Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Structure & Syllabus of

B. Tech. (Chemical Engineering)

Pattern 'C25/D25'

Effective from Academic Year 2025-26

B.Tech. Chemical Structure Pattern C25 (applicable w.e.f. AY 25-26)

Third Year Module - V

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH3261	TRANSPORT PHENOMENON	2	2	1	4
S2	CH3234	PROCESS EQUIPMENT DESIGN	2	2	1	4
S3	CH3238	CHEMICAL REACTION ENGINEERING	2	2	1	4
S4	CH3237	MASS TRANSFER OPERATIONS	2	2	-	4
S5	CH3287	ENGINEERING DESIGN AND INNOVATION –V	-	12	-	6
S6	CH3289	DESIGN THINKING - V	-	-	1	1
S7	SH3001	REASONING AND APTITUDE DEVELOPMENT				1
		Total	14	16	3	24

Third Year Module - VI

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH3232	INSTRUMENTATION AND PROCESS CONTROL	2	2	1	4
S2	CH3234	PETROLEUM REFINERY AND	2	2	1	4

		PETROCHEMICALS				
S3	CH3236	SEPARATION TECHNIQUES	2	2	1	4
S4	CH3238	PROCESS MODELING AND SIMULATION	2	2	-	4
S5	CH3294	ENGINEERING DESIGN AND INNOVATION – IV	-	12	-	6
S6	CH3293	DESIGN THINKING – 6	-	-	1	1
S7	SH3002	REASONING AND APTITUDE DEVELOPMENT	-	-		1
		Total	13	16	3	24

FF No. : 654

CH3237::MASS TRANSFER OPERATION

Course Prerequisites:

Course Objectives:

1. Apply principles of diffusion to separation and purification processes.
2. Select and design appropriate gas-liquid contacting devices
3. calculate mass transfer flux and estimate mass transfer coefficient and diffusivity for gas-liquid and liquid-liquid system
4. Performs mass transfer calculations for absorber, humidification and dehumidification and design cooling tower
5. Calculate rate of drying and select proper dryer, and find batch time for batch drier and design rotary drier for given requirement
6. Comprehend the fundamentals of the crystallization system.

Credits:4 **Teaching Scheme Theory:2** Hours/Week

Tut:1 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

SECTION-1
Introduction to Mass Transfer and Molecular Diffusion: Introduction to Mass Transfer Operations. Molecular Diffusion in gases and liquids, diffusivities of gases and liquids, types of diffusion, Fick's and Maxwell law of diffusion, Measurement of liquid-phase diffusion coefficient, Concept of diffusivity, diffusivity of liquids, Eddy diffusion, film theory, penetration theory, surface renewal theory, Steady state diffusion. mass transfer coefficients, Mass, heat and momentum transfer analogies. ; Interphase mass transfer, local two phase mass transfer, overall mass-transfer coefficient, average overall coefficient, steady state co-current and countercurrent processes, Continuous co- current and counter current processes, cascades, batch processes, Stages and mass transfer rates. Gas- liquid operations and Equipment for Mass Transfer, Overall mass transfer coefficient, Gas dispersal equipments – bubble columns, Liquid dispersal equipments – Venturi scrubbers, wetted wall columns. Gas dispersed Sparged vessels – flow of gas velocity problems based on aeration tank as a time for sparging Gas hold up.

Liquid hold up – determination of interfacial area based on hold up and MTC. Tray tower versus packed tower

SECTION-1I

Gas Absorption: Mechanism of gas absorption, equilibrium in gas absorption, choice of solvent, Countercurrent multistage operation, Non-isothermal operation, absorption in wetted wall columns, values of transfer coefficient, absorption in packed tower and spray tower, calculation of HETP, HTU, NTU, calculation of height of packed and spray tower. Absorption in tray towers, absorption and stripping factors, calculation of number of trays for absorption Tray efficiencies, absorption with chemical reaction. ; Humidification, Dehumidification Principles, vapour-liquid equilibria, enthalpy of pure substances, wet bulb temperature relation, Lewis relation, Psychrometric chart, methods of humidification and dehumidification, cooling tower design – HTU, NTU concept, calculation of height of cooling tower.; Drying and Liquid-liquid extraction: Principles, equilibrium in drying, type of moisture binding, mechanism of batch drying, continuous drying, time required for drying, mechanism of moisture movement in solid, Design principles of tray dryer, rotary dryer, spray dryer. Spray dryer, fluidized bed and spouted bed dryer, pneumatic dryer and vacuum dryer. Crystallisation- Theory and design.

List of Practicals: (Any Six)

1. Study diffusion of liquid into a gas in a vertical pipe and calculate mass transfer coefficient.
2. Study steady state diffusion of acetone in air and calculate diffusivity.
3. To study characteristics of tray dryer and calculate rate of drying.
4. To study steady state molecular diffusion of acetic acid through water and determine diffusivity.
5. To determine efficiency of rotary dryer.
6. To study characteristics of cooling tower for efficiency and relative cooling.
7. To calculate mass transfer coefficient for absorption of CO2 into NaOH solution.
8. To calculate mass transfer coefficient for absorption of CO2 into water.
9. To determine mass transfer coefficient for air-water system during humidification and de- humidification process.
10. To study crystallization to find yield.
11. Study diffusion of solid into a liquid and calculate mass transfer coefficient
12. Any two experiments from above syllabus using virtual lab.

List of Course Projects:

1. Design of tray dryer
2. Design of rotary dryer
3. Design of plate column stripper
4. Design of packed column stripper
5. Design of tray tower absorber
6. Design of packed tower absorber
7. Design of cooling tower
8. Design of batch crystallizer
9. Design of forced circulation crystallizer
10. Data analysis of diffusion of solid into liquid
11. Data analysis of diffusion of liquid into gas
12. Data analysis of diffusion of liquid into liquid

List of Course Group Discussion Topics:

1. Mass Transfer essential part over heat transfer in given process
2. Molecular versus convective diffusion
3. Interphase mass transfer key study for 2 or more phases and component system
4. Mass Transfer coefficient important to decide efficacy of process
5. Absorber crucial part for environment verses economy of process
6. Is mass transfer consideration crucial for nuclear system
7. Is mass transfer crucial for pharmaceutical industry
8. Selection appropriate dryer for low moisture content process
9. Selection of appropriate dryer for high moisture content product
10. Selection of crystalliser for low solid content magma
11. Selection of crystalliser for high solid content in magma
12. Operating window for distillation column
13. Operating window for absorber
14. Mass transfer in microchannels
15. Mass transfer in nanofluids

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

ESE	***Lab***	***CP***	***VIVA***	***GD***
30	***10***	***20***	***20***	***20***

ESE - End Semester Examination
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
GD - Group Discussion

Text Books: ***(As per IEEE format)***

1. Robert Trybal, Mass Transfer operation, Edition 5, Mcgraw hill publication
2. B. K. Datta, Principle of mass transfer, Edition, PHI Learning publication, 2015

Reference Books: ***(As per IEEE format)***

1. Perry R. H., Green D. W.; Perry's Chemical Engineer's Handbook; Sixth Edition, McGraw-Hill, 1984
2. Coulson J. M.; Richardson, J. F.; Chemical Engineering – Vol. I & II; 6 th Edition, Butterworth- Heinemann.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

The student will be able to –

1. Apply principles of diffusion to separation and purification processes and calculate mass transfer flux and estimate mass transfer coefficient and diffusivity for gas-liquid and liquid-liquid system
2. Select and design appropriate gas-liquid contacting devices
3. Select and design gas absorption and stripping column
4. Calculate mass transfer coefficient for humidification and dehumidification and design cooling tower
5. Calculate rate of drying and select proper dryer, and find batch time for batch drier and design rotary drier for given requirement
6. Comprehend crystallization system and fundamental of design

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO :13	PSO :14
CO: 1	2	2	2	2	2	1	1	2	2	2	0	1	2	1
CO: 2	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 3	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:	2	2	2	2	2	1	1	2	2	2	0	1	3	1

5														
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	4
CO:2	4
CO:3	4
CO:4	5
CO:5	5
CO:6	5

Future Courses Mapping:

Separation Techniques, Chemical Reaction Engineering, Transport Phenomena

Job Mapping:
Core Chemical Engineering industrial job

CH3238::CHEMICAL REACTION ENGINEERING

Course Prerequisites: Chemical reaction kinetics, numerical methods

Course Objectives:

1. Apply knowledge of RTD to diagnose non ideal reactors and selection of appropriate models to predict conversion from different reactors
2. Apply principles and kinetic tools in analyzing the rates of chemical reactions for
3. heterogeneous reactions
4. Demonstrate catalytic phenomena with extensions to surface chemistry,
5. Selection of a model for gas-solid non catalytic reactions and apply it to design
6. reactors
1. Determine fluid -fluid reaction rate equations and apply to equipment design
2. Design various types of catalytic reactors

Credits:4 **Teaching Scheme Theory: 2.** Hours/Week

Tut:1... Hours/Week

Lab: **2..** Hours/Week

Course Relevance: Chemical reaction engineering is an advanced course of undergraduate chemical engineering curriculum, which is concerned with the exploitation of chemical reactions on a commercial scale. Chemical Process economics depends upon the selection and design of a chemical reactor.

SECTION-1

Non-Ideal flow Heterogeneous processes, catalysis and adsorption

Residence time distribution in vessels: E, F and C curve, and their relationship for closed vessels, conversion in reactors having non-ideal flow; models for non-ideal flow: Dispersion model, Tank in Series, model, mixing of fluids, two parameter model, Global rate of reaction, Types of Heterogeneous reactions Catalysis, The nature of catalytic reactions, Adsorption: Surface Chemistry and adsorption, adsorption isotherm, Rates of adsorption. Solid catalysts: Determination of Surface area, Void volume and solid density, Pore volume distribution, Theories of heterogeneous catalysis, Classification of catalysts, Catalyst preparation, Promoters and inhibitors.

SECTION-1I

Fluid-particle noncatalytic, catalytic and fluid-fluid non-catalytic reactions

Selection of a model for gas-solid non catalytic reaction, Un-reacted core model, Shrinking core model, Rate controlling resistances, Determination of the rate controlling steps, Application of models to design problems. Various contacting patterns and their performance equations, Introduction to heterogeneous fluid - fluid reactions, Rate equation for eight kinetic regimes i.e. instantaneous, Fast and slow reaction, Equipment used in fluid- fluid contacting with reaction, Application of fluid -fluid reaction rate equation to equipment design, Towers for fast reaction, Towers for slow reactions. Introduction of fluid particle catalytic reactions, Rate equation, Pore diffusion controlling, Heat effects during reaction, Various types of catalytic reactors construction, operation and design, Isothermal operation in Fixed bed reactor, Fluidized bed reactor, Experimental methods for finding rates.

List of Practical: (Any Six)

1. To study residence time distribution (RTD) in a CSTR and to find out peclet Number
2. To study residence time distribution (RTD) in a plug flow reactor
3. To determine RTD of a packed bed reactor and to find out Peclet No.
4. To determine RTD of CSTRs in series
5. To determine number of tanks in series equivalent to a real PFR
6. To determine heterogeneous reaction kinetics by LHHW approach
7. ASPEN simulation of Packed bed reactor
8. Study of a fluidized bed reactor and its performance
9. Case study of a trickle bed reactor
10. Adsorption isotherms

List of Projects:

1. Synthesizing a rate law, mechanism and rate limiting step for heterogeneous reactions.
2. Design of fluid- fluid reactors and Simulation using ASPEN
3. Design of fluid- particle reactors and Simulation using ASPEN
4. Catalyst preparation and adsorption isotherms
5. Conversion prediction by Dispersion Model
6. Study of Scale up processes for nano particle synthesis
7. Design of a fermentor
8. Multiple reactions in CSTR with heat effects
9. Design and simulation of a fixed bed reactor
10. Design and simulation of a fluidised bed reactor
11. Conversion prediction by T-I-S model
12. Conversion prediction by segregation model
13. Conversion prediction by maximum mixedness model
14. Diagnosis of reactors using RTD curves
15. Design of slurry reactor

List of Course Seminar Topics:

1. Modern nuclear reactors
2. Poisoning, Deactivation, regeneration and deactivation rate determination
3. Membrane bioreactors and it’s application in wastewater treatment
4. Role of Chemical reaction engineering in pollution prevention
5. Recent catalyst Characterization techniques
6. Reactive Distillation
7. Reactive Absorption
8. Reactive Extraction
9. Nano materials and it’s application in chemical reaction engineering
10. Micro reactors and its application
11. Scope of Chemical reaction engineering in sustainable development
12. Adsorption process and it’s application
13. Advances in chemical reactors
14. Scope of Chemical reaction engineering in biotechnology
15. Membrane bio reactors
16. Catalytic reactors used in petroleum industries
17. Synthesis of nanoparticles by various methods
18. Fisher Tropsch reaction in slurry reactor
19. Challenges in manufacturing of polymers
20. Coal hydrogenation in slurry reactor
21. Any advanced technique used in process intensification in a chemical process
22. Modern reactors in chemical industries
23. Heat exchange facilities for highly exothermic reactions in fixed bed reactor
24. Recent trends in chemical reaction engineering
25. Softwares used in chemical reaction engineering
26. Membrane reactors and it's applications in chemical industries
27. Polymers and it’s applications
28. Nano bio materials and it’s application

Suggest an assessment Scheme:

ESE	*Lab*	*CP*	*VIVA*	*SEM*
30	*10*	*20*	*20*	*20*

ESE - End Semester Examination

CP - Course Project

VIVA - Viva voice

SEM – Seminar

Text Books: ***(As per IEEE format)***

1. Levenspiel, O., 'Chemical Reaction Engineering', 3rd. edition, John Wiley& Sons, 2001.
2. Fogler, H. S., 'Elements of Chemical Reaction Engineering', 3rd Ed., PHI, 2002.
3. Smith, J.M., 'Chemical Engineering Kinetics', 3rd ed., McGraw Hill, 1987.

Reference Books: ***(As per IEEE format)***

1. Walas, S. M., 'Reaction Kinetics for Chemical Engineers', McGraw Hill, 1959.
2. .Fromment G.F. and Bischoff K.B., Chemical Reactor Analysis and Design, John Wiley 1994.
3. Sharma, M.M. and Doraiswamy, L.K. Heterogeneous reactions: Analysis, Examples and
4. Reactor Design. Vols. I & II, John Wiley and Sons, NY, 1984.

Moocs Links and additional reading material: www.nptelvideos.in

https://www.edx.org/course/technology-innovation-sustainable-epflx-innov4devx

Course Outcomes:

Course Outcomes:

The student will be able to –

1. Distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information
2. Calculate the global rate of heterogeneous catalytic reactions
3. Determine the characteristics of solid catalyst like surface area, porosity, pore volume, etc
4. Select model for fluid-particle reactions and design the fluid particle reactors
5. Select model for fluid-fluid reactions and design columns and tanks
6. Design fixed bed and fluidized bed reactor

CO PO Map

CO/PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:13	PSO:14
CO:1	1	2	2	2	2	1	1	2	2	2	0	1	2	1
CO:2	1	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:3	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO:6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	4
CO:2	5
CO:3	4
CO:4	5
CO:5	4
CO:6	5

Future Courses Mapping:

Advanced reaction engineering, Petroleum refining and petrochemicals technology, Bioengineering, Environment engineering

Job Mapping:

Student can work in chemical, petrochemical, pharmaceutical, fertilizer, biochemical industries

FF No. : 654

CH3234::PROCESS EQUIPMENT DESIGN

Course Prerequisites: Basics of heat transfer and materials

Course Objectives:

1. To Understand design the heat exchanger
2. To Comprehend design of hydraulic plate design
3. To Understand the material standards for design
4. To Comprehend axillary equipment
5. To Understand mixing vessel details

Credits:04 **Teaching Scheme Theory: 02 Hours/Week**

Tut: 01 Hours/Week

Lab: 02 Hours/Week

Course Relevance:

Process equipment design is of vital importance for industrial design. It covers important design of heat exchange that is crucial for heat recovery or heat transfer in industry. Agitator vessel design is another crucial part for chemical industry. Plate and pack column comprehension is very much part of every chemical industry. Auxiliary equipment study completes remaining part of any process industry.

Introduction to Course outcome and assessment: 2 hr

a. Explanation of Course outcomes

b. Explanation of Course outcome to assessment mapping.

SECTION-1
Topics and Contents 14 hr *Heat Exchangers: Introduction, process heat transfer, types of heat exchangers, codes and standards for heat exchangers, materials of construction, API scale, LMTD, countercurrent & concurrent exchangers, temperature approach & cross, counter-flow: double pipe exchangers, baffles and tie rods, design of shell and tube heat exchangers as per IS: 4503 and TEMA standards i.e. shell, tube sheets, channel, channel cover, flanged joints. Design of Double pipe, plate type heat exchangers. Joints, bearings, drives, mechanical seals, fabrication methods. Evaporators & pressure vessels: Classification of vaporizing equipment, evaporators (including different types such as kettle, thermosiphon, vertical, horizontal etc. Chemical evaporators, natural circulation & forced circulation evaporators, the calculation of chemical evaporators. Types of pressure vessels, codes and standards for pressure vessels (ASME Sec VIII Div-1, 2), material of construction, selection of material, selection of corrosion allowance and weld joint efficiency, purging of vessels. selection and design of various heads such as flat, torispherical, elliptical, hemispherical and conical. Opening/ nozzles and manholes, nozzle sizing, calculations etc. Condenser design for condensation of single vapors, Design of total and partial condenser with pressure balance. Vertical condenser, horizontal condenser. Allowable pressure drop in condensers, condenser-subcooler, condensation of steam- surface condenser. jacket for vessels. Introduction and classification of supports, design of bracket or lug supports, saddle support*
SECTION-1I

Topics and Contents	14 hr
Mass transfer equipment with storage vessel and mixer consideration: Tray column design and storage vessels: Design of plate column- distillation columns, design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate contactors, plate hydraulic design. Various types of storage vessels and applications, losses in storage vessels, storage of fluids- storage of volatile & non-volatile liquids- fixed roof and variable volume tanks, Packed Column Design and mixers: Choices of packing, types of packing, packed bed height (distillation and absorption), HETP, HTU, NTU, Cornell's method, Onda's method, column diameter, column internals, column auxiliaries. Mixers- Various types of mechanical mixers- propeller, turbines & paddles their selection, flow patterns in agitated tanks, baffling, design practices, standard geometry tank, power dissipation and discharge flow correlation, mechanical agitator design. Reaction vessels. Filters, Dryers and auxillary process vessels : Study of various types of filters like vacuum filters, pressure filters, centrifuges and rotary drum filters, design of rotary drum filters including design of drum, shaft, bearing and drive system. Types of dryers, batch type dryers, continuous dryers. Study of auxiliary process vessels such as reflux drum, knockout drum, liquid-liquid and gas-liquid separators, entrainment separators, oil water separator, Decanter, gravity separator.	

List of Practicals: (Any Six)

1. Design of Shell and Tube heat exchanger.
2. Design of double pipe heat exchanger
3. Design of vaporiser
4. Design of condenser
5. Design of distillation column
6. Design of types of supports for vessels
7. Design of various types of heads for vessels
8. Design of agitators for chemical reactors
9. Literature survey on types of safety valves, safety devices for chemical equipments
10. Autocad drawing of tubes sheet for the Shell and tube heat exchanger.
11. Economic analysis for Shell and tube heat exchanger.
12. Economic analysis for Shell and tube heat exchanger.

List of Course Projects:

Every project will consist of Process flow diagram, Process Utility diagram, Piping and Instrumentation diagram, Material balance, heat balance, heat exchanger, reactor, distillation column design for given flowsheet for Chemical manufacturing.

1. Manufacturing of Sulfuric acid
2. Manufacturing of Hydrochloric acid
3. Manufacturing of Nitric acid
4. Manufacturing of salicylic acid
5. Manufacture of toluene
6. Manufacturing of caprolactum
7. Manufacturing of phenol
8. Manufacturing of cyclohexane
9. Manufacturing of cumene
10. Synthesis gas by steam methane reforming
11. Manufacturing of ammonia
12. Manufacturing of Soda Ash
13. Manufacturing of Caustic soda
14. Manufacturing of Acetone
15. Manufacturing of Ethanol
16. Manufacturing of Butanol
17. Manufacturing of Methanol
18. Manufacturing of Pentane
19. Manufacturing of hexane
20. Manufacturing of Heptane
21. Manufacturing of Benzoic Acid
22. Manufacturing of MTBE
23. Manufacturing of Butylene
24. Design of multi-effect evaporator.
25. Design of extractive distillation system
26. Design of extractive distillation system
27. Design of liquid-liquid separator.
28. Design of liquid-liquid separator.

List of Course Group Discussion Topics:

1. Advances in heat exchanger design
2. Best heat exchanger for corrosive fluids handled
3. Best heat exchanger for petroleum product cooling or heating
4. National, international material codes for design
5. Distillation plate vs packed column
6. Best Evaporators for industry i.e Chemical, forced, natural circulation
7. overall heat transfer, velocity, pressure drop, dirt factor balance
8. Necessity of heat exchange in process industry
9. Necessity of heat exchange in daily life
10. re-Boilers in chemical industry
11. Condensers in Process industry
12. Dryers in process industry
13. Agitators for process industry
14. Best suitable cooling tower for process industry
15. Role of materials in Heat exchanger design

List of Home Assignments:

Design:

1. Design heat exchanger to cool crude oil available at 50000 kg/hr flowrate from 110 0C to 50 0C.
2. Design plate type distillation column to recover 99% ethanol from 50% ethanol water feed available at 20000 kg/hr flow rate
3. Design efficient agitator for absorption of CO2 in K2CO3 solution
4. Design multiple efficient evaporator for concentration of sugar syrup from 15% to 45% with flowrate of 35000 kg/hr of feed
5. Design of distillation column for separation of ethanol water system for handling 10000 kg/hr of 50% Ethanol in feed, giving 99% purity at top.

Case Study:

1. Heat exchanger used for heat recovery in Chemical process industry
2. Plate type heat exchanger
3. Tray column
4. Packed column
5. Auxillary equipments

Blog

1. Smart heat exchangers for 21st centry
2. Distillation boon for chemical industry
3. Codes, standards: Best safety aspect of industry
4. 4.Separators bottleneck of chemical industry
5. Valves selection for industry

Surveys

1. Recent advances in heat exchanger
2. Advancement in plate type column

3. Pack column efficient way for enrichment of compound
4. Most efficient Agitator for process industry
5. Best accessory stream for process industry

Assessment Scheme:

ESE	*HA*	*CP*	*VIVA*	*GD*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination

HA - Home Assignment

CP - Course Project

VIVA - Viva voice

GD - Group Discussion

Text Books: ***(As per IEEE format)***

1. D. Q. Kern;Process Heat Transfer; Tata McGraw Hill Publications, 2009
2. R. K. Sinnott; Coulson & Richardson’s Chemical Engineering, Volume-6; Elsevier Butterworth Heinemann, MA, 2005.
3. V.V. Mahajani, S. B. Umarji; Joshi's Process Equipment Design; 5th Edition; Trinity Press
4. Lloyd E. Brownell, Edwin H. Young; Process Equipment Design; 1st Edition; Wiley-Interscience

Reference Books: ***(As per IEEE format)***

1. Walas, S. M; Chemical process equipment: selection and design; Butterworth-Heinemann, 1990.

2. Ludwig, E.E.; Applied Process Design for Chemical and Petrochemical Plants, Vol. 1 and 2; 3rd Ed.; Gulf Publishing Co., 1997.

3. Eugene F. Megyesy; Pressure Vessel Handbook; 10th Edition; Pressure Vessel Publishing, INC.

4. R. K. Sinnott; Coulson and Richardson's Chemical Engineering Volume 6 - Chemical Engineering Design; 4th Edition; Pergamon Press.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:

1. Carry out the detailed thermal design of double pipe and shell and tube heat exchanger for given requirement
2. Design a multiple effect evaporation system for specific requirement of concentration
3. Do hydraulic plate design and tray column design for desired separation needs
4. Select type and size of packing and packed column design with internals for required separation
5. Select and design support for vessels
6. Choose and design auxiliary process equipment required for various simple separation & storage requirements

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO :4	PO: 5	PO: 6	PO: 7	PO: 8	PO :9	PO :10	PO: 11	PO :12	PSO: 13	PSO: 14
CO: 1	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 2	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 3	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 4	1	1	3	1	1	1	1	1	1	1	1	1	1	1
CO: 5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO 6	1	1	1	1	1	1	1	1	1	1	1	1	1	1

CO attainment levels

CO	Attainment levels
CO:1	3
CO:2	3
CO:3	4
CO: 4	4
CO: 5	5
CO: 6	3

Future Courses Mapping:

Advanced design, Design with assistance of sotware

Job Mapping:

In design, In Engineering Project company industry

Software based Chemical industry

In scale up of plant in consultancy industry

CH3261:: TRANSPORT PHENOMENON

Course Objectives:

The student will learn to

1. Set up shell momentum balance for chemical engineering systems
2. Set up shell heat balance for chemical engineering systems
3. Set up shell mass balance for chemical engineering systems
4. Study various aspects of turbulent transport phenomena
5. Study various aspects of problems in boundary layer theory

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Section-I

SECTION-1
Dimensions and units, dimensional analysis: Dimensions and units, dimensions and units dimension of an equation, dimensional analysis, settling sphere, Brownian diffusivity, torque on a particle, mass transfer to suspended particles. Dimensional analysis, dimensionless groups and correlations: Heat transfer in a heat exchanger, momentum transfer, flow in a pipe, friction factor, dimensionless groups — ratio of convection and diffusion, Dimensionless fluxes, other dimensionless groups, laminar and turbulent flow in a pipe. Correlations: Momentum transfer: Flow past flat plate, Drag coefficient for flow around an object, correlations for drag coefficient, Flow through packed column, Unit operations for mixing. Correlations: Heat and mass transfer: Droplet breakup, Heat and mass transfer, Colburn and Reynolds analogy, Low Peclet number heat/mass transfer, high Peclet number laminar flow, high Peclet number laminar/turbulent flow. Flow in pipe, flow past flat plate, high Peclet number laminar/turbulent flows. Flow past particles. Correlations: Heat and mass transfer, Diffusion: Flow past mobile interfaces, flow in packed column, Natural convection, Mass diffusion in gasses, mass diffusion in liquids. Diffusion and Dispersion. Unidirectional transport: Cartesian coordinates:
SECTION-1I

Unidirectional transport: Cartesian coordinates. Steady solutions: Unidirectional transport. Common form of transport equations, steady solutions, constant diffusivity, parallel and series conduction, Steady solutions, internal source, viscous heating, steady solutions, flow down inclined plane, Steady solution, internal source, electrokinetic flow. Unidirectional transport: Cartesian coordinates. Binary diffusion: Steady solutions, internal source, electrokinetic flow, steady solutions, internal source, diffusion-reaction, binary diffusion, correlations in balance equations. Transport by diffusion. Unidirectional transport: Correlations in balance equations: Correlations in balance equations. forced convection, correlations in balance equations, natural convection, correlations in balance equations, packed columns. Unidirectional transport: Cylindrical and Spherical coordinates: Cylindrical coordinates, balance equation, cylindrical coordinates, steady conduction, cylindrical coordinates, heat transfer resistance, cylindrical coordinates, examples, spherical coordinates, balance equation. Pressure-driven flow: Laminar flow in a pipe: Spherical Coordinates. Heat transfer resistance, laminar flow in a pipe. Momentum balance, Laminar flow in a pipe. Velocity profile. Friction factor, laminar flow in a pipe. Friction factor correlation, laminar flow in a pipe. Examples. Pressure-driven flow: Turbulent flow in a pipe: Laminar flow in a pipe. Examples, turbulence, instability, and transition, turbulent flow in a pipe. Dissipation rate, turbulence scales, Turbulent flow in a pipe, turbulence cascade, turbulent flow in a pipe, structure of turbulence. Pressure-driven flow: Bernoulli equation: Bernoulli equation, Discharge from a tank, Bernoulli equation, filling of closed tank, venturi meter, Bernoulli equation. Flow over a weir, macroscopic momentum balance, Bernoulli equation for rotating fluid.

List of group discussion topics

1. Why Transport Phenomena is Considered the Heart of Chemical Engineering
2. Similarities and Differences among Momentum, Heat, and Mass Transfer
3. Importance of Dimensionless Numbers in Transport Phenomena
4. Coupled Heat and Mass Transfer: Applications and Challenges
5. Role of Boundary Layer Theory in Transport Analysis

List of Course Project topics

1. Modeling Laminar and Turbulent Flow through a Pipe (Reynolds Experiment Simulation)
2. Heat Transfer through a Composite Wall – Analytical and Numerical Study
3. Mass Transfer through a Slab/Film – Study of Steady-State Diffusion
4. Comparison of Lumped vs Distributed Parameter Models for Heat Conduction

5. Dimensionless Number Correlation in Natural Convection from a Vertical Plate Simulation of Velocity Profile in a Fully Developed Pipe Flow using CFD
6. Transient Heat Conduction in a Solid Rod using Finite Difference Method
7. CFD Analysis of Heat Transfer in a Double Pipe Heat Exchanger
8. Modeling Mass Transfer in a Packed Bed Absorber using COMSOL/Matlab
9. Coupled Heat and Mass Transfer Simulation in Drying of Porous Materials

List of Lab practicals:

Experiment Title

1. Verification of Hagen-Poiseuille Law (laminar flow in a capillary tube)
2. Determination of friction factor in turbulent pipe flow
3. Flow through packed bed – Pressure drop vs flow rate
4. Flow through fluidized bed – minimum fluidization velocity
5. Measurement of drag coefficient using falling sphere method
6. Flow through orifice meter / venturimeter – calibration and discharge coefficient
7. Determination of thermal conductivity of a metal rod
8. Natural and forced convection heat transfer coefficient measurement
9. Heat transfer through composite walls or insulated pipes
10. Study of unsteady-state heat conduction
11. Heat transfer in double pipe heat exchanger – LMTD and effectiveness
12. Boiling heat transfer – Pool boiling curve
13. Radiation heat transfer using Stefan-Boltzmann apparatus

List of Home Assignments:

Design:

1. Design of a viscometer.
2. Design of a spherical gas storage vessel.
3. Design of a multiphase reactor.
4. Design of a membrane bioreactor.
5. Design of a membrane separation unit.

Case Study:

1. Importance of Mass Transfer in industries.
2. Importance of Heat Transfer in industries
3. Advantage and Disadvantage of Laminar and Turbulent in Industries
4. Diffusion in Stagnant fluid
5. Flow through circular tubes and annulus

Blog:

1. Heat flux and temperature distribution for heat sources such as electrical and nuclear.
2. Temperature and pressure distribution of diffusivity
3. Thermal and momentum boundary layer theory
4. Equation of continuity and motion
5. Newton's law of Viscosity.

Survey:

1. Transport phenomena in Biomaterials
2. Transport phenomena during convective drying with superheated steam and moist air.
3. Heat flux through composite wall
4. A linear theory of transdermal transport phenomena
5. Problem in Food Process Engineering

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE	*ESE*	*HA*	*VIVA*
30	*30*	*10*	*30*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

Text Books: ***(As per IEEE format)***

1. Bird R. B, Stewart W.E., Lightfoot E.W., 'Transport Phenomena', John Wiley, 2ndEd., 2000.
2. Brodkey R. S., Hershey H. C., 'Transport Phenomena', McGraw-Hill International Edition,1988.

Reference Books: ***(As per IEEE format)***

1. Wilty J.R., Wilson R.W., Wicks C.W., 'Fundamentals of Momentum, Heat and Mass Trasport', 2nd Ed., John Wiley, New York, 1973.

Course Outcomes: The student will be able to –

1. Set up shell momentum balance for chemical engineering systems
2. Set up shell heat balance for chemical engineering systems
3. Set up shell mass balance for chemical engineering systems
4. Study various aspects of turbulent transport phenomena
5. Study various aspects of problems in boundary layer theory

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	2	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level
1	2
2	3
3	3
4	5
5	5
6	4

FF No. : 654

CH3287::ENGINEERING DESIGN AND INNOVATION -V

Course Prerequisites: Basic principles of physics, mathematics, chemistry, heat transfer

Course Objectives:

The students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members
4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 04 **Teaching Scheme Theory: …..** Hours/Week

Tut: …….. Hours/Week

Lab: **08** Hours/Week

Course Relevance: Engineering Design and development is specially design part of curriculum, that will facilitate application of theory concept in practice. This is project based learning experience. As in practical situation, where first project is defined and then respective required skilled are learned to accomplish the project. We are making student ready to face and approach actual problem.

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.* *The external from Industry/research organization is invited to evaluate the projects done by students.*

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. 7.Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Assessment of Engineering Design and Innovation project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

1. https://nptel.ac.in/courses/103/103/103103039/#watch
2. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
3. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
4. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
5. https://www.coursera.org/learn/uva-darden-project-management
6. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

6. Apply chemical engineering knowledge.
7. Learn how to work in a team.
8. Define a task (problem) and execute it.

9. Carry out literature search related to the topic.
10. Write synopsis and complete literature search related to topic and complete report.
11. Present the outcome of work systematically in a team.

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	2	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level
1	2
2	3
3	3
4	5
5	5
6	4

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

CH3289::DESIGN THINKING 5

Course Prerequisites: Basic principles of science

Course Objectives:

To provide ecosystem for paper publication and patent filing

Credits: 01 **Teaching Scheme** **Tut: 1** Hours/Week

Course Relevance: To assist for publication of research paper or patent

SECTION-1&II
Topics and Contents *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A paper/patent is required to be published at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.* *The external from Industry/research organization is invited to evaluate the projects done by students.*

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

It is based on type of publication

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes: The student will be able to –

1. Understand the importance of doing Research
2. Interpret and distinguish different fundamental terms related to Research
3. Apply the methodology of doing research and mode of its publication
4. Write a Research Paper based on project work
5. Understand Intellectual property rights
6. Use the concepts of Ethics in Research
7. Understand the Entrepreneurship and Business Planning

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO2	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO3	2	2	3	3	2	2	1	2	2	3	0	1	1	1
CO4	3	3	3	3	3	2	1	2	2	3	1	1	1	1
CO5	1	1	1	1	1	0	0	0	0	0	0	1	0	0
CO6	2	2	2	2	2	2	1	3	2	3	0	1	0	0
CO7	1	1	1	1	1	0	0	0	0	0	0	1	0	0

CO attainment levels

CO	Attainment level
1	2
2	2
3	3
4	5
5	2
6	3
7	2

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

FF No. : 654

CH3232::INSTRUMENTATION AND PROCESS CONTROL

Course Prerequisites: None

Course Objectives:

1. To understand the methodology of dynamic modeling
2. To understand the notion of feedback control
3. To understand the operation of a PID controller
4. To be able to carry out controller design using various time-domain and frequency domain techniques
5. To understand advanced process control schemes used in industry.

Credits: 4 **Teaching Scheme Theory: 2** Hours/Week

Tut: 1 Hours/Week

Lab: 2**.** Hours/Week

Course Relevance: This subject deals with control of industrial systems and so is of vital importance. With this subject the students will get an understanding of dynamic behavior of processes. The key notion of control of a process at the desired operating point is addressed in this course. With a number of theoretical and practical controller design tools covered in the course, the students will get a thorough exposure to this important area of industrial process control.

SECTION-1
Instrumentation, Process Dynamics, Feedback Control *Instrumentation: Measurement fundamentals. Temperature, flow, pressure, level and composition measuring instruments. Static and dynamic characteristics. Control valves: sizing and valve characteristics* *Process Dynamics: Introduction to process control. Review of Laplace transforms. Development of mathematical and dynamic models of chemical engineering systems. First order, second order systems. Systems with time delays. Interacting & non-interacting processes.* *Feedback control: Block diagram. PID controller. Typical time-domain responses of feedback control systems. Servo and regulatory problems.*

SECTION-1I

Control System Design, Advanced Process Control

Stability Analysis: Stability analysis of closed-loop control systems. Routh stability criterion. Root locus. Bode stability analysis. Design of feedback control systems using time-domain and frequency-domain techniques. Controller tuning methods such as Ziegler-Nichols.

Advanced Process Control: Feedforward control, cascade control, etc. Introduction to digital control.

Overview of data science techniques relevant to industrial process control.

List of Practicals: (Any Six)

1. Measurements for temperature, pressure, flow, level etc
2. Interacting and non-interacting systems
3. Process identification: First order plus dead time system
4. P controlled system
5. PI controlled system
6. PID controlled system
7. Root locus-based controller design using a software tool such as Scilab
8. Bode analysis-based controller design using a software tool such as Scilab
9. Dynamic simulation of simple systems such as liquid level on a chemical engineering simulation software
10. Dynamic simulation of a distillation column

List of Projects:

1. Controller tuning
2. P&ID diagrams for flow sheets
3. Design a control system using time-domain techniques such as root-locus
4. Design a control system using frequency-domain techniques such as Bode design
5. Dynamic behavior of pure capacity process
6. Feedback control system design using Scilab/Octave/Matlab/Python etc
7. Dynamic simulation of a distillation column
8. Dynamic simulation of a chemical plant flowsheet
9. Data science techniques in chemical process control
10. Feedforward control / Cascade control / Selective control / Multiloop and multivariable control
11. PID Controller tuning using Cohen-Coon method
12. Digital PID controller implementation with anti-reset windup & derivative overrun compensation
13. Digital PID controller implementation with anti-reset windup & derivative overrun compensation
14. PID controller tuning using Ziegler-Nichols open loop method
15. Use of nanotechnology in process instrumentation

List of Course Group Discussion Topics:

1. Variable head flow meters
2. Variable pressure flow meters
3. PID Controller tuning
4. Root locus and controller design
5. Bode plot and controller design
6. Level control
7. Flow control
8. Process control in paper industry
9. Distillation column control
10. Boiler control
11. Control of highly nonlinear processes
12. Real time optimization (RTO) systems
13. Sustainability through process control
14. On-line analyzers in chemical industry
15. Batch process control
16. Statistical process control
17. Big data analytics in chemical industry

18. BASF Verbund
19. Machine learning in chemical industry
20. PID Controller tuning using Cohen-Coon method
21. Process control in plant-on-chip systems
22. BASF Verbund

Suggest an assessment Scheme:

ESE	*Lab*	*CP*	*VIVA*	*GD*
30	*10*	*20*	*20*	*20*

ESE - End Semester Examination

Lab- Laboratory

CP - Course Project

VIVA - Viva voice

GD- Group discussion

Text Books: ***(As per IEEE format)***

1. D. R. Coughanowr, “Process Systems Analysis and Control”, 2nd ed. McGraw-Hill, 1991.
2. B. C. Nakra and K. K. Chaudhry, “Instrumentation, Measurement and Analysis”, 2nd ed. Tata McGraw-Hill, 2004.

Reference Books:

1. Chemical Process Control by George Stephonopolous
2. D. E. Seborg, T. F. Edgar and D. A. Mellichamp, “Process Dynamics and Control”, 2nd ed. John Wiley & Sons, 2004.

Moocs Links and additional reading material:

1. P. Saha, "Process Control and Instrumentation", IIT Guwahati, NPTEL. [Online]. Available: https://nptel.ac.in/courses/103/103/103103037/
2. S. S. Jogwar, "Chemical Process Control", IIT Bombay, NPTEL. [Online]. Available:https://nptel.ac.in/courses/103/105/103105064/
3. B. S. Johnson, "Process Dynamics, Operations and Cotrol", MIT OPENCOURSEWARE, MIT. [Online] Available: https://ocw.mit.edu/courses/chemical-engineering/10-450-process-dynamics-operations-and-control-spring-2006/

Reference Books: ***(As per IEEE format)***

D. E. Seborg, T. F. Edgar and D. A. Mellichamp, "Process Dynamics and Control", 2nd ed. John Wiley & Sons, 2004.

Moocs Links and additional reading material:

4. P. Saha, "Process Control and Instrumentation", IIT Guwahati, NPTEL. [Online]. Available: https://nptel.ac.in/courses/103/103/103103037/
5. S. S. Jogwar, "Chemical Process Control", IIT Bombay, NPTEL. [Online]. Available:https://nptel.ac.in/courses/103/105/103105064/
6. B. S. Johnson, "Process Dynamics, Operations and Cotrol", MIT OPENCOURSEWARE, MIT. [Online] Available: https://ocw.mit.edu/courses/chemical-engineering/10-450-process-dynamics-operations-and-control-spring-2006/

Course Outcomes:

The student will be able to –

1. Carry out selection and performance analysis of measuring instruments
2. Write dynamic models of chemical engineering systems
3. Carry out process identification and tune a PID controlled system
4. Design a control system using time-domain techniques such as root-locus
5. Design a control system using frequency-domain techniques such as Bode design

6. Carry out preliminary analysis of Advanced Process Control systems

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO : 13	PSO : 14
CO1	2	1										1	1	
CO2	2	1	2	1	2					1		1	1	
CO3	2	1	3	3	2				1	1		1	1	
CO4	2	1	3	1	2				1	1		1	1	
CO5	2	1	2	1	2				1	1		1	1	
CO6	2	1	2	1								1	1	

CO attainment levels

CO	Attainment Level
1	3
2	5
3	5
4	5
5	5
6	3

Future Courses Mapping:

None

Job Mapping:
1. *Industries providing control system solutions*
2. *Industries providing chemical process simulation services, OTS etc*
3. *Postgraduate education*

FF No. : 654

CH3236::SEPARATION TECHNIQUES

Course Prerequisites: Heat Transfer, Chemical Engineering Thermodynamics, Fluid Flow Operations, Mass transfer 1

Course Objectives:

1. To understand and apply principles of mass transfer operations
2. To generate the input data for design of separation columns
3. To design the separation columns for distillations, extraction, leaching and adsorption
4. To analyse the factors affecting separation
5. To understand working of industrial separation equipments

Credits: 4 **Teaching Scheme Theory: 2** Hours/Week

Tut: 1 Hour/Week

Lab: **2** Hours/Week

Course Relevance:

Separation Techniques play a vital role in many industrial processes. Separation is crucial for the quality of desired product. A group of operations are carried out for separating the components of mixtures and is based on the transfer of material from one phase to another.

SECTION-1

Topics and Contents

Distillation: Vapour – liquid equilibria for ideal and non-ideal systems, relative volatility, methods of distillation - differential, flash, low pressure, batch rectification. Continuous rectification for binary system, multistage (tray) towers, McCabe Thiele method, concept of reflux, Fenske's equation, Fenske-Underwood equation, use of open steam. Partial and total Condensers, reboilers. Ponchon Savarit method for multistage operations, tray efficiencies, complex distillation columns, concept of multi component distillation, extractive and azeotropic distillation, Fenske- Underwood-Gilliland shortcut method for multi-component distillation.
Liquid-Liquid Extraction: Ternary liquid-liquid equilibrium, triangular coordinates, single-stage extraction, Multi-stage crosscurrent extraction, continuous countercurrent multistage extraction. Types of extractors.

SECTION-1I

Topics and Contents

Solid-Liquid Extraction: Single stage leaching, continuous counter current leaching, ideal stage equilibrium, operating time, constant and variable underflow, number of ideal stages, stage efficiencies, Leaching equipments.
Adsorption: Physical and chemical adsorption, adsorbents, adsorption equilibrium and isotherms, Single-stage, multi-stage cross-current and multi-stage counter current operations, equilibrium and operating lines, Liquid-solid agitated vessel adsorber, packed continuous contactor, breakthrough curves, Rate equations for adsorbents, nonisothermal operation, pressure-swing adsorption, Ion Exchange- Principles of Ion Exchange Equilibria and rate of ion exchange

List of Practicals: (Any Six)

1. To generate VLE data for binary ideal/non-ideal systems
2. To study ASTM Distillation
3. To determine Column Tray Efficiency for distillation
4. To generate equilibrium data for liquid-liquid extraction
5. To study solid-liquid mass transfer with/without chemical reaction
6. To verify Freundlich/ Langmuir isotherm equation for batch adsorption
7. To study differential distillation and verify Rayleigh equation
8. To study / carry out steam distillation of substance and determine steam requirement
9. To conduct binary distillation in a packed column at total reflux and to estimate HETP and HTU for column
10. To obtain data for equilibrium distribution of solute in two insoluble solvents for example acetic acid in water and toluene phases and determine percentage extraction
11. To study the (cross current) liquid- liquid extraction for extracting acetic acid from benzene using water as solvent
12. To carry out leaching operation using groundnuts and n-Hexane and find out quantity of oil and to determine the efficiency of single stage leaching operation
13. To obtain the breakthrough curve for continuous process in adsorption column
14. To study the operation of a batch rectification column under constant or total reflux condition

List of Projects:

1. Design of distillation column
2. Ternary diagram for a system of three liquid one pair partially soluble for example acetic acid, benzene and water system
3. Study liquid- liquid extraction in a packed column and determine HTU and HETP for the tower
4. Analysis of ion-exchange equilibria
5. Analysis of multi-component distillation system
6. Process design of leaching equipment
7. Process design of adsorption equipment
8. Analysis of vapour liquid equilibria
9. Design and simulation of reactive distillation
10. Analysis and Design of hybrid separation processes
11. Design and analysis of Supercritical Extraction Units
12. Process Design of Solvent Extractors
13. Design and Simulation of Extractive Distillation

List of Course Seminar Topics:

Production of ethanol to blend in gasoline
Oil and gas value chain
Solar distillation
Industrial application of leaching operation
Multicomponent distillation
Ion exchange resins and its industrial application
Role of vacuum distillation unit in refinery
Solvent Extraction: A potential separation technique
Importance of isotherms and breakthrough curve in adsorption
Pressure swing adsorption and applications
Atmospheric distillation unit in refinery
Finer selection of solvents for solvent extraction
Separation techniques in Fertilizer industry
Separation applications by Ion exchange process
Separation Techniques in pharmaceutical industry

List of Home Assignments:

Design:

1. Tray type Distillation Column
2. Packed type Distillation Column
3. Solvent Extraction Column
4. Leaching Column
5. Adsorption Column

Case Study:

1. Industrial separation equipments for gaseous mixture
2. Separation processes in chemical plant
3. Development of novel separation techniques
4. Competing separation techniques
5. Industrial separation equipments for liquid mixtures

Blog

1. Recent developments in distillation processes
2. Adsorption Isotherms and their interpretations
3. Use of Green Technology in Separation Processes
4. Improvements in conventional leaching techniques
5. Hybrid separation Techniques used in Industry

Surveys

Comparison between azeotropic distillation and solvent extraction for separation of azeotropes
Application of leaching in food processing industries
Solvent choice in liquid-liquid extraction
Use of leaching process in small scale industries
5. Alternative to adsorption process used in industry

Suggest an assessment Scheme:

ESE	*HA*	*CP*	*VIVA*	*SEM*
20	*20*	*20*	*20*	*20*

ESE - End Semester Examination

HA - Home Assignment

CP - Course Project

VIVA - Viva voice

SEM – Seminar

Text Books: ***(As per IEEE format)***

1. Treybal R. E.; Mass Transfer Operations, Third edition, McGraw Hill, 1980
2. Coulson J. M., Richardson J. F.; Chemical Engineering – Vol. I & II, Sixth edition, Butterworth Heinemann, 1999
3. King C.J.; Separation Processes; Tata McGraw - Hill Publishing Co. Ltd., 1982.
4. 4. Dutta B. K.; Principles of Mass Transfer and Separation Processes; Prentice-Hall of India Private Ltd., 2007

Reference Books: ***(As per IEEE format)***

3. McCabe W. L., Smith J. C., Harriett P.; Unit Operations of Chemical Engineering; Fourth edition, McGraw-Hill, 1985.
4. Wankat. P.C.; Separations in Chemical Engineering: Equilibrium Staged Separations; Prentice Hall, NJ, US, 1988
5. 3. Perry R. H., Green D. W.; Perry's Chemical Engineer's Handbook; Sixth Edition, McGraw-Hill, 1984

Moocs Links and additional reading material: www.nptelvideos.in
https://swayam.gov.in/nd1_noc19_ch31/preview

Course Outcomes:
The student will be able to –

1. Carry out process design of distillation column using/generating VLE data
2. Determine parameters like distribution of key components using various shortcut methods for multicomponent distillation and/or analyze implications of factors affecting distillation column
3. Select suitable solvent for liquid-liquid extraction and design liquid-liquid extraction column
4. Calculate the number of stages required for a leaching operation
5. Carry out process design of adsorption column
6. Draw analogy between adsorption and ion exchange and analyze ion exchange equilibria

CO PO Map

CO/ PO	PO: 1	PO: 2	PO: 3	PO: 4	PO: 5	PO: 6	PO: 7	PO: 8	PO: 9	PO: 10	PO: 11	PO: 12	PSO :13	PSO :14
CO: 1	2	2	2	2	2	1	1	2	2	2	0	1	2	1
CO: 2	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 3	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	**4**
CO:2	**5**

CO:3	**5**
CO:4	**5**
CO:5	**5**
CO:6	**5**

Future Courses Mapping:
Mass Transfer with Chemical reactions, Petroleum Refining, Advanced Separation Techniques, Advanced Transport Phenomena

Job Mapping:

Industries like refineries, pharmaceuticals, paint, fertilizers, chemicals, automobiles etc

CH3252::PETROLEUM REFINERY AND PETROCHEMICAL ENGINEERING

Credits: 4

Teaching Scheme Theory: 2 Hours/Week
Tut: 1 Hour/Week
Lab: **2** Hours/Week

Course Relevance:

The subject plays a vital role in Petroleum and Petrochemical Engineering.It encompasses techniques and processes for refining petroleum and extracting chemicals from crude,

SECTION-1

Petroleum Refining and Products

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods. Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum. Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

SECTION-1I

Petrochemicals Engineering

Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes. Blending, Additives, Storage of products, Transportation, Housekeeping, Marketing of petroleum Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines. Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

1. **List of Practicals: (Any Six)**
2. Develop PFD of a petroleum processes
3. Design problem on distillation
4. Simulation of fractional distillation column using ASPEN One
5. Evaluate the characteristics of gasoline,
6. Evaluate the characteristics of Diesel
7. Evaluate the characteristics of Lubericants

List of Projects:

1. Design of pipe still heaters
2. Design of multi-component distillation column.
3. Plant design of refinery processes.
4. Determination of properties of petrochemical product.

List of Course Seminar Topics:

1. Production of ethanol to blend in gasoline
2. Oil and gas value chain
3. Chemical and thermal properties of petroleum fractions and their products
4. Different tests required for characterizing petroleum products.
5. Types of blending required for improving properties of gasoline.
6. Various treatment techniques to remove impurities from petroleum fractions.
7. Thermal cracking versus catalytic cracking
8. Hydrogenation process applications, Advantages and disadvantages
9. Alkylation process applications, Advantages and disadvantages
10. Thermal Reforming verses catalytic reforming process
11. Isomerization applications, Advantages and disadvantages
12. .Polymers production and process challenges
13. Process control in refining processes
14. Oil and gas key safety features for high risk environment
15. Logistics of oil and gas products

Suggest an assessment Scheme:

ESE	*CP*	*VIVA*	*SEM*	*LAB*
30	*20*	*20*	*20*	*10*

ESE - End Semester Examination

LAB- Laboratory

CP - Course Project

VIVA - Viva voice

SEM – Seminar

Text Books: ***(As per IEEE format)***

1. Nelson W. L.; Petroleum refinery Engineering; 3rd Edition, John Wiley & Sons New York, 1985
2. Rao, B.K.B. "Modern Petroleum Refining Processes", 4th Edition, Oxford and IBH Publishing, 2002
3. Gary James, Handwerk, Glenn, Kaiser, Mark; Petroleum Refining: Technology and Economics;5th Edition, Taylor and Francis - CRC Press, 2005.

Reference Books: ***(As per IEEE format)***

1. Meyers R. A.; Handbook of Petroleum refining processes; 3rd Edition, H Prentice-Hall, 2003.
2. Speight J. G.; Chemistry and Technology of Petroleum; 4th Edition, Taylor and Francis - CRC Press, 1999.

Moocs Links and additional reading material: www.nptelvideos.in
https://swayam.gov.in/nd1_noc19_ch31/preview

Course Outcomes:
The student will be able to –
1. Discuss the origin, formation and composition of crude oil & their test methods.

2. Recognize the importance of dehydration of crude and distillation operation and design the operations.

3.Describe the importance of thermal and catalytic cracking.

4. Classify the feed stocks for production of chemicals from methane

5. Classify the chemicals that can be obtained from Ethane, Ethylene and Acetylene.

CO PO Map

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CO: 1	3	2	2	2	2	1	1	2	2	2	0	1	2	1
CO: 2	3	2	2	2	2	1	1	2	2	2	0	1	3	1
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CO: 4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

CO attainment levels

CO	Attainment level
CO:1	**4**
CO:2	**5**
CO:3	**5**
CO:4	**5**
CO:5	**5**
CO:6	**5**

Future Courses Mapping:
Petroleum Refining, Petrochemicals Engineering

Job Mapping:

Industries like refineries, Petro chemicals, automobiles etc

CH3253:: PROCESS MODELING AND SIMULATION

Credits: 4 Teaching Scheme: 5 Hours / Week

Section I: Parameter Estimation and model

Introduction to process modeling and simulation, tools of simulation, approaches of simulation, planning of calculation in a plant simulation. Parameter estimation techniques in theoretical as well as numerical models. Models, need of models and their classification, models based on transport phenomena principles, alternate classification of models, population balance, stochastic, and empirical models, unit models. Development of detailed mathematical models of evaporators, use of Newton Raphson method for solving evaporator problems.

Section II: Model for Separation Techniques, Reactors and simulation

Separation of multicomponents mixtures by use of a single equilibrium stage, flash calculation under isothermal and adiabatic conditions. Tridigonal formulation of component material balances and equilibrium relationships for distillation, absorption and extraction of multicomponents. Thiele and Geddes method plus θ - method and Kb method, models of absorbers , strippers and extractors. Classification of partial differential equations (PDE's), solution of PDEs by Finite difference techniques, method of weighted residuals. Orthogonal collocation to solve PDEs with their application to chemical engineering systems models.

List of Project areas:

1. Modeling and simulation of heat exchanger

2. Modeling and simulation of distillation column

2. Modeling and simulation of reactors

3. Simulation for unit operations

List of Course Group Discussion/Presenation Topics:

1. Comparing Steady-State vs Dynamic Simulation in Chemical Processes
2. Role of Modeling in Reducing Pilot Plant Trials
3. Limitations of Mathematical Modeling in Real-Life Applications
4. Choosing Between Lumped vs Distributed Parameter Models
5. Deterministic vs Stochastic Models – When and Why
6. Using Simulators like Aspen Plus or MATLAB/Simulink: Are They Enough?
7. Data-Driven vs Physics-Based Models in Process Industry
8. Simulation vs Experimental Validation – What Should Come First?
9. Importance of Modeling and Simulation in Process Design

List of lab Practicals

Suggest an assessment Scheme:

ESE	*Lab*	*CP*	*VIVA*	*SEM*
30	*10*	*20*	*20*	*20*

ESE - End Semester Examination

Lab - Laboratory Assessment

CP - Course Project

VIVA - Viva voice

SEM – Seminar

CO PO Map

CO/ PO	**PO: 1**	**PO: 2**	**PO: 3**	**PO: 4**	**PO: 5**	**PO: 6**	**PO: 7**	**PO: 8**	**PO: 9**	**PO: 10**	**PO: 11**	**PO: 12**	**PSO :13**	**PSO :14**
CO: 1	3	2	2	2	2	1	1	2	2	2	0	1	2	1
CO: 2	3	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 3	2	2	3	3	3	2	2	2	2	2	0	1	3	1
CO: 4	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 5	2	2	2	2	2	1	1	2	2	2	0	1	3	1
CO: 6	2	2	2	2	2	1	1	2	2	2	0	1	3	1

Text Books:

1. Luyben, W.L. ‘Process Modeling, Simulation and Control for Chemical Engineers’, 2nd ed., McGraw-Hill.

2. Rice, R.G.; Do, D.D., "Applied Mathematics and Modeling for Chemical Engineers", John Wiley and Sons, 1995.
3. Jenson, V.G.; Jeffreys, G. V., "Mathematical Methods in Chemical Engineering", 2nd Edition, Academic Press, 1997.

Reference Books:

1.Denn M. M.,"Process Modeling", Longman, 1986.

2. Holland C. D.,"Fundamentals and Modeling of Separation Processes",Prentice Hall., 1975.

3. Luyben W. L.,"Process Modeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill, 1990.

4. Najim K.,"Process Modeling and Control in Chemical Engineering", CRC, 1990.

5. Aris R.,"Mathematical Modeling,Vol. 1:A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999.

Course outcomes

The Student will be able to

1. Comprehend basics of modeling and simulation.

2. Comprehend modeling for heat exchangers

3.Comprehend modeling for distillation

4. Comprehend modeling for reactors

5. Understand different numerical methods for solving models for variations operations.

FF No. : 654

CH3294::ENGINEERING DESIGN AND INNOVATION VI

Course Prerequisites: Basic principles of physics, mathematics, chemistry, heat transfer

Course Objectives:

The Students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members
4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 04 **Teaching Scheme Theory: …..** Hours/Week

Tut: …….. Hours/Week

Lab: **8** Hours/Week

Course Relevance: Engineering Design and development is specially design part of curriculum, that will facilitate application of theory concept in practice. This is project based learning experience. As in practical situation, where first project is defined and then respective required skilled are learned to accomplish the project. We are making student ready to face and approach actual problem.

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.*

The external from Industry/research organization is invited to evaluate the projects done by students.

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Assessment of Engineering Design and Innovation project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

1. https://nptel.ac.in/courses/103/103/103103039/#watch
2. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
3. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
4. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
5. https://www.coursera.org/learn/uva-darden-project-management
7. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. Learn how to work in a team.
3. Define a task (problem) and execute it.
4. Carry out literature search related to topic.
5. Write synopsis and complete literature search related to topic and complete report.
6. Present the outcome of work systematically in a team.

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	2	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	**Attainment level**

1	**2**
2	**3**
3	**3**
4	**5**
5	**5**
6	**4**

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

FF No. : 654

CH3293::DESIGN THINKING 6

Course Prerequisites: Basic principles of Science

Course Objectives:

To provide ecosystem for paper publication and patent filing

Credits: 04 **Teaching Scheme** **Tut: 1** Hours/Week

Course Relevance: To assist for publication of research paper or patent

SECTION-1&II
Topics and Contents *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A paper/patent is required to be published at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.* *The external from Industry/research organization is invited to evaluate the projects done by students.*

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes: The student will be able to –

1. Understand the importance of doing Research
2. Interpret and distinguish different fundamental terms related to research
3. Apply the methodology of doing research and mode of its publication
4. Write a Research Paper based on project work
5. Understand Intellectual property rights
6. Use the concepts of Ethics in Research
7. Understand the Entrepreneurship and Business Planning

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO2	1	1	1	1	1	0	0	0	0	0	0	1	1	1
CO3	2	2	3	3	2	2	1	2	2	3	0	1	1	1
CO4	3	3	3	3	3	2	1	2	2	3	1	1	1	1
CO5	1	1	1	1	1	0	0	0	0	0	0	1	0	0
CO6	2	2	2	2	2	2	1	3	2	3	0	1	0	0
CO7	1	1	1	1	1	0	0	0	0	0	0	1	0	0

CO attainment levels

CO	Attainment level
1	2
2	2
3	3
4	5
5	2
6	3
7	2

Future Courses Mapping:

Next semester project, BTech course project

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

B.Tech. Chemical Structure Pattern D22 (applicable w.e.f. AY 23-24)

Final Year Module -VII

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH4259	INDUSTRIAL POLLUTION CONTROL	2	-		2
S2	CH4203	PLANT ENGINEERING AND PROJECT ECONOMICS	2			2
S3	CH4201	TRANSPORT PROCESSES	2	-	-	2
S4	CH4289	MAJOR PROJECT	-	20	-	10
		OR				
S1	CH4293	INDUSTRY INTERNSHIP	-	-	-	16
	CH4291	RESEARCH INTERNSHIP				
	CH4294	INTERNATIONAL INTERNSHIP				
	CH4292	PROJECT INTERNSHIP				

Total				16

Final Year Module -VIII

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH4259	INDUSTRIAL POLLUTION CONTROL	2	-		2
S2	CH4353	BIOPROCESS ENGINEERING	2			2
S3	CH4255	NANOSCIENCE AND NANOTECHNOLOGY	2			2
S4	CH4280	MAJOR PROJECT 2	-	20	-	10
OR						
S1	CH4293	INDUSTRY INTERNSHIP	-	-	-	16
	CH4291	RESEARCH INTERNSHIP				
	CH4294	INTERNATIONAL INTERNSHIP				
	CH4295	CAPSTONE PROJECT				
		Total				16

FF No. : 654

CH4203:: PLANT ENGINEERING AND PROJECT ECONOMICS

Course Prerequisites:

Process Calculations, Chemical Technology, Process equipment design

Course Objectives:

The student will be able to

1. Understand capital cost estimation, product cost estimation
2. Understand different interest rates, cash flows, taxes and insurance
3. Understand depreciation and profitability analysis
4. Understand general consideration: health and safety hazards

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Tut: …0... Hours/Week

Lab: **0…...** Hours/Week

Course Relevance: The study of the subject will help to understand general design considerations, health and safety considerations, different types of cost estimations of chemical plants. Move over this subject also deals with depreciation and different types of methods for depreciation calculations.

SECTION-1

Topics and Contents

Chemical Plant Cost Estimation; Cash flow for industrial operations:

Cumulative cash position, Factors Affecting Investment and Production Costs,

Capital Investments: Fixed-Capital Investment, Working Capital, and

Estimation of Capital Investment: Types of Capital Cost Estimates, Cost

Factors in Capital Investment, Estimation of Total Product Cost:

Manufacturing Costs, General Expenses. Estimation of various components of

project cost as per recommended practice by India Financial Institutes, Plant

& machinery estimate, Cost of Production. Cost Indexes

SECTION-1I

Topics and Contents

Depreciation: purpose of depreciation as a cost, types of depreciation,

depletion, service value, salvage value, present value, depreciation in chemical

project, methods for determining depreciation, depreciation rates.

Health and Safety Considerations; General Design Considerations:

Health and Safety Hazards, Loss Prevention: Hazard Assessment Techniques: HAZOP, HAZAN, Fault Tree Analysis, etc.

List of Home Assignments:

Design:

1. Estimation of profitability
2. HAZOP analysis of Urea manufacturing plant
3. Fault Tree analysis of Distillation column
4. Estimation of total product cost
5. Estimation of depreciation

Case Study:

1. Personal safety and industrial safety
2. Recent trends in cost estimation of chemical plant
3. Sustainable energy sources
4. Capital cost estimation of the chemical plant
5. Safety consideration in a particular plant.

Blog

1. Safety-A major issue in chemical industry
2. New trends in chemical industries
3. Importance of pilot plant in chemical industry
4. Cash flow in the chemical industry.
5. Importance of depreciation.

Surveys

1. Market survey of a particular chemical.
2. Various cost indices used in Chemical industry cost estimation
3. Various types of annuities in India
4. Different types of taxes in India
5. Different types of methods for calculation of depreciation

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE	*ESE*	*HA*	*VIVA*
30	*30*	*20*	*20*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

Text Books: ***(As per IEEE format)***

1. Peters, M.S., Timmerhaus, K.D. "Plant design and economics for chemical engineers", 4^{th} Edition, McGraw Hill, 1990.

Reference Books: ***(As per IEEE format)***

1. Mahajani V.V., Mokashi S. M. "Chemical Project Economics", Macmillan India Publication, 1^{st} Edition, 2005.
1. Bausbacher E. and Hunt R. "Process Plant Layout and Piping Design", 1st Edition, Prentice Hall Publication, 1993.

Moocs Links and additional reading material: www.nptelvideos.in

Course Outcomes:
The student will be able to

1. Estimate & predict capital investment of chemical plant
2. Estimate & predict total product cost of chemical plant.

3. Describe and calculate depreciation
4. Describe different health and safety measures in chemical industry

CO PO Map

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CO:2	1	1	2	1	1	1	1	1	1	0	3	3	3	1
CO:3	1	1	2	1	1	1	1	0	0	0	2	2	3	1
CO: 4	1	1	3	1	1	3	2	1	0	0	2	2	3	1

CO attainment levels

CO	Attainment level
CO : 1	4
CO : 2	5
CO : 3	5
CO : 4	4

Future Courses Mapping:
Project Management

Job Mapping:
All core chemical industries e.g. Oil and gas, paint, fertilizers, food, industrial chemicals manufacturing, etc

CH4259::INDUSTRIAL POLLUTION CONTROL

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Tut: …0... Hours/Week

Lab: **0…...** Hours/Week

Course Prerequisites: Nil

Course objectives

This course will enable the students to -

1. Understand the various methods of monitoring and various techniques used in the control of Environmental pollutants
2. Focus on the principles and mechanisms of pollutant removal

3. Design the conventional and advanced technologies applied in treatment and control

SECTION-1

Air pollutant sampling and measurement: Types of air pollution, types of emissions from chemical industries, and effects of the environment legislation, Effluent guidelines and standards. Sources and characteristics of pollutants in various industries such as fertilizer, paper and pulp industry, petrochemical and petroleum industry; Particle size distributions. Ambient air sampling: collection of gaseous air pollutants, collection of particulate air pollutants. Stack sampling: Sampling system, particulate sampling, and gaseous sampling Monitoring of air pollutants; Principles of industrial air pollution control methods for gaseous and particulate;

Air pollution control methods and equipment: Preventive Techniques: Shift of the sources, Substitution of raw material and fuels, Process modification. Cleaning of gaseous effluents particulate emission control: collection efficiency, air pollution control equipment like gravitational settling chambers, Cyclone separators, fabric filters, ESP and their constructional and design aspects. Scrubbers: wet scrubbers, spray towers, centrifugal scrubbers, packed beds and plate columns, venturi scrubbers, and their design aspects. Control of gaseous emissions: absorption by liquids, absorption equipment, adsorption by solids, equipment and the design aspects.

Section II

Characterization of effluent streams, oxygen demands and their determination (BOD, COD, and TOC). Introduction to wastewater treatment, Methods of primary treatments: screening, sedimentation, flotation, neutralization. Secondary treatment of wastewater, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds, Attached growth processes, trickling filters and anaerobic processes. Methods of tertiary treatment: carbon adsorption, ion exchange, membrane filtration, chlorination, Advanced oxidation treatment.

municipal solid waste sources, and control methods hazardous waste management:. Chemical wastes: health and environmental effects, treatment and disposal: treatment and disposal by industry, off-site treatment and disposal, treatment practices in various countries. Nuclear wastes: health and environment effects, sources and disposal methods Biomedical wastes: types of wastes and their control.

Course Outcomes:

The Student will be able to

CO1: Explain the adverse effects of emissions from chemical industries and guidelines set by the environmental protection agencies.

CO2: Select the correct air and water pollutant sampling collection method and their measurement technique.

CO3: Describe the working principle of air and water pollution control equipment and.

Select the appropriate treatment method required for treating waste water.

CO4: Explain different techniques for municipal solid waste and hazardous waste management.

Text Books:

1. Rao. C.S., "Environmental Pollution and Control Engineering", 2nd Edition, Revised, New Age International, 2007

2. Mahajan. S.P., "Pollution Control in Process Industries", Tata-McGraw Hill, New Delhi, 1985.

References:

1. Narayana Rao, M. and Datta, A.K., "WasteWater Treatment", 2nd Edition, Oxford and IBH Publications, New Delhi, 2005.

2. Swamy, A.V.N., "Industrial Pollution Control and Engineering", Galgotia Publications, Hyderabad, 2005.

FF No. : 654

CH4205::TRANSPORT PROCESS

Course Prerequisites: Fluid Flow Operations, Heat Transfer and Mass Transfer

Course Objectives:

The student will learn to

6. Set up shell momentum balance for chemical engineering systems
7. Set up shell heat balance for chemical engineering systems
8. Set up shell mass balance for chemical engineering systems
9. Study various aspects of turbulent transport phenomena
10. Study various aspects of problems in boundary layer theory

Credits:2 **Teaching Scheme Theory: …2...** Hours/Week

Course Relevance:.

1. Chemical engineering systems where space dimensions are considered are studied within the scope of Transport Phenomena.
2. Most of the problems considered in the prescribed textbook are systems of parabolic partial differential equations.
3. In general, the problems in transport phenomena arise in allied engineering sciences such as biochemical, biological, agricultural, pharmaceutical, molecular and material sciences and other areas.
5. The topics focus on studies relevant to transport processes (momentum, heat and mass) and obtain vector field expressions for fluid velocity, temperature and concentration of substances in solids/ liquids.
6. Examples can be drawn from fluid flow operations, mass transfer operations and heat transfer problems of interest in engineering applications and include problems in homogeneous and heterogeneous catalysis and general problems in chemical reaction engineering.

SECTION-1
Dimensions and units, dimensional analysis: Dimensions and units, dimensions and units dimension of an equation, dimensional analysis, settling sphere, Brownian diffusivity, torque on a particle, mass transfer to suspended particles. Dimensional analysis, dimensionless groups and correlations: Heat transfer in a heat exchanger, momentum transfer, flow in a pipe, friction factor, dimensionless groups — ratio of convection and diffusion, Dimensionless fluxes, other dimensionless groups, laminar and turbulent flow in a pipe. Correlations: Momentum transfer: Flow past flat plate, Drag coefficient for flow around an object, correlations for drag coefficient, Flow through packed column, Unit operations for mixing. Correlations: Heat and mass transfer: Droplet breakup, Heat and mass transfer, Colburn and Reynolds analogy, Low Peclet number heat/mass transfer, high Peclet number laminar flow, high Peclet number laminar/turbulent flow. Flow in pipe, flow past flat plate, high Peclet number laminar/turbulent flows. Flow past particles. Correlations: Heat and mass transfer, Diffusion: Flow past mobile interfaces, flow in packed column, Natural convection, Mass diffusion in gasses, mass diffusion in liquids. Diffusion and Dispersion. Unidirectional transport: Cartesian coordinates: Thermal diffusion, momentum diffusion, dispersion, Turbulent dispersion, dispersion in packed column, Taylor dispersion, unidirectional transport, and shell balance.

SECTION-1I

Unidirectional transport: Cartesian coordinates. Steady solutions: Unidirectional transport. Common form of transport equations, steady solutions, constant diffusivity, parallel and series conduction, Steady solutions, internal source, viscous heating, steady solutions, flow down inclined plane, Steady solution, internal source, electrokinetic flow. Unidirectional transport: Cartesian coordinates. Binary diffusion: Steady solutions, internal source, electrokinetic flow, steady solutions, internal source, diffusion-reaction, binary diffusion, correlations in balance equations. Transport by diffusion. Unidirectional transport: Correlations in balance equations: Correlations in balance equations. forced convection, correlations in balance equations, natural convection, correlations in balance equations, packed columns. Unidirectional transport: Cylindrical and Spherical coordinates: Cylindrical coordinates, balance equation, cylindrical coordinates, steady conduction, cylindrical coordinates, heat transfer resistance, cylindrical coordinates, examples, spherical coordinates, balance equation. Pressure-driven flow: Laminar flow in a pipe: Spherical Coordinates. Heat transfer resistance, laminar flow in a pipe. Momentum balance, Laminar flow in a pipe. Velocity profile. Friction factor, laminar flow in a pipe. Friction factor correlation, laminar flow in a pipe. Examples. Pressure-driven flow: Turbulent flow in a pipe: Laminar flow in a pipe. Examples, turbulence, instability, and transition, turbulent flow in a pipe. Dissipation rate, turbulence scales, Turbulent flow in a pipe, turbulence cascade, turbulent flow in a pipe, structure of turbulence. Pressure-driven flow: Bernoulli equation: Bernoulli equation, Discharge from a tank, Bernoulli equation, filling of closed tank, venturi meter, Bernoulli equation. Flow over a weir, macroscopic momentum balance, Bernoulli equation for rotating fluid.

List of Home Assignments:

Design:

6. Design of a viscometer.
7. Design of a spherical gas storage vessel.
8. Design of a multiphase reactor.
9. Design of a membrane bioreactor.
10. Design of a membrane separation unit.

Case Study:

6. Importance of Mass Transfer in industries.
7. Importance of Heat Transfer in industries
8. Advantage and Disadvantage of Laminar and Turbulent in Industries
9. Diffusion in Stagnant fluid
10. Flow through circular tubes and annulus

Blog:

6. Heat flux and temperature distribution for heat sources such as electrical and nuclear.
7. Temperature and pressure distribution of diffusivity
8. Thermal and momentum boundary layer theory
9. Equation of continuity and motion
10. Newton's law of Viscosity.

Survey:

6. Transport phenomena in Biomaterials

7. Transport phenomena during convective drying with superheated steam and moist air.
8. Heat flux through composite wall
9. A linear theory of transdermal transport phenomena
10. Problem in Food Process Engineering

Suggest an assessment Scheme:

Suggest an Assessment scheme that is best suited for the course. Ensure 360 degree assessment and check if it covers all aspects of Blooms Taxonomy.

MSE	***ESE***	***HA***	***VIVA***
30	*30*	*10*	*30*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

Text Books: ***(As per IEEE format)***

3. Bird R. B, Stewart W.E., Lightfoot E.W., 'Transport Phenomena', John Wiley, 2ndEd., 2000.
4. Brodkey R. S., Hershey H. C., 'Transport Phenomena', McGraw-Hill International Edition,1988.

Reference Books: ***(As per IEEE format)***

2. Wilty J.R., Wilson R.W., Wicks C.W., 'Fundamentals of Momentum, Heat and Mass Trasport', 2nd Ed., John Wiley, New York, 1973.

Moocs Links and additional reading material:

1.www.nptelvideos.in

2.https://nptel.ac.in/courses/103108123,

3. https://www.edx.org/course/the-basics-of-transport-phenomena

4. Advanced Transport Phenomena | edX

5. https://www.edx.org/course/analysis-of-transport-phenomena-i-mathematical-met?utm_source=mitopenlearning-mit-open-learning&utm_medium=affiliate_partner,

Course Outcomes:
The student will be able to

1.Solve shell momentum balance problems for simple systems.
3. Solve shell energy balance problems for simple systems.
4. Solve shell mass balance problems for simple systems.
5. Set up and solve macroscopic momentum balances for a given system.
6. Set up general equations of continuity and motion.
7. Carry out dimensional analysis and scale up exercise for complex systems.

CO PO Map

CO/PO	PO:1	PO:2	PO:3	PO:4	PO:5	PO:6	PO:7	PO:8	PO:9	PO:10	PO:11	PO:12	PSO:13	PSO:14
CO:1	1	1	2	1	1	1	1	1	1	0	3	3	3	1

CO:2	1	1	2	1	1	1	1	1	1	0	3	3	3	1
CO:3	1	1	2	1	1	1	1	0	0	0	2	2	3	1
CO: 4	1	1	3	1	1	3	2	1	0	0	2	2	3	1
CO: 5	1	1	3	1	1	3	2	1	0	0	2	2	3	1
CO: 6	1	1	3	1	1	3	2	1	0	0	2	2	3	1

CO attainment levels

CO	Attainment level
CO : 1	4
CO : 2	4
CO : 3	5
CO : 4	5
CO : 5	5
CO : 6	5

Future Courses Mapping:

Students wishing to apply for higher education in Indian as well as in foreign Universities should take up this course, as they will be learning advanced transport phenomena during MS/ M.Tech. programs. The scope of transport phenomena is such that it covers all chemical engineering subdisciplines and finds applications in real life problems.

Job Mapping:

Once transport phenomena course is completed successfully by a student, s/he will be able to derive a problem statement for applications of fluid flow operations, heat transfer, *mass transfer and chemical reaction engineering problems. Thus, the subject is of importance to devise and solve problems in process and plant engineering and so of relevance to industrial design practice and trouble shooting.*

FF No. : 654

CH4289::MAJOR PROJECT

Course Prerequisites:

Process Calculation, Chemical Technology, Mass Transfer, Heat Transfer

Course Objectives:

The Students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members
4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 10

Teaching Scheme Theory: ….. Hours/Week
Tut: ……... Hours/Week
Lab: **20** Hours/Week

Course Relevance:.........

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.* *The external from Industry/research organization is invited to evaluate the projects done by students.*

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:

Assessment of project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

8. https://nptel.ac.in/courses/103/103/103103039/#watch
9. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
10. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
11. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
12. https://www.coursera.org/learn/uva-darden-project-management
13. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. Learn how to work in a team.
3. Define a task (problem) and execute it.
4. Carry out research and development work.

5. Design equipments or process for chemical engineering plants.
6. Document findings or design in selected topic

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	3	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level
1	2
2	3
3	3
4	5
5	5
6	4

Future Courses Mapping:

Semester long inturnship

Job Mapping:

What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

CH4288::MAJOR PROJECT 2

Course Prerequisites: Basic principles of physics, mathematics, chemistry, heat transfer

Course Objectives:

The students will be able to

1. Do literature search appropriately with available tools
2. Defining of project title/idea
3. Allocation of tasks among the team members
4. Team spirit development
5. Write a report, research paper with required format
6. Present work effectively with concrete results

Credits: 10 **Teaching Scheme Theory: …..** Hours/Week

Tut: …….. Hours/Week

Lab: **20** Hours/Week

Course Relevance:.........

SECTION-1&II
Topics and Contents *This stage will include a complete report consisting of synopsis, the summary of the literature survey carried out, Details of experimental/theoretical work and results and discussion and conclusion.* *Students may undertake studies in application chemical engineering knowledge for manufacturing project, synthesis, design and development, experimental work, testing on the product or system, generation of new ideas and concept, modification in the existing process/system, development of computer programs, solutions, modeling and simulation related to the subject. Topics of interdisciplinary nature may also be taken up. A detailed literature survey is expected to be carried out as a part of this work. The group of students is required to choose the topic in consultation with the Guide.* *A technical report of 15 pages is required to be submitted at the end of the term and a presentation made based on the same. Modern audio-visual techniques may be used at the time of presentation.*

The external from Industry/research organization is invited to evaluate the projects done by students.

List of Project areas:

1. Agriculture
2. Personal Health
3. Social health
4. Hygiene
5. Energy
6. Environment
7. Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waste management
13. Low-cost product development

Suggest an assessment Scheme:
Assessment of project includes three reviews spread across 4 months, where research innovative ideas, strategy of execution, actual execution, teamwork is assessed.

Every review is based on report writing, presentation of results and team work demonstration.

Two reviews are with internal faculty members
Third review is with an external industry expert.

Review 1: Literature search and deciding appropriate topic
Review 2: Progress of work on decided topic i.e setting experimental setup, developing methodology of solving the opted problem.
Review 3: Overall assessment of project work with team efforts.

Moocs Links and additional reading material: www.nptelvideos.in

14. https://nptel.ac.in/courses/103/103/103103039/#watch
15. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
16. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
17. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
18. https://www.coursera.org/learn/uva-darden-project-management
19. https://www.coursera.org/specializations/innovation-creativity-entrepreneurship

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. Learn how to work in a team.
3. Define a task (problem) and execute it.
4. Carry out research and development work.
5. Design equipments or process for chemical engineering plants.
6. Document findings or design in selected topic

CO PO Map

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
CO1	3	1	1	1	0	1	1	1	1	1	1	1	1	1
CO2	0	0	0	0	0	0	0	2	3	1	3	1	0	0
CO3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	3	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	1	1	1	1

CO attainment levels

CO	Attainment level

1	**2**
2	**3**
3	**3**
4	**5**
5	**5**
6	**4**

Future Courses Mapping:

Semester long internship

Job Mapping:
What are the Job opportunities that one can get after learning this course
Core Chemical Engineering industrial job
Chemical Engineering Design job
Chemical Engg. research jobs

CH4293::INDUSTRY INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and produce
3. Digital record duly signed by competent authority.
4. Total Internship period is minimum 16 weeks or 4 months.
5. Internship undertaken is to be Industrial Internship.
6. Students need to submit monthly reports to Company and Institute.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipment's or process for chemical engineering plants
3. Apply knowledge in core and multidisciplinary field though research and development.
4. Work effectively as member or leader in team.
5. Organize, comprehend and write technical report.
6. Follow ethics and professional standards of organization/industry.

FF No. : 654

CH4291::RESEARCH INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and produce
3. digital record duly signed by competent authority.
4. Total Internship period is minimum 16 weeks or 4 months.
5. Internship undertaken is to be Research Internship.
6. Students need to submit monthly reports on Research Project.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipments or process for chemical engineering plants
3. Apply knowledge in core and multidisciplinary field though research and development.
4. Work effectively as member or leader in team.
5. Organize, comprehend and write technical report.
6. Follow ethics and professional standards of organization/industry.

FF No. : 654

CH4294::INTERNATIONAL INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and produce
3. digital record duly signed by competent authority.
4. Total Internship period is approximately 16 weeks or 4 months.
5. Internship undertaken to be taken outside India as Industrial Internship or Research Internship.
6. Students need to submit monthly reports on Industry Project/Research Project.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipments or process for chemical engineering plants or apply knowledge in core and multidisciplinary field though research and development
3. Work effectively as member or leader in team
4. Organize, comprehend and write technical report
5. Follow ethics and professional standards of organization/industry

FF No. : 654

CH4292::PROJECT INTERNSHIP

Course Prerequisites:

Heat Transfer, Mass Transfer, Fluid Flow Operations, Process Calculations, Mass Transfer Operation, Separation Techniques, Chemical Reaction Engineering, Instrumentation and Process Control, Transport Phenomena

Guidelines:

1. HOD to constitute a committee of four senior faculty members for Internship allocation.
2. Students need to maintain minimum attendance of 75% at the place of work and
3. Produce digital record duly signed by competent authority.
4. Total Internship period is minimum 16 weeks or 4 months.
5. Internship undertaken is to be Project Internship.
6. Students need to submit monthly project report.
7. Final presentation (CVV) would be conducted at the end of semester.
8. Distribution of credits and other guidelines are subject to change.

Course Outcomes:

The student will be able to –

1. Apply Chemical Engineering knowledge
2. Design equipment’s or process for chemical engineering plants
3. Apply knowledge in core and multidisciplinary field though research and development.
4. Work effectively as member or leader in team.
5. Organize, comprehend and write technical report.
6. Follow ethics and professional standards of organization/industry.

PROGRAM OUTCOMES:

Engineering Graduates will be able to:

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

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

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

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

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

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Rec`1ognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES STATEMENTS

Engineering Graduates will be able to:

1. Work in chemical engineering organizations demonstrating expertise in conventional chemical engineering design and operations.

2. Work in diverse, multidisciplinary fields such as biotechnology, nanotechnology, food, energy, environmental, product designs etc.