D. Y. Patil College of Engineering and Technology

Kasaba Bawad, Kolhapur

(An Autonomous Institute)

NBA Accredited

Accredited by NAAC with 'A' Grade

D Y PATIL
COLLEGE of
ENGINEERING & TECHNOLOGY
(AN AUTONOMOUS INSTITUTE)
KASABA BAWADA, KOLHAPUR

Structure and Syllabus

(As per NEP 2020)

for

Third Year B. Tech in Chemical Engineering

Department of Chemical Engineering

w.e.f. 2025-26

Department of Chemical Engineering
DYPCET
Kolhapur

Head of Department
Department of Chemical Engineering
D. Y. Patil College of Engg. & Tech. Kolhapur.

D.Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY, KOLHAPUR
Teaching and Evaluation Scheme from Year 2025-26 (as per NEP 2020)
Third Year B. Tech Chemical Engineering
Semester - V

Sr. No.	Course Code	Course Type	Name of the Course	Teaching Scheme Per Week				Theory			Practical		Total Marks
				Credits	Contact Hrs			ISE	MSE	ESE	INT	OE/P OE	
					L	P	T						
1	231CHPCCL301	PCC	Mass Transfer I	3	3	-	-	20	30	50	-	-	100
2	231CHPCCL302	PCC	Chemical Process Technology	3	3	-	-	20	30	50	-	-	100
3	231CHPCCL303	PCC	Chemical Reaction Engineering	3	3	-	-	20	30	50	-	-	100
4	231CHMDML301	MDM-3	Green Fuel Technology (ODL)	3	3	-	-	20	30	50	-	-	100
5	231CHOECL301	OEC-III	Corporate Skills & Behaviour	2	2	-	-	-	-	50	-	-	50
6	231CHPECL301	PEC 1	Petroleum Engineering	4	4	-	-	20	30	50	25	-	125
7	231CHPECL302		Green Technology										
8	231CHPCCP301	PCC	Mass Transfer I Lab	1	-	2	-	-	-	-	25	25	50
9	231CHPCCP302	PCC	Chemical Process Technology Lab.	1	-	2	-	-	-	-	25	-	25
10	231CHPCCP303	PCC	Chemical Reaction Engineering Lab	1	-	2	-	-	-	-	25	25	50
11	231CHMDMP301	MDM-3	Green Fuel Technology Lab (ODL)	1	-	2	-	-	-	-	25	-	25
12	231CHMCL301	MC	Finishing School Training V	Audit	3*	-	-	50*	-	-	-	-	Grade
13	231CHCCAL301	CCA	Liberal Learning	Audit	-	2*	-	50*	-	-	-	-	Grade
			Total	**22**	**18**	**08**	**-**	**200**	**150**	**300**	**125**	**50**	**725**

***- Values not Included in Total Min. Marks for Passing- 40 % of Total Marks of Individual Course**

D.Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY, KOLHAPUR
Teaching and Evaluation Scheme from Year 2025-26 (as per NEP 2020)
Third Year B. Tech Chemical Engineering
Semester - VI

Sr. No.	Course Code	Course Type	Name of the Course	Teaching Scheme Per Week				Theory			Practical		Total Marks
				Credits	Contact Hrs			ISE	MSE	ESE	INT	OE/ POE	
					L	P	T						
1	231CHPCCL304	PCC	Mass Transfer II	2	2	-	-	-	-	50	-	-	50
2	231CHPCCL305	PCC	Process Dynamics & Control	3	3	-	-	20	30	50	-	-	100
3	231CHPCCL306	PCC	Transport Phenomena	3	3	-	-	20	30	50	-	-	100
4	231CHMDML302	MDM-4	Hydrogen Technology	2	2	-	-	-	-	50	-	-	50
5	231CHPECL303	PEC-2	Petrochemical Technology	3	3	-	-	20	30	50	-	-	100
6	231CHPECL304		Energy Conservation & Audit										
7	231CHPECL305	PEC-3	Industrial Safety & Management	3	3	-	-	20	30	50	-	-	100
8	231CHPECL306		Modelling & Simulation in Chemical Engineering										
9	231CHVSECL301	VSEC	Business Communication	1	1		-	25	-	-	-	-	25
10	231CHPCCP304	PCC	Mass Transfer II Lab	1	-	2	-	-	-	-	25	25	50
11	231CHPCCP305	PCC	Process Dynamics & Control Lab	1	-	2	-	-	-	-	25	25	50
12	231CHPECP301	PEC-2	Analytical Techniques in Chemical Engineering	1	-	2	-	-	-	-	25	-	25
13	231CHPECP302		Waste Water Engineering										
14	231CHPECP303	PEC-3	Chemical Plant Design by Aspen Plus	1	-	2	-	-	-	-	25	25	50
15	231CHPECP304		Application of AI in Chemical Engineering										
16	231CHVSECP301	VSEC	Business Communication	1	-	2	-	-	-	-	25	-	25
17	231CHMCL302	MC	Finishing School Training VI	Audit	3*	-	-	50*	-	-	-	-	Grade
18	231CHCCAL302	CCA	Liberal Learning	Audit	-	2*	-	25*	-	25*	-	-	Grade
			Total	**22**	**17**	**10**	**-**	**180**	**120**	**325**	**125**	**75**	**725**

***- Values not included in Total Min. Marks for Passing- 40 % of Total Marks of Individual Course**

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Department of Chemical Engineering

T.Y. B. Tech. Curriculum (as per NEP-2020 Policy)

w.e.f. A.Y. 2025-26

Course Plan

Course Title: Mass Transfer-I	
Course Code :231CHPCCL301	**Semester**: V
Teaching Scheme: L-T-P: 3-0-0	**Credits:** 3
Evaluation Scheme: ISE + MSE Marks: 20+30=50	**ESE Marks**: 50

Course Description:

This course explain concept of steady state & unsteady state diffusional operations studied for controllingparameters in actual industrial process. Mass transfer-I course provides knowledge to design equipment's for mass transfer operations.

After learning this course, student can able to implement the knowledge of various unit operations in the real plants and to understand the trouble shooting problems in actual operation

Sr. No.	Course Objectives
1	To understand classification of industrial mass transfer operations, molecular diffusion in fluids and solids.
2	To understand fundamentals of mass transfer coefficient, theories of mass transfer, Inter-phase mass transfer concepts, designing of stages in it.
3	To study industrially important gas and liquid dispersed equipment's for gas-liquid operations in industries.
4	To understand fundamentals of gas absorption with design of industrial tray and packed tower absorber.
5	To understand fundamentals of adsorption, ion exchange, material balance and break through curve, design of adsorber.
6	To study theory of simultaneous mass transfer and chemical reaction with its kinetic regimes.

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Course Outcomes (COs):

COs	**At the end of successful completion of the course the student will be able to**
231CHPCCL301.1	**Explain** & **determine** diffusivity, flux in fluids and solids.
231CHPCCL301.2	**Understand, & apply** mass transfer coefficient, inter phase mass transfer concepts, designing of stages in it.
231CHPCCL301.3	**Understand & select** gas and liquid dispersed equipment's for gas-liquid operations and to understand the trouble shooting problems in industries.
231CHPCCL301.4	**Understand & apply** fundamentals of gas absorption with design of tray and packed tower absorber.
231CHPCCL301.5	**Understand** fundamentals, material balance, design of adsorption, ion exchange to **apply** the knowledge gained in the real plants.
231CHPCCL301.6	**Explain** mass transfer with Chemical reaction & its kinetic Regimes

Prerequisites:	Chemistry, Applied mathematics, Physics, Process Calculations, Thermodynamics,Fluid mechanics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes: Program Outcomes mapping

Course Outcomes (COs)	POs												PSO	PSO	BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
221CHL301.1	2	2	1	2	-	2	2	-	-	-	-	1	2	-	3
221CHL301.2	2	2	1	2	-	2	1	-	-	-	-	1	2	-	3
221CHL301.3	1	1	1	2	-	1	1	-	-	-	-	1	2	-	3

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221CHL301.4	2	2	1	2	-	1	1	-	-	-	-	1	2	-	3
221CHL301.5	2	2	1	2	-	1	1	-	-	-	-	1	2	-	3
221CHL301.6	1	1	1	1	-	1	1	-	-	-	-	1	2	-	3
221CHL301	1.67	1.67	1	1.83	-	1.33	1.16	-	-	-	-	1	2	-	3

Strong contribution: 3 Medium contribution: 2 Weak contribution: 1 No contribution: -

Content	Hours
Unit 1: Introduction to Mass Transfer Operations, Diffusion in Fluids and Solids Classification & Applications, Concept of diffusivity, Knudson diffusion, Flux transfer equations for gas and liquid phase based on steady and unsteady state equation, empirical equations used to determine diffusivity through gas and liquid phase, equation of continuity and its application in the form of Navier -Stoke equation. Experimental diffusivity measurement equipment's – Arnold cell, Stefan tube, Diaphragm cell, Molecular diffusion in solids, Industrial applications of diffusion & these equipment's.	07

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Unit 2: Mass Transfer Coefficients & Inter-phase Mass Transfer Relation between different mass transfer coefficients, its relation, Determination of mass transfer coefficient through contacting equipment. Eddy diffusion, film theory, penetration theory, surface renewal theory, New theories of Mass transfer, Viz Surface stretch theory, Dobbins theory, analogy of mass transfer, heat Transfer and its significance, mass transfer coefficient in laminar flow and turbulent flow, Simultaneous mass & heat transfer, industrial applications of mass transfer coefficient. Inter-phase mass transfer: Equilibrium, Study of Raults law, Henrys law, Two Film Theory - Concept of individual and overall mass transfer coefficient, operating line, driving force line. Cascades, material balance – co-current, cross current, counter current stages. Operating & driving force line concept. Stage efficiency, solved examples on stages and driving force lines with interfacial compositions, Kremser-Brown equation, Industrial applications of liquid dispersed equipment's.	10
Unit 3: Industrial Equipment's for gas –liquid operations: a) Gas dispersed: Multistage absorption tray towers, mechanical difficulties in tray tower, Type oftrays, flow arrangements on tray, Tray efficiency, sparged vessels. Gas hold up – concept of sleep velocity, Mechanically agitated vessels, vortex formation & prevention, fluid mechanics of agitation, Industrial applications of gas dispersed equipment's. b) Liquid dispersed: Ventury Scrubber, Wetted wall tower, Spray tower, Spray chamber, Packed tower & its internals, Mass Transfer coefficients for packed tower, Random & Stacked(Structured) packing, End effects and axial mixing, Tray tower Verses packed tower .Liquidhold up – determination of interfacial area based on hold up and Mass Transfer Coefficients. Industrial applications of gas dispersed equipment's.	08

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Unit 4: Gas absorption (Scrubbing): Ideal & non ideal liquid solutions, Choice of solvent, Material balance on concurrent, crosscurrent and countercurrent absorption or stripping, Absorptionfactor and stripping factor, Tray efficiency ,Design equation for packed tower ,HETP,NTU,HTU calculation for packed tower, Industrial applications of absorption (Scrubber)	08
Unit 5: Adsorption & Ion Exchange: Types of adsorption, Nature of adsorbents, adsorption isotherms, Types of adsorbents, Adsorption equipment's, Adsorption hysteresis, Heat of adsorption, break through curves, design of packed bed adsorber, Single and multistage adsorption operation material balance, calculations, Principle of Ion Exchange,Principles, structure, types & Techniques of Ion Exchange, regeneration of ion exchange, Industrial applications of adsorption & IE.	09
Unit 6: Mass Transfer with Chemical Reactions: Industrial applications of mass transfer with reaction, theory of simultaneous mass transfer and chemical reaction, Mass transfer reaction operations considering heterogeneous and homogeneous slow reaction, fast reaction, and Enhancement factor.	03

Text Books;

1	Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw Hill,1980.
2	Richardson & Coulson, "Chemical Engineering", Vol. 1, Pergamon Press, 1970
3	Richardson & Coulson, "Chemical Engineering", Vol. 2, Pergamon Press, 1970
4	Richardson & Coulson, "Chemical Engineering", Vol. 4, Pergamon Press, 1970
5	Richardson & Coulson, "Chemical Engineering", Vol. 5, Pergamon Press, 1970

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Reference Books;

1	Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke, "Mass transfer" International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
2	McCabe and Smith, "Unit Operation of Chemical Engineering",5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3	C. J Geankoplis, Transport Processes and unit operations, 3rdEdition, Prentice hall, India, 1993.
4	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh
6	B.K Datta, Principles of mass transfer & separation process
7	K. D Patil, Mass Transfer Operation Vol. I & II.

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Course Plan

Course Title: Chemical Process Technology	
Course Code: 231CHPCCL302	**Semester:** V
Teaching Scheme: L-T-P:3-0-0	**Credits:** 03
Evaluation Scheme: ISE+MSE Marks: 20 + 30 = 50	**ESE Marks:**50

Course Description:

This course provides a comprehensive understanding of the fundamental principles and applications of chemical process technology in industrial settings. Students will learn about the design, analysis, and optimization of chemical processes used in the production of various chemical products. Key topics include mass and energy balances, thermodynamics, fluid mechanics, heat and mass transfer, reactor design, and separation processes.

Course Objectives:

1	To learn food preservation and processing methods.
2	To learn manufacturing processes of nitrogen industry.
3	To study the synthesis of pharmaceutical and dye products.
4	To learn synthesis process of sulphur based inorganic chemicals.
5	To learn manufacturing processes of paper and pulp.
6	To study the synthesis of explosive materials.

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHPCCL302.1	**Understand** processes for food and beverage industries.
231CHPCCL302.2	**Elaborate** the manufacturing processes of nitrogen industries
231CHPCCL302.3	**Understand** manufacturing processes for pharmaceuticals and dyes industries.
231CHPCCL302.4	**Understand** the various synthesis process sulphur based inorganic chemicals.
231CHPCCL302.5	**Understand** the manufacturing processes of paper & pulp industries.
231CHPCCL302.6	**Understand** the manufacturing processes for explosive materials.

Prerequisite:	Applied chemistry, Mechanical Operation

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO	PSO	BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
231CHPCCL302.1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	2
231CHPCCL302.2	1	-	-	-	-	-	-	-	-	-	-	-	2	2	2
231CHPCCL302.															

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3	1	-	-	-	-	-	-	-	-	-	-	-	2	2	2
231CHPCCL302.4	1	-	-	-	-	-	-	-	-	-	-	-	2	2	2
231CHPCCL302.5	1	-	-	-	-	-	-	-	-	-	-	-	2	2	2
231CHPCCL302.6	1	-	-	-	-	-	-	-	-	-	-	-	2	2	2

Content	Hours
Unit 1-FoodIndustries Types of food processing, preservation methods, future scope of food byproducts.	8
Unit 2– Pharmaceutical industries Classification of pharmaceutical products. Manufacture of antibiotics, isolates from animals, dyes and pigments: types of dyes, manufacturing of dyes, manufacturing of pigments.	8
Unit 3.-Pulp and paper industries Manufacturing of pulp, manufacturing of paper. Plastic industries: raw materials, general polymerization processes, manufacturing processes. future scope	8
Unit 4-Sulphur industries Manufacture of elemental sulphur and sulphuric acid, modern tools and techniques.	8
Unit 5-Nitrogen industries Manufacture of synthetic ammonia, nitric acid, ammonium nitrate, and urea and their engineering problems.	7
Unit 6. Explosives Types of explosives, explosive characteristic, Industrial explosives, propellants, missiles.	6

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Text Books:

1	P. H. Groggins; Unit Processes in organic Synthesis
2	Georget Austin; Shreve's Chemical Process Industries, 5th edn. McGraw Hill Book Company,1985.
3	Paul T. Anastaj; Green Chemistry–Theory and Practice
4	C. E. Dryden, Outlines of Chemical Technology, Affiliated East-West Press, 1973.

Reference Books:

1	Anastas, P.Warner, J. Green Chemistry: Theory and Practice; Oxford University Press: London
2	S. D. Shukla, G. N. Pandey, A Text book of Chemical Technology, 3rd Edition
3	D. Venkateshwara, Chemical Technology, I & III manuals of Chemical Technology, Chemical Engineering. Ed. Dev.III Madras, 1977
4	Perry R. H. Green D. W., Perry's chemical Engineer's Hand book, McGraw Hill, New York, 2007.
5	S. D. Shukla, G. N. Pandey, A Text book of Chemical Technology, 3rd Edition

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Course Plan

Course Title: Chemical Reaction Engineering	
Course Code: 231CHPCCL303	**Semester: V**
Teaching Scheme: L-T-P:3-0-0	**Credits**: 03
Evaluation Scheme: ISE + MSE Marks: 20 + 30 = 50	**ESE Marks**: 50

Course Description:

Chemical Reaction Engineering subject deals with homogeneous and heterogeneous reaction system. In this syllabus we will be discussing various types of reaction, various types of reactors, performance equations, and types of reactor arrangements and effects of temperature on homogenous system.

Course Objectives:

1	Find rate law and define reaction order and activation energy for given reaction.
2	Demonstrate the ability to quantitatively predict the performance of common chemical reactors using simplified engineering models.
3	Demonstrate the ability to regress the experimental data from which they determine the kinetic model of a multi-reaction system and use this information to design a commercial reactor.
4	Develop understanding of heterogeneous solid catalyst, fluid - particle fluid - fluid reactions.

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Course Outcomes (COs): At the end of the course the student should be able to:

231CHPCCL303.1	**Understand** the kinetics of homogeneous reactions
231CHPCCL303.2	**Develop** the rate equation of various types reactions based on interpretation of batch reactor data.
231CHPCCL303.3	**Design** the batch reactors, semi batch reactors, CSTRs, PFRs for given rate law and feed condition.
231CHPCCL303.4	**Apply** knowledge of non-ideal flow and will find conversion in actual reactors from experiment and different models.
231CHPCCL303.5	**Understand** industrial terms related to solid catalyst & find different characteristics of solid catalysts.
231CHPCCL303.6	**Understand** the design of fluid particle and fluid-fluid reactions with different models.

Prerequisite	Process Calculation, Chemical Engineering Thermodynamics

Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (Pos) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO	PSO	BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
231CHPCCL303.1	3	2	2	-	-	-	-	-	-	-	-	-	2	-	2
231CHPCCL303.2	2	2	2	2	-	-	-	-	-	-	-	-	2	-	2
231CHPCCL303.3	-	2	2	2	-	-	-	-	-	-	-	-	2	-	3

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231CHPCCL303.4	2	2	2	2	-	-	-	-	-	-	-	-	2	-	3
231CHPCCL303.5	2	2	1	1	-	-	-	-	-	-	-	-	2	-	2
231CHPCCL303.6	2	2	3	2	-	-	-	-	-	-	-	-	2	-	2
231CHPCCL303	**2.2**	**2**	**2**	**1.8**	-	-	-	-	-	-	-	-	**2**	-	-

Content	Hours
Unit1: Introduction with Kinetics of Homogeneous Reactions Classification of reactions, Order and molecularity of reaction. Fractional conversion, Rate of reaction, Rate Constant Based on thermodynamic activity, partial pressure, mole fraction and concentration of the reaction components and their interrelation. Temperature dependency of rate Constant, Arrhenius law, Transition state theory and collision theory.	07
Unit2: Interpretation of Batch Reactor Data Batch reactor concept, Constant volume batch reactor system; Design equation for zero, first, Second and third order irreversible and reversible reactions, graphical interpretation of these equations, Variable volume Batch reactors. Rate equations for series and parallel reactions. Industrial applications of batch reactor.	07

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Unit3: Ideal Flow Reactors Types of flow reactors, Space-time and space velocity. Design equation for plug flow reactor and CSTR for first and second order reversible and irreversible, constant volume and variable volume reactor, mean holding time, Staging of reactors in series and parallel; performance of infinite number of back mix reactors in series, Back mixed and plug flow reactors of different sizes in series and their optimum way of staging; Recycle reactors, Optimum recycle ratio for auto–catalytic(recycle) reactors. Demonstration of various reactor arrangements in chemical industry with real time example.	09
Unit4: Non-Ideal Flow: Basic concept of non-ideal flow; residence time distribution. Determination of RTD from Tracer Curves, Stimulus Response technique, Mathematical tools, Tubular Reactor, E- and F-Curves for a Stirred Tank Reactors, Analysis of RTD from Pulse Input and step input, Models for predicting conversion from RTD data, One Parameter model, Dispersion model, Tank in Series model, Introduction to Multi parameter model.	07
Unit 5: Heterogeneous processes and Solid catalyzed reactions Global rate of reaction, Catalysis, Nature of catalytic reactions, Determination of Surface area, Void volume and solid density, Pore volume distribution, Catalyst Classification, preparation, Poisoning, Characterizations, Promoters, accelerators, Support, carrier and inhibitors. Film resistance controlling, surface area controlling, Pore diffusion controlling. Heat effects during reaction, Design of catalytic reactors.	08
Unit 6: Fluid particle reactions (Non catalytic) and Fluid-fluid reaction: Practical examples of fluid particle reaction, Selection of a model for gas-solid reactions Un-reacted core and Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps. Introduction to heterogeneous fluid - fluid reactions, , Rate equation for instantaneous, Fast and slow reaction, Equipments used in fluid- fluid contacting with reaction.	07

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Text Book:

1.	Octave Levenspeil, "Chemical Reaction Engineering" , 2nd Edition, John Wiley, London
2.	S. H. Fogler, Elements of Chemical Reaction Engineering", PHI, 4th Edition

Reference Books:

1.	S. M. Walas, "Reaction Kinetics for Chemical Engineers" McGraw Hill, New York.
2.	J. M. Smith, "Chemical Engineering Kinetics", McGraw Hill, New York.
3.	J. Rajaram and J. C. Kuriacose, "Kinetics and Mechanics of Chemical Transformation", McMillan India Ltd., 1993

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Course Plan

Course Title: Green Fuel Technology (ODL)	
Course Code: 231CHMDML301	**Semester:** V
Teaching Scheme: L-T-P: 3-0-0	**Credits:** 03
Evaluation Scheme: ISE + MSE Marks: 20 + 30 =50	**ESE Marks:** 50

Course Description:

This course typically encompasses the study of alternative and renewable energy sources, focusing on their environmental benefits, technological applications, and integration into existing energy systems. Below is a synthesized outline of such a course, including its syllabus, course objectives, expected outcomes, their mapping to program outcomes, and recommended textbooks and reference materials.

Course Objectives:

1	Understand the importance and impact of green fuels on the environment.
2	Explore various renewable energy sources and their technological applications.
3	Analyze the environmental challenges associated with conventional fuels.
4	Evaluate energy requirements and compare different energy resources and technologies.
5	Design and develop systems utilizing suitable fuels in an economic and energy-efficient manner.

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Course Outcomes (CO's):

COs	At the end of successful completion of course, the students will be able to…
MDML301.1	**Understand** the importance of green technology and current energy requirements
MDML301.2	**Explain** the concept of cleaner production
MDML301.3	**Understand** environmental challenges associated with fossil fuels and comparison between conventional fossil fuels and green fuels
MDML301.4	**Understand** various technologies of biomass conversion and biodiesel production
MDML301.5	**Explain** various renewable energy resources and green building concept
MDML301.6	**Describe** environmental and economical impact aspects of green fuel manufacturing process

Prerequisite:	Knowledge of organic and inorganic chemistry, reaction mechanisms and fuel composition, Understanding energy efficiency, entropy and Gibbs free energy calculations

Course Articulation Matrix:

Mapping of Course Outcomes (CO's) with Program Outcomes (PO's) and Program Specific Outcomes (PSO's)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BT L
	1	2	3	4	5	6	7	8	9	10	11	12			
MDML301.1	1					2									2
MDML301.2						2								2	2

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MDML301.3						2	1					1			2
MDML301.4						2	1								2
MDML301.5						2	2				1	1	2	2	2
MDML301.6							2				1				2

Content	Hours
Unit 1. Introduction to Green Technology Definition, importance, historical evolution, advantages and disadvantages, Role of industry, government and institutions in promoting green technology, role of industrial ecology in green technology, Current energy requirements, growth in future energy requirements	09
Unit 2. Cleaner Production Principles, benefits, promotion, barriers, and the role of various stakeholders, Concepts of clean development mechanism, reuse, recovery, recycling and raw material substitution	07
Unit 3. Green Fuels Definition, benefits, challenges, and comparison with conventional fossil fuels concerning environmental, economic and social impacts, Public policies and market-driven initiatives supporting green fuels, bio-fuels, fuel cells- working, selection of fuels	07
Unit 4. Biomass Energy Concepts of biomass energy utilization, types, and conversion processes, Technologies such as charcoal production, gasification, biogas plants and biodiesel production	07

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Content	Hours
Unit 5. Renewable Energy Sources and Green Buildings Overview of solar, wind, geothermal, tidal, and hydrothermal energy sources, Energy conversion technologies and their principles, equipment and suitability in various contexts Definition of Green building- Features and benefits, Eco-friendly and cost effective materials, Energy management	08
Unit 6. Environmental and Economic Aspects Green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, Life Cycle Assessment (LCA), carbon credits, carbon sequestration, carbon trading and eco-labelling, Environmental assessment and economic impact of bio-fuel production	07

Text Books:

1	**"Handbook on Renewable Energy and Green Technology"** by S. Pugalendhi, J. Gitanjali, R. Shalini, and P. Subramanian.
2	**"Green Chemistry for Sustainable Biofuel Production"** edited by Veera Gnaneswar Gude
3	**"Textbook on Renewable Energy and Green Technology"** by Amit Deogirikar and Atul Mohod
4	**Khan B.H, Non-conventional energy resources,** Tata McGraw-Hill, New Delhi 2006
5	Rashmi Sanghi and M.M. Srivastava, **Green Chemistry-Environment Friendly Alternatives,** Narosa Publishing House, New Delhi 2009.

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Reference Books:

1	**"Biomass and Alternate Fuel Systems"** by Thomas F. McGowan et al.
2	**"Fuels and Combustion"** by Samir Sarkar
3	**"Alternative Fuels"** by S.S. Thipse
4	Paul L. Bishop, **Pollution prevention–Fundamentals and Practices,** McGraw-Hill-international 2000.
5	N. Vinutha bai, R. Ravindra, **Energy efficient and green technology concepts,** International Journal of Research in Engineering and Technology p 253-258, Volume: 03 Special Issue: 06, 2014, eISSN: 2319-1163 pISSN: 2321-7308

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Course Plan

Course Title: Corporate Skills and Behavior	
Course Code: 231CHOECL301	**Semester**: V
Teaching Scheme: L-T-P: 2-0-0	**Credits:** 02
Evaluation Scheme: --	**ESE Marks:** 50

Course Description:

This course explores behavioural skills training involves the blend of skills needed in interpersonal relationships, productive emotions, effective communication, and engaging attitudes. Key topics include the mind, Effective communication, Business Etiquettes, Executive skills, Special Corporate Skills. This course also addresses the development of individual and team by adapting corporate skills. By the end of the course, students will be equipped with a comprehensive understanding of how corporate skills enhances personal growth and development contribute to organizational growth and competitive advantage in a global marketplace.

Course Objectives:

1	To create dynamic and effective corporate skills and behaviour
2	To transform the individuals to cater to the needs of the corporate skills and contribute to nation building
3	To develop professional etiquettes in business under individual and team behavior improvement
4	To improve corporate behaviour by having a sound knowledge of corporate cultural behaviour

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHOECL301.1	**Understand** the expected individual and team behaviour in business world.
231CHOECL301.2	**Understand** of applicable Corporate Skills for entrepreneurs / corporate / managers
231CHOECL301.3	To **apply** skills and inculcate stress and time management
231CHOECL301.4	To **understand** corporate executive skills
231CHOECL301.5	To **apply** individual, corporate etiquettes and to be able to master over them

Prerequisite:	Communication skills, soft skills

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHOECL301.1	-	2	-	-	-	-	-	1	1	1	1	2			2

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231CHOEC L301.2	-	2	-	-	-	-	-	1	1	-	1	-			2
231CHOEC L301.3	-	-	-	-	-	-	-	1	-	1	1	2			3
231CHOEC L301.4	-	2	-	-	-	-	-	-	1	1	1	2			2
231CHOEC L301.5	-	2	-	-	-	-	-	1	1	1	-	2			3

Content	Hours
Unit 1: The Mind Positive thinking & Attitude, Motivation, Character Building, Self Esteem, Goal Setting, Presentation.	6
Unit 2. Effective Communication English Conversation, Pronunciation, Voice Modulation, Stressing and stretching, Accent Improvisation, Facial Expressions, Body language, Writing skills	6
Unit 3. Business Etiquettes Business Etiquettes Office Etiquettes, Phone Etiquettes. Writing a profile (Personal/ Company), Group Discussion, Facing an Interview, Business Presentation Skills	6

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Unit 4. Executive Skills Writing a profile (Personal/ Company), Group Discussion, Facing an Interview, Business Presentation Skills, Presentation	6
Unit 5. Special Corporate Skills - Interpersonal Relationship, Leadership Qualities, Time Management, Stress Management, Presentation	6

Text Books:

1	Enhancing Employability: Connecting Campus with Corporate: M.S. Rao\
2	Corporate Soft skills: Sarvesh Gulati
3	The ACE of Soft Skills: Attitude, Communication and Etiquette for Success: Gopala swamy Ramesh, Mahadevan Ramesh

Reference Book:

1	"The Power of Now" by Eckhart Tolle
2	"Atomic Habits" by James Clear
3	"The 7 Habits of Highly Effective People" by Stephen Covey:
4	Mindset: The New Psychology of Success" by Carol Dweck
5	The Power of Positive Thinking" by Norman Vincent Peale:
6	"How to Win Friends and Influence People" by Dale Carnegie

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Course Plan

Course Title: Petroleum Engineering	
Course Code :231CHPECL301	**Semester: V**
Teaching Scheme: L-T-P: 4-0-0	**Credits** :04
Evaluation Scheme: ISE + MSE Marks: 20 + 30 = 50	**TW + ESE Marks**: 25 + 50 = 75

Course Description:

Petroleum Refinery Engineering subject deals with study of various survey methods for crude oil along with all essential practices to explore the crude oil by using various drilling methods to derive various cuts of hydrocarbons at respective temperature and pressure by using atmospheric and vacuum distillation.

Course Objectives:

COs	Students completing this course are expected to..
231CHPECL301.1	Understand what is crude oil, petroleum resources & scenario of petroleum refineries in India as well across the world.
231CHPECL301.2	Aware about origin of petroleum, exploration techniques and drilling techniques in details.
231CHPECL301.3	Understand composition, classification, distillation & separation techniques including pre-treatment.
231CHPECL301.4	Explain properties & specification of petroleum products and overall separation processes.
231CHPECL301.5	Get familiar with various conversion processes, Treatment methods and post production operations of Petroleum refineries.

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHPECL301.1	**Explain** basic information about crude, resources and overall scenario of refineries in India as well across the world.
231CHPECL301.2	**Describe** about origin, exploration techniques, Drilling Rigs and Drilling techniques in detailed manner.
231CHPECL301.3	**Discuss** composition, classify crude oil and able to **explain** various distillation processes & separation methods.
231CHPECL301.4	**Compare** properties and specification of petroleum products and **relate** Overall separation processes.
231CHPECL301.5	**Differentiate** various steps in conversion processes, treatments and post operations in refinery.
Prerequisite:	Chemistry, Heat Transfer, Mass Transfer

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program specific outcome (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPECL301.1	3	2	-	-	-	-	-	-	-	-	-	-	2		2
231CHPECL301.2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2
231CHPECL301.3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
231CHPECL301.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

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231CHPECL301.5	2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
231CHPECL301.6	3		1	-	-	2	-	-	-	-	-	-	2	-	2
231CHPECL301.2	**2.60**	**2.33**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	3

Contents	Hours
Unit –I Introduction to Petroleum Refineries: Resources of petroleum, Origin and exploration techniques: Origin of petroleum, methods of exploration, drilling rigs, drilling techniques, production methods of crude oil etc	05
Unit –II Natural Gas - Introduction, Processing, Properties, Uses, gas Hydrates, Shell gas, Purification. Composition of crude, Classification of crude, Types of distillation methods – ASTM, TBP, Pretreatment of crude, Different arrangement of Distillation column, Multi component Atmospheric Distillation, Vacuum Distillation, Transportation of crude. Distillation, Transportation of crude.	08
Unit –III Properties and specifications of petroleum products Properties and specifications of fuel gas, LPG, Gasoline, Naphtha, Jet fuel, Kerosene, Diesel, Lubricating oils, Greases, Waxes, Coke, etc. Separation processes: Solvent Extraction Processes, Solvent de-waxing.	06
Unit –IV Conversion process: Thermal cracking, Vis-breaking, Coking, Catalytic cracking, Thermal reforming, Catalytic reforming, Hydro-cracking, Hydro processing, Alkylation, Isomerization and Polymerization. Treatment methods, Sweetening process, hydrodesulphurization, Smoke point improvement.	07
Unit –V Post Production Operations:	06

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Blending of additives (ETBE, MTBE, Ethanol, Lead), Storage of products, Transportation of products, Housekeeping, Marketing of Petroleum and Petroleum products, Safety and Pollution considerations in refineries.	
Unit –VI Recent trends in petroleum refineries: Recent trends in petroleum in terms of Distillation, Packing materials, Catalyst, Non-conventional fuels, Necessity of Bio-fuels, Trans-esterification process, etc. Note: A Case study on the petroleum refineries may be taught.	04

Text Books:

1	"Petroleum Refinery Engineering" Dr. Ram Prasad
2	"Modern Petroleum Refining Processes" B. K. Bhaskara Rao

Reference Books:

1	"Petroleum refining" Gary J H, Handwerk G E, Nelson W. L., Handbook of Petroleum Refinery Engg.I, McGraw Hill, International, Auckland, 1982
2	"Modern Petroleum Technology-I" Hobson G.D., Phol W., I, 5th ed., Halsted Division of Wiley Eastern New York, 1984.
3	"Petroleum Products, Hand-Book" Guthre, V. B. McGraw Hill.

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Course Plan

Course Title: Green Technology	
Course Code: 231CHPECL302	**Semester:** V
Teaching Scheme: L-T-P: 4-0-0	**Credits:** 04
Evaluation Scheme: ISE + MSE Marks: 20 + 30 = 50	**TW + ESE Marks:** 25 +50 = 75

Course Description:

This course typically encompasses the study of alternative and renewable energy sources, focusing on their environmental benefits, technological applications, and integration into existing energy systems. Below is a synthesized outline of such a course, including its syllabus, course objectives, expected outcomes, their mapping to program outcomes, and recommended textbooks and reference materials.

Course Objectives:

1	Understand the importance and impact of green fuels on the environment.
2	Explore various renewable energy sources and their technological applications.
3	Analyze the environmental challenges associated with conventional fuels.
4	Evaluate energy requirements and compare different energy resources and technologies.
5	Design and develop systems utilizing suitable fuels in an economic and energy-efficient manner.

Course Outcomes (CO's):

COs	**At the end of successful completion of course, the students will be able to…**
PECL301.1	**Explain** the importance of green technology and current energy requirements

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PECL301.2	**Understand** the concept of cleaner production along with oxidation technologies for waste water treatment
PECL301.3	**Understand** environmental challenges associated with fossil fuels and comparison between conventional fossil fuels and green fuels
PECL301.4	**Describe** various technologies of biomass conversion and biodiesel production
PECL301.5	**Explain** various renewable energy resources and green building concept
PECL301.6	**Understand** environmental and economical impact aspects of green fuel manufacturing process

Prerequisite:	Knowledge of organic and inorganic chemistry, reaction mechanisms, and fuel composition, Understanding energy efficiency, entropy and Gibbs free energy calculations

Course Articulation Matrix:

Mapping of Course Outcomes (CO's) with Program Outcomes (PO's) and Program Specific Outcomes (PSO's)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
PECL301.1	1					2									2
PECL301.2						2								2	1
PECL301.3						2	1					1			1
PECL301.4						2	1								1

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PECL301.5						2	2				1	1	2	2	1
PECL301.6							2				1				

Content	Hours
Unit 1. Introduction to Green Technology Definition, importance, historical evolution, advantages and disadvantages, Role of industry, government and institutions in promoting green technology, role of industrial ecology in green technology, Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil Shale, Nuclear energy Option	09
Unit 2. Cleaner Production Principles, benefits, promotion, barriers, and the role of various stakeholders, Concepts of clean development mechanism, reuse, recovery, recycling and raw material substitution, Oxidation technology for waste water treatment- Cavitation, Fenton chemistry, photo catalysis and hybrid processes.	07
Unit 3. Green Fuels Definition, benefits, challenges, and comparison with conventional fossil fuels concerning environmental, economic, and social impacts, Public policies and market-driven initiatives supporting green fuels, bio-fuels, fuel cells- working, selection of fuels	07
Unit 4. Biomass Energy Concepts of biomass energy utilization, types, and conversion processes, Technologies such as charcoal production, gasification, biogas plants, ethanol, methanol and biodiesel production	07

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Content	Hours
Unit 5. Renewable Energy Sources and Green Buildings Overview of solar, wind, geothermal, tidal, and hydrothermal energy sources, Energy conversion technologies and their principles, equipment and suitability in various contexts Definition of Green building- Features and benefits, Fundamental planning decisions for energy efficient building- site selection, building fabrics and insulation, ventilation, passive solar features, Eco-friendly and cost effective materials, Energy management	08
Unit 6. Environmental and Economic Aspects Green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of sustainable green production systems. Life Cycle Assessment (LCA), carbon credits, carbon sequestration, carbon trading, and eco-labelling, Environmental assessment and economic impact of bio-fuel production	07

Text Books:

1	**"Handbook on Renewable Energy and Green Technology"** by S. Pugalendhi, J. Gitanjali, R. Shalini, and P. Subramanian.
2	**"Green Chemistry for Sustainable Biofuel Production"** edited by Veera Gnaneswar Gude
3	**"Textbook on Renewable Energy and Green Technology"** by Amit Deogirikar and Atul Mohod
4	**Khan B.H, Non-conventional energy resources,** Tata McGraw-Hill, New Delhi 2006

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5	Rashmi Sanghi and M.M. Srivastava, **Green Chemistry-Environment Friendly Alternatives,** Narosa Publishing House, New Delhi 2009.

Reference Books:

1	**"Biomass and Alternate Fuel Systems"** by Thomas F. McGowan et al.
2	**"Fuels and Combustion"** by Samir Sarkar
3	**"Alternative Fuels"** by S.S. Thipse
4	Paul L. Bishop, **Pollution prevention–Fundamentals and Practices,** McGraw-Hill-international 2000.
5	N. Vinutha bai, R. Ravindra, **Energy efficient and green technology concepts,** International Journal of Research in Engineering and Technology p 253-258, Volume: 03 Special Issue: 06, 2014, eISSN: 2319-1163 pISSN: 2321-7308

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Laboratory Course Plan

Course Title: Mass Transfer-I (Laboratory work)	
Course Code: 231CHPCCP301	**Semester**: V
Teaching Scheme: L-T-P: 0-0-2	**Credits**: 01
Evaluation Scheme: --	**TW + ESE (POE) Marks**: 25 + 25 = 50

Course Description:

The course includes experiments based on industrial mass transfer operations including separation of gas- liquid, gas-solid, liquid-liquid and solid-liquid phases.

Course Objectives:

The purpose of this course is to introduce the undergraduate students with the most important separation equipment's in the process industry, and provide proper understanding of mass transfer operations.

1	To study the fundamental/basics of diffusion operation.
2	To introduce the undergraduate students with the most important separation equipment's in the process industry.
3	To provide proper understanding of mass transfer operations.
4	To study & understand the equipment's used for separation and purification in chemical industries.

Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHPCCP301.1	**Understand**; learn about the diffusion mass transfer.
231CHPCCP301.2	**Describe** most important separation equipment's in the process industry.

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231CHPCCP301.3	**Understand and describe** industrial mass transfer operations.
231CHPCCP301.4	**Understand; demonstrate** working of equipment's used for separation and purification in chemical industries by absorption, adsorption & ion exchange.

Prerequisites	Chemistry, Applied mathematics, Physics, Process Calculations, Thermodynamics, Fluid mechanics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes COs	POs												PSO	PSO	BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
231CHPCCP301.1	2	2	1	2									2		3
231CHPCCP301.2	2	2	1	2									2		3
231CHPCCP301.3	2	2		2		1	1						2		3
231CHPCCP301.4	2	1	1	1		1	1						2		3

List of Experiments			
Expt. No.	Name of Experiment	Type	Hours
1	Diffusivity of acetone: To determine diffusivity of acetone in air at various temperatures.	O	2
2	Surface Evaporation: To determine the constant characteristic equation for surface evaporation.	O	2

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3	Batch adsorption: To study the adsorption of acetic acid on activated charcoal.	O	2
4	Ion Exchange: To find degree of saturation and capacity of ion exchange bed.	O	2
5	Wetted wall tower: To determine mass transfer coefficient for the diffusion of vapour into the gas stream with the help of wetted wall column.	O	2
6	Humidification: To determine volumetric mass transfer coefficient for air - water system in cooling tower	O	2
7	Gas absorption: To determine values of gas side or liquid side mass transfer coefficient for CO2 absorbed into NaOH System in packed column.	O	2
8	Vapour- Liquid Equilibrium: To determine vapour liquid equilibrium data for given system.	O	2
9	Liquid hold up in packed Column: To determine liquid hold up in packed Column.	O	2
10	Liquid-Liquid Diffusion: To study liquid- liquid diffusion.	O	2
11	Membrane Separation: To study diffusion by using membrane.	O	2

- S-STUDY, O-OPERATIONAL
- Minimum 10 Experiments should be conducted

Text Books:

1	Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw Hill,1980.
2	Richardson & Coulson, "Chemical Engineering", Vol. 1, Pergamon Press, 1970
3	Richardson & Coulson, "Chemical Engineering", Vol. 2, Pergamon Press, 1970
4	Richardson & Coulson, "Chemical Engineering", Vol. 4, Pergamon Press, 1970
5	Richardson & Coulson, "Chemical Engineering", Vol. 5, Pergamon Press, 1970

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Reference Books;

1	Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke,"Mass transfer" International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
2	McCabe and Smith, "Unit Operation of Chemical Engineering",5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3	C. J Geankolis, Transport Processes and unit operations, 3rdEdition, Prentice hall, India, 1993.B.K Datta, Principles of mass transfer & separation process.
4	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh
6	B.K Datta, Principles of mass transfer & separation process
7	K. D Patil, Mass Transfer Operation Vol. I & II.

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Laboratory Course Plan

Course Title: Chemical Process Technology (Laboratory work)	
Course Code: 231CHPCCP302	**Semester:** V
Teaching Scheme: L-T-P:0-0-2	**Credits:** 01
Evaluation Scheme: -	**TW Marks:** 25

Course Description:

The Chemical process technology laboratory course offers students a comprehensive understanding of the various manufacturing processes and techniques used in the production of goods. The course provides a practical learning environment where students can apply theoretical concepts to real-world manufacturing operations.

Course Objective:

1	To introduce students to the fundamental manufacturing processes and their applications.
2	To study the relationship between material properties and manufacturing methods.

Course Outcomes (COs): At the end of the course the student should be able to:

231CHPCCP302.1	Apply the theoretical knowledge of chemical processes to real-world laboratory experiments.
231CHPCCP302.2	Study practical aspects of chemical process technology.

Prerequisite	Industrial Engineering Chemistry, Material and Energy Balances

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes COs	POs												PSO	PSO	BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
231CHPCCP302.1	1	-	-	-	-	-	-	-	-	-	-	-	2	2	3
231CHPCCP302.2	1	-	-	-	-	-	1	-	-	-	-	-	1	-	3
231CHPCCP302	1	-	-	-	-	-	1	-	-	-	-	-	1	-	-

Expt. No.	Name of Experiment	Type	Hours
1	To prepare chrome yellow pigment.	O	2
2	To prepare a greenish blue pigment from CuSO4 and Na2CO3.	O	2
3	To prepare Azo dye from aniline and B-Naphthol.	O	2
4	To prepare soap by cold process.	O	2
5	Preparation of phenol formaldehyde resin.	O	2
6	Preparation of nitrobenzene by nitration of benzene.	O	2
7	To prepare aspirin.	O	2
8	To prepare paracetamol.	O	2
9	To prepare Picric acid.	O	2
10	To Check Food adulteration.	O	2

- S-Study, O-Operational
- Minimum 10 Experiments should be conducted

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Text Books:

1	P. H. Groggins; Unit Processes in Organic Synthesis
2	Georget Austin; Shreve's Chemical Process Industries, 5th edition. McGraw Hill Book Company, 1985.
3	Paul T. Anastaj; Green Chemistry–Theory and Practice

Reference Books:

1	Anastas P.; Warner, J. Green Chemistry: Theory and Practice; Oxford University Press: London,
2	S. D. Shukla, G. N. Pandey, A Text book of Chemical Technology, 3rd Edition
3	D.Venkateshwara, Chemical Technology, I & III manuals of Chemical Technology, Chemical Engineering. Ed. Dev. III Madras, 1977
4	Perry R. H. Green D. W., Perry's chemical Engineer's Hand book, McGraw Hill, New York, 2007.

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Laboratory Course Plan

Course Title: Chemical Reaction Engineering (Laboratory Work)	
Course Code: 231CHPCCP303	**Semester:** V
Teaching Scheme: L-T-P:0-0-2	**Credits:** 01
Evaluation Scheme: --	**TW + ESE (POE) Marks:** 25 + 25 = 50

Course Description:

This subject deals with practical understanding of rate constant, order of reaction, reaction rate, analysis of kinetic data by using various models and effect of various parameters on homogenous reaction, Non-Ideal Flow, Heterogeneous processes and Solid catalyzed, Fluid particle reactions (Non catalytic) and Fluid-fluid reaction reactions.

Course Objective:

1.	Demonstrate the ability to quantitatively predict the performance of common chemical reactors using simplified engineering models.
2.	Demonstrate the ability to regress the experimental data from which they determine the kinetic model of a multi-reaction system and use this information to design a commercial reactor

Course Outcomes (COs): At the end of the course the student should be able to:

231CHPCCP303.1	**Understand** rate constant and order of reaction from analysis of experimental data for different types of reactor.
231CHPCCP303.2	**Develop** rate constant and order of reaction for different reactor arrangements.
231CHPCCP303.3	**Apply** the concept of non-ideal reactor and understand heterogeneous catalysts.
231CHPCCP303.4	**Understand** theory and design concepts of fluid-particle, fluid-fluid, and solid catalyzed reactions, deactivating catalyst.

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Prerequisites	Process Calculations, Chemical Engineering Thermodynamics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO	PSO	BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
231CHPCCP303.1	-	2	3	2	-	-	-	-	-	-	-	-	2	-	2
231CHPCCP303.2	-	2	3	3	-	-	-	-	-	-	-	-	2	-	2
231CHPCCP303.3	-	2	3	3	-	-	-	-	-	-	-	-	2	-	3
231CHPCCP303.4	-	2	3	3	-	-	-	-	-	-	-	-	2	-	2
231CHPCCP303	-	2.0	3.0	2.8	-	-	-	-	-	-	-	-	2.0	-	-

Expt. No.	Name of Experiment	Type	Hours
1	To calculate value of rate constant "K" for the saponification of Ethyl acetate with NaOH in batch reactor-I (where M=1, M=II).	O	2
2	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in straight tube reactor.	O	2
3	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in bend tube reactor	O	2
4	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in helical coil reactor.	O	2

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5	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in spiral coil reactor.	O	2
6	To calculate value of rate constant "K" for the saponification of ethyl acetate with NaOH in mixed flow reactor.	O	2
7	To calculate value of rate constant "K" f or the saponification of Ethyl acetate with NaOH in mixed flow reactors in series.	O	2
8	To study catalytic activity of Charcoal & to verify Freundlich & Temkin adsorption isotherms.	O	2
9	RTD Studies in tubular flow reactor: To find out the residence time distribution (RTD) of step and pulse inputs in straight tube	O	2
10	RTD Studies in CSTR: To find out the residence time distribution (RTD) of step and pulse inputs in CSTR.	O	2
11	RTD Studies in Packed bed reactor: To find out the residence time distribution (RTD) of step and pulse inputs in Packed bed	O	2
12	Porosity Measurement: To determine apparent porosity of refractory materials using boiling water method.	O	2

- S-Study, O-Operational
- Minimum10 Experiments should be conducted

Note: Experimental calculations & graphs by using software's like Excel etc.

Text Book:

1.	Octave Levenspeil, "Chemical Reaction Engineering", 2nd Edition, John Wiley, London.
2.	S. H. Fogler, Elements of Chemical Reaction Engineering", PHI, 4th Edition.

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Reference Books:

1.	S. M. Walas, "Reaction Kinetics for Chemical Engineers" McGraw Hill, New York.
2.	J. M. Smith, "Chemical Engineering Kinetics", McGraw Hill, New York.
3.	J. Rajaramand J. C. Kuriacose, "Kinetics and Mechanics of Chemical Transformation", McMillan India Ltd., 1993.

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Course Plan

Course Title: Green Fuel Technology Laboratory Work (ODL)	
Course Code: 231CHMDMP301	**Semester:** V
Teaching Scheme: L-T-P: 0-0-1	**Credits:** 01
Evaluation Scheme: --	**TW Marks:** 25

Course Description:

The course focuses on the study, development and evaluation of sustainable fuel alternatives to fossil fuels. It provides hands-on experience in the production, characterization, and performance testing of bio fuels, hydrogen fuel, synthetic fuels, and other renewable energy sources.

Course Objectives:

1	Understand the production, characterization, and application of green fuels.
2	Develop hands-on experience in testing and analyzing bio-fuels, biogas, and alternative fuels.
3	Compare the performance and emissions of bio-fuels with conventional fossil fuels.

Course Outcomes (CO's): After completing the laboratory, students will be able to:

CO	Statements
MDMP301.1	Demonstrate knowledge of production process and analysis of biodiesel, bio-ethanol and hydrogen
MDMP301.2	Understand the fuel cells, catalysts for bio-fuel conversion processes and carbon savings from bio-fuel usage

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Course Articulation Matrix:

Mapping of Course Outcomes (CO's) with Program Outcomes (PO's) and Program Specific Outcomes (PSO's)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
MDMP301.1	2					2							2		3
MDMP301.2	2				1	2							2		2

List of Experiments

Exp. No.	Title of Experiments	Type	Hours
01	Production of Biodiesel from Vegetable Oils-Trans-esterification process	O	02
02	Separation and purification of biodiesel manufactured from vegetable oils	O	02
03	Characterization of Biodiesel-Determination of viscosity, density, flash Point and calorific value	O	02
04	Production of Bio-ethanol from Biomass-Fermentation of sugarcane/ molasses, distillation of ethanol	O	02
05	Analysis of Bio-ethanol Properties (density, viscosity, calorific value)	O	02
06	Gas Chromatography Analysis of Bio-ethanol-Identification and Quantification of bio-fuel components	O	02
07	Solar Energy-Based Hydrogen Production-Electrolysis of water using solar energy for hydrogen generation	O	02
08	Comparative Study of Fuel Cells vs. Conventional Batteries	S	02
09	Catalytic Conversion of Biomass to Bio-fuel-Study of catalysts used in bio-fuel conversion processes	S	02

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10	Carbon Credit & Carbon Sequestration Analysis-Estimation of carbon Savings from bio-fuel usage	S	02
11	Cetane Number Determination of Biodiesel-Assessing ignition quality and combustion characteristics	S	02

Text Books:

1	**"Renewable Energy and Green Technology"**- Amit Deogirikar & Atul Mohod
2	**"Green Chemistry for Sustainable Biofuel Production"**-Veera Gnaneswar Gude
3	**"Fuels and Combustion"**-Samir Sarkar
4	**Alternative Fuels"-S. S. Thipse**

Reference Books:

1	**"Hand book on Renewable Energy and Green Technology"**-S. Pugalendhi, J. Gitanjali, R. Shalini, P. Subramanian
2	"Biomass and Alternate Fuel Systems"-Thomas F. McGowanetal.
3	**"Biofuels: Biotechnology, Chemistry, and Sustainable Development"**-David M. Mousdale
4	**"Environmental Impacts of Renewable Energy"**-Frank R.Spellman
5	**"The Science and Technology of Industrial Biodiesel Production"**-LuizC. Meherand Samuel R.Moreira

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Course Plan

Course Title: Liberal Learning Course	
Course Code: 231CHCCAL301	**Semester:** V
Teaching Scheme: L-T-P:0-0-2	**Credits:** Audit
Evaluation Scheme: ISE Marks: 50 (Grade)	**ESE Marks: –**

- Liberal Learning Through Students Clubs and particular areas is a Two-credit course run for Third Year B.Tech.
- Students are required to go through the list of liberal learning courses and rank their preferences through google form provided by department at the beginning of semester.
- They will be allocated one area from the list. Faculties from particular areas conducts session once a week for each area on campus through activities, discussion, presentation and lecture methods and evaluation out of 50 as per area is done for each area throughout semester.
- Evaluation pattern may be differed according to the nature of the club.
- Although the reisno predefined syllabus, there is an out line which experts normally develop and follow for the sessions.
- However, students may approach to the faculty to cover certain topics of interest in that area during sessions based on students interests and experts.
- List of liberal learning course will get display at the beginning of semester.

List of liberal learning courses

Sr. No	Name of the Course
1	GATE and Higher Education Club
2	Training and Placement club
3	Hobby club
4	Industry Sponsored Lab club

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Course Plan

Course Title: Mass Transfer-II	
Course Code :231CHPCCL304	**Semester: VI**
Teaching Scheme: L-T-P: 2-0-0	**Credits**: 2
Evaluation Scheme: --	**ESE Marks**: 50

Course Description:

This course also explain concept of steady state & unsteady state industrial mass transfer operations studied for controlling parameters in actual industrial process. Mass transfer-II course provides knowledge to design equipment's for industrial mass transfer operations; after learning this course, student can able to implement the knowledge of various operations in the real plants and to understand the troubleshooting problem in plants.

Course Objectives:

Sr. No.	Course Objectives
1	To study & determine basic knowledge of binary distillation by understanding types, methods of design & applications of it in industries.
2	To understands calculation, types, material balance, coordinate systems and industrial equipment's in extraction
3	To study basic principle, calculation & methods, and equipment's of leaching to apply in industries.
4	Students should be able to apply basic knowledge of humidification, cooling tower, humidification equipment's in industries.
5	To understand theory, calculation of industrial dryer, different industrial dryers & steps, concepts, calculation of crystallization.

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Course Outcomes (COs):

COs	At the end of successful completion of the course the student will be able to
231CHPCCL304.1	**Describe & apply** knowledge of binary distillation to able to design equipment's in industries by different methods.
231CHPCCL304.2	**Understand & apply** concepts, triangular coordinate system, material balance, calculation, equipment's in extraction.
231CHPCCL304.3	**Describe & apply** knowledge & calculation of leaching in industries for controlling parameters in industrial process.
231CHPCCL304.4	**Apply** the knowledge of humidification, i cooling tower with its calculation, troubleshooting with other industrial equipment's.
231CHPCCL304.5	**Apply** knowledge of drying, dryer, its calculation in industries & knowledge of concepts, steps, calculation of crystallization in industries.

Prerequisites:	Mass transfer-I, Chemistry, Applied mathematics, Physics, Process calculations, Thermodynamics, Fluid mechanics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes – Program Outcomes mapping

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPCCL304.1	2	2	1	2	-	2	1	-	-	-	-	1	2	-	3
231CHPCCL304.2	2	2	1	2	-	2	1	-	-	-	-	1	2	-	2
231CHPCCL304.3	1	2	1	2	-	2	1	-	-	-	-	1	2	-	3

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231CHPCCL304.4	2	2	1	2	-	2	1	-	-	-	-	1	2	-	3
231CHPCCL304.5	2	2	1	2	-	2	1	-	-	-	-	1	2	-	3
221CHL304	2	2	1	2	-	2	1				-	1	2	-	-

Strong contribution: 3 Medium contribution: 2 Weak contribution: 1 No contribution: -

Contents	Hours
Unit 1: Distillation: Vapour Liquid Equilibrium, Ideal Solutions, Relative volatility, Azeotropic mixtures ,Methods of distillation: Flash, Differential, Steam, Vacuum, molecular, continuous, Multi-component system, Heavy & Light key component, Batch rectification, Introduction to reactive distillation. Analysis and determination of stages: Material balance, Analysis of Fractionating column by McCabe Thiele method, Lewis–Sorrel method, Ponchon-Savrit method, Lewis Matheson (Only theory),Transfer Concept in Packed Column Design, Industrial applications of Distillation	08
Unit 2: Liquid–Liquid Extraction: Liquid Equilibrium, Field of usefulness, Different coordinate systems, Choice of solvent, Single stage, cross and counter current operation and its calculation, Counter current extraction with reflux, Selection of extractors, Industrial extraction equipment's, Industrial applications of Extraction	06
Unit 3: Leaching Leaching Principles, Preparation of the solid, Various Types of Leaching Operations with application, Method of Calculations, Leaching equipment's, Industrial applications of Leaching	05

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Unit 4: Humidification Industrial applications of Humidification, Study of Adiabatic Saturation Curve, Humidifier height calculations, definition of wet bulb, dry bulb and equation for wet bulb depression, Percentage saturation , Percentage Humidity, Important industrial terms in humidification, Water cooling towers in detail & its design, Spray chamber, Evaporative Cooler, Industrial applications of Humidification.	05
Unit 5: Drying Theory and Mechanism of Drying, Steady and Unsteady Drying, Definition of moisture content, total time of drying, length of continuous dryer, Material and Enthalpy balance in dryer, Classification and selection of Industrial dryers, Industrial applications of Drying & new trends in industrial dryer. **Crystallization:** Nucleation, Crystal Growth, Methods of super-saturation, material and enthalpy balance of crystallizer, Yield of crystallization, Industrial applications of Crystallization.	06

Text Books:

1	Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw Hill,1980.
2	Richardson & Coulson, "Chemical Engineering", Vol. 1, Pergamon Press, 1970
3	Richardson & Coulson, "Chemical Engineering", Vol. 2, Pergamon Press, 1970
4	Richardson & Coulson, "Chemical Engineering", Vol. 4, Pergamon Press, 1970
5	Richardson & Coulson, "Chemical Engineering", Vol. 5, Pergamon Press, 1970

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Reference Books:

1	Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke, "Mass transfer" International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
2	McCabe and Smith, "Unit Operation of Chemical Engineering",5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3	C. J Geankoplis, Transport Processes and unit operations, 3rdEdition, Prentice hall, India, 1993.
4	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh
6	B.K Datta, Principles of mass transfer & separation process
7	K. D Patil, Mass Transfer Operation Vol. I & II.

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Course Plan

Course Title: Process Dynamics & Control	
Course Code: 231CHPCCL305	**Semester: VI**
Teaching Scheme: L-T-P:3-0-0	**Credits**: 03
Evaluation Scheme: ISE +MSE Marks: 20 + 30 = 50	**ESE Marks**: 50

Course Description:

This course introduces the fundamental principles of Process Dynamics as well as Process Control, focusing on the dynamic analysis and design of control systems in chemical engineering operations. It covers the dynamic behaviour of chemical processes, control strategies and techniques for stability analysis. The course emphasizes the application of mathematical modelling and simulation tools to develop effective control strategies for maintaining process stability and optimizing performance.

Course Objectives:

By the end of the course, students will be able to:

1	Develop dynamic models to describe the dynamic behaviour of chemical processes.
2	Analyse and design control systems to maintain optimal operating conditions.
3	Apply stability and frequency response analysis techniques to evaluate control system performance.
4	Utilize process control tools and simulation software for practical chemical engineering applications.

This course is essential for chemical engineers involved in process optimization, automation and plant operations, ensuring safe, efficient, and stable chemical and allied industrial processes.

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Course Outcomes (COs):

	At the end of the course the student should be able to…
231CHPCCL305.1	To **remember** Laplace transforms and understands basic principles and objectives of process control.
231CHPCCL305.2	To **understand** basic fundamentals of first and second order process dynamics and its behavior.
231CHPCCL305.3	To know about **applying** fundamental knowledge to design controllers and the control system.
231CHPCCL305.4	To **discuss** different parameters affecting on the overall transfer function and response of process control system.
231CHPCCL305.5	To **explain** stability characteristics of control systems.
231CHPCCL305.6	To **apply** the frequency response for design of process control systems.

Prerequisites	Applied Mathematics, Chemical Process Instrumentation

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPCCL305.1	2	2	2	2											1
231CHPCCL30	2	2	2	2									1		2

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5.2															
231CHPCCL305.3	2	2	2	3								1	1	1	3
231CHPCCL305.4	2	2	2	2								1	1	1	2
231CHPCCL305.5	2	2	2	2											2
231CHPCCL305.6	2	2	2	2								1	1	1	3
231CHPCCL305	**2**	**2**	**2**	**2**								**1**	**1**	**1**	

Content	Hours
Unit 1: Laplace Transform & Importance of Process Control Introduction of Laplace transform, Applications of Laplace transform, Introduction to process dynamics, introduction of process control, History of process control, Basic principals involved in process control, Design aspects involved in process control.	06
Unit 2: First and Second Order Systems **First order system:** Transfer Function, Time constant, Mercury in glass thermometer, Transient response of First order system, Single liquid level system, Mixing process, CSTR& RC Circuit. **Response of first order system in series:** Non-interacting system, Interacting system, Linearization of nonlinear system, Transportation lag.	09

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Second order systems: U tube manometer, Damped vibrator, Step response for second order systems, and Impulse and Sinusoidal response for Second order Systems, Terms used to describe second order under damped system, Industrial application and case studies.	
Unit 3: Process Control System Introduction, Control system for CSTR, Block diagram, Development of block diagram, Negative versus Positive feedback control system, Servo & Regulator mechanism problem, Introduction to feedback control, Types of Feedback Controllers P, PI, PD, PID with transfer function and application, Final control element, Control valves with transfer function, Block diagram for Chemical Reactor control system, Industrial application and case studies.	08
Unit 4: Overall Transfer Function & Transient Response of Control System Overall transfer function single loop system, Overall transfer function for change in set point & load variable, Overall transfer function multiple loop system, Definition of offset, P controller for change in set point & load point.	07
Unit 5: Stability of Feedback Systems Concept of Stability, definition, Stability criterion, The Characteristic Equation, Routh-Hurwitz Criterion for Stability with theorems and limitations, Examples, Root-Locus Analysis, Concept, Plotting root locus diagram, Rules for negative feedback system, examples.	07
Unit 6: Frequency Response & Design Aspects of Process Control Bode diagrams, Rules, Bode plot for a) first order system, b) second order system, c) Transportation lag, d) P, PI, PD, PID controllers, Bode stability criterion, Gain &Phase margin, Process & Instrumentation Diagram of Distillation column, Heat Exchanger, Reactor, Pressure vessel, Interlock system decode, Emergency shutdown, DCS, PLC and SCADA systems, Software's used in Chemical industries for process control.	08

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Text Book:

1	Donald R. Coughanowr, **Process System Analysis and Control**, International Edition, McGraw Hill, New York. 1991.
2	Coulson and Richardson, **Chemical Engineering** Volume - III, Second Edition, Pergmon Press, (UK), 1985

Reference Books:

1	Le Blanc & Coughanowr, **Process system Analysis and Control**, McGraw Hill, Third edition
2	Peter Harriott, **Process Control**, Tata McGraw Hill, New Delhi, 1977.
3	Stephanopoulos G, **Chemical Process Control and introduction to theory and practice.**

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Course Plan

Course Title: Transport Phenomena	
Course Code: 231CHPCCL306	**Semester:** VI
Teaching Scheme: L-T-P:3-0-0	**Credits**: 03
Evaluation Scheme: ISE +MSE Marks: 20 + 30 = 50	**ESE Marks**: 50

Course Description:

This course provides an in-depth study of the fundamental principles governing the transport of momentum, energy, and mass in chemical engineering systems. It covers the derivation and application of conservation laws, shell balances, and differential equations to analyse transport processes in various engineering applications. The course emphasizes the similarities among these transport mechanisms and their mathematical modelling in both steady-state and unsteady-state conditions.

Course Objectives:

By the end of the course, students will be able to:

1	Apply fundamental transport equations to solve chemical engineering problems
2	Develop mathematical models for transport phenomena in various systems.
3	Analyse heat, mass, and momentum transfer mechanisms using physical and computational methods.
4	Apply transport principles in the design and optimization of chemical processes.

This course is essential for understanding advanced chemical engineering operations, including Fluid Flow, Heat Transfer and Mass Transfer operations.

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Course Outcomes (COs):

At the end of the course the student should be able to:

231CHPCC306.1	To **explain** the similarity between momentum, heat and mass transport and their analogy.
231CHPCC306.2	To **solve** the mathematical problems of momentum transport.
231CHPCC306.3	Able to **apply** fundamental knowledge to solve momentum and heat transport problems.
231CHPCC306.4	To **discuss** different parameters affecting on the mathematical formulation of heat transfer problem and its numerical solution.
231CHPCC306.5	To **solve** the mathematical problems of mass transfer operations.
231CHPCC306.6	To **explain** the fundamentals of computational fluid dynamics.

Prerequisites	Fluid Flow operations, Heat Transfer Operations, Mass Transfer operations

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
C415.1	2	2	1	1									1	0	2
C415.2	2	2	2	2								1	2	2	3
C415.3	2	2	2	2									2	2	3

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C415.4	2	2	2	2								2	2	2
C415.5	2	2	2	2							1	2	2	3
C415.6	2	2	2	2							1	2	2	2
C415	2	2	2	2							1	2	2	

Content	Hours
Unit – 1 Viscosity and the mechanism of momentum transport: Newton's law of viscosity, non-Newtonian fluids, pressure & temperature dependence of Viscosity, estimation of viscosity from critical properties. **Velocity distribution in laminar flow:** Shell momentum balances, boundary conditions, flow of a falling film, flow through a circular tube, flow through annular, creeping flow along a solid sphere.	08
Unit-2 The equations of change for isothermal systems Time derivatives, the equation of continuity, the equation of motion, the equations of change in curvilinear, co-ordinates, use of the equations of change to set up steady flow problems. **Inter phase transport in isothermal systems** Definition of friction factors, friction factors for flow in tubes, friction factors for flow around spheres, friction factors for packed column.	07
Unit-3 Macroscopic balances for isothermal systems The Macroscopic mass balance, the macroscopic mechanical energy balances, estimation of friction loss. **Thermal conductivity and the mechanism of energy transport** Fourier's law of heat conduction, temperature and pressure dependence of thermal	08

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conductivity in gases and liquids, theory of thermal conductivity of gases at low density.	
Unit-4 Temperature distributions in solids and in laminar flow Shell energy balance, boundary conditions, Heat conduction with an electrical heat source, Heat conduction in cooling fins, heat conduction with exothermic reactions. **Inter phase Transport in Non-isothermal Systems** Definition of heat transfer coefficients, Heat transfer coefficient for forced convection in tubes, Heat transfer coefficient for forced convection around submerged objects and through packed beds, Heat transfer coefficient for free convection, Heat transfer coefficient for condensation of pure vapors.	08
Unit-5 Diffusivity and the mechanism of mass transports Definitions of concentrations, velocities & mass fluxes, Fick's law of diffusion, Temperature & pressure dependence of mass diffusivity, Maxwell's law of diffusion. **Concentration distributions in solids and in a laminar flow** Shell mass balance, boundary conditions, diffusion through a stagnant gas film, Diffusion with Heterogeneous chemical reaction, Diffusion with homogeneous chemical reaction, Diffusion into a falling liquid film.	08
Unit-6 Introduction to the Computational Fluid Dynamics Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, in viscid, potential and creeping flows, classification of flows, Grid Generation, Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving engineering problems.	06

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Text Book:

1	R. B. Bird, W. E. Stewart and E. N. Light foot, **Transport Phenomena**, John Wiley & Sons.
2	C. J. Geankopolis **Transport Processes & Unit Operations** 2nd Edition, Allyn and Bacon Inc., Boston, 1983.

Reference Books:

1	C. O. Bennett, J. E. Mayers, **Momentum, Heat & Mass transfer**, 3Edition, McGraw Hill, Chemical Engineering Series, 1985.
2	Alan S. Foust, Leonard A.Wenzel, Curtisw Clump, Louis Maus, L Bryce Andersen **Principles of Unit Operations**, 2nd Edition, McGraw Hill,1985.
3	L.E. Sissom & D.R. Ritts, **Elements of Transport Phenomena**, McGraw Hill
4	Welty, R. E. Wilson & C. E. Wicks, **Fundamentals of Momentum, Heat & Mass Transfer**, 2nd Edition, John Wiley, NewYork 1973
5	Anderson Jr J. D., **Computational Fluid Dynamics: The Basics with Applications**, McGraw Hill.1995

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Course Plan

Course Title: Hydrogen Technology	
Course Code: 231CHMDML302	**Semester:** VI
Teaching Scheme: L-T-P: 2-0-0	**Credits:** 02
Evaluation Scheme: --	**ESE Marks:** 50

Course Description:

This course explores that Hydrogen has wide applications across many industries, including petroleum refineries, hydro treating processes, and metallurgy applications. In addition, a number of valuable chemicals, such as ammonia, alcohols, and acids, are manufactured directly or indirectly with hydrogen. It incorporates information on the latest developments and the current research in the field, including: new techniques for isolating and storing hydrogen.

Course Objectives:

1	To understand the fundamentals of Hydrogen and Hydrogen Technology
2	:xplore various methodologies and tools for Hydrogen Production Technologies.
3	To understand the basic engineering behind Hydrogen Storage and Transportation.
4	To explore various industrial uses of Hydrogen.
5	To study an importance and need of Safety and Environmental Aspects in Hydrogen Technology.

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHMDML302.1	Understand the fundamentals of hydrogen and hydrogen technology
231CHMDML302.2	Explore various methodologies and tools for hydrogen production technologies
231CHMDML302.3	Understand the basic engineering behind hydrogen storage and transportation
231CHMDML302.4	Explore various industrial uses of hydrogen
231CHMDML302.5	Study an importance and need of safety and environmental aspects in hydrogen technology

Prerequisite:	Foundational concepts in business, Creativity, Problem solving skills

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHMDML302.1	1	-	1	-	1	-	2	-	-	-	-	2	1		2
231CHMDML302.2	1	-	1	1	1	-	2	-	-	-	-	2		1	2

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231CHMD ML302.3	1	-	1	-	1	-	2	-	-	-	-	2			3
231CHMD ML302.4	1	-	1	-	1	-	2	-	-	-	-	2			2
231CHMD ML302.5	1	-	1	-	1	-	2	-	-	-	-	2	1		2

Content	Hours
Unit 1. Fundamentals of Hydrogen and Hydrogen Technology Introduction to Hydrogen: Properties, applications, and role as a clean energy carrier. Hydrogen Energy Value Chain: Overview of production, storage, transportation, and utilization. Thermodynamics and Kinetics: Relevant concepts for hydrogen production and reactions. Case studies.	06
Unit 2. Hydrogen Production Technologies Electrolysis: Principles, types (PEM, alkaline, solid oxide), and efficiency. Renewable Energy-Based Hydrogen Production: Solar, wind, and biomass-based hydrogen production.	06
Unit 3. Hydrogen Storage and Transportation Gaseous Hydrogen Storage: Pressure vessels, pipelines, Liquid Hydrogen Storage: insulation, and safety. Solid Hydrogen Storage: Metal hydrides, and other materials. Hydrogen Transportation: Trucks, and trains. Hydrogen Refueling Stations: Design and operation, Case studies.	06
Unit 4. Hydrogen Utilization Fuel Cells: Types (PEM, SOFC, MCFC), materials, and performance. Hydrogen Combustion: Engines, turbines, and industrial applications. Hydrogen in	06

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Transportation: Fuel cell vehicles, hydrogen-powered trains, and ships. Hydrogen in Power Generation: Fuel cells and hydrogen turbines, Case studies.	
Unit 5. Safety and Environmental Aspects Hydrogen Safety: Flammability, ignition sources, and safety regulations. Hydrogen Storage and Transportation Safety: Design and operation for safety. Hydrogen Utilization Safety: Fuel cell safety and hydrogen combustion safety. Environmental Impact of Hydrogen Technology: Greenhouse gas emissions, water usage, and waste management, Case studies.	06

Text Books:

1	Hydrogen Fuel: Production, Transport and Storage, Gupta, R. B., CRC Press, Taylor & Francis Group, 2009.
2	Hydrogen Production by Electrolysis, Agata Godula-Jopek, Wiley-VCH, Germany, 2015
3	"Hydrogen storage: state-of-the-art and future perspective. Netherlands" European Communities, 2003

Reference Books:

1	Introduction to Hydrogen Technology, 2nd EditionK. S. V. Santhanam, Roman J. Press, Massoud J. Miri, Alla V. Bailey, Gerald A. Takacs ISBN: 978-1-119-26554-2 October 2017
2	Introduction to Hydrogen Technology Roman J. Press, K. S. V. Santhanam, Massoud J. Miri, Alla V. Bailey, Wiley Publications 2008.
3	"Handbook of Hydrogen Storage" Michael Hirscher, Wiley-VCH, 2010

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Course Plan

Course Title: Petrochemical Technology	
Course Code: 231CHPECL303	**Semester:** VI
Teaching Scheme: L-T-P: 3-0-0	**Credits:** 03
Evaluation Scheme: ISE + MSE Marks: 20 + 30 = 50	**ESE Marks:** 50

Course Description:

Petrochemical Technology explores the chemical processes involved in the production of petrochemicals, which are essential building blocks for various industries including polymers, pharmaceuticals and chemical. This course provides an in-depth examination of the conversion of raw petroleum and natural gas into valuable chemical intermediates and end-products.

Course Objectives:

1	To provide students with a comprehensive understanding of the fundamental principles and technologies involved in the petrochemical industry
2	Familiarize students with the various raw materials and feed-stocks used in the production of petrochemicals, including natural gas and crude oil
3	To explore and explain the key chemical reactions and processes, such as cracking, reforming, polymerization, and alkylation, that converts raw materials into petrochemical products.
4	To examine the critical unit operations involved in petrochemical processing, including distillation, separation, catalytic processes, and reactor design.
5	To explore the latest advancements and future trends in petrochemical technology, including bio-based feedstocks, digitalization, and smart manufacturing.

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
PECL303.1	**Understand** the fundamental principles of petrochemical industries
PECL303.2	**Describe** the major raw materials and their conversion into petrochemical products
PECL303.3	**Explain** the conversion processes of various petrochemicals from low molecular weight alkanes
PECL303.4	**Explain** the conversion processes of various petrochemicals from High molecular weight alkanes
PECL303.5	**Describe** the role of polymers in petrochemical industries
PECL303.6	**Understand** the latest innovations and recent trends in petrochemical industries

Prerequisite:	Basic Chemistry, Introduction to Chemical Engineering

Course Articulation Matrix:

Mapping of Course Outcomes (CO's) with Program Outcomes (PO's) and Program Specific Outcomes (PSO's)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
PECL303.1	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
PECL303.2	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2
PECL303.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
PECL303.4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
PECL303.5	1	-	-	-	-	-	-	-	-	-	-	1	-	1	2

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PECL303.6	1	-	-	-	-	-	-	-	-	-	-	1	1	-	2

Content	Hours
Unit 1. Introduction to Petrochemical Industries Definition and classification of petrochemicals, history of petrochemical industry, development of petrochemical industry in India, product profile of petrochemicals, general cost considerations, economics of R&D, sources of petrochemicals, General idea of LNG, CNG, NGL, LPG and their generation	06
Unit 2. Raw Materials In Petrochemical Industries Coal, Biomass, Petroleum, Steam reforming, Chemicals from Methanol: Methanol, Formaldehyde, Carbon-di-sulphide, Hydrogen cyanide	07
Unit 3. Low Molecular Weight Alkanes Chemicals from Ethane, Ethylene & Acetylene: Ethanol, Acetaldehyde, Acetic acid, Vinyl acetate, Acrylonitrile Chemicals from Propane & Propylene: Isopropanol, Acetone, Propylene oxide, Isoprene	09
Unit 4. High Molecular Weight Alkanes Chemicals from Butanes & Pentanes: Butadiene, Butyl acetate, Methyl-Ethyl Ketone. Chemicals from aromatics: Nitrobenzene, Benzoic acid, Nitrotolune, Isopthalic acid, Adipic acid, Aniline, Caprolactum	09
Unit 5. Role of polymers in petrochemical industries Polymers, elastomers, synthetic fibers, PVC, Nylon and Polyesters	07

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Unit 5. Recent Trends in Petrochemicals Energy crises in Petrochemical industry, Natural gas as Petrochemical feedstock, Import of heavy feedstock on Petrochemicals, Ecology and energy crises, Synthetic fuels, Trends in Petrochemical Industry.	07

Text Books:

1	B.K. Bhasker Rao - A Text on Petrochemicals, 2nd Edition, Khanna publishers, 1996.
2	SukumarMaiti - Introduction to Petrochemicals Oxford & IBH publishing Co. Pvt. Ltd., 1991.
3	Ram Prasad - Petroleum Refinery Technology, Khanna publications.

Reference Books:

1	J. H. Gary, G. E. Handwerk and M. J. Kaiser - Petroleum Refining Technology and Economics, 5th Edition, CRC press Taylor & Francis Group, 2007.
2	A.V.G. Halm - The Petrochemical Industry, McGraw Hill 1970.
3	A.L. Waddams - Chemicals from Petroleum, Chemical publishing Co.
4	M.J Astle - The Chemistry of Petrochemicals, Reinhold.
5	C.E. Dryden - Outlines of Chemical Technology, Affiliated East-West Press, 1973. F. Keys - Industrial Chemicals.
6	Advanced Petrochemicals: Dr. G. N. Sarkar, Khanna Publishers
7	Petrochemical processes: Chauvel ,Gulf Publishing

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Course Plan

Course Title: Energy Conservation & Audit	
Course Code: 231CHPECL304	**Semester:** VI
Teaching Scheme: L-T-P: 3-0-0	**Credits:** 03
Evaluation Scheme: ISE + MSE Marks: 20 + 30 = 50	**ESE Marks:** 50

Course Description:

Energy conservation and audit course provides the detail information of using energy efficiently. Course also provides a systematic process of analyzing energy usage in process or system to identify opportunities for energy conservation and efficiency improvements. This course focuses on Indian energy scenario, role of energy conservation, implementation of energy conservation in industry, energy audit in detail.

Course Objectives:

1	To study the Indian energy scenario and importance of energy.
2	To study the energy available for industrial use and role of energy conservation.
3	To study in detail energy management and policy.
4	To learn the basics of energy audit.
5	To learn the implementation of energy audit.
6	To learn the case study.

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHPECL304.1	Explain energy scenario in India and importance of energy in production and employment.
231CHPECL304.2	Describe how to forecast industrial energy details? and role of energy conservation in industry.
231CHPECL304.3	Understand the energy conservation policy.
231CHPECL304.4	Understand the basic concepts of energy audit and energy management.
231CHPECL304.5	Discuss energy audit instruments, Procedures and Techniques.
231CHPECL304.6	Discuss the case study on energy audit in chemical and allied industries.

Prerequisite:	Chemical Engineering Thermodynamics, Process Calculations

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPECL304.1	1	-	-	-	-	2	-	-	-	-	-	-	2	-	2
231CHPECL304.2	1	-	-	-	-	-	-	-	-	-	-	-	2	-	2

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231CHPEC L304.3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	2
231CHPEC L304.4	1	-	-	-	-	-	-	-	-	-	-	-	2	-	2
231CHPEC L304.5	1	1	-	-	-	-	-	-	-	-	-	-	2	-	2
231CHPEC L304.6	2	1	-	-	-	-	-	-	-	-	-	-	2	-	2

Content	Hours
Unit 1 –Indian energy scenario Definition of energy conservation, Growth and demand of energy, Energy availability, Comparison of specific energy use in select industry, Potential and status of energy in India, Energy saving potential in industries, Potential of energy efficiency in India, Barriers, Energy conservation act 2001.Importanceofenergy in production and employment. Case study.	06
Unit 2- Energy available for industrial use and the role of conservation Methodology for forecasting industrial energy supply and demand, Review of alternative approaches and major models and studies, Method for fore casting industrial energy price and availability, New energy technologies and conservations.	07
Unit 3 – Energy management and policy Comprehensive energy conservation planning (CECP), Motivation for CECP, Principles of energy conservations, Procedure for comprehensive energy conservation planning, Significance of CECP, Tasks required for CECP and Application / Case study of CECP.	10
Unit 4 - Basics of energy audit	06

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Definition and objectives of energy management, Energy audit definition, Need for energy audit, Scope of energy audit, Responsibility of energy management, Types of energy audit and approach.	
Unit 5 - Energy audit and management Understanding energy cost, Benchmarking, energy performance, Matching energy usage to requirement, Maximizing system efficiencies, Optimizing input energy requirements, Fuel & energy substitution, Instruments & metering for energy audit, Targeting and monitoring energy consumption, General questionnaire, Case study of energy audit, Bureau of energy efficiency regulations, 2008.	10
Unit 6 –Case Study on energy audit in chemical and allied industries.	6

Text Books:

1	S. Devid Hu., Handbook of Industrial Energy Conservation, Van Nostrand Reinhold Company Inc., New York.
2	Rao, Diwalkar P. L., Energy Conservation Handbook, Utility Publication, Hydrabad.
3	The Bulletinon Energy Efficiency and Management by IRADA, MITCON, MEDHA etc.
4	Sonal Desai, Handbook of Energy Audit, Mcgraw Hill Education Private Ltd.
5	General Aspects of Energy Management and Energy Audit, Guide book for National Certification Examination for Energy Managers and Energy Auditors.

Reference Books:

1	A Practical Guide to Energy Conservation, PCRA Publication, Ministry of Petroleum & Natural Gas, 2010.
2	De. B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3	L.C. Witte, P.S. Schmidt, D.R. Brown,Industrial Energy Management and Utilization,

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	Hemisphere Publication, Washington, 1988.
4	Amit Tagi, Hand book Energy Audit, Tata McGraw Hill publication, 2000.

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Course Plan

Course Title: Industrial Safety & Management	
Course Code:231CHPECL305	**Semester:** VI
Teaching Scheme: L-T-P: 03-0-0	**Credits:** 03
Evaluation Scheme: ISE+MSE Marks: 20 + 30 = 50	**ESE Marks:** 50

Course Description:

This course provides an in-depth understanding of safety principles in chemical process industries. It covers hazard identification, risk assessment, toxicology, fire and explosion prevention, relief systems, and process safety management. The course integrates theoretical knowledge with real-world case studies to develop problem-solving skills for safety challenges in the chemical industry.

Course Objectives:

1	Understand fundamental safety concepts in chemical processing.
2	Identify potential hazards and assess risks in chemical plants.
3	Analyze toxicological and fire hazards in chemical industries.
4	Implement process safety management and case studies
5	Learn about pressure relief systems and safety instrumentation.
6	Apply safety standards and regulations in process industries.

Course Outcomes (COs): After successful completion of the course, students will be able to:

CO	Statements
231CHPECL305.1	**Explain** key concepts of chemical process safety, including inherent safety principles.
231CHPECL305.2	**Explain** hazard and risk assessment using tools such as HAZOP and QRA.

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CO	Statements
231CHPECL305.3	**Describe** the industrial hygiene and toxicology in the chemical industry
231CHPECL305.4	**Develop** a process safety management (PSM) system for a given chemical plant.
231CHPECL305.5	**Design** and recommend appropriate pressure relief systems.
231CHPECL305.6	**Interpret** safety regulations (OSHA, EPA, etc.) and apply them to industrial scenarios.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPECL305.1	-	-	-	1	-	2	2	-	-	-	-	2	2	-	2
231CHPECL305.2	-	-	-	1	-	2	2	-	-	-	-	2	2	-	2
231CHPECL305.3	-	-	-	1	-	2	2	-	-	-	-	2	2	-	2
231CHPECL305.4	-	-	-	1	-	2	2	-	-	-	-	2	2	-	3
231CHPECL305.5	2	1	-	1	-	2	2	-	-	-	-	2	2	-	3
231CHPECL305.6	-	-	-	1	-	3	1	-	-	-	-	2	2	-	3
231CHPECL305	**2**	**1**	**-**	**1**	**-**	**2.2**	**1.8**	**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**

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Course Content	Hours
Unit 1 –Concept of industrial safety History and development of safety movement, Safety programs, Need for safety, Plant safety inspections, Job safety, First aid, Nature of Accident, Process of accident, Causes of accidents, Analysis and investigation of accidents, Accident prevention and control techniques, Accident sequence/causation theories, Financial costs-direct and indirect, social costs of accidents.	07
Unit 2-Hazard identification, risk assessment and control Fire triangle, roll of national fire protection association (NFPA), Flammability characteristics of liquids and gases, Hierarchy of hazard control (LOPA), Hazard Identification and Risk Assessment (HIRA), Hazard Analysis (HAZAN), Hazard and operability (HAZOP) studies Maximum Credible Accident Analysis (MCAA)/Quantitative Risk Assessment (QRA), Bo tie Analysis fault tree and event tree analysis methods Hazard identification and risk control approaches and techniques: Reactive approach: Incident recall technique (after-the-event approach), Proactive approaches: Critical incident review technique (before-the-event approach), Deductive technique, Inductive technique.	08
Unit 3 - Industrial Hygiene and Toxicology Definition of Industrial Hygiene, Phases of industrial hygiene Industrial Hygiene: Control Methods, Substitution, Changing the process, isolation, wet method, local exhaust ventilation, personal hygiene, housekeeping and maintenance, waste disposal, special control measures. Introduction to chemical hazards, dangerous properties of chemical, dust, gases, fumes, mist, vapours, smoke and aerosols, use of MSDS(Material Safety Data Sheets), : Effect of Toxicants on Biological Organisms, Toxicological Studies, Dose versus, Response, Models for Dose and Response Curves, Relative Toxicity, Threshold Limit Values.	08

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Unit 4 - Process Safety Management Purpose of PSM, its elements and Risk-Based Process Safety Management (RBPSM), Major Industrial Disasters (Case Studies), Bhopal disaster (1984), Chernobyl Disaster, Fukushima Daiichi Disaster etc.	**06**
Unit 5: Relief devices and sizing Relief Concepts, Definitions, Location of Reliefs, Relief Types and Characteristics, Relief Scenarios, Data for Sizing Reliefs, Relief Systems. Conventional Spring-Operated Reliefs in Liquid and in Vapour or Gas Services, Rupture Disc Reliefs in Liquid in Vapour or Gas Services, Two-Phase Flow during Runaway, Reaction Relief, Pilot-Operated and Bucking-Pin Reliefs, Deflagration Venting for Dust andVapour Explosions, Venting for Fires External to Process Vessels, Reliefs for Thermal Expansion of Process Fluids.	**08**
Unit 6 - Industrial Safety Legislations Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels. Legislative measures in industry: Factories Act, 1948, the factories rules, History, Provisions under the factories Act and rules made there under with amendments, Electricity act 2003, Functions of safety management. Workman's Compensation Act, 1943, Employees State Insurance Act, 1948, Air Pollution (Prevention and control) Act, 1981, Water Pollution (Prevention and Control) Act, 1974, Boiler Vessels Act, Child Labour and Women Employee Act. EPA 1986.	**08**

Text Books:

1	Industrial Accident Prevention, H.W. Heinrich, Dan Petersen, and Nestor Roos, McGraw Hill
2	Book Company, New York / New Delhi White, F. M. (1979). Fluid mechanics, 1999Mc Graw-Hill.

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3	Industrial Safety and Environment, A. K. Gupta, Laxmi Publications, New Delhi
4	Techniques of Safety Management (ISBN: 978-18-8-558139-6), Dan Petersen, McGraw-Hill Book Co. Ltd., New York, N.Y. USA,

References Book:

1	Hazardous Chemical Data Book ISBN: 081-551072-1), G. Weiss, Noyes Data Corporation, Park Ridge, New Jersey, N.Y. (USA)
2	The Factories Act, 1948 & Factory Rules

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Course Plan

Course Title: Modeling and Simulation in Chemical Engineering	
Course Code: 231CHPECL306	**Semester:** VI
Teaching Scheme: L-T-P: 3-0-0	**Credits:** 03
Evaluation Scheme: ISE + MSE Marks: 20 + 30 = 50	**ESE Marks:** 50

Course Description:

This course provides an introduction to the process of designing models of existing or proposed real-world systems, and how to use the models to perform simulations that allow for predictions about the future behavior of the system. A Modeling and Simulation in Chemical Engineering syllabus covers fundamental concepts, mathematical modeling of processes, simulation techniques, and applications in various chemical engineering areas like reactors, separation heat transfer etc. This course focuses on developing mathematical modeling and simulation of chemical process.

Course Objectives:

1	To study the basic concepts of modeling.
2	To study the basic equations required for modeling the chemical systems.
3	To develop the model equations of tank reactors.
4	To study the modeling of mass transfer operations.
5	To develop the model equations of dynamic system.
6	To study the basics of simulation of chemical engineering.

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHPECL306.1	Explain the physical and chemical laws used to model chemical system.
231CHPECL306.2	Memorize the model equations used for chemical systems.
231CHPECL306.3	Execute mathematical model of tank reactors.
231CHPECL306.4	Execute modele quations for the mass transfer operations.
231CHPECL306.5	Execute model equations for the dynamic systems.
231CHPECL306.6	Understand simulation software used in chemical engineering.

Prerequisite:	Chemical Engineering Thermodynamics, Process Calculations

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPECL306.1	2	1	1	-	1	-	-	-	-	-	-	-	2	2	2
231CHPECL306.2	2	2	1	-	1	-	-	-	-	-	-	-	2	2	1
231CHPECL306.3	2	2	1	-	1	-	-	-	-	-	-	-	2	2	3

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231CHPEC L306.4	2	2	1	-	1	-	-	-	-	-	-	-	2	2	3
231CHPEC L306.5	2	2	1	-	1	-	-	-	-	-	-	-	2	2	3
231CHPEC L306.6	2	-	1	-	2	-	-	-	-	-	-	-	2	2	2

Content	Hours
Unit 1: Basic modeling Introduction, Chemical engineering modeling, Types of models, Dependent & Independent variables, Application of modeling and simulation, Principles of formulation, Fundamental laws, Modeling approach, General modeling procedure, Lumped & Distributed system.	06
Unit 2: Formulation of dynamic models Balancing procedure, Case studies: CSTR, Tubular reactor, Coffee percolator, Total mass balance - Case studies: Tank drainage, Component balances - Case Studies: Waste holding tank, Energy balance - Case Studies: Heating in a filling tank, Parallel reaction in a semi continuous reactor with large temperature difference, Momentum balances – Case Studies: Gravity flow tank, Dimensionless model equations - Case Studies: CSTR.	08
Unit 3: Modeling of stage wise processes Introduction, Stirred tank reactor - Reactor Configurations, Generalized model description, Heat transfer to and from reactors, Steam heating in jacket, Dynamics of the metal jacket walls, Batch reactor - Constant volume, Semi - batch reactor, CSTR	08

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- Constant volume CSTR, Stirred tank reactor cascade, Bubble column reactor, Reactor stability.	
Unit 4: Stage wise mass transfer models Liquid-liquid extraction, distillation, multi component separation, multi component steam distillation, absorber- stage wise absorption.	08
Unit 5: Dynamic modeling Plug flow reactor – Liquid phase & Gas phase tubular reactor, Plug flow reactor contactors - Liquid-liquid extraction column dynamics, Co-current & counter current heat exchanger.	07
Unit 6: Simulation of chemical engineering Introduction to software's used in chemical industry, Process simulation, Scope of process simulation, Formulation of problem, Step for steady state simulation, Process simulation approaches for steady state simulation, Strategies, Process simulator, Structure of process simulator, Integrated process simulation, Simulation tools, ISIM, Case studies: Studies of integrated process simulation, ICAS – Integrated Computer Aided System, Sequential modular method, Case study.	08

Text Books:

1	John Ingham, Irving, J. Dunn, Elmar, Heinzle Jiri, E. Prenosil, Chemical Engineering Dynamics, VCH Publishers Inc., New York, 1974.
2	R. W. Gaikwad, Dr. Dhirendra, Process Modeling and Simulation, Central Techno Publications, Nagpur, 2003.
3	C. L. Smith, R. L. Pike and P. W. Murill, Formulation Optimization of Mathematical Models, International Text, Pennsylvania, 1970.

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Reference Books:

1	W. L. Luyben, Process Modeling, Simulation and Control for Chemical Engineering, McGraw Hill Book co., 1973.
2	Roger G. E. Franks, Modeling and Simulation in Chemical Engineer, Wiley Inter Science, New York, 1972.

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Course Plan

Course Title: Business Communication	
Course Code: 231CHVSECL301	**Semester:** VI
Teaching Scheme: L-T-P: 1-0-0	**Credits:** 01
Evaluation Scheme: ISE Marks: 25	**MSE Marks: --**

Course Description:

This course explores students taking this course will gain practical experience in workplace communication. They will practice common types of business writing, such as the memo, letter, and report. They will also review their basic writing skills to gain greater mastery of grammar, mechanics, and style. This course introduces students to the strategies successful business professionals employ to handle a variety of situations. Students will learn techniques for writing informational, persuasive, sales, employment, good news, and bad news communications. They will also learn how to analyse their audience effectively to communicate both inside and outside of their organization.

Course Objectives:

1	To create Dynamic and Effective Business Communication Skills.
2	To familiarize the students with the process of communication, make them understand the principles and techniques of Business Communication.
3	To enable students to comprehend the different dimensions of Business Communication.
4	To enlighten about the communications strategy for managers

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHVSECL 301.1	**Understand** the expected individual and team behaviour in business world.
231CHVSECL 301.2	The Students will able to **apply** communication skills effectively in professional circles.
231CHVSECL 301.3	**Understanding** positive change in the oral and written communication skills of the students after studying the subject
231CHVSECL 301.4	The students will **apply** those skills to draft business letters, give effective presentations, write formal reports and deliver speeches independently

Prerequisite:	Basic communication skills , letter writing skills

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHVS ECL301.1	-	2	-	-	-	-	-	1	1	1	1	2	-	-	2
231CHVS ECL301.2	-	-	-	-	-	-	-	1	-	1	-	-	-	-	3

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231CHVS ECL301.3	-	2	-	-	-	-	-	-	1	-	1	2	-	-	2
231CHVS ECL301.4	-	2	-	-	-	-	-	1	1	1	1	2	-	-	3

Content	Hours
Unit 1: Basic Principles of Communication: Introduction, Understanding Communication, the Communication Process, Barriers to Communication, the Importance of Communication in the Workplace, Types of Communication channels, their effectiveness and limitations, Importance of Non-Verbal Communication	03
Unit 2. Communication in Organizations Communication needs of business organization, Strategies for improving Organizational communication, direction of flow of communication in organization, networks of flow of communication–wheel network, chain network, Y network, circle network. Feedback, types of feedback, importance of feedback Intra-organizational communication, inter-organizational communication. Inter-cultural communication – guidelines for effective communication across cultures	04
Unit 3. Verbal & Non-verbal communication: Introduction, Advantages of verbal Communication, Public Speaking, Meaning, Importance, Uses of non- verbal communication, Body Language, Gestures, Postures, Para Language, nonverbal aspects of written communication. Presentation Skills –	04

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Techniques for effective Presentations, Qualities of a skilful Presenter. Group Discussions and Interviews: Introduction, What is a Group Discussion? Attending Job Interviews, Preparation for GD, and Interviews. Exercises for Oral Communications – Individual and Group Presentations, Group discussion, Extempore, Role Playing, Debates, and Quiz	
Unit 4. Guidelines for Written Business Communication: Introduction, General Principles of Writing, Principles of Business Writing Internal Business Communication: Introduction, Writing Memos, Circulars, Notices, Meeting: agenda, minutes of the meeting ,Email, Communication with Shareholders External Business, Writing Business Letters: Introduction, Types of Business Letters, Format for Business Letters (Types of business letters: office order, office circular, invitation letters, inquiry letters, trade reference letters, etc Letters from Purchase department, Letters from the different functional departments, Letters of social significance, Tenders, Quotations and Orders, Banking Correspondence, dealing with complaints) **Exercises for Written Communications:** Essay writing, Speech Writing, Creative Writing, Poster Making, Writing, an Advertisement Copy, Slogans, Captions, & preparing Press notes, Letter Of Acceptance, Letter Of Resignation Writing Business Reports: Introduction, What is a Report? Types of Business Reports, Format for Business Reports, Steps in Report Preparation Employment Communication – Resumes and Cover Letters: Introduction, Writing a Resume, Writing Job Application Letters, And Other Letters about Employment	04

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Text Books:

1	"Business Communication" Meenakshi Raman, Prakash Singh
2	"Business Communication" by R. K. Madhu karvikas publication
3	"Business Communication" by Urmila Rai, S M Rai, Himalaya publication
4	"Crucial Conversations: Tools for Talking When Stakes Are High" by Kerry

Reference Book:

1	Cronen, V., & Pearce, W. B. (1982). The coordinated management of meaning: A theory of communication. In F. E. Dance (Ed.), Human communication theory
2	Habermas, J. (1984). The theory of communicative action (Vol. 1, p. 100). Boston, MA: Beacon Press.
3	Leavitt, H., & Mueller, R. (1951). Some effects of feedback on communication. Human Relations,
4	McLean, S. (2003). The basics of speech communication. Boston, MA: Allyn & Bacon.

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Laboratory Course Plan

Course Title: Mass Transfer-II (Laboratory Work)	
Course Code: 231CHPCCP304	**Semester: VI**
Teaching Scheme: L-T-P: 0-0-2	**Credits:** 01
Evaluation Scheme: --	**TW + ESE (POE) Marks:** 25 + 25 = 50

Course Description:
The course includes experiments based on industrial mass transfer operations including separation of gas- liquid, gas-solid, liquid-liquid and solid-liquid phases.

Course Objectives:
To teach the students different separation techniques, at the end of the study students will come to know the design of a distillation column, as well as design of an adsorber and calculations involved in liquid-liquid extraction and solid liquid extraction, Humidification, Drying and Crystallization.

1	To study the different separation techniques in process industries.
2	At the end of the study, students will come to know the design of a distillation column.
3	To study the calculations involved in liquid-liquid extraction and solid liquid extraction.
4	At the end of the study, students will come to know the design of industrial dryer & cooling tower.

Course Outcomes (COs):

COs	**At the end of successful completion of course, the students will be able to…**
231CHPCCP304.1	**Know** different separation techniques in process industries.
231CHPCCP304.2	**Design** & do the calculation of distillation column.

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231CHPCCP304.3	**Design** & do the calculations involved in liquid-liquid extraction and leaching.
231CHPCCP304.4	**Design** & do the calculation of industrial dryer & cooling tower.

Prerequisites	Mass Transfer I, Chemistry, Applied mathematics, Physics, Process Calculations, Thermodynamics, Fluid mechanics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BT L
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPCCP304.1	2	2	-	2	-	1	2	-	-	-	-	1	2	-	2
231CHPCCP304.2	2	2	1	2	-	-	-	-	-	-	-	1	2	-	3
231CHPCCP304.3	2	2	1	2	-	-	-	-	-	-	-	1	2	-	3
231CHPCCP304.4	2	2	1	2	-	1	1	-	-	-	-	1	2	-	3
231CHPCCP304.	**2**	**2**	**1**	**2**	-	1	1	-	-	-	-	1	**2**	-	-

List of Experiments			
Expt. No.	Name of Experiment	Type	Hours
1	Simple Distillation: To verify Rayleigh's equation for simple distillation.	O	2
2	Bi-nodal curve: To plot bimodal curve by using system distilled water, chloroform & acetone.	O	2

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3	Cross current leaching: To study principle of leaching by studying result obtained by leaching a mixture of Oxalic acid & sand with distilled water by cross current leaching	O	2
4	Counter current leaching: To study principle of leaching by studying result obtained by leaching a mixture of Oxalic acid & sand with distilled water by counter current leaching	O	2
5	Liquid- liquid extraction: To calculate percentage recovery of acetic acid from mixture of acetic acid and water with benzene as extracting solvent by single stage and multistage cross current extraction.	O	2
6	Tray Dryer-I: To study drying characteristics and to study characteristic curve for saw dust and moisture content.	O	2
7	Tray Dryer-II: To study drying characteristics and to study characteristic rate of drying curve for saw dust and moisture content.	O	2
8	Steam Distillation: To determine thermal, vaporization efficiency in steam distillation operation..	O	2
9	Oil Extraction: To determine percentage of recovery of oil by leaching operation.	O	2
10	Crystallization: To find yield of batch crystallization	O	2
11	Cooling Tower: To determine volumetric mass transfer coefficient for air water system in cooling tower	O	2
12	Reactive Distillation: To study the principle, construction, working of reactive distillation.	S	2

- S-STUDY, O-OPERATIONAL
- Minimum 10 Experiments should be conducted

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Text Books:

1	Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw Hill,1980.
2	Richardson & Coulson, "Chemical Engineering", Vol. 1, Pergamon Press, 1970
3	Richardson & Coulson, "Chemical Engineering", Vol. 2, Pergamon Press, 1970
4	Richardson & Coulson, "Chemical Engineering", Vol. 4, Pergamon Press, 1970
5	Richardson & Coulson, "Chemical Engineering", Vol. 5, Pergamon Press, 1970

Reference Books:

1	Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke,"Mass transfer" International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
2	McCabe and Smith, "Unit Operation of Chemical Engineering",5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3	C. J Geankoplis, Transport Processes and unit operations, 3rdEdition, Prentice hall, India, 1993.B.K Datta, Principles of mass transfer & separation process.
4	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh
6	B.K Datta, Principles of mass transfer & separation process
7	K. D Patil, Mass Transfer Operation Vol. I & II.

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Laboratory Course Plan

Course Title: Process Dynamics & Control (Laboratory Work)	
Course Code: 231CHPCCP305	**Semester: VI**
Teaching Scheme: L-T-P:0-0-2	**Credits**: 01
Evaluation Scheme: --	**TW + ESE (POE) Exam.**: 25 + 25 = 50

Course Description:

The Process Dynamics and Control Laboratory in Chemical Engineering focuses on understanding and analyzing the dynamic behavior and control of chemical processes. The lab typically includes experiments and exercises designed to provide hands-on experience with various control systems and process dynamics.

Course Objectives:

The Process Dynamics & Control Lab in Chemical Engineering aims to provide hands-on experience in understanding and applying control strategies to chemical processes. The course objectives typically include:

1	To study the dynamic behaviour of chemical processes and to analyses first-order and higher-order dynamic systems.
2	To implement and analyses different control strategies (P, PI, PD &PID) and to understand industrial process control applications.

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Course Outcomes (COs):

CO	At the end of the course the student should be able...
231CHPCCP305.1	To **develop** an understanding of the dynamic behaviour of chemical processes, including first-order and second-order systems.
231CHPCCP305.2	To implement and **analyse** different process control parameters and control strategies with help of various controllers.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs),

Course Outcomes (COs)	POs												PSO1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPCCP 305.1	2	3	2	1	-	-	-	-	-	-	-	-	1	1	2
231CHPCCP 305.2	3	2	2	2	-	-	-	-	-	-	-	-	1	1	2
	2.5	**2.5**	**2.0**	**1.5**	-	-	-	-	-	-	-	-	**1**	**1**	

List of Experiments conducted in Process Dynamics &Control laboratory are as follows,

Sr. No.	Name of Experiment	Type	Hour
1	Time Constant of Thermometer	O	2
2	Time Constant of U tube Manometer	O	2
3	Single Liquid Level System	O	2
4	Two Tank Interacting System	O	2
5	Two Tank non-interacting System	O	2

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6	Study of Control Valve Characteristics	O	2
7	Control of Flow System	O	2
8	Control of level System	O	2
9	Control of Pressure System	O	2
10	Control of temperature System	O	2
11	PID control of Shell and tube heat exchanger	O	2
12	P&ID Diagram of Chemical Reactor	S	2
13	P&ID Diagram of Distillation Column	S	2
14	Study of DCS and PLC Process Control Systems	S	2

- **S - Study, O - Operational**
- **Minimum 10 Experiments should be conducted**

These experiments provide students with practical experience in designing, implementing, and analyzing control strategies for various chemical engineering processes. The hands-on approach helps in understanding the theoretical concepts of process dynamics and control, preparing students for real-world applications in the chemical industry.

Text Book:

1	Donald R. Coughanowr, **Process System Analysis and Control**, International Edition, McGraw Hill, New York. 1991.
2	Coulson and Richardson, **Chemical Engineering** Volume - III, Second Edition, Pergmon Press, (UK), 1985.

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Reference Books:

1	Le Blanc & Coughanowr, **Process system Analysis and Control**, McGraw Hill, Third edition
2	Peter Harriott, **Process Control**, Tata McGraw Hill, New Delhi, 1977.
3	Stephanopoulos G, **Chemical Process Control and introduction to theory and practice.**

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Laboratory Course Plan

Course Title: Analytical Techniques in Chemical Engineering Laboratory	
Course Code: 231CHPECP301	**Semester:** VI
Teaching Scheme: L-T-P: 0-0-2	**Credit:** 01
Evaluation Scheme: --	**TW Marks: 25**

Course Description:

The course is designed to equip students with hands-on experience in modern analytical methods used in chemical engineering and related fields. The course provides an in-depth understanding of various qualitative and quantitative analytical techniques, focusing on instrumental methods such as spectroscopy, chromatography, thermal analysis, and electrochemical techniques.

Course Objectives:

1	To introduce fundamental analytical techniques for chemical analysis.
2	To familiarize students with various instrumental methods used in chemical engineering.
3	To develop practical skills in handling analytical instruments and interpreting results.

Course Outcomes (COs): After successful completion of the course, students will be able to:

CO	Statements
231CHPECP301.1	**Demonstrate** knowledge of basic analytical techniques used in chemical engineering
231CHPECP301.2	**Perform** spectroscopic, chromatographic, and electrochemical analyses
231CHPECP301.3	**Interpret** experimental data and relate it to theoretical principles

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Course Articulation Matrix: Mapping of Course Outcomes (Cos) with Program Outcomes (PO's)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPEC P301.1	2	1	-	1	-	-	-	-	-	-	-	-	2	-	2
231CHPEC P301.2	2	1	-	1	-	-	-	-	-	-	-	-	2	-	2
231CHPEC P301.3	2	1	-	1	-	-	-	-	-	-	-	-	2	-	2
231CHPEC P301	**2**	**1**	-	**1**	-	-	-	-	-	-	-	-	**2**	-	-

List of Experiments

Exp. No.	Title of Experiments	Type	Hours
1	**Identification of Organic Compounds Using Thin Layer Chromatography (TLC)**	O	02
2	Gas Chromatography (GC) for the Quantitative Analysis of Volatile Compounds	O	02
3	High-Performance Liquid Chromatography (HPLC) for Quantitative Analysis of Organic Compounds	O	02

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Exp. No.	Title of Experiments	Type	Hours
4	Identification of Polymers and Plastics Using Differential Scanning Calorimetric (DSC)	O	02
5	**Functional Group Identification Using Fourier Transform Infrared Spectroscopy (FTIR)**	O	02
6	**X-ray Diffraction (XRD) for Phase Identification of Solid Samples**	O	02
7	Surface Morphology Analysis of Metallic and Non-Metallic Materials using Scanning Electron Microscopy (SEM)	O	02
8	Determination of Heavy Metals in Water Samples Using Atomic Absorption Spectroscopy (AAS)	O	02
9	Characterization of nonmaterial's using Transmission Electron Microscopy (TEM)	O	02
10	**Spectrophotometric Determination of Unknown Sample Concentration (UV-Vis Analysis)**	O	02
11	Determination of Protein Concentration Using UV-Vis Spectroscopy (Biuret Test Method)	O	02
12	**Determination of Glucose Concentration in a Solution Using Polarimetry**	O	02
13	**Quantitative Estimation of Sodium and Potassium Using Flame Photometry**	O	02

- **S- Study and O-Operational**
- **Minimum 10 Practical's Should be conduct**

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Text books:

1	Principles of Instrumental Analysis – 5th edition – Skoog. Holler. Nieman
2	Instrumental methods of Analysis, Chatwal Anand.
3	Instrumental methodology, chemical analysis – Ewing
4	Analytical chemistry, Skoog& West
5	Hand book for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle

Reference Books:

1	Mass Spectrometry for Chemists and Bio-Chemists, Robert A.W. Johnstone and Malcolm. E. Rose, 2nd Edition.
2	Chemical Analysis A.K. Srivastava & Jain
3	Analytical chemistry, Gary Christian, Sixth edition, John Wiley and Sons. New York,
4	Instrumental methods of Analysis-B. K. Sharma, Goel Publishing House, Meerut.
5	Mass Spectrometry Principles & Applications, Hoffman & Stroobant, (Wiley)
6	Analytical NMR Ed. Ld. Field and S. Stern hill, John Wiley and Sons. New York

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Laboratory Course Plan

Course Title: Waste Water Engineering (Laboratory Work)	
Course Code :231CHPECP302	**Semester: VI**
Teaching Scheme: L-T-P:0-0-2	**Credits:** 01
Evaluation Scheme: --	**TW Marks:** 25

Course Description:

This subject deals with practical understanding of waste water treatment techniques, importance, environmental impact, norms etc.

Course Objective:

1	To analyse the physical, chemical and biological characteristics of water and wastewater.
2	To study about the oxygen demand in water.
3	To gain knowledge on water pollution and the treatment methods.

Course Outcomes (COs): At the end of the course the student should be able to:

231CHPECP302.1	**Quantify** the pollutant concentration in water and wastewater.
231CHPECP302.2	**Suggest** the type of treatment required and amount of dosage required for the treatment
231CHPECP302.3	**Understand** the impact of water and waste water treatment on people and environment and ethical issues associated with water

Prerequisite	Industrial Engineering Chemistry, Process Calculation.

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPECP302.1	2	2	1	-	-	-	3	2	-	-	-	-	1	-	2
231CHPECP302.2	2	2	1	-	-	-	3	2	-	-	-	-	1	-	2
231CHPECP302.3	2	2	1	-	-	-	3	2	-	-	-	-	1	-	2
231CHPECP302	**2**	**2**	**1**	**-**	**-**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	

Expt. No.	Name of Experiment	Type	Hours
1	Determination of pH, turbidity and conductivity in water	O	2
2	Determination of hardness in water	O	2
3	Determination of alkalinity and acidity in water sample Panchaganag river sample	O	2
4	Determination of alkalinity and acidity in water sample Jayanati Nala Sample	O	2
5	Determination of phosphates and sulphates in given water samples	O	2
6	Determination of optimum coagulant dosage in waste water sample.	O	2
7	Determination of residual chlorine and available chlorine in bleaching powder	O	2

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8	Determination of suspended, settleable, volatile and fixed solids in waste water.	O	2
9	Determination of dissolved oxygen and BOD for the given sample.	O	2
10	Determination of COD for given sample.	O	2
11	Determination of sodium and potassium for the given sample	O	2
12	Determination and removal techniques of heavy metals from waste water.	S	2
13	Determination of MPN index of given water sample.	O	2

- S-Study,O-Operational
- Minimum10 Experiments should be conducted

Note: Experimental calculations & graphs by using software's like Polymath, Excel etc.

Text Book:

1.	Waren Viessman and Mark J. Hammer, "Water supply and pollution control", Harper & Row, New York, 1985.
2.	M. N. Rao, A. K. Datta ,"Waste water treatment",3rd Edition.
3.	P. Kamaraj, P. A. Vivekanand, Waste water treatment principle and processes

Reference Books:

1.	Soli Arceivala, "Waste Water Treatment for Pollution Control"
2.	M. J. Hammer, "Water & waste water Technology", Wiley, 1975

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Laboratory Course Plan

Course Title: Chemical Plant Design by Aspen Plus Laboratory	
Course Code: 231CHPECP303	**Semester:** VI
Teaching Scheme: L-T-P: 0-0-2	**Credits:** 01
Evaluation Scheme: --	**TW + ESE (POE) Marks:** 25 + 25 = 50

Course Description:

Aspen Plus is a process modeling tool used for process monitoring, optimization and conceptual design, especially by chemical process industries. This is a simple course on Aspen Plus Simulation engine that will teach one how to model the most common unit operations of a chemical plant. This course focus on to provide hands-on training in aspen plus, focusing on chemical process modeling, simulation.

Course Objectives:

1	To develop skills in defining material steams, unit operations and thermodynamic models.
2	To gain proficiency in performing steady state simulation for chemical process.

Course Outcomes (Cos):

COs	At the end of successful completion of course, the students will be able to…
231CHPECP303.1	Explain the principles and importance of process simulation in chemical engineering.
231CHPECP303.2	Execute aspen plus efficiently for modeling and simulation of chemical process.

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Prerequisite:	Chemical Reaction Engineering, Mass Transfer, Chemical Engineering Thermodynamics, Process Calculations.

Course Articulation Matrix:

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPEC P303.1	2	2	1	1	2	-	-	-	-	-	-	-	2	2	2
231CHPEC P303.2	2	2	1	2	2	-	-	-	-	-	-	-	2	2	3

List of Experiments			
Expt. No.	**Name of Experiment**	**Type**	**Hours**
1	To navigate aspen plus software and set up a new project.	O	2
2	To define chemical components.	O	2
3	To Select Thermodynamic property.	O	2
4	To analyze physical properties of chemical compounds.	O	2
5	To develop flow sheet.	O	2
6	To simulate a heat exchanger to analyze temperature profiles.	O	2
7	To simulate a reactor for conversion efficiency.	O	2
8	To simulate a distillation column to separate binary mixture.	O	2
9	To simulate a distillation column by RadFrac method.	O	2

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10	To study the sensitivity analysis and optimization of parameters in distillation.	O	2
11	To simulate a water stripper.	O	2
12	To simulate conventional solid dryer	O	2
13	To develop and simulate the benzene flow sheet.	O	2
14	To simulate a chemical process e.g. Vinyl chloride monomer, Ethanol etc.	O	2
15	To simulate a chemical process e.g. Ethylene, Cyclo hexane etc.	O	2

- **S-Study, O-Operational**
- **Minimum 10 Experiments should be conducted.**

Text Books:

1	Thomas A. Adams, II, Learn Aspen Plus in 24 Hours, 2nd Edition, McGraw Hill
2	Kamal I.M. Al-Malah, ASPEN PLUS Chemical Engineering Applications, John Wiley & Sons, Inc., Hoboken, New Jersey
3	Ralph Schefflan, Teach Yourself the Basics of Aspen Plus, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey

Reference Books:

1	Juma Haydary, Chemical Process Design and Simulation, American Institute of Chemical Engineers and John Wiley & Sons, Inc.
2	B.V. Babu, Process Plant Simulation, Oxford University Press
3	R. W. Gaikwad, Dr. Dhirendra, Process Modeling and Simulation, Central Techno Publications, Nagpur, 2003.

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Laboratory Course Plan

Course Title: Applications of AI in Chemical Engineering (Laboratory Work)	
Course Code:231CHPECP304	**Semester:** VI
Teaching Scheme: L-T-P:0-0-2	**Credits:** 01
Evaluation Scheme: --	**PW + ESE (POE) Exam:** 25 + 25 = 50

Course Description:

With the growing impact of Artificial Intelligence (AI) in chemical engineering, laboratories are now incorporating AI-based experiments to improve process control, optimization, and predictive analytics. Below are some AI-driven lab experiments that demonstrate its applications in chemical engineering.

Course Objectives:

The Course Objectives of Applications of Artificial Intelligence (AI) in chemical engineering typically include:

1	Analyse dynamic behaviour of chemical processes using mathematical modelling.
2	To develop predictive models for chemical processes.

Course Outcomes (COs):

	At the end of the course the student should be able to...
231CHPECP304.1	Provide a fundamental **understanding** of artificial intelligence (AI) and machine learning (ML) techniques relevant to chemical engineering.

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231CHPECP304.2	**Apply** AI techniques to **develop** predictive models for chemical processes, including process control, reaction kinetics, heat transfer, and mass transfer operations.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific outcomes (PSOs),

Course Outcomes (COs)	POs												PSO1	PSO2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHPECP 304.1	2	2	2	1	-	-	-	-	-	-	-	-	1	2	2
231CHPECP 304.2	2	1	1	2	-	-	-	-	-	-	-	-	1	2	3
	2	**1.5**	**1.5**	**1.5**	-	-	-	-	-	-	-	-	**1**	**2**	

Below are some AI-driven lab experiments that demonstrate its applications in chemical engineering.

Sr. No.	Name of Experiment	Type	Hour
1	Use machine learning (ML) models to predict key process parameters (e.g., temperature, pressure, reaction yield).	S	2
2	Use AI to automatically tune PID controllers for optimal performance.	S	2

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3	Optimize process conditions (e.g., temperature, pressure, reactant ratio) to maximize yield.	S	2
4	Use AI to minimize energy consumption in chemical processes.	S	2
5	AI-based image recognition to analyse chemical properties (e.g., particle size in crystallization)	S	2
6	Develop an AI model for predicting water quality parameters (pH, COD, BOD).	S	2
7	Implement AI for safety monitoring in chemical plants.	S	2
8	Use AI to predict molecular properties of new chemical compounds.	S	2
9	Use deep learning models to predict the properties of new materials or catalysts based on molecular structures.	S	2
10	Use ML models to predict water quality parameters and optimize treatment processes	S	2
11	Develop an AI system to detect process faults using historical sensor data.	S	2
12	Develop an AI-based soft sensor to estimate unmeasured process parameters.	S	2

- **S - Study, O - Operational**
- **Minimum 10 Experiments should be conducted**

AI is transforming chemical engineering by enhancing efficiency, safety, and sustainability. These laboratory experiments integrate AI into process control, optimization, and predictive maintenance, making chemical plants smarter and more efficient.

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Text Book:

1	**AI and Machine Learning in Chemical Engineering** by Basant Giri, Virendra S. Bisaria.
2	**Machine Learning in Chemical Safety and Health** by Huixiao Hong.

Reference Books:

1	**Computational Intelligence Techniques in Chemical Engineering** byAhmad Taher Azar, Sundarapandian Vaidyanathan.
2	**Artificial Intelligence in Process Engineering** byMario R. Eden, Costas Kravaris, Mahmoud El-Halwagi.
3	**Artificial Intelligence and Data Science in Environmental Sensing** byMohsen Asadnia, Saeid Sadri.

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Laboratory Course Plan

Course Title: Business Communication Laboratory Work	
Course Code: 231CHVSECP301	**Semester:** VI
Teaching Scheme: L-T-P: 0-0-2	**Credits:** 01
Evaluation Scheme: --	**TW Marks:** 25

Course Description:

This course explores students taking this course will gain practical experience in workplace communication. They will practice common types of business writing, such as the memo, letter, and report. They will also review their basic writing skills to gain greater mastery of grammar, mechanics, and style. This course introduces students to strategies successful business professionals employ to handle a variety of situations. Students will learn techniques for writing informational, persuasive, sales, employment, good news, and bad news communications.

Course Objectives:

1	To create dynamic and effective business communication skills.
2	To familiarize the students with the process of communication, make them understand the principles and techniques of business communication.
3	To enable students to comprehend the different dimensions of business communication.
4	To enlighten about the communications strategy for managers

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Course Outcomes (COs):

COs	At the end of successful completion of course, the students will be able to…
231CHVSECL301.1	**Understand** the expected individual and team behaviour in business world.
231CHVSECL301.2	The Students will able to **apply** communication skills effectively in professional circles.
231CHVSECL301.3	**Understanding** positive change in the oral and written communication skills of the students after studying the subject
231CHVSECL301.4	The students will **apply** those skills to draft business letters, give effective presentations write formal reports and deliver speeches independently

Prerequisite:	Basic communication skills, letter writing skills

Course Articulation Matrix:

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	POs												PSO 1	PSO 2	BTL
	1	2	3	4	5	6	7	8	9	10	11	12			
231CHVSECL301.1	-	2	-	-	-	-	-	1	1	1	1	2	-	-	2
231CHVSECL301.2	-	2	-	-	-	-	-	-	1	-	1	2	-	-	3

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231CHVS ECL301.3	-	-	-	-	-	-	-	1	-	1	1	2	-	-	2
231CHVS ECL301.4	-	2	-	-	-	-	-	1	1	1	1	2	-	-	3

	Name of Experiment	Hours
1	Formal Communication and Informal Communication	2
2	Verbal and Non-Verbal Communication	2
3	Group discussion's	2
4	Debate's	2
5	Role play and Quiz competition's	2
6	Interview techniques.	2
7	Formal and Informal Letter writing	2
8	Job Application letter writing	2
9	Letter of Acceptance and Resignation	2
10	Writing Memos, Notices, Agenda	2
11	CV and Resume writing	2
12	Mock interviews	2

Text Books:

1	"Business Communication" Meenakshi Raman, Prakash Singh oxford higher education
2	"Business Communication" by R. K. Madhu karvikas publication
3	"Business Communication" by Urmila Rai, S M Rai, Himalaya publication

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4	"Crucial Conversations: Tools for Talking When Stakes Are High" by Kerry petterson & joseph granny Mcgraw-hill

Reference Book:

1	Cronen, V., & Pearce, W. B. (1982). The coordinated management of meaning: A theory of communication. In F. E. Dance (Ed.), Human communication theory New York, NY: Harper & Row.
2	Habermas, J. (1984). The theory of communicative action (Vol. 1, p. 100). Boston, MA: Beacon Press.
3	Leavitt, H., & Mueller, R. (1951). Some effects of feedback on communication. Human Relations,
4	McLean, S. (2003). The basics of speech communication. Boston, MA: Allyn & Bacon.

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Course Plan

Course Title: Liberal Learning Course	
Course Code: 231CHCCAL302	**Semester:** VI
Teaching Scheme: L-T-P:0-0-2	**Credits:** Audit
Evaluation Scheme: ISE Marks: 25 (Grade)	**ESE Marks: 25 (Grade)**

- Liberal Learning Through Students Clubs and particular areas is a Two-credit course run for Third Year B.Tech.
- Students are required to go through the list of liberal learning courses and rank their preferences through google form provided by department at the beginning ofsemester.
- They will be allocated one area from the list. Faculties from particular areas conducts session once a week for each area on campus through activities, discussion, presentation and lecture methods and evaluation out of 50 as per area is done for each area throughout semester.
- Evaluation pattern may be differed according to the nature of the club.
- Although there is no predefined syllabus, there is an out line which experts normally develop and follow for the sessions.
- However, students may approach to the faculty to cover certain topics of interest in that area during sessions based on students interests and experts.
- List of liberal learning course will get display at the beginning of semester.

  List of liberal learning courses

Sr. No	Name of the Course
1.	GATE and Higher Education Club
2.	Training and Placement club
3.	Hobby club
4.	Industry Sponsored Lab club

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