TE and BE)
- Department Level Research meet of all department on 4th Saturday of every month
- Minimum one Industrial Visit per class per semester. (FE,SE,TE and BE)
- Organization of National/International level Seminar/Workshop/Conference by Departmental once in a semester.

Course: 02

Heat Transfer

(209348)

[Theory & Practical]

Heat Transfer (209348)

Unit I: Conduction **(L07)**

Introduction, Heat Transfer and Thermodynamics, Modes of heat transfer, Heat transfer fluxes and resistances, Thermal conductivity, Fourier's law of conduction; General equation for conduction. Conduction through plane, cylindrical and spherical and composite walls, Heat losses and insulation, Critical insulation thickness, introduction to heat transfer with heat sources.

Unit II: Convection **(L07)**

Introduction, thermal boundary layer, Natural and forced convections, film thickness, heat transfer coefficient, various resistances, Empirical equations for convection heat transfer in laminar and turbulent flow through tubes, through annulus and over a flat plate. Reynolds analogy, Chilton-Colburn analogy, Dimensional analysis, dimensional groups used in heat transfer.

Unit III: Radiation **(L07)**

Radiant energy-distribution, various laws of radiation and their derivations, Planck's law, Wien's law, The Stefan-Boltzmann law for blackbody, Kirchhoff's law, black body, gray body, emissive power; Exchange of energy between two surfaces; View factors, combined heat transfer by conduction, convection and radiation, Furnace calculations

.Unit IV: Boiling and Condensation **(L07)**

Introduction, importance of latent heat, Pool boiling and film boiling, concept of critical heat flux. Condensation: Modes and features, derivation of Nusselt equation on condensate film, condensation on vertical and horizontal plates, condensation on inside and outside pipes for horizontal and vertical flows.

Unit V: Heat Exchange Equipment **(L07)**

Types of heat exchangers; Co-current and counter-current flows, Fouling factors, choice of thermic fluids, Equivalent diameter; LMTD, correction factors, Temperature profiles in heat exchangers, pressure drop, Process design of heat exchangers including double pipe heat exchanger, Why multi-pass exchangers, shell and tube heat exchanger, effectiveness of cocurrent and counter-current heat exchangers, cross flow heat exchangers, Heat transfer equipment auxiliaries: Steam trap.

Unit VI: Evaporation **(L07)**

Introduction, solution properties, foaming, degradation due to high temperature, scaling, equipment material, types of evaporators, material and energy balance for single effect systems,

boiling point elevation, capacity and economy, multiple effect evaporators. design of evaporators.

References:

1. Holman J. P., “Heat Transfer”, McGraw-Hill, Inc.
2. Kern D. Q., “Process Heat Transfer”, McGraw-Hill, Inc.
3. Coulson, J. M., Richardson, J. E., “Chemical Engineering”, Vol.- I, Pergamon Press.
4. Sinnott R. K., “Chemical Engineering”, Vol.- VI, 4th Edition, Chemical Engineering Design, Elsvier.
5. Cengel Y. A., “Heat and Mass Transfer” 3rd ed., Tata McGraw Hill Publications, New Delhi (2007)

209348: Heat Transfer

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week Practical : 2 Hours / Week	In Semester: 30 End Semester: 70 Oral : 25 **Total: 125** **Credits: 3 + 1 = 4**

Course Outcomes (CO's) : Heat Transfer

After successful completion of this course, students will be able to:

Course Outcomes	Statements	Bloom's Taxonomy	
		Level	Descriptor
C209348.1	Apply knowledge of basic concepts of Modes of Heat Transfer.	**1**	**Remembering**
C209348.2	Apply knowledge of Heat Conduction	**2**	**Understand**
C209348.3	Illustrate identify, formulate and solve engineering problems related to Convection	**3**	**Applying**
C209348.4	Identify, formulate and solve engineering problems related to Radiation	**3**	**Applying**
C209348.5	Identify heat exchange equipment appropriate for a given duty and to design the same	**6**	**Creating**
C209348.6	Identify, formulate and solve engineering problems related to Evaporation.	**5**	**Evaluating**

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put "-"

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C248.1	2	2								1		1	2		1
C248.2	2	2	2	1	1					1		1	2	2	1
C248.3	2	2	2	2	1					1		1		2	1
C248.4	2	2	2	2	1					1		1		2	1
C248.5	2	2	2	2	1					1		1		2	1
C248.6	2	2	2	2	1					1		1		2	1
Sum	12	12	10	9	5					6		6	4	10	6
Total Wt	18	18	15	15	15					18		18	6	15	18
% Mapping	66.7	66.7	66.7	60.0	33.3					33.3		33.33	66.67	66.67	33.33
C248	3	3	3	2	1					1		1	3	3	1

Levels: 3 for ≥ 60; 2 for < 60 ≥ 40; 1 for < 40

CO Assessment Tools

Course Outcomes (COs)	Assessment Tools							
	Continuous Internal Evaluation					Semester End Exam (SEE) conducted by SPPU Pune		
	T1	T2	T3	Assignment	CIE-Pr	OR	Insem	Endsem
C248.1	√			√	√	√	√	
C248.2	√			√	√	√	√	
C248.3		√		√	√	√		√
C248.4		√		√	√	√		√
C248.5			√	√	√	√		√
C248.6			√	√	√	√		√

Chemical Engineering Department

Teaching Plan (

Heat Transfer (209348)

Teaching Scheme:
Theory: 03 h/week

Practical: 2 h / week

Examination Scheme:
Insem: 30
Endsem: 70 : Credit = 3
PR: 25 : Credit = 1

Lect . No.	Topics / Sub- Topics	CO Mapped
1	PO,PSO,CO & Subject orientation	-
2	**Conduction:-** Introduction, Heat Transfer and Thermodynamics	1
3	Modes of heat transfer, Heat transfer fluxes and resistances,	1
4	Thermal conductivity, Fourier's law of conduction	1
5	General equation for conduction. Conduction through plane wall	1
6	Cylindrical and spherical and composite walls	1
7	Heat losses and insulation, Critical insulation thickness	1
8	Introduction to heat transfer with heat sources.	1
9	Numerical	1
10	**Convection:-** Introduction, thermal boundary layer	2
11	Natural and forced convections, film thickness	2
12	Heat transfer coefficient, various resistances	2
13	Empirical equations for convection heat transfer in laminar and turbulent flow through tubes, through annulus and over a flat plate	2
14	Reynolds analogy, Chilton-Colburn analogy	2
15	Dimensional analysis, dimensional groups used in heat transfer.	2
16	Numerical	2
17	Numerical	2
18	**Radiation:-** Radiant energy-distribution	3
19	Various laws of radiation and their derivations	3
20	Black body, gray body, emissive power	3
21	Exchange of energy between two surfaces	3
22	View factors, combined heat transfer by conduction, convection and radiation	3
23	Furnace calculations	3
24	Numerical	3
25	**Boiling and Condensation:-** Introduction, importance of latent heat	4
26	Pool boiling and film boiling	4
27	Concept of critical heat flux	4

28	**Condensation**: Modes and features	4
29	Derivation of Nusselt equation on condensate film	4
30	Condensation on vertical and horizontal plates	4
31	Condensation on inside and outside pipes for horizontal and vertical flows.	4
32	Numerical	4
33	**Heat Exchange Equipment:-** Types of heat exchangers; Co-current and counter-current flows	5
34	Fouling factors, choice of thermic fluids, Equivalent diameter;	5
35	LMTD, correction factors, Temperature profiles in heat exchangers, pressure drop	5
36	Process design of heat exchangers including double pipe heat exchanger	5
37	Multi-pass exchangers, shell and tube heat exchanger	5
38	Effectiveness of concurrent and counter-current heat exchangers, cross flow heat exchangers	5
39	Heat transfer equipment auxiliaries: Steam trap	5
40	Numerical	5
41	**Evaporation:-** Introduction, solution properties	6
42	Foaming, degradation due to high temperature	6
43	Scaling, equipment material, types of evaporators	6
44	Material and energy balance for single effect system	6
45	Boiling point elevation, capacity and economy	6
46	Multiple effect evaporators.	6
47	Design of evaporators.	6
48	Numerical	6

Chemical Engineering Department

Question Bank

Heat Transfer (209348)

Unit-I

Que.No.1. What is the relation of Heat transfer with Thermodynamics?

Que.No.2. Explain different Modes of Heat Transfer with their fundamental laws?

Que No.3. What is thermal conductivity? Explain variable thermal conductivity equation?

Que.No.4. Derive the steady state heat Conduction equation for composite Wall, Cylinder & Sphere?

Que.No.5 .Explain different natural Heat Source?

Que.No.6.What is Insulation ?Explain optimum thickness of Insulation?

Que.No.7 What are fins? Explain efficiency and effectiveness of Fins?

UNIT-II

Que.No.1. What is dimensional analysis? Explain the significance of different dimensionless numbers?

Que.No.2. What is Convection? Differentiate between Natural & Forced Convection?

Que.No.3. By dimensional analysis derive the following relationship for forced convection heat transfer process: $Nu = A (Re)^{a} (Pr)^{e}$

Que.No.4. Explain different methods of dimensional analysis?

Que.No.5.Explain thermal boundary layer theory?

Unit-III

Que.No.1. What is Radiation? Differentiate between Specular & Diffused reflection?

Que.No.2. What is thermal Radiation? Explain concept of artificial Black body?

Que.No.3. What is Radiation Shield? Explain? Differentiate between Specular & Diffused reflection?

Que.No.4. What are the different laws of Radiation? Explain?

Que.No.5. Explain Radiosity and Irradiation?

Unit-IV

Que.No.1. What is Condensation & Boiling? Explain Pool Boiling Curve?

Que.No.2 Explain concept of Critical Heat Flux?**.**

Que.No.3. Explain types of boiling?

Que.No.4.Explain Nusselts equation?

Que.No.5. What is the modes and features of Condensation?

Unit-V

Que.No.1. What is Heat Exchanger? Give the detail classification of Heat Exchanger?

Que.No.2. Explain Shell & Tube Heat Exchanger in detail?

Que.No.3. Explain Heat exchanger design by LMTD & Effectiveness-NTU method?

Que.No.4. Explain Fouling factor & Log mean temperature difference in connection with Heat Exchanger?

Que.No.5. A shell & tube heat exchanger is to be provided with tubes of 31 mm outer diameter & 27 mm inner diameter, 4 m long. It is required for heating water from 295 K to 318 K with the help of condensing steam at 393 K on the outside of tubes. Determine the number of tubes required if water flow rate is 10 kg/sec. Heat transfer coefficient on steam side & water side are 6000W/m^2 K & 850 W m^2 K respectively. Neglect all other resistances.

Unit-VI

Que.No.1. What is Evaporation? What are the different types of evaporator? Explain?

Que.No.2. Explain Boiling Point Elevation and Vacuum Evaporation?

Que.No.3 Explain classification of Evaporators?

Que.No.4. What are multiple effect evaporators? Explain?

Que.No.5. What is Capacity & Economy of evaporator? Explain Vacuum evaporation?

Que.No.6. An evaporator operating at atmospheric pressure (101.325 kPa) is fed at the rate of 10000 kg/hr of weak liquor containing 4% caustic soda. Thick liquor leaving the evaporator contains 25% caustic soda. Find the capacity of the evaporator?

Chemical Engineering Department

Heat Transfer (209348)

Practical: University Guidelines

Guidelines for Student's Lab Journal should be completed by the students in his/her own hand writing**.**

Guidelines for Conduct of Laboratory Course

- General laboratory safety instructions should be told to the students before performance of the practical's..
- Specific chemicals, machinery, hardware handling instructions should be given in the
- SOPs and displayed in the laboratory.
- Aim and objectives of the laboratory experiment/assignment should be explained**.**
- Review the attainment of aim and objectives of the experiment after completion of
- experiment

List of Practical

Sr. No.	Name of Experiment	CO Mapped
1	Thermal Conductivity of metal rod	CO1
2	Thermal Conductivity of Insulating material	CO1
3	Pin-Fin	CO1
4	Natural Convection	CO2
5	Emissivity measurement	CO3
6	Stefan Boltzman Apparatus	CO3
7	Open Pan Evaporator	CO6
8	Double pipe Heat Exchanger	CO5
9	Study Pool boiling curve	CO4
10	Study Shell and Tube Heat Exchanger	CO5

Course: 03

Principles of Design

(209349)

[Theory & Practical]

Course Syllabus

Principles of Design (209349)

Unit 1. Basic considerations in design: (L07)

Concept of Stress, strain and modulus of elasticity, Factor of Safety, Stress Concentration, Lateral strain and Poisson's Ratio, Stresses due to static and dynamic loads. Thermal stresses, Impact stresses, Distinction between process design and process equipment design (mechanical design), Design Codes, Design working pressure and temperature, Design Loads, corrosion allowance, weld joint efficiency factor, proportioning of pressure vessels, selection of L/D ratio, optimum proportions

Unit 2: Design Preliminaries: (L07)

Shear force and bending moment, SFD and BMD for point load and uniformly distributed load, deflection in beams, bending stress, torsional shear stress, Principal stresses and principal planes, application of principal stresses in designing machine members, theories of failure.

Unit 3: Design of shafts, keys, and couplings: (L07)

Shafts: Types of shafts, Design of shafts under steady load, suddenly applied load and fluctuating loads, shafts subjected to combined loads, equivalent bending and twisting moments. Keys: Types of keys, stresses developed in flat keys, shear and crushing design procedure. Couplings: Types of couplings, Design of rigid flange coupling

Unit 4: Design of joints and drives: (L07)

Joints: Design of riveted joints, strength and efficiency of a riveted joint, Types of welded joints, Design of welded joints, strength of transverse fillet welded joints, strength of parallel fillet welded joints, strength of butt joints Drives: Types of belts and belt drives, Velocity ratio, slip and creep of the belt, length of belt, ratio of driving tension, condition for transmission of maximum power

Unit 5: Design of thin-walled pressure vessels: (L07)

Introduction to pressure vessels, types of pressure vessels, codes and standards for pressure vessels (IS: 2825:1969), design stress, design criteria, design of shell (spherical and cylindrical), design of different types of heads and closures, design of flanges and nozzles, compensation for openings and branches. Design of pressure vessels subjected to external pressure: design of shell, heads, stiffening rings as per IS: 2825: 1969

Unit 6: Design of thick-walled pressure vessels (High pressure) (L07)

Materials of construction, stresses in thick cylinder, prestressing of thick walled vessels, monoblock, multilayer, autofrettage, shrink fitted shell, ribbon and wire wound vessel, analysis and design of high pressure vessels including shell and head along with the stress distribution

Reference Books:

1. R. S. Khurmi, J. K. Gupta, 2005, A Textbook of Machine Design, Eurasia Publishing House.
2. V. V. Mahajani, S. B. Umarji, 2014, Joshi's Process Equipment Design, Trinity Press.
3. L. E. Brownell, E. Young, 1963, Process equipment design, John Wiley, New York.
4. B. C. Bhattacharya, 2015, Introduction to Chemical Equipment Design, C.B.S. Publishers.
5. J. M. Coulson, J. F. Richardson, R. K. Sinott, 2005, Chemical Engineering Design Vol. 6, Pergamon Press.

S.E Chemical
209349 Principles of Design

Teaching Scheme:	**Examination Scheme:** Total: 4 Credits
Lectures: 3 Hrs/ Week	In Sem : 30 marks
Practical: 2 Hrs/ Week	End Semester: 70 marks
	TW: 25 marks

Course Outcomes (COs): 209349 Principles of Design

After successful completion of this course, students will be able to:

Course Outcomes	CO Statements	Bloom's Taxonomy	
		Level	Descriptor
C249.1	Formulate and analyze stresses and strains in machine elements and structures subjected to various loads.	1	Formulate
C249.2	Apply multidimensional static failure criteria in the analysis and design of mechanical components.	4	Apply
C249.3	Analyze and design power transmission shafts carrying various elements like keys and couplings with geometrical features.	3	Analyze
C249.4	Analyze and design structural joints like riveted and welded joints.	3	Analyze
C249.5	Select appropriate belt drive arrangement and bearings for required service.	2	Select
C249.6	Design pressure vessels for variety of unit operations (absorption/stripping, distillation, extraction, adsorption, crystallization, chemical conversions etc.)	1	Design

Mapping of Course Outcomes to Program Outcomes (POs) & PSOs:

CO-PO Correlation Matrix															
COs	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C249.1	3	2	3	2	-	-	-	-	-	-	-	2	3	3	2
C249.2	3	2	3	2	-	-	-	-	-	-	-	1	3	3	1
C249.3	3	2	3	1	-	-	-	-	-	-	-	1	3	3	2
C249.4	3	2	3	2	-	-	-	-	-	-	-	2	3	3	2
C249.5	3	2	3	2	-	-	-	-	-	-	-	1	3	2	2
C249.6	3	2	3	1	2	-	-	-	-	-	-	1	3	2	3
Total	18	12	18	10	2							8	18	16	12
Total Wt	18	18	18	18	3	-	-	-	-	-	-	18	18	18	18
% Mapping	100	66.66	100	55.55	66.66	-	-	-	-	-	-	44.44	100	88.88	66.66
C249	3	3	3	3	3							2	3	3	3

Levels: **3 for ≥50 ;** **2 for < 50 ≥ 40;** **1 for < 40**

CO Assessment Tools

Course Outcomes (COs)	Assessment Tools								
	Continuous Internal Evaluation					Semester End Exam (SEE) conducted by SPPU Pune			
	T1	T2	T3	Assignment	CIE-Pr	OR	TW	Insem	Endsem
C249.1	√			√		√	√	√	
C249.2	√			√	√	√	√	√	
C249.3		√		√	√	√	√		√
C249.4		√		√	√	√	√		√
C249.5			√	√	√	√	√		√
C249.6			√	√	√	√	√		√

Chemical Engineering Department

Teaching Plan

Principles of Design (209349)

Teaching Scheme:
Theory: 03 h/week

Practical: 2 h / week

Examination Scheme:
Insem: 30
Endsem:70 : Credit = 3
OR: 25,TW:25: Credit = 1

Lect. No.	Topics / Sub- Topics	CO Mapped
1	PO,PSO,CO & Subject orientation	-
2	Unit I (Basic considerations in design) Concept of Stress, strain and modulus of elasticity, Factor of Safety	1
3	Stress Concentration, Lateral strain and Poisson's Ratio, Stresses due to static and dynamic loads.	1
4	Thermal stresses, Impact stresses,	1
5	Distinction between process design and process equipment design (mechanical design), Design Codes,	1
6	Design working pressure and temperature,	1
7	Design Loads, corrosion allowance, weld joint efficiency factor,	1
8	proportioning of pressure vessels, selection of L/D ratio, optimum proportions	1
9	Unit II (Design Preliminaries) Shear force and bending moment,	1
10	SFD and BMD for point load and uniformly distributed load,	2
11	Deflection in beams, bending stress,	2
12	Torsional shear stress, Principal stresses and principal planes,	2
13	Application of principal stresses in designing machine members, theories of failure.	2
14	Unit III (Design of shafts, keys, and couplings) Shafts: Types of shafts,	3
15	Design of shafts under steady load,	3
16	Suddenly applied load and fluctuating loads,	3
17	Shafts subjected to combined loads,	3
18	Equivalent bending and twisting moments.	3
19	Keys: Types of keys, stresses developed in flat keys, shear and crushing design procedure.	3
20	Couplings: Types of couplings, Design of rigid flange coupling	3
21	Unit IV: (Design of joints and drives) Joints: Design of riveted joints,	4

22	strength and efficiency of a riveted joint, Types of welded joints,	4
23	Design of welded joints, strength of transverse fillet welded joints,	4
24	strength of parallel fillet welded joints, strength of butt joints Drives:	4
25	Types of belts and belt drives, Velocity ratio, slip and creep of the belt, length of belt,	4
26	ratio of driving tension, condition for transmission of maximum power	4
27	Unit V: (Design of thin-walled pressure vessels) Introduction to pressure vessels,	4
28	types of pressure vessels,	5
29	codes and standards for pressure vessels (IS: 2825:1969)	5
30	design stress ,design criteria	5
31	design of shell (spherical and cylindrical),	5
32	design of different types of heads and closures	5
33	design of flanges and nozzles, compensation for openings and branches	5
34	Design of pressure vessels subjected to external pressure:	5
35	design of shell, heads, stiffening rings as per IS: 2825: 1969	5
36		5
37	Unit VI(Design of thick-walled pressure vessels (High pressure) Materials of construction	5
38	Stresses in thick cylinder	6
39	Prestressing of thick walled vessels	6
40	Monoblock, multilayer	6
41	Autofrettage	6
42	Shrink fitted shell	6
43	Ribbon and wire wound vessel	6
44	Analysis and design of high pressure vessels including shell and head along with the stress distribution	6
45	Peer Activity	
46	University Q P	

Question Bank

Principles of Design (209349)

	Unit-I	
Que.No.1.	Distinguish between codes and standards state the engineering aspects covered in standard specifications.	[CO1]
Que.No.2.	What do you mean by factor of safety?	[CO1]
Que.No.3.	A steel rod of 30mm diameter, 280mm long is subjected to axial forces alternating between maximum compression of 15KN and a maximum tension of 5KN.Find the difference between the greatest and least length of the rod. E=210GPa.	[CO1]
Que.No.4.	The piston rod of a steam engine is 50mm in diameter and 600 mm long. The diameter of the piston is 400mm and the maximum steam pressure is 0.9N/mm^2. Find the compression of the piston rod if the young's modulus for the material of the piston rod is 210KN/mm^2.	[CO1]
Que.No.5.	Explain the following terms in concentration with design of machine members subjected to variable loads i) Endurance Limit. ii) Fatigue. iii)Stress concentration	[CO1]
Que.No.6.	Define stress, strain and elasticity. Derive a relation between stress and strain of elastic body.	[CO1]
Que.No.7.	A steel rod of 60mm diameter, 560mm long is subjected to axial forces alternating between maximum compression of 30KN and a maximum tension of 10KN.Find the difference between the greatest and least lengths of the rod.E=210GPa.	[CO1]
Que.No.8.	Derive a relation for the shear stress developed in a shaft when it is subjected to torsion.	[CO1]
Que.No.9.	Distinguish between codes and standards state the engineering aspects covered in standard specifications.	[CO1]
	UNIT-II	
Que.No.1.	Horizontal beam ABE is hinged at A and supported on rollers at B.span AB=5m and BE=2m.It carries point loads of 2400 N,3600 N and 1400N at C,D and E respectively.AC=1.5m,CD=2m,DB=1.5m.All the point loads act vertically. Calculate supports ions and draw S.F and B.M diagrams.	[CO2]
Que.No.2.	A simply supported beam 6m long is carrying a uniformly distributed load of 2KN/m over a length of 3m from the right end .Draw the S.F and B.M diagram for the beam and also calculate the maximum B.M on the section.	[CO2]
Que.No.3.	A simply supported beam 6m long is carrying a uniformly distributed load of 2KN/m over a length of 3m from the right end .Draw the S.F and B.M diagram for the beam and also calculate the maximum B.M on the section	[CO2]

	Unit-III	
Que.No.1.	Discuss the function of coupling. Give at least three practical application.	[CO3]
Que.No.2.	How are the keys classified? Draw neat sketches of different types of keys and state their applications.	[CO3]
Que.No.3.	Discuss the function of coupling. Give at least three practical application.	[CO3]
Que.No.4.	The load on a bolt cosists of an axial pull of 10KN together with a transverse shear force of 5KN.Find the diameter of bolt required according to1.Maximum principal stress theory,2.Maximum shear stress theory,3.Maximum principal strain theory,4.Maxium strain energy theory,and 5.Maximum distortion energy theory.Take permissible tensile stress at elastic limit=100MPa and poisson's ratio=0.3.	[CO3]
Que.No.5.	A shaft rotating at constant speed is subjected to variable load. The bearing supporting the shaft are subjected to stationary equivalent radial load of 3KN for 10 percent of time 0.2KN for 20 percent of time ,1KNfor 30 percent of time and no load for remaining time of cycle .If the total life expected for the bearing is 20x106 revolutions at 95 percent reliability .calculate dynamic load rating of the ball bearing.	[CO3]
Que.No.6	Design a muff coupling which is used to connect two steel shafts transmitting 40KW at 350 r.p.m.The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40MPa and 80MPa respectively.The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa.	[CO3]
	Unit-IV	
Que.No.1.	Determine the length of the weld run for a plate of size 120mm wide and 15 mm thick to be welded to another plate by means of 1. A single transverse weld; and 2. Double parallel fillet welds when the joint is subjected to variable loads.	[CO4]
Que.No.2.	A double riveted lap joint is made between 15mm thick plates.The rivet diameter and pitch are 25mm and 75 mm respectively.If the ltimate stresses are 400MPa in tension,320MPa in shear and 640 MPa in crushing,find the minimum force per pitch which will rupture the joint. If the above joint is subjected to a load such that the factor of safety is 4,find out the actual stresses developed in the plates and the rivets.	[CO4]
Que.No.3.	A flat belt is required to transmit 30KW for a Pulley of 1.5 m effective diameter running at 300 r p m .The angle of contact is spread over 11/24 of the circumference. The coefficient of friction between the belt and pulley surface is 0.3. Determine taking centrifugal tension into	[CO4]

	account, width of the belt required .It is given that the bolt thickness is 9.5mm .density of its material is 1100Kg/m3 and the related permissible working stress is 2.5MPa.	
Que.No.4.	Develop the model equation for a direct heated counter current rotary dryer (continuous dryer) in which simultaneous heat and mass transfer takes place between gas phase and solid phase. In this dryer three zones exists, (i) Preheating zone (ii) Evaporation zone (iii) Reheating zone. In evaporation zone actual removal of water from wet solids takes place and solid surface remain at temperature equal to wet bulb temperature of gas.	[CO4]
Que.No.5.	Develop the state model for an ideal binary mixture of component A and B to be separated into two product streams using conventional distillation	[CO4]
Que.No.6.	Consider an ideal binary distillation column and write all the model equations to describe the system.	[CO4]
Que.No.7.	Develop a model for counter current cooling tower with neat figure.	[CO4]
	Unit-V	
Que.No.1.	Calculate the thickness of a torispherical heads (100-6)and (80-6)elliptical head(2:1)and hemispherical head for a pressure vessel having design pressure 7kg/cm2.diameter of vessel is 1.5m and the permissible stress is1250Kg/cm2.welded joint efficiency is 85%.	[CO5]
Que.No.2.	A thick walled high pressure vessel has 500 mm inside diameter. It is subjected to an internal pressure of 6000 bar, the yield strength of material is 5000 Kg/cm2. Ultimate tensile strength of material is 6500 kg/cm2. Calculate the thickness of vessel according to the various theories of failure. Factor of safety is 1.4.Also estimate the tangential stress and radial stress variation along the vessel wall.	[CO5]
Que.No.3.	Explain the various types of ends used for pressure vessel giving practical applications of each.	[CO5]
Que.No.4.	Explain with a neat sketch various types of flanged joints used in pressure vessels.	[CO5]
Que.No.5.	With neat sketch explain stresses induced in thick vessel subjected to internal pressure.	[CO5]
Que.No.6.	What are various types of welding joints used in pressure vessels? Discuss with neat sketch.	[CO5]
Que.No.7.	A multilayer vessel is to be operated at 133.33MN/m2 and is to be fabricated by using three shells. Inside diameter of the vessel is 30.5cm while outside diameters 59.5 cm. The vessel is fabricated by shrink fit construction .The internal diameter are 38.5cm and 47.6cm respectively. Determine the maximum combined stress at the interface, interface pressure and the circumferential stress variation in each of the three shells	[CO5]
	Unit-VI	
Que.No.1.	Write short note on Autofrettaging of monoblock Pressure vessels.	[CO6]

Que.No.2.	Calculate the thickness of a flanged torispherical head for a vessel having internal diameter 6000 mm. Design pressure of the vessel is 3.4 kg/cm^2. Inside crown radius is 6000 mm. Inside knuckle radius is 380 mm. Permissible stress of the material is 1190 kg/cm^2, welded joint efficiency is 100%.	
Que.No.3.	How do you distinguish between a thick and thin cylinder?	[CO6]
Que.No.4.	A pressure vessel is required to process 19.0m3 nonhazardous slurry at 17.7Kg/cm2.maximum operating temperature are50 and 1750c.the cylindrical shell of the vessel is closed at both end by 2.1elliptical head with 5cm straight flange portion the maximum ratio of liquid height to vessel diameter is 1.9.The vessel is fabricated from S.S 316 having permissible stress 1140 kg/cm2.the welded joint efficiency is 85%.No corrosion allowance is necessary. Maximum diameter of the vessel can be 2.4m.Calculate i) the height of the vessel. ii) Minimum thickness of shell and elliptical head.	[CO6]
Que.No.5.	Discuss the design procedure for pressure vessels subjected to higher external pressure.	[CO6]
Que.No.6.	A pressure vessel having outer diameter 1.3m and height 3.8m is subjected to an internal pressure of 12 Kg/cm^2.If a vessel is fabricated as class B vessel joint efficiency is 85%.If provided with a strip all along the longitudinal joint, joint efficiency is 100% calculate the vessel thickness under these different conditions and find out how much is the % material saving by welding a strip along a longitudinal joint. Allowable stress of the material=1020kg/cm^2.corrosion allowance is 1 m m.	[CO6]
Que.No.7.	A cylindrical pressure vessel 1.8m in diameter and 5m in height is subjected to an internal pressure of 8 kg/cm^2.corrosion allowance is 2mm.If the vessel is fabricated as: Class B vessel with J=0.85.	[CO6]

Chemical Engineering Department

Principles of Design (209349)

List of Practical:

Sr. No.	Name of Experiment	CO Mapped
1	Design of welded and riveted joints	**CO4**
2	Design of shaft and pulley	**CO3**
3	Design of keys	**CO3**
4	Design of coupling	**CO3**
5	Design of Joints	**CO4**
6	Design of Heads	**CO5**
7	Auto Cad-I (Design of couplings)	**CO3**
8	Auto Cad-II (Design of heads)	**CO5**

Course: 04

Chemical Technology-I

(209350)

[Theory]

Course Syllabus

Chemical Technology-I (209350)

Unit I: **Introduction**

Chemical industries-facts and figures, Unit operation and unit process concepts, chemical processing and role of chemical engineers. Chloro-Alkali Industries: Soda ash, Solvay process, dual process, Natural soda ash from deposits, Electrolytic process, Caustic soda.

Unit II: **Phosphorus Industries**

Phosphoric acid, Wet process, Electric furnace process, Calcium phosphate, Ammonium phosphates, Nitro phosphates, Sodium phosphate. Potassium recovery from sea water.

Unit III: Nitrogen Industries

Ammonia, Nitric acid, Urea from ammonium carbonate, Ammonium nitrate.

Unit IV: **Soap and Detergents**

Batch saponification production, Continuous hydrolysis and saponification process, Sulfated fatty alcohols, Alkyl-aryl sulfonates.

Unit V: Plastic Industries

Polymerization fundamentals, Polymer manufacturing processes, Ethenic polymer processes, Poly condensation processes, Polyurethanes.

Unit VI: **Petroleum Processing**

Production of crude petroleum, Petroleum refinery products, Types of refineries, Design of refinery, Choice of crude petroleum, Refinery processes, Pyrolysis and cracking, Reforming, Polymerization, Isomerization, Alkylation. Rubber: Elastomer polymerization processes, Rubber polymers, Butadiene-Styrene copolymer, Polymer oils and rubbers based on silicon.

Reference Books

1. Austin G.T., Shreve's Chemical Process Industries - International Student Edition, 5th Edition, McGraw Hill Inc., 1998.
2. Sittig M. and Gopala Rao M., Dryden's Outlines of Chemical Technology for the 21st Century, 3rd Edition, WEP East West Press, 2010
3.Chemical Technology Vol. I, II, III, IV Chemical Engg. IIT Madras

SE Chemical
209350: Chemical Technology-I (2019 Pattern)

Teaching Scheme: Lectures : 3 Hours / Week	**Examination Scheme: Credits: 3** In Semester: 30 End Semester: 70 **Total: 100**

Course Outcomes (CO's): Chemical Technology-I

After successful completion of this course, students will be able to:

Course Outcomes	Statements	Bloom's Taxonomy	
		Level	Descriptor
C250.1	Describe the basic principles of chemical process industries and mfg. processes for chloro-alkali Industries.	2	Describe
C250.2	Draw and explain various process flow diagram for phosphorous industries.	4	Diagram
C250.3	Draw and explain various process flow diagram for nitrogen industries.	4	Diagram
C250.4	Draw and explain various process flow diagram for soap and detergents industries.	4	Diagram
C250.5	Describe the various mfg. processes with process flow diagrams for plastic industries.	2	Describe
C250.6	Understand the mfg. processes related with petroleum processing.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PROGRAM OUTCOMES												PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C250.1	2	2					2						2	2	
C250.2	2	2	2				2						2	2	
C250.3	2	2	2				2						2	2	
C250.4	2	2	2				2						2	2	
C250.5	2	2	2				2						2	2	
C250.6	2	2	2				2						2	2	
Total	12	12	10				12						12	12	
Total Wt.	18	18	15				18						18	18	
% Mapping	66.6	66.6	66.6				66.6						66.6	66.6	
C250	3	3	3				3						3	3	

Levels: 3 for ≥60; 2 for < 60 ≥ 40; 1 for < 40

CO Assessment Tools

Course Outcomes (COs)	Assessment Tools						
	Continuous Internal Evaluation					Semester End Exam (SEE) conducted by SPPU Pune	
	T1	T2	T3	Assignment	CIE	Insem	Endsem
C250.1	√			√	√	√	
C250.2	√			√	√	√	
C250.3		√		√	√		√
C250.4		√		√	√		√
C250.5			√	√	√		√
C250.6			√	√	√		√

Chemical Engineering Department

Teaching Plan

Chemical Technology-I (209350)

Teaching Scheme:
Theory: 03 h/week

Examination Scheme:
Insem: 30
Endsem: 70: Credit = 3

Lect. No.	Topics / Sub- Topics	CO mapped
1	PO,PSO,CO & Subject Orientation	-
2	**Introduction:** Unit operation and unit process concepts, Chemical Industries facts and fig. Chemical processing and role of chemical engineers.	1
3	Mfg. of Soda ash by Solvay process.	1
4	Soda ash by Dual Process (Modified Solvay).	1
5	Major Engineering Problems for Solvay process and Dual Process	1
6	Mfg. of Caustic soda by Electrolytic process.	1
7	Advantages and disadvantages of various cell processes and major Engg. Problems for Electrolytic process	1
8	Innovative teaching methods	1
9	**Phosphorous Industries:** Introduction	2
10	Mfg. of Phosphoric acid by wet process (strong acid)	2
11	Phosphoric acid by Electric furnace process	2
12	Phosphoric acid by HCL Leaching process	2
13	Mfg. of Single and Triple Super Phosphate	2
14	Mfg. of Nitro phosphate	2
15	Mfg. of Sodium phosphate	2
16	Innovative teaching methods-	2
17	**Nitrogen Industries:** Mfg. of Ammonia.	3
18	Mfg. of Nitric acid.	3
19	Major Engg. Problems in mfg. ammonia and nitric acid	3
20	Mfg. of Urea from ammonium carbonate.	3
21	Ammonium Nitrate	3
22	Mfg. of Urea from ammonium nitrate	3
23	Major Engineering Problems for above	3
24	Innovative teaching methods-	3
25	**Soaps and Detergents:** Introduction	4
26	Batch and continuous saponification process	4
27	Production of soap	4
28	Production of detergents	4

29	Ziegler catalytic process	4
30	Surfactants	4
31	Sulfated fatty acids	4
32	Innovative teaching methods-	4
33	**Plastic Industries :** Introduction	5
34	Polymerization fundamentals	5
35	Polymer manufacturing processes	5
36	Mfg. of polyvinyl resins	5
37	Low density polyethylene	5
38	High density polyethylene	5
39	Mfg. of polyolefin	5
40	Innovative teaching methods- Peer Teaching	5
41	**Petroleum Processing:** Introduction	6
42	Production of crude petroleum	6
43	Types of refineries and its design	6
44	Pyrolysis and cracking	6
45	Isomerization and Alkylation	6
46	Rubber polymers	6
47	Butadiene-styrene copolymer	6
48	Innovative teaching methods-	6

Chemical Engineering Department

Question Bank

Chemical Technology-I (209350)

Unit-I (CO-1)

Q. 1 Draw the process flow sheet/diagram for mfg. of soda ash by Solvay process.
Q.2 Describe the process for mfg. of soda ash by Solvay process with major engineering problems.
Q.3 Draw the process flow sheet/diagram for mfg. of chlorine-caustic soda by electrolytic process.
Q.4 Explain the process for mfg. of chlorine-caustic soda by electrolytic process with major engineering problems.
Q.5 Draw the process flow sheet for mfg. of soda ash by dual process (modified Solvay).
Q.6 Describe the process for mfg. of soda ash by dual process (modified Solvay) with major engineering problems.
Q.7 Draw the process flow sheet for Mfg. of chlorine-caustic soda by electrolytic process.
Q.8 State the Advantage and disadvantages of various cells/process used in Mfg. of chlorine-caustic soda by electrolytic process.
Q. 9. Describe the work of chemical engineer in chemical processing.
Q. 10. Define the following unit operations with schematic diagram.
I. Batch and Continuous Distillation II. Crystallization III. Centrifugation IV. Evaporation V. Extraction VI. Drying
Q. 11 State the end uses for following
I. Caustic Soda II. Soda Ash
Q. 12 Define unit operations and processes. Differentiate the unit operations and processes.

UNIT-II (CO-2)

Q1. Draw the process flow sheet/diagram for Mfg. of phosphorus by electric furnace method.

Q2. Explain the process for mfg. of Nitro phosphate with major engineering problems.

Q3. State the major engineering problems for mfg. of phosphoric acid by wet acid and HCl leaching process.

Q.4 Draw the process flow sheet/diagram for mfg. of phosphoric acid by wet process. (Strong Acid).

Q5. Describe mfg. process of Ammonium Phosphate.

Q6. Draw the process flow sheet for mfg. of single and triple superphosphate process.

Q7. Explain the process for Mfg. of phosphoric acid by HCl leaching process with major engineering problems.

Q 8 Draw the process flow sheet for Mfg. of phosphoric acid by HCl leaching process.

Q. 9 State the end uses for following

I. Elemental Phosphorous II. Phosphoric Acid III. Ammonium Phosphate

Q. 10. Explain the potassium recovery from sea.

Q. 11. Describe the mfg. of calcium phosphate.

Q. 12. Describe the mfg. process for sodium triphosphate.

UNIT-III (CO-3)

Q1. Draw the process flow sheet/diagram for mfg. of Synthesis of Ammonia.

Q2. Describe the process for mfg. of synthesis of Ammonia.

Q3. Draw the process flow sheet/diagram for mfg. of Nitric Acid by ammonia oxidation process.

Q.4 Explain the process for mfg. of Nitric Acid by ammonia oxidation process.

Q5. Draw the process flow sheet/diagram for mfg. of urea from ammonium carbamate.

Q6. Describe the process for mfg. of urea from ammonium carbamate.

Q7. Describe the mfg. of Ammonium Nitrate and nitro lime by prilling process with neat process flow diagram.

Q 8. State the various methods for production of Ammonium Nitrate and its raw materials use.

Q. 9. Describe the major engineering problems for production/mfg. Ammonia and Nitric Acid

Q. 10. State the end uses for following

I. Ammonia II. Nitric Acid III. Urea IV. Ammonium Nitrate and Nitro lime

Q. 11. Describe the major engineering problems for production/mfg. Urea and Ammonium Nitrate, Nitro lime.

Q. 12. Describe the mfg. of Ammonium Nitrate and nitro lime by crystallisation process with neat process flow diagram.

UNIT-IV (CO-4)

Q1. Draw the process flow sheet/diagram for mfg. of soap by continuous hydrolysis and saponification process.

Q2. Describe the process of mfg. of soap by continuous hydrolysis and saponification process.

Q3. Describe the methods for mfg. of detergents.

Q.4 Describe the mfg. of soap by batch saponification process.

Q5. Draw process flow sheet for mfg. of detergent: dodecyl benzene Sulphonate.

Q6. Explain Ziegler Catalytic Process.

Q7. Describe in brief methods for production of soap with chemical reaction.

Q 8 Explain how the soap differ from detergents. Explain the difference between soap and detergents.

Q. 9. Describe the mfg. of glycerin with process flow diagram.

Q. 10. What are the surfactants? State importance of surfactants in soap and detergents.

Q. 11. Explain the difference between batch and continuous saponification process.

Q. 12. State the end uses for Soap and Detergents.

UNIT-V (CO-5)

Q1. Draw the process flow sheet/diagram for mfg. of mfg. of polyvinyl polymers.

Q2. Describe the process of mfg. of polyvinyl polymers.

Q3. Explain in brief LDPE and HDPE.

Q.4 Describe the mfg. of Polyolefin.

Q5. Explain mfg. of Polyolefin by low Ziegler process with process flow diagram.

Q6. Explain Ziegler Catalytic Process.

Q7. Describe in brief poly condensation process.

Q. 8 Explain in brief role of chemistry and chemical engineer in polymerization industries.

Q. 9. Draw the process flow sheet/diagram for mfg. of mfg. of Butadiene styrene.

Q10. Describe the process of mfg. of Butadiene styrene.

Q. 11. Explain in brief reaction kinetics for poly condensation process.

Q. 12.Descibe the major role of plastic in agriculture.

UNIT-VI (CO-6)

Q1. Draw the process flow sheet/diagram for mfg. of Isomerization process.

Q2. Describe the process of mfg. of crude petroleum by drilling.

Q3. Describe the types of refineries and location in India.

Q.4 Describe the thermal cracking process with diagram.

Q5. Draw process flow sheet for synthetic rubber polymerization.

Q6. Explain alkylation process with neat diagram.

Q7. Describe in mfg. of butadiene with process flow diagram.

Q 8 Explain mfg. of rubber polymers.

Q. 9. Describe the high pressure platinum catalyst reforming process with neat diagram.

Q10. Describe the fluidized bed catalytic cracking process with neat diagram.

Q. 11. Describe the types of refinery processes.

Q. 12. Describe the polymer oil and rubber based silicon with neat diagram.

Course: 05

Mechanical Operations

(209351)

[Theory & Practical]

Syllabus

Mechanical Operations (209351)

Unit I: Screening and Size Reduction of Solids (7 h)

Properties of solids, Performance of screening equipment / testing sieves, U.S.sieve series, Tyler standard sieve series, sieve shaker, types of screen analysis.Necessity of size reduction, Crushing efficiency, energy requirement calculations by using crushing laws. Classification of size reduction equipment: Crushers, Grinders, Ultrafine grinders, Cutters. Dry versus wet grinding. Open and closed circuit grinding.

Unit II: Settling and Sedimentation (7 h)

Motion of particle in fluid, drag force, drag coefficient. Gravity settling methods, Terminal falling velocity, Stoke's law and Newton's law of settling.Gravity sedimentation operations, Sedimentation test, Kynch theory, Determination of thickener area and depth of thickener. Thickeners, Clarifiers, Sedimentation centrifuges.

Unit III: Fluidization and Beneficiation Equipment (7 h)

Types of fluidization, fluidized bed systems, determination of minimum fluidization velocity, flow through packed bed, applications of fluidized bed. Ergun equation and its derivation,Kozeny Carman equation, Darcy's law. Flotation cell, magnetic separator, cyclone separator,
liquid cyclone, electrostatic separator, precipitator, scrubbers, fabric filter, mineral jig.

Unit IV: Mixing and Agitation (7 h)

Types of Impellers, flow patterns in un-baffled and baffled tanks, Draft tube, mechanically agitated vessel, power requirement in mixing, performance of mixers, Paste and viscous material
mixing, solid-solid mixing, Batch and continuous mixers.

Unit V: Filtration (7 h)

Classification of filtration and filters. Theory of filtration-equations. Filter media and filter aids. Batch and continuous filters. Plate and frame filter press, filling and washing in a filter press, horizontal pressure leaf filters. Rotary drum vacuum filters. Centrifugal filters-basket type.

Unit VI:Handling and Conveying of Solids (7 h)

Storage of solids, characteristics of bulk solids, Conveyors: Principle, Construction and Working. Advantages, Disadvantages and design calculations of Belt Conveyors, Screw conveyors, Chain & Flight conveyors, Bucket elevators and Pneumatic conveyors.

Guidelines for Student's Lab Journal

Laboratory journal should be completed by the students in his/her own hand writing.

Guidelines for Lab /TW Assessment

Assignment or practical work write-up should be submitted in the next laboratory session. Assessment should be carried out with grades.

Guidelines for Conduct of Laboratory Course

- Arrangements for the practical should be done prior General laboratory safety instructions should be told to the students.
- Specific chemicals, machinery, hardware handling instructions should be given in the instructions
- Aim and objectives of the practical should be explained.
- After completion of experiment, review the attainment of aim and objectives of the experiment.

Reference Books:

1. McCabe W. L. &Smith J.C. "Unit Operations in Chemical Engineering". McGraw Hill Publications.
2. Coulson J. M. and Richardson J.F. "Chemical Engineering Vol. 2", Pergamon Press.
3. Badger W. L and Banchero J.T. "Introduction to Chemical Engineering", McGraw HillPublications.
4. Foust A. S "Principles of Unit Operation".
5. George G. Brown, "Unit operations", CBS publishers and distributors.

Chemical Engineering Department

209351: Mechanical Operations

Course Outcomes (COs): Mechanical Operations

After successful completion of this course, students will be able to:

Course Outcomes	*Statements*	*Bloom's Taxonomy*	
		Level	*Descriptor*
C**209351**.1	Applying suitable type of screening and size reduction equipment for analysis of different particle sizes	*3*	*Applying*
C**209351**.2	Select suitable type of thickeners and clarifiers for separation of suspended solid particles.	*5*	*Evaluating*
C**209351**.3	Apply fluidization and beneficiation techniques in chemical industries.	*3*	*Applying*
C**209351**.4	Evaluate Mixing index and power consumption in mixing and agitation.	*5*	*Evaluating*
C**209351**.5	Examine a suitable type of filter for filtration of slurry or a suspension.	*5*	*Evaluating*
C**209351**.6	Identify a suitable type of conveyor for transportation of different types of solids.	*6*	*Understand*

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

COs	PROGRAM OUTCOMES												PROGRAM SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
1	3	2		2	2								2		3
2	3	2		2	2								2	3	2
3	3	2		2										3	2
4	3	2		2	2										2
5	3	2		2	2									3	2
6	3	1		2	2									3	3
Total	7	14		7	10								4	12	14
Total Wt	18	18		15	15								6	12	18
% Mapping	38.89	77.78		46.67	66.67								66.67	100.00	77.78
C209351	1	3		2	3								3	3	3

CO Assessment Tools

Course Outcomes (COs)	Assessment Tools						
	Continuous Internal Evaluation					Semester End Exam (SEE) conducted by SPPU Pune	
	T1	T2	T3	Assignment	CIE	Insem	Endsem
C351.1	√			√	√	√	
C351.2	√			√	√	√	
C351.3		√		√	√		√
C351.4		√		√	√		√
C351.5			√	√	√		√
C351.6			√	√	√		√

Chemical Engineering Department

Mechanical Operations (209351)

Teaching Plan

Teaching Scheme:
Theory: 03 h/week

Practical: 2 h / week

Examination Scheme:
Insem: 30
Endsem:70 : Credit = 3
PR: 100 : Credit = 2

Lect . No.	Topics / Sub- Topics	CO Mapped
1	PO,PSO,CO & Subject Orientation	-
2	Introduction: Mechanical Operations concepts, Chemical Industries facts , Chemical processing and role of chemical engineers.	1
3	Properties of solids, Performance of screening equipment / testing sieves	1
4	U.S.sieve series, Tyler standard sieve series.	1
5	Sieve shaker, types of screen analysis. Necessity of size reduction, Crushing efficiency, energy requirement calculations by using crushing laws.	1
6	Classification of size reduction equipment: Crushers, Grinders, Ultrafine grinders, Cutters.	1
7	Dry versus wet grinding. Open and closed circuit grinding.	1
8	Innovative teaching methods-	1
9	Motion of particle in fluid, drag force, drag coefficient.	2
10	Gravity settling methods, Terminal falling velocity.	2
11	Stoke's law and Newton's law of settling.	2
12	Gravity sedimentation operations, Sedimentation test	2
13	Kynch theory	2
14	Determination of thickener area and depth of thickener.	2
15	Clarifiers	2
16	Sedimentation centrifuges. Types of fluidization.	2
17	Innovative teaching methods	3
18	fluidized bed systems, determination of minimum fluidization velocity	3
19	determination of minimum fluidization velocity	3
20	flow through packed bed ,cyclone separator,	3
21	Applications of fluidized bed.	3
22	Ergun equation and its derivation, Magnetic separator	3
23	Kozeny Carman equation, Darcy's law. Flotation cell	3

24	Innovative teaching methods	3
25	Types of Impellers	4
26	Flow patterns in un-baffled and baffled tanks,	4
27	Draft tube	4
28	Mechanically agitated vessel	4
29	Power requirement in mixing	4
30	Performance of mixers, Batch and continuous mixers.	4
31	Paste and viscous material mixing, solid-solid mixing,	4
32	Innovative teaching methods	4
33	Classification of filtration and filters.	5
34	Theory of filtration-equations.	5
35	Filter media and filter aids.	5
36	Batch and continuous filters.	5
37	Plate and frame filter press	5
38	Filling and washing in a filter press, horizontal pressure leaf filters	5
39	Rotary drum vacuum filters. Centrifugal filters-basket type.	5
40	Innovative teaching methods	5
41	Storage of solids, characteristics of bulk solids,	6
42	Conveyors: Principle, Construction and Working.	6
43	Advantages, Disadvantages and design calculations of Belt Conveyors	6
44	Screw conveyors,	6
45	Chain & Flight conveyors	6
46	Bucket elevators.	6
47	Pneumatic conveyors	6
48	Innovative teaching methods-	6

Question Bank

Mechanical Operation (209351)

Unit-I (CO 1)

Q. 1 Discuss Sieve Shaker with Diagram
Q.2 Explain U.S. Sieve series
Q.3 Explain Crushers with Diagram.
Q.4 Explain Tyler Standard sieve Sieve series
Q.5 Explain types of screen analysis+
Q.6 Explain Crushers in Short.
Q.7 Explain Grinders in details
Q.8 Explain Open verses Closed circuit grinding.
Q. 9 Discuss in short Ultra-Fine Grinders
Q. 10Explain properties of Solids
Q. 11 Explain in short Size reducing equipment
Q. 12 Explain necessity of Size reduction.

UNIT-II (CO 2)

Q1. Draw the figure of Fabric filter and explain its working

Q2. Draw the figure of Electrostatic separator and explain its working

Q3. Describe the working of Cyclone separator

Q4 Describe the working of Flotation cell.

Q5. Explain strokes law

Q6. Explain Sedimentation Centrifuge

Q7. Explain Newton's law of Settling

Q 8 Discuss Depth of Thickener.

Q. 9 Explain Thickeners and its working.

Q. 10 Explain Clarifiers with Diagram

Q. 11 Discuss Terminal Falling Velocity

Q. 12 Explain Drag Force

Unit (III+IV)

UNIT-III (CO 3)

Q1. Draw the figure of Fabric filter and explain its working

Q2.Draw the figure of Electrostatic separator and explain its working

Q3. Describe the working of Cyclone separator

Q4 Describe the working of Flotation cell.

Q5.Draw the figure of Mineral Jig.

Q6.Describe the working of Cyclone separator

Q7.Explain is fluidization.

Q8.Explain the types of Fluidization

Q9. Explain Scrubbers with diagram

Q10.Explain Magnetic Separator.

Q11.Discuss the application of Fluidized Bed

Q12.Explain flow of liquid through packed bed.

UNIT-IV (CO 4)

Q1. Explain Baffled tanks

Q2.Explain Unbaffled tanks

Q3. Explain performance of mixers.

Q.4Discuss the working of batch mixers

Q5. Discuss the working of continuous mixers

Q6. Explain Paste and Viscous material mixing.

Q7.Explain Solid solid Mixing

Q 8 Explain mechanically agitated vessels

Q. 9. Explain flow pattern in Baffled tanks.

Q. 10. Explain flow pattern in Unaffledtanks.

Q. 11. Explain with figure different types of Impellers with figure

Q. 12. Explain Draft Tube..

UNIT-V (CO 5)

Q1. Explain Batch filters

Q2.Explain Continuous Filters

Q3. Explain the working of Plate and frame filter.

Q.4 Explain Filling and Washing in Filter Press.

Q5. Discuss the working of Pressure leaf filters

Q6. Explain Rotary drum vacuum filters.

Q7. Explain the working of Centrifugal Filter Basket type

Q. 8 Explain the different filter media used in filtration.

Q. 9. State the advantages and disadvantages of Filter press

Q10.Explain the working of Rotary drum vacuum filters.

Q. 11.Exlain the working of Plate and frame filters

Q. 12.Explain Open verses Closed circuit filtration

UNIT-VI (CO 6)

Q1. Explain the Principle of Belt Conveyors.

Q2.Explain the advantages and disadvantages of Belt Conveyors

Q3. Discuss the working of Screw Conveyors.

Q.4 Explain Chain and flight conveyors.

Q. 5. Explain the advantages and disadvantages of Screw conveyors.

Q6. Discuss Bucket Conveyors

Q 7 Explain the advantages and disadvantages of Bucket conveyors

Q8. Discuss Pneumatic Conveyors.

Q9. State the characteristics of bulk solid

Q10.Explain the advantages and disadvantages of chain and flight conveyors..

Q. 11. Discuss screw conveyors in details

Q. 12.Discuss the storage of Bulk solid.

Chemical Engineering Department

Mechanical Operations (209351)

Practical: University Guidelines

Ten practical will be conducted with the use of different mechanical operations like grinding , crushing , size reduction and separation by Ball Mill , Jaw crusher , sieve shaker etc

List of Practical

Sr. No.	Name of Experiment	CO Mapped
1	To determine effectiveness of given set of standard screen.	CO1
2	To determine energy consumption and crushing law constants for jaw crusher	CO1
3	To determine Critical speed of Ball mill & Average particle size of the product obtainedin ball mill OR Average particle size of product obtained in Buhrstone mill.	CO1
4	To determine mixing Index of a mixture in Ribbon Blender. OR To determine mixing Index of mix in Sigma Mixer.	CO4
5	To determine filter medium resistance and specific cake resistance by using Plate & frame filter Press OR by using centrifugal filter.	CO5
6	To determine area of batch thickener by conducting batch sedimentation test.	CO2
7	To determine separation efficiency by using magnetic separator	CO1
8	To determine separation efficiency by using froth flotation cell	CO1
9	To determine collection efficiency of Cyclone separator for various particle sizes and pressure drops.	CO1
10	To study conveying of solids by using working models of Belt conveyor, Chain conveyor, Screw conveyor, Bucket conveyor or elevator and pneumatic conveyor.	CO6

Course: 06

Project Based Learning

(209352)

[Practical]

Project Based Learning (209352)

Course Objectives:

1. To improve the exposure, understanding and learning of the students.
2. To integrate knowledge and skills from various domains.
3. To help students gain confidence for meeting new challenges through lifelong learning.

Group Structure:

Students can work individually or in a team of maximum 4.A faculty as a supervisor/mentor will be assigned to individual/groups.

Selection of Project/Problem:

The project will start by identifying latest problems related to various Chemical Engineering processes and will involve designing relevant solutions. The problems may be from environment or process industries or any other domain which can be studied and solved. The problem will give a foundation for the learning as it will be having a particular practical, scientific, social and/or technical sphere of influence. The problem should position as one precise case or demonstration of added general learning outcomes related to knowledge and/or modes of inquiry.

The learning from the problem will be based on the approach of solving the problem. Thus, the process of solving the problem will form the basis for Project-Based Learning (PBL). The solution of the problem can be elucidated from among three broad categories: Study-based, Laboratory-based and Computer-based. Under these broad categories, Project-Based Learning will lead to the learning of either or combination of understanding using literature survey, different computer programming tools, various lab opportunities for solving different problems, and understanding the preparation of report. This will lead to a well-rounded, lifelong learning for the students.

Assessment:

Progress of the PBL will be assessed on a weekly basis. The students and the mentor will be responsible for the weekly evaluation. The individual and the group performance must be monitored and will be continuously evaluated and be presented in the Continuous Assessment

Sheet (CAS). An active participation from both the mentor and the students for the continuous assessment will enhance its efficiency and effectiveness.

The individuals or the groups should adhere to ethical standards, by maintaining a culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The mentors and the Department should support the students by providing proper guidance, explaining them the importance of the course and the various resources and services available for it.

The assessment will evaluate the various skills acquired during the learning through developing a model and/or report and/or presentation. The assessment will be considering:

- Individual assessment for each student (individual capacity, role and involvement in the project)
- Group assessment (defined roles, distribution of work, intra-team communication and teamwork)
- Documentation and presentation

Evaluation and Continuous Assessment:

It is recommended to have a continuous assessment of the course and therefore all the activities must be properly recorded on a regular basis. For the same, proper documentation in the form of Continuous Assessment Sheet (CAS), to be maintained by the mentor/Department and the students.

Recommended parameters for assessment, evaluation and weightage:

- Idea Inception **(5%)**
- Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product **(50%)** (Individual assessment and team assessment)
- Documentation (Gathering requirements, design and modeling, implementation/execution, use of technology and final report, other documents) **(25%)**
- Demonstration (Presentation, User Interface, Usability etc) **(10%)**
- Contest Participation/publication **(5%)**
- Awareness/Consideration of Environment/Social ethics/Safety measures/Legal aspects **(5%)**

Chemical Engineering Department

209352: Project Based Learning

Teaching Scheme: Practical : 4 Hours / Week	**Examination Scheme:** Term work: 50 **Total: 50** **Credits: 2**

Course Outcomes (CO's) : Project Based Learning

After successful completion of this course, students will be able to:

Course Outcomes	Statements	Bloom's Taxonomy	
		Level	Descriptor
C252.1	Identify and formulate the problem and approach the solution comprehensively.	**6**	**Formulate**
C252.2	Demonstrate professionalism with engineering ethics and communicate effectively, team work, environmental and safety issues for the benefit of society.	**3**	**Demonstrate**
C252.3	Appreciate the need for, and develop a capability to employ life-long learning.	**6**	**Develop**

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
C252.1	3	2	1	1	-	-	-	-	-	-	-	-	3	2	-
C252.2	3	2	2	2	1	1	1	2	3	3	2	3	3	2	2
C252.3	3	2	2	2	2	1	1	-	2	2	2	3	3	-	-
Total	9	6	5	5	3	2	2	2	5	5	4	6	9	4	4
Total Wt	9	9	9	9	6	6	6	3	6	6	6	6	9	6	6
% Mapping	100	67	56	56	50	33	33	67	83	83	67	100	100	67	67
C252	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**2**

Rubrics for assessment of Project Based Learning

The following rubrics are developed for the evaluation of the Project Based Learning (PBL).

Sr. No.	Assessment Parameter	Marks Allotted
1	Idea Inception	5
2	Design / modeling/ model preparation	10
3	Outcome of PBL/ solution /final product	20
4	Demonstration	5
5	Contest participation/publication	5
6	Awareness – Social/ ethics / Environmental / safety / legal aspects	5
	Total	**50**