Syllabus Book

4th Year B. Tech.
Chemical Engineering

P P Savani University

School of Engineering

Department of Chemical Engineering

Effective From: 2020-21

Authored by: P P Savani University

P P SAVANI UNIVERSITY																
SCHOOL OF ENGINEERING																
TEACHING & EXAMINATION SCHEME FOR FOURTH YEAR B.TECH. CHEMICAL ENGINEERING PROGRAMME																
Sem	**Course Code**	**Course Title**	**Offered By**	**Teaching Scheme**					**Examination Scheme**							
				Contact Hours				**Credit**	**Theory**		**Practical**		**Tutorial**		**Total**
				Theory	**Practical**	**Tutorial**	**Total**		**CE**	**ESE**	**CE**	**ESE**	**CE**	**ESE**	
7	SECH4011	Process Equipment & Design-II	CH	04	04	00	08	06	40	60	20	30	00	00	150
	SECH4021	Chemical Reaction Kinetics - II	CH	04	02	00	06	05	40	60	20	30	00	00	150
	SECH4030	Petroleum Studies	CH	03	02	00	05	04	40	60	20	30	00	00	150
	SECH4041	Chemical Engineering Plant design, Economics & Industrial Management	CH	02	00	00	02	02	40	60	00	00	00	00	100
	SECH4050	Modelling, Simulation & CAD in Chemical Engineering	CH	03	02	00	05	04	40	60	20	30	00	00	150
	SEPD4010	Creativity, Problem Solving & Innovation	SEPD	03	00	00	03	03	40	60	00	00	00	00	100
	SEME4910	Industrial Training	CH	04			00	04	0	0	100	100	00	00	200
		Elective-III	CH	03	00	00	03	03	40	60	00	00	00	00	100
8	SECH4062	Transport Phenomena	CH	04	00	01	05	05	40	60	00	00	50	00	150
	SECH4070	Process Integration & Process Optimization	CH	04	02	00	06	05	40	60	20	30	00	00	150
	SECH4920	Project based learning	CH	08			08	08	00	00	100	150	00	00	250

P P SAVANI UNIVERSITY															
SCHOOL OF ENGINEERING															
TEACHING & EXAMINATION SCHEME FOR FOURTH YEAR B.TECH. CHEMICAL ENGINEERING PROGRAMME (ELECTIVE COURSES)															
Sem	**Course Code**	**Department Elective Course Title**	**Offered By**	**Teaching Scheme**					**Examination Scheme**						
				Contact Hours				**Credit**	**Theory**		**Practical**		**Tutorial**		**Total**
				Theory	**Practical**	**Tutorial**	**Total**		**CE**	**ESE**	**CE**	**ESE**	**CE**	**ESE**	
7	SECH4510	Chemical System Modelling	CH	03	00	00	03	03	40	60	00	00	00	00	100
	SECH4520	Quality Control & Quality Assurance – Instrumentation & Validation Process	CH	03	00	00	03	03	40	60	00	00	00	00	100
	SECH4530	Membrane Technology	CH	03	00	00	03	03	40	60	00	00	00	00	100
	SECH4540	Industrial Health & Safety Engineering	CH	03	00	00	03	03	40	60	00	00	00	00	100

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5.	SECH4050	Modelling, Simulation & CAD in Chemical Engineering	13-15
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7.	SECH4070	Process Integration & Process Optimization	19-21
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Electives

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Course Code: SECH4011
Course Name: Process Equipment & Design-II
Prerequisite Course(s): SECH3062 - Process Equipment & Design-I

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
04	04	00	06	40	60	20	30	00	00	150

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- understand modifications and additions to existing plants or creating design layouts of plant / Equipment.
- rapidly increase rate in the advancement of knowledge and relevant application for equipment design.
- observe conclusively the practices in using the reference literature and software.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Introduction to Chemical Engineering Design** Process Design, Mechanical aspects of process equipment design, General design procedure, Equipment classifications, Design codes and standards (IS, ASTM and BS).	02	05
2.	**Process Design of Piping, Fluid Moving Devices and Flow meters** Introduction, Process Design of Piping, Npsha & Npshr, Power Required by Pump, Evaluation of Centrifugal Pump Performance When Handling Viscous Liquids, Power Required in Fan, Blower and Adiabatic Compressor, Flow Meters, Process Design of Orifice Meter, Rotameter Etc.	13	20
3.	**Process Design of Extractor** Industrial Applications of Liquid-Liquid Extraction, Choice of Solvent, Process Design of Counter Current Multistage Extractor, Selection Criteria among Different Types of Extractor, Process Design of Mixer-Settler Type Extractor & Packed Tower Type Extractor, Guidelines for the Design of Other Types of Extractors	15	25

Section II			
Module No.	Content	Hours	Weightage in %
1.	**Mechanical design of Reaction Vessel** Mechanical Design of Shell, Head, Jacket, Coil, Agitator, Nozzle, Body Flange, Etc., Different Types of Agitators & their Selection Criteria, Different Types of Agitator Shaft Sealing System & their Selection Criteria, Different Types of Power Transmission System, Determination of Power Required for Agitation, Shaft Diameter, Blade Thickness, Etc.	12	20
2.	**Mechanical design of Storage Tan** Classification of Storage Tank as Per Is-803, Capacity of Storage Tank, Its Diameter & Height, Design of Shell and Bottom Plate for Storage Tank, Design of Self Supported Conical Roof, Design of Structured Supported Conical Roof as Per Api 620, Selection of Column, Girders and Rafters, Roof Curb Angel, Floating Roof	10	18
3.	**Supports** Different Types of Supports, Mechanical Design of Bracket Support, Skirt, Support & Saddle Support, Numerical	08	12

List of Practical:

Sr. No	Name of Practical	Hours
1.	Flow sheeting of piping	04
2.	Flow sheeting of pumps	04
3.	Flow sheeting of compressor	04
4.	Flow sheeting of flow meters	04
5.	Flow sheeting of extractor	08
6.	Flow sheeting of agitated vessel	04
7.	Flow sheeting of different types of agitator	08
8.	Flow sheeting of different types of extractors	08
9.	Flow sheeting of storage tank	04
10.	Flow sheeting of bracket support	04
11.	Flow sheeting of skirt support	04
12.	Flow sheeting of saddle support	04

Text Book(s):

Title	Author/s	Publication
Chemical Engineering - Volume 6 (3rd Edition)	Sinnott. R.K, Coulson & Richardson's	Butterworth Heinemann, New Delhi, 1999
Chemical Engineers Handbook - Perry's (7th Edition)	Perry. R.H., et al.	McGraw Hill, NewYork, 1997
Process Equipment Design	Bownell, L.E., and Young, E.M	Wiley Eastern, 1968
Introduction to Process Engineering and Design (1st Edition)	S B Thakore and B I Bhatt	Tata McGraw Hill, 2007

Process Equipment Design	Joshi. M.V. and Mahajani. V.V	Macmillan India Limited, New Delhi, 1996

Reference Book(s):

Title	Author/s	Publication
Chemical Process Equipment: Design and Drawing	Maidargi, Suresh C.	Maidargi, Suresh C.
Introduction to Chemical Equipment Design: Mechanical Aspects	Bhattacharyy, B C.	CBS Publisher, 2012

Web Material Link(s):

- https://nptel.ac.in/courses/103103027/

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 Hour of duration, which will be converted to 30 marks.
- Faculty evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Practical:

- Continuous Evaluation consists of performance of practical which will be evaluated out of 10 marks for each practical and average of the same will be converted to 10 marks.
- Internal viva consists of 10 marks.
- Practical performance/quiz/drawing/test consists of 15 marks during End Semester Exam.
- Viva/ Oral performance consists of 15 marks during End Semester Exam.

Course Outcome(s):

After completion of the course, the student will be able to

- design process equipment and modify the design of existing equipment to new process conditions or new required capacity.
- build a bridge between theoretical and practical concepts used for designing the equipment in any process industry.
- create understanding of equipment design.
- review the importance of design concepts in process industry.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4021
Course Name: Chemical Reaction kinetics - II
Prerequisite Course(s): SECH3052 - Chemical Reaction Kinetics – I

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
04	02	00	05	40	60	20	30	00	00	150

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- comprehend residence time distributions, and how they can be used to characterize and design non-ideal reactors.
- understand the preparation of catalysis, solid-catalyzed reactions and heterogeneous reaction and its application in various chemical industries.
- kinetics and design of reactors for non-catalytic fluid-fluid and fluid-particle reactions.
- to know the basic operational principle of advance reactors and it's used in allied chemical industries.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Non-Ideal Flow** Basics of non-ideal flow, Residence time distribution, stimulus response techniques, The E, F and C Curves, their interrelationship, conversion in non-ideal flow reactors, Dispersion model, Chemical Reaction and dispersion, Intensity of fluid mixing. Tanks in series model, Deviation from plug flow, Models for real stirred tanks.	09	15
2.	**Heterogeneous Reactions: Introduction** Rate steps involved in heterogeneous systems, Overall rate expression for linear and non-linear process, contacting patterns for two-phase systems.	07	10
3.	**Fluid-Fluid Systems** Rate equation, rate equation for straight mass transfer, kinetic regimes of mass transfer and chemical reaction, rate equation for mass transfer and chemical reactions, film conversion parameter, fluid-fluid reactor design.	08	15

4.	**Fluid-Particle Systems** Fluid partial reaction kinetics, selection of a model, Shrinking Core Model for unchanging and changing size spherical partials, Diffusion through gas film and through ash layer controlling, Chemical reaction controlling, shrinking core model, its limitations, Determination of rate controlling step.	06	10
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Catalysis** Catalysts, Physical properties of catalyst, surface area, void volume, solid density, pore volume distribution, Classification and preparation of catalyst, catalyst promoters. Catalyst inhibitors, Catalyst poisons, Nature and Mechanism of Catalytic reactions.	12	20
2.	**Solid-Catalysed Reactions: Kinetics** Adsorption isotherms and rates of adsorption and desorption. Kinetic regimes, rate equations for surface kinetics, Pore diffusion, determining rate controlling step, experimental methods for finding rates, product distribution in multiple reactions.	08	15
3.	**Introduction to Catalytic Reactor** Packed bed catalytic reactors, fluidized bed reactors, trickle beds, slurry reactors. Kinetics of Bio-Reaction, Monod Equation, Design of Bioreactors, Reactions in Solids – Reactors for Solid Reactions, CVD Reactors, Monolithic Reactors, Gauze Reactors	10	15

List of Practical

Sr. No	Name of Practical	Hours
1.	RTD study in Tubular reactor	02
2.	RTD study in CSTR reactor	04
3.	RTD study in Packed bed reactor	04
4.	RTD study in PFTR	04
5.	Kinetics study in Batch enzyme reactor	04
6.	Heterogeneous reaction kinetics study in catalytic reactor	04
7.	Heterogeneous reaction kinetics study in catalytic fluidized bed reactor	04
8.	Kinetics study in Annular UV photo reactor.	04

Text Book(s):

Title	Author/s	Publication
Chemical Engineering Kinetics - 3rd Edition	J. M. Smith	McGraw-Hill (1990)
Chemical Reaction Engineering - 3rd Edition	O. Levenspiel	John Wiley (1998)

Reference Book(s):

Title	Author/s	Publication
Chemical and Catalytic Reaction Engineering	J. J. Carberry	McGraw Hill, New York, 1976.
Elements of Chemical Reaction Engineering	H. Scott Fogler	3rd Edition, John Wiley & Sons (Asia) pvt. Ltd.

Web Material Link(s):

- https://nptel.ac.in/courses/103/108/103108097/
- https://nptel.ac.in/courses/103/101/103101141/
- https://nptel.ac.in/courses/103/102/103102012/

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 hour of duration.
- Faculty Evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Practical:

- Continuous Evaluation consists of performance of practical which will be evaluated out of 10 for each practical and average of the same will be converted to 10 marks.
- Internal viva consists of 10 marks.
- Practical performance/quiz/drawing/test of 15 marks during End Semester Exam.
- Viva/Oral performance of 15 marks during End Semester Exam.

Course Outcome(s):

After completion of the course, the student will be able to

- analyze the RTD studies for any flow reactor, to predict the deviation from ideal reactors by evaluating the dispersion number.
- analyze the various contacting pattern for two phase system and predict the rate equation for heterogeneous reactions.
- analyze the best kinetic regimes for mass transfer and reaction for a given reaction and
- predict the rate equation.
- predict the rate controlling step for the fluid - particle reactions.
- classify catalysts and predict physical properties of catalyst, surface area, void volume, solid density pore volume distribution.
- understand the nature and mechanism of catalytic reactions.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4030
Course Name: Petroleum Studies
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
03	02	00	04	40	60	20	30	00	00	150

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- understand various chemical allied operations related to petroleum industries.
- know the wide field of chemical engineering in petrochemical.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Basic of Petroleum** Role of Crude oil in global economy, Present Scenario of Crude Oil Refinery, Importance, Occurrence, Origin(formation), Exploration, Composition, Classification and Evaluation of Crude oil, Crude Assay Analysis, Distillation Characteristics such as TBP, ASTM& EFV etc.	04	10
2.	**Properties of Crude and Petroleum Products** Various types of Average Boiling Points of Crude Oil & Petroleum Fractions, Types of Gases & their Composition,Types of Gasoline & it's Important Properties and tests such as ASTM Distillation, RVP, Octane Number, Oxidation Stability, Sulphur Content etc, Various Types of Naphtha and their Important Properties & Applications. Important Tests & Properties of Kerosene such as Flash& Fire Point,Smoke Point , Aniline Point etc., Types of Diesel & its Important Properties & Tests such as Pour Point, Diesel Index, Cetane Number etc. Heavy Fractions like Lube Oil, Bitumen, Asphalt etc & their Important Properties such as Viscosity Index, Carbon Residue, Penetration Index, Softening Point etc.	06	10
3.	**Processing of Petroleum** Pretreatment of Crude (Dehydration & Desalting), Pumping of	04	10

	Waxy Crude, Heating of Crude, Distillation of Petroleum & Types of Reflux, ADU & VDU, Topping Operations etc.		
4.	**Treatment Techniques** Physical Impurities found in Crude& their Removal, Sweetening Techniques, Production and Treatment of LPG & their Methods, Dehydration and Sweetening of Gases, Gasoline Treatment such as Lead Doctoring, Merox Sweetening, Catalytic Desulphurization etc. Treatment of kerosene, Various Methods of Treatment of Lubes such as Clay Treatment, Phenol Extraction, Furfural Extraction, Dewaxing etc.	04	10
5.	**Thermal & Catalytic Cracking** Necessity and Types of Cracking **Thermal Cracking** Mechanism of Thermal Cracking, Properties of Cracked Materials, Vis Breaking, Dubb's Two Coil Process, Delayed Coking, Naphtha Cracking, etc. **Catalytic Cracking** Advantage & Theory of Catalytic Cracking, Fixed bed, Moving Bed & Fluidized Bed Technology, FCC, Hydrocracking, Catalytic Reforming, Platforming, Continuous Catalyst Regeneration Reforming, Catalytic Polymerization, Catalytic Alkylation, Catalytic Isomerization, etc.	05	10
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Petrochemicals and Petro Industries** Physical & Chemical Properties, Various Routes of Production, Manufacturing Processes, Flow Sheets, Thermodynamics & Kinetics Consideration & Major Engineering Problems for following Petrochemicals	05	10
2.	**C1 Petrochemicals** Petrochemicals Obtained from Methanol, Formaldehyde, Chloromethane etc.	04	10
3.	**C2 Petrochemicals** Petrochemicals obtained from Ethylene, Ethanolamine, Ethylene Dichloride, Vinyl Chloride, Ethylene Oxide etc.	05	10
4.	**C3 &Aromatic Petrochemicals** Petrochemicals Obtained from Propylene, ACN, Isopropanol, Cunene, BTX Separation, Phenol, Styrene, Phthalic Anhydride etc.	04	10
5.	**Polymers** PVC, LDPE, LLDPE, HDPE, Polypropylene, Polypropylene Co-polymers, Polystyrene, SBR, Polyesters etc.	04	10

List of Practical:

Sr. No	Name of Practical	Hours
1.	Determination of Aniline point of the given oil sample	02
2.	Determination of the flash & fire point of a given sample of oil by Pensky – Martin apparatus	04
3.	Determination of distillation characteristics of gasoline using A.S.T.M distillation	04
4.	Determination of viscosity of given sample of heavy oil saybolt viscometer	04
5.	Determination of viscosity of given sample of heavy oil redwood viscometer	04
6.	Determination of percentage carbon residue of petroleum product by conradson carbon residue.	04
7.	Determination of softening point of given bituminous material	04
8.	Determination of the flash point of a given sample of oil by Able's apparatus	04

Text Book(s):

Title	Author/s	Publication
Modern Petroleum Refining Processes	B. K. Bhaskar Rao	Oxford and IBH 2007
Dryden's Outlines of Chemical technology, 3rd Edition	M Gopal Rao	East-West press Pvt. Ltd, Delhi

Reference Book(s):

Title	Author/s	Publication
Petroleum Refinery Engineering	W. L. Nelson	McGraw Hill, Newyork, 1958.
The Chemistry and technology of Petroleum	Speight, J. G.	5th Edition, M. Dekker, 1991

Web Material Link(s):

- https://nptel.ac.in/courses/103/102/103102022/

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 hour of duration.
- Faculty evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Practical:

- Continuous Evaluation consists of performance of practical which should be evaluated out of 10 for each practical and average of the same will be converted to 10 marks.
- Internal viva consists of 10 marks.
- Practical performance/quiz/drawing/test of 15 marks during End Semester Exam.
- Viva/Oral performance of 15 marks during End Semester Exam.

Course Outcome(s):

After completion of the course, the student will be able to

- understand fundamentals of petroleum refinery & various petrochemical plants.
- characterize & test various properties of different petroleum fractions.
- understand scenario of refinery & petrochemical industries.
- understand manufacturing processes & applications of widely used petrochemicals.

P P Savani University
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Course Code: SECH4041
Course Name: Chemical Engineering Plant design, Economics & Industrial Management
Prerequisite Course(s): SECH3071 - Chemical Process Technology

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
02	00	00	02	40	60	00	00	00	00	100

CE: Continuous Evaluation, ESE: End Semester Exam

Objectives of the Course:
To help learners to

- deal with design aspect, selection of equipment, importance of utilities and auxiliaries for any process industries.
- deal with various cost involve in industrial processes, capital investments and investment returns.
- fill the gap between technical knowledge commercial sustainability of any plant by imparting brief description of any plant from top to bottom approach.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Introduction** Basic Considerations in Chemical Engineering Plant Design, Optimization & Feasibility of Plant Design	03	05
2.	**Process Design Aspects** Selection of Process-Factors Affecting Process Selection. Types of Project Design, Importance of Laboratory Development Pilot Plant, Safety Factors, Types of Flow Diagrams	06	15
3.	**Selection of Process Equipment** Standard Versus Special Equipment-Material of Construction for Process Equipment, Selection Criteria, and Specification Sheets	03	05
4.	**Process Auxiliaries and Process Utilities** Piping Design, Layout, and Supports for Piping Insulations. Pipe Fittings, Types of Valves, Selection of Valves, Process Control and Instrumentation Control System Design. Process Water, Boiler Feed Water, Water Treatment, Waste Treatment and Disposal, Disposal, Steam, Oil Heating System, Chilling Plant, Compressed Air and Vacuum	06	15

5.	**Plant location and layout** Factors Affecting Plant Location, Factors in Planning Layouts, Principles of Plant Layout, Use of Scale Models	05	10
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Cost Estimation** Cash Flow and Cumulative Cash Position for Industrial Operations, Factors Affecting Estimation of Investment and Production Cost, Breakeven Point and Its Significance, Total Capital Investment, Fixed and Working Capital Investment & Their Estimations, Type of Estimates, Cost Indexes, Method for Estimating Capital Investment	05	10
2.	**Estimation of Total Product Cost** Estimation of Total Product Cost: Manufacturing Cost, General Expenses, Manufacturing Cost: Direct Production Cost, Fixed Charges, Plant Overhead Cost.	04	10
3.	**Depreciation** Types of Depreciation, Method for Determining Depreciation: Straight Line Method, Decline Balance Method, Sum of the Year Digit Method, Shrinking Fund Method etc, Single Unit and Group Depreciation, Adjustment of Depreciation Account, Evaluation of Depreciation Methods	05	10
4.	**Profitability, Alternative Investments and Replacement** Methods for Profitability Evaluation, Evaluation of Break Even Point, % Rate of Return, Practical Factors in Alternative Investment and Replacement Studies.	04	10
5.	**Project Management** Planning of Project Schedule by BAR CHART, Inventory Control Scheduling a Project using CPM/PERT Methods.	04	10

Text Book(s):

Title	Author/s	Publication
Plant design and Economics for Chemical Engineers	M.S. Peters and Timmerhaus	McGraw Hill 3rd Edition
Chemical Engineering Plant Design	F.C. Vibrandt and C.E. Dryden	McGraw Hill 5th Edition

Reference Book(s):

Title	Author/s	Publication
Industrial Engineering and Management	O. P. Khanna	Dhanpat Rai & Sons, 1985 7th Edition

Web Material Link(s):

- https://nptel.ac.in/courses/103103039/

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 hour of duration.
- Faculty evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Course Outcome(s):

After completion of the course, the student will be able to

- learn basic economic concept, to understand and apply these concepts in the project works undertaken and to chemical engineering situation by solving problem.
- carry out the primary techno-economic feasibility of project.
- select appropriate process for a project.
- differentiate the equipment and able to prepare specification sheet.
- understand piping and instrumentation diagram.
- evaluate the project cost including capital investment, product cost, breakeven point, depreciation cost for equipment and the total project cost.
- control and schedule of the project using CPME/PERT technique, calculations.
- solve problem on profitability and replacement analysis.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4050
Course Name: Modelling, Simulation & CAD in Chemical Engineering
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
03	02	00	04	40	60	20	30	00	00	150

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- understand the basic principles of process modelling & simulation.
- apply the concepts of modelling and simulation to develop models of chemical engineering systems.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Process Analysis and its Basic Principles** Description of Systems, Subsystems, Scientific Methods, System Parameters, Process Analysis and Simulation	06	10
2.	**Introduction to Simulation Tools**	04	8
3.	**Mathematical Models and their Classification** Models Based on Transport Phenomena Principles, Alternate Classification of Models, Population Balance, Stochastic, and Empirical Models, Unit Models	10	17
4.	**Models of Heat Transfer Equipment** Development of Detailed Mathematical Models of Evaporators, Use of Newton Raphson Method for Solving Evaporator Problems	10	15
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Models of Separation Processes** Separation of Multi-Components Mixtures by Use of a Single Equilibrium Stage, Flash Calculation Under Isothermal and Adiabatic Conditions. Tridiagonal Formulation of Component	20	25

	Material Balances and Equilibrium Relationships for Distillation, Absorption and Extraction of Multi-Components. Thiele and Geddes Method, Plus θ-method and k_b method, models of Absorbers, Strippers and Extractors		
2.	**Models of Reactors** Classification of Fixed Bed Reactor Models, One Dimensional and Two-Dimensional Fixed Bed Reactor Models, Fluidized Bed Reactor Models, Bioreactor Models	10	25

List of Practical:

Sr. No	Name of Practical	Hours
1.	Introduction to ASPEN Plus	02
2.	Thermodynamic model in ASPEN Plus	04
3.	Steady State simulation in ASPEN Plus	02
4.	Rigorous modelling Example-01	02
5.	Rigorous modelling Example-02	04
6.	Rigorous modelling Example-03	04
7.	Rigorous modelling Example-04	02
8.	Reactor Modelling Example -01	02
9.	Reactor Modelling Example -02	04
10.	Reactor Modelling Example -03	04

Text Book(s):

Title	Author/s	Publication
Process Plant Simulation	B. V. Babu	Oxford University Press

Reference Book(s):

Title	Author/s	Publication
Numerical methods for engineers	S. K. Gupta	New Age International Publishers Ltd., (1995)
Applied Mathematics and modelling for Chemical Engineers	R. G. Rice, D. D. Do	John Wiley & Sons (1995)
Transport Phenomena	R. B. Bird, W. E. Stewart, E. N. Lightfoot	John Wiley & Sons (2002)

Web Material Link(s):

- https://nptel.ac.in/courses/103/107/103107096/
- https://lecturenotes.in/notes/17696-note-for-simulation-and-modelling-sm-by-bohar-singh
- https://nptel.ac.in/courses/112107214/

Course Evaluation:

Theory:

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- End Semester Examination consists of 60 marks.

Practical:

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- Internal viva consists of 10 marks.
- Practical performance/quiz/drawing/test consists of 15 marks during End Semester Exam.
- Viva/ Oral performance consists of 15 marks during End Semester Exam.

Course Outcome(s):

After completion of the course, the student will be able to

- learn basic definitions and fundamental principles related to process modelling and simulation.
- understand different types of models and their hierarchy as well as the general steps followed in developing a process model.
- develop appropriate mathematical models of varying complexities for different chemical engineering systems.
- know and learn about the commonly available mathematical tools and techniques as used in the simulation of developed models.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4062
Course Name: Transport Phenomena
Prerequisite Course(s): SECH3010- Heat Transfer Operations
SECH2050- Fluid Flow Operations

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
04	00	01	05	40	60	00	00	50	00	150

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- learn momentum, Heat and Mass Transfer are three basic transport processes in chemical engineering.
- understand mathematical modeling and analogical aspects of chemical process systems where these transport processes occur simultaneously.
- understand transport Phenomena also focuses on typical situations and thereby its complete understanding on axial as well as radial profiles.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Analogies in Momentum, Heat and Mass Transfer** Introduction, Reynolds Analogy, Prandtl Taylor Analogy, Van Karman Analogy, Martinelli Analogy, Chilton Analogy	08	15
2.	**Principles of Momentum & Overall Balances** Newtonian and Non-Newtonian Fluid Models, Classification of Fluids on the Basis of Rheology, General Molecular Transport Equation for Momentum Transfer, Review of Shell Balance Method and Equations of Changes for Fluid Flow Problems, Time Derivatives	12	20
3.	Equations of Changes for Isothermal, Non-Isothermal, and Multi Component Mixtures. Velocity, Temperature, and Concentration Distributions with more than one Independent Variable; Boundary Layer Theory	10	15

Section II			
Module No.	Content	Hours	Weightage in %
1.	**Turbulent transport** Laminar-turbulent transition; Basic characteristic features of turbulent flow; Time smoothed equation of changes; Eddy viscosity, thermal conductivity and diffusivity; Distribution of velocity, temperature, and concentration in turbulent flows.	08	10
2.	**Principles of Heat Transfer** Application of Shell balance and Equations of changes for temperature distributions in heat flow problems Heat conduction with various heat sources, Heat conduction with cooling fins, Temperature distribution for fully developed viscous flow, Heat transfer for non-Newtonian fluids, Unsteady state heat transfer in various geometries, Partial freezing model, Chilling & Freezing of biological materials, Heat transfer with phase change.	10	20
3.	**Principles of Mass Transfer** Application of Shell balance method and Equations of changes for mass transfer problems, Diffusivity, mass and molar transport by convection, Concentration distributions for isothermal and non-isothermal mixtures, Multi component systems with more than one independent variable and in turbulent flow convective mass transfer and correlation, inter phase mass transfer, Diffusion with chemical reaction, Transport across selectively permeable membrane and porous media.	12	20 0

Text Book(s):

Title	Author/s	Publication
Transport Phenomena	Bird R.B., Stewart W.E., Lightfoot E. N.	John Wiley & Sons, 2002.
Fundamentals of Momentum, Heat and Mass transfer	Welty, J.R., Wicks, C.W., Wilson, R.E. and Rorrer, G.	John Wiley & Sons.

Reference Book(s):

Title	Author/s	Publication
Momentum Heat and Mass Transfer in Cintiniua.	Slattery J.C.	McGraw-Hill
Advanced Transport Phenomena.	Slattery J.C.	Cambridge University Press

Web Material Link(s):

- https://nptel.ac.in/courses/103/106/103106159/
- https://nptel.ac.in/courses/103/102/103102024/

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 hour of duration and average of the same will be converted to 30 marks.
- Submission of Power point presentation which is to be presented by the students in a group of 3 which carries 10 marks of evaluation.
- End Semester Examination consists of 60 marks.

Tutorial:

- Continuous Evaluation consists of performance of tutorials which will be evaluated out of 10 marks for each tutorial and average of the same will be converted to 30 marks.
- MCQ based examination consists of 10 marks.
- Internal Viva consists of 10 marks.

Course Outcome(s):

After completion of the course, the student will be able to

- setup overall balances for conservation of momentum, energy and mass.
- recognize and apply analogies among momentum, heat and mass transfer.
- reduce and solve the appropriate equations of change to obtain desired profiles for velocity, temperature and concentration.
- utilize information obtained from solutions of the balance equations to obtain engineering quantities of interest.
- reduce and solve appropriate macroscopic balances for conservation of momentum, energy and mass.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4070
Course Name: Process Integration & Process Optimization
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
04	02	00	05	40	60	20	30	00	00	150

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- understand the fundamental principles and practical methodologies of process integration;
- impart background knowledge for employment in the process industries as well as for post graduate studies and research;
- formulate simple optimization problem, writing objective functions, equality and inequality constraints and bounds;
- understand simple constrained and unconstrained optimization problem, formulate and solve simple linear programming problems, non-linear programming problems and appreciate the application of optimization in chemical process engineering.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Introduction to process integration** Role of thermodynamics in process integration, Concept of pinch technology and its application	04	8
2.	**Heat Exchange Networks** HENS, Composite curves, Problem table algorithm, Targeting of energy, area, number of units, shell and cost.	09	17
3.	**Network Integration** Super targeting, Continuous targeting, Maximum energy recovery (MER), Network for multiple utilities and multiple pinches, Grand composite curve (GCC).	09	16
4.	**Mass Exchange Network Synthesis** Waste water targeting and system design.	08	09

Section II			
Module No.	Content	Hours	Weightage in %
1.	**Introduction** Basic Concepts of Optimization, Objective function, Model fitting, Regression analysis.	06	08
2.	**Unconstrained Optimization** Single Variable Optimization: one-dimensional search techniques, Multivariable optimization: direct & indirect methods of first and second order, Simplez method, Newton's method.	10	18
3.	**Constrained Optimization** Linear Programming (LP) and application: Graphical solution for solving LP problem, simplex method, duality in LP. Non-Linear Programming (NLP) and application: the Langrange multiplier methods, quadratic programming.	08	15
4.	**Applications of Optimization**	06	09

List of Practical:

Sr. No	Name of Practical	Hours
1.	Plotting Composite Curve in Excel	02
2.	Tutorial on Pinch Technology	04
3.	Plotting Grand Composite Curve in Excel	04
4.	Area Targeting in Excel	08
5.	Mass exchange network diagram in Excel	02
6.	Tutorial from module -01	02
7.	Practical on multivariable optimization in Excel	02
8.	Practical on Linear Programming	02
9.	Practical on Non- Linear Programming	02
10.	Tutorial on Lagrange Multiplier Methods	02

Text Book(s):

Title	Author/s	Publication
Pinch Analysis and Process Integration: A user guide on process integration for the efficient uses of energy (2nd edition)	Ian C. Kemp	Butterworth-Heinemann (2007)
Optimization of Chemical Processes (2nd edition)	Thomas F. Edgar, David M. Himmelblau and L. S. Lasdon	McGraw Hill (2005)

Reference Book(s):

Title	Author/s	Publication
Chemical Process Design & Integration (2nd edition)	Robin Smith	Wiley Publishing House
Systematic Methods of Chemical Process Design (1st Edition)	Beigler L. T., Grossman I. E., Westerberg A. W.	Prentice Hall

Web Material Link(s):

- https://nptel.ac.in/courses/103/107/103107094/
- https://simplicable.com/new/process-integration

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 Hour of duration and the average of the same will be converted to 30 marks.
- Faculty evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Practical:

- Continuous Evaluation consists of performance of practical which will be evaluated out of 10 marks for each practical and average of the same will be converted to 10 marks.
- Internal viva consists of 10 marks.
- Practical performance/quiz/drawing/test consists of 15 marks during End Semester Exam.
- Viva/ Oral performance consists of 15 marks during End Semester Exam.

Course Outcome(s):

After completion of the course, the student will be able to

- understand the concept of pinch in mass and energy exchange network and be able to calculate the targets.
- apply process integration techniques in various heat and mass transfer processes.
- classify process models and formulate verbal optimization problem into a mathematical expression in the form of objective function and identify constraints and bounds.
- use commercial optimization problem solvers and will be able to apply principles of optimization in chemical engineering process design/operation improvement.

P P Savani University
School of Engineering

Center for Skill Enhancement and Professional Development

Course Code: SEPD4010
Course Name: Creativity, Problem Solving & Innovation
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
03	00	00	03	100	00	00	00	00	00	100

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- achieve expertise with the technicalities of creativity and problem solving.
- advance an assertiveness for innovation.
- advance creative thinking skills using shaft of learning components leading to understanding of plans of creativity, problem solving and innovation
- discuss uses of the concepts of creativity and problem-solving skills in personal, social, academic, and profession life.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Introduction to Creativity, Problem Solving and Innovation** • Definitions of Problem Solving, Creativity and Innovation • Need for Problem Solving and Innovation & Scope of Creativity • Types and Styles of Thinking • Strategies to Develop Creativity, Problem Solving and Innovation Skills	08	17
2.	**Questioning and Learning** • Introduction to Questioning, Learning and Visualization and its Strategies • Sources and Methods of Questioning and Learning • Finding Perspective, Visualizing thinking • Mind Mapping	07	16
3.	**Creative Thinking and Problem Solving** • Need of Creative Thinking • Cracking Creativity - Reversals, Reversing Perspective, seeing all sides, Looking in other world,	08	17

	• Finding what you are not looking for and following up • Fishbone Diagram • SCAMPER Technique		
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Logic and Reasoning** • Basic Concept of Logic • Divergent Vs Convergent Thinking, Inductive Vs Deductive Thinking • Fusion of Ideas for Problem Solving • Moral Reasoning • Improvisation	08	17
2.	**Practices of Playing** • Collaboration and Brainstorming • The Spirit of Koinonia • QFT Model • Connecting the Unconnected • Making Novel Combinations	07	16
3.	**Review Strategies for Creative problem-solving methods** • A Heuristic Technique • Problem-Solving Strategies: Why Bother? • Five Building Blocks as per Fogler & LeBlanc • Strategy for Critical Thinking for Choosing • Lateral Thinking • Six Thinking Hats by Edward De Bono • Design Thinking	07	17

Text Book(s):

Title	Author/s	Publication
Thinker Toys	Michael Michalko	Random House Publication 2006
Crackling Creativity, The Secrets of Creative Genus	Michael Michalko	Ten Speed Press 2001

Reference Book(s):

Title	Author/s	Publication
Zig Zag, The Surprising Path to Greater Creativity	R Keith Sawyer	Jossy-Bass Publication 2013
De Bono's Thinking Course	Edward De Bono	Penguin Publication 1994
Six Thinking Hats	Edward De Bono	Penguin Publication 1999
How to Mind Map	Tony Buzan	Thorsons Publication 2002
The Myths of Innovation	Scott Berkum	Berkun Publication 2010
Creative confidence: Unleashing the creative Potential within Us all	Tom Kelly and David Kelly	William Collins Publication 2013
The all Laughed	Ira Flatow	Harper Publication 1992

The Ultimate Lateral & Critical Thinking Puzzle book	Paul Sloane, Des MacHale & M.A. DiSpezio	Sterling Publication 2002

Course Evaluation:

Section	Module No.	Evaluation Criteria	Marks
1	1	Group Activity on Brainstorming	15
	2	Mind Mapping Activity	10
	3	Chart Preparation on 'Practicality of Fishbone Diagram'	15
		Group presentation on 'SCAMPER Technique & its applications'	10
2	1	Group Presentation on Critical Analysis of a Govt. scheme/ policy/ budget (merit/ demerit, pros/cons etc)	15
	2	Group Discussion/ Debate/ Elocution	10
	3	Problem Solving Activity (Individual)	10
		Presentation (Learning Outcomes)	15
		Grand Total	**100**

Course Outcome(s):

After completion of the course, the student will be able to

- establish creativity in their day to day actions and educational output.
- solve all types of problems with an optimistic and an impartial attitude.
- reflect innovatively and work towards problem solving in a tactical way.
- initiate different and advanced practices in their selected field of profession.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4510
Course Name: Chemical System Modelling
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
03	00	00	03	40	60	00	00	00	00	100

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- give an overview of various methods of process modeling, different computational techniques for simulation.
- focus on the techniques, rather than specific applications so that the student can take up modeling and simulation challenges in his profession.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Introduction to Process Modeling** Systematic Approach to Model Building, Classification of Models. Conservation Principles, Thermodynamic Principles of Process Systems	05	10
2.	**Models based on First Principle** Development of Steady State and Dynamic Lumped and Distributed Parameter Models Based on First Principles. Analysis of Ill-conditioned Systems. Models with Stiff Differential Equations.	08	20
3.	**Development of Grey Box Models** Empirical model building. Statistical model calibration and validation. Examples. Introduction to population balance models, multi-scale modeling.	09	20
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Solution Strategies for Lumped Parameter Models and Stiff Differential Equations** Solution Methods for Initial Value and Boundary Value	10	20

	Problems. Euler's Method. R-k Methods, Shooting Method, Finite Difference Methods – Predictor Corrector Methods.		
2.	**Solution Strategies for Distributed Parameter Models** Solving parabolic, elliptic and hyperbolic partial differential equations. Introduction to finite element and finite volume methods.	10	20
3.	**Solving Problems using MATLAB**	03	10

Text Book(s):

Title	Author/s	Publication
Process Modeling, Simulation and Control for Chemical Engineers (2nd edition)	W.L. Luyben	McGraw Hill Book Co., New York (1990)

Reference Book(s):

Title	Author/s	Publication
Mathematical Methods in Chemical Engineering (2nd edition)	Jensen V.G., Jeffrey's G.V.	Academic Press, London (1978)
Computational Methods for Process Simulation (2nd edition)	W. F. Ramirez	Butterworths (1997)
Chemical Process Modelling and Computer Simulation (2nd edition)	Amiya K. Jana	Prentice Hall of India (2011)
Applied Numerical Analysis using MATLAB (2nd edition)	Laurene V. Fausett	Pearson (2009)

Web Material Link(s):

- https://nptel.ac.in/courses/103101142/
- https://lecturenotes.in/subject/383/simulation-and-modelling-sm

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 Hour of duration and the average of the same will be converted to 30 marks.
- Faculty evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Course Outcome(s):

After completion of the course, the student will be able to

- develop process models based on conservation principles and process data;
- understand computational techniques to solve process models;
- use simulation tools.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4520
Course Name: Quality Control and Quality Assurance – Instrumentation and Validation Process
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
03	00	00	03	40	60	00	00	00	00	100

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- understand the importance of quality
- learn about ISO management systems
- know the tools for quality improvement
- analyze the issues in quality
- learn the importance of quality evaluation of pharmaceuticals
- understand the concept of stability testing of drug and drug substances
- practice statistical approaches for quality

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Introduction** Concept and evolution and Scopes of Quality Control and Quality Assurance, Good Laboratory Practice, GMP, Overview of ICH Guidelines - QSEM, with special emphasis on Q series guidelines. Good Laboratory Practices: Scope of GLP, Definitions, Quality Assurance Unit, Protocol for Conduct of Non-Clinical Testing, Control on Animal House, Report Preparation and Documentation. CPCSEA Guidelines	07	14
2.	**Inspection Convention** cGMP Guidelines according to schedule M, USFDA (inclusive of CDER and CBER) Pharmaceutical Inspection Convention(PIC), WHO and EMEA Covering: Organization and Personnel Responsibilities, Training, Hygiene and Personal Records, Drug Industry Location, Design, Construction and Plant Lay Out, Maintenance, Sanitation, Environmental Control, Utilities	07	18

	and Maintenance of Sterile Areas, Control of Contamination and Good Warehousing Practice.		
3.	**Quality Control** Analysis of Raw Materials, Finished Products, Packaging Materials, In Process Quality Control (IPQC), Developing Specification (Ich Q6 And Q3), Purchase Specifications and Maintenance of Stores for Raw Materials. In Process Quality Control and Finished Products Quality Control for Following Dosage Forms in Pharma Industry according to Indian, US and British Pharmacopoeias: Tablets, Capsules, Ointments, Suppositories, Creams, Parenterals, Ophthalmic and Surgical Products (How to Refer Pharma Copoeias).	08	18
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Documentation** Documentation in Pharmaceutical Industry: Three tier documentation, Policy, Procedures and Work Instructions, and Records (Formats), Basic Principles- How to Maintain, Retention and Retrieval etc. Standard Operating Procedures (How to write), Master Batch Record, Batch Manufacturing Record, Quality Audit Plan and Reports. Specification and Test Procedures, Protocols and Reports. Distribution Records. Electronic Data Handling. Concepts of Controlled and Uncontrolled Documents. Submission documents for regulators DMFs, as Common Technical Document an Electronic Common Technical Documentation (CTD, eCTD). Concept of regulated and non regulated markets.	12	25
2.	**Manufacturing Operations and Controls** Sanitation of Manufacturing Premises, Mix-Ups and Cross Contamination, Processing of Intermediates and Bulk Products, Packaging Operations, IPQC, Release of Finished Product, Process Deviations, Charge-In of Components, Time Limitations on Production, Drug Product Inspection, Expiry Date Calculation, Calculation of Yields, Production Record Review, Change Control, Sterile Products, Aseptic Process Control, Packaging, Reprocessing, Salvaging, Handling of Waste and Scrap Disposal. Introduction, Scope and Importance of Intellectual Property Rights. Concept of Trade Mark, Copyright and Patents.	11	25

Text Book(s):

Title	Author/s	Publication
Quality Assurance Guide by organization of Pharmaceutical Procedures of India	D H Shah	3rd revised edition, Volume I & II, Mumbai, 1996.
How to Practice GMP's	P P Sharma,	Vandana Publications, Agra, 1991.

Reference Book(s):

Title	Author/s	Publication
Quality Assurance of Pharmaceuticals- A compendium of Guide lines and Related materials Vol I & II, 2nd edition	--	WHO Publications, 1999
Good laboratory Practice Regulations –, Volume 38,	Allen F. Hirsch	Marcel Dekker Series, 1989

Web Material Link(s):

- www.pharmaguide.com

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 Hour of duration and average of the same will be converted to 30 marks.
- Faculty evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Course Outcome(s):

After completion of the course, the student will be able to

- define importance of quality.
- give information about ISO management systems.
- exhibit tools for quality improvement.
- analyze issues in quality.
- do quality evaluation of pharmaceuticals.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4530
Course Name: Membrane Technology
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
03	00	00	03	40	60	00	00	00	00	100

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- enable to understand membrane-based separation problems by acquiring in-depth knowledge in the area of membrane separation mechanisms, transport models, membrane materials and modules.
- focus particularly on various applications of membrane science and technology.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Rate Governed and Equilibrium Membrane Separation Processes** Fundamentals, Types of Membranes, Modules, Flow Patterns, Preparation and Characterization of Membranes, Melt Pressing, Film Stretching, Sol-gel Peptization, Interfacial Polymerization etc. Measurement of Pore Size and Solute Rejection Properties	06	15
2.	**Reverse Osmosis** Design and Operating Parameters, Various Transport Models, Kedem-katchalsky Model, Spiegler-kedem Model, Solution-diffusion Model, Concentration Polarization and Flux Decline, Design of an RO module, Forward Osmosis	06	15
3.	**Nanofiltration** Transport Mechanism in NF Membranes, Parameters affecting the Performance of NF Membranes, Fouling Model, Determination of Various Resistances	06	10
4.	**Ultrafiltration** Factors Affecting Performance of Ultrafiltration, Resistance Model, Gel Polarization Model, Fouling and Flux Decline, Micellar-Enhanced Ultrafiltration, Affinity Ultrafiltration, Microfiltration Advances	05	10

Section II			
Module No.	Content	Hours	Weightage in %
1.	**Membrane Gas Separation** Membranes for Gas Separation, Fundamental Mechanism of Gas Transport, Knudsen Diffusion, Molecular Sieving, Solution Diffusion, Dual Sorption Model, Factors Affecting Gas Permeation, Complete Mixing Model, Solution of Equations, Equations for Multicomponent Mixtures, Cross - Flow Model, Countercurrent Model, Applications	07	20
2.	**Pervaporation** Mass Transfer and Thermodynamics Aspects of Pervaporation, Temperature Drop at Membrane Interface	05	10
3.	**Dialysis** Principle of Dialysis, Dialysis Systems, Mass Transfer in Dialysis, Modeling of Solute Transport in Hemodialyzer, Advantages of Diffusion Dialysis, Application of Diffusion Dialysis, Electrodialysis	06	10
4.	**Membrane Reactor** Membrane Bioreactor, Membrane Distillation	04	10

Text Book(s):

Title	Author/s	Publication
Membrane technology and applications	Baker, R.W.	2nd ed., John Wiley 2004
Membrane separation Processes	K Nath	Prentice Hall of India, New Delhi

Reference Book(s):

Title	Author/s	Publication
Basic Principles of Membrane Separation	Mudler J	(2nd Edition), Springer

Web Material Link(s):
https://nptel.ac.in/courses/103105121/

Course Evaluation:
Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 hour of duration and average of the same will be converted to 30 marks.
- Submission of power point presentation which is to be presented by the students in a group of 3 which carries 10 marks of evaluation.
- End Semester Examination consists of 60 marks.

Course Outcome(s):

After completion of the course, the student will be able to

- apply various transport models for the calculation of membrane fluxes and the extent of separation for various membrane systems.
- identify the types of experimental data needed for the calculation of membrane parameters
- select a membrane process and design components to carry out a specific separation
- apply advanced membrane techniques to solve environmental as well as chemical industries problems.
- review the importance and relevance of separation process with the help of membrane in industry.

P P Savani University
School of Engineering

Department of Chemical Engineering

Course Code: SECH4540
Course Name: Industrial Health & Safety Engineering
Prerequisite Course(s): --

Teaching & Examination Scheme:

Teaching Scheme (Hours/Week)				Examination Scheme (Marks)						
Theory	Practical	Tutorial	Credit	Theory		Practical		Tutorial		Total
				CE	ESE	CE	ESE	CE	ESE	
03	00	00	03	40	60	00	00	00	00	100

CE: Continuous Evaluation, ESE: End Semester Exam

Objective(s) of the Course:
To help learners to

- provide knowledge on design features for a process industry and safety in the operation of various equipment in industry.
- understand the various hazards and prevention in commissioning stage of industry.
- recognize and identify the safe operation of equipment in process industry.
- plan and trained for emergency planning in a process industry.
- get fundamental knowledge on safe storage of chemicals.
- understand mathematical modeling and analogical aspects of chemical process systems where these transport processes occur simultaneously.
- transport Phenomena also focuses on typical situations and thereby its complete understanding on axial as well as radial profiles.

Course Content:

Section I			
Module No.	Content	Hours	Weightage in %
1.	**Hazard, Risk Issues, and Hazard Assessment** Introduction, Hazard assessment, Hazard operability studies (HAZOP, HAZAN), Fire triangle, OSHA standards	03	05
2.	**Safety in Process Design** Design Process, Conceptual Design and Detail Design, Assessment, Inherently Safer Design Chemical Reactor, Types, Batch Reactors, Reaction Hazard Evaluation, Assessment, Reactor Safety, Operating Conditions, Unit Operations and Equipment, Utilities	05	08
3.	**Safety in Pressure System Design** Pressure System, Pressure Vessel Design, Standards and Codes- Pipe Works and Valves - Heat Exchangers - Process Machinery-	06	17

	Over Pressure Protection, Pressure Relief Devices and Design, Fire Relief, Vacuum and Thermal Relief, Special Situations, Disposal- Flare and Vent Systems Failures In Pressure System.		
4.	**Plant Commissioning** Commissioning Phases and Organization, Pre-Commissioning Documents, Process Commissioning, Commissioning Problems, Post Commissioning Documentation	04	10
5.	**Plant Inspection** Plant Inspection, Pressure Vessel, Pressure Piping System, Non-Destructive Testing, Pressure Testing, Leak Testing and Monitoring - Plant Monitoring, Performance Monitoring, Condition, Vibration, Corrosion, Acoustic Emission-Pipe Line Inspection	05	10
Section II			
Module No.	Content	Hours	Weightage in %
1.	**Plant Maintenance, Modification and Emergency Planning** Management of Maintenance, Hazards - Preparation for Maintenance, Isolation, Purging, Cleaning, Confined Spaces, Permit System - Maintenance Equipment - Hot Works - Tank Cleaning, Repair and Demolition - Online Repairs - Maintenance of Protective Devices - Modification of Plant, Problem-Controls of Modifications.	07	10
2.	**Storages and Transportation** General consideration, petroleum product storages, storage tanks and vessel- storages layout segregation, separating distance. LPG storages, pressure storages, layout, instrumentation, vaporizers, refrigerated storages - LNG Storages, Hydrogen Storages, Toxic Storages, Chlorine Storages, Ammonia Storages. Chemical Storages- Underground Storages- Loading and Unloading Facilities- Drum and Cylinder Storage- ware House, Storage Hazard Assessment of LPG and LNG Hazards during Transportation – Pipeline Transport.	07	20
3.	**Plant Operations** Application of Shell Balance Method and Equations of Changes for Mass Transfer Problems, Diffusivity, Mass and Molar Transport By Convection, Concentration Distributions for Isothermal and Non-Isothermal Mixtures, Multi-component Systems with more than one Independent Variable and in Turbulent Flow Convective Mass Transfer and Correlation, Inter Phase Mass Transfer, Diffusion with Chemical Reaction, Transport Across Selectively Permeable Membrane and Porous Media	08	20

Text Book(s):

Title	Author/s	Publication
Safety and Accident Prevention in Chemical Operations.	Fawcett, H.h. and Wood	Wiley inters, Second Edition.
High Risk Safety Technology.	Green, A.E.	John Wiley & Sons.

Reference Book(s):

Title	Author/s	Publication
Loss Prevention in Process Industries.	Lees, F. P	Butterworths and Company
Guidelines for Chemical Process Quantitative Risk Analysis	--	AICHE, 2000

Course Evaluation:

Theory:

- Continuous Evaluation consists of two tests each of 30 marks and 1 hour of duration and average of the same will be converted to 30 marks.
- Faculty evaluation consists of 10 marks as per the guidelines provided by the course coordinator.
- End Semester Examination consists of 60 marks.

Course Outcome(s):

After completion of the course, the student will be able to

- become familiar of safe design of equipment which are the essential to chemical industry and leads to design of entire process industries.
- be able to understand the design of pressure systems.
- understand the problems and find innovative solutions while industries facing problems in commissioning and maintenance stages.
- be able to prepare the emergency planning for chemical industry problems.
- be would be able to create safe storage systems.