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 'B20/C20/D20'

Effective from Academic Year 2020-21

Prepared by: - Board of Studies, Chemical Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman -BOS	Dean-Academics	Chairman – Academic Board

B.R.A.C. TRUST * VISHWAKARMA INSTITUTE OF TECHNOLOGY

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 'B20/C20/D20'

Effective from Academic Year 2020-21

Vision of the Institute

To be globally acclaimed Institute in Technical Education and Research for holistic Socio-economic development

Mission of the Institute

1. To endure that 100% students are employable in Industry, Higher studies, Become Entrepreneurs, Civil/Defense Services / Government Jobs and other areas like Sports and Theatre.
2. To strengthen Academic Practices in terms of Curriculum, Pedagogy, Assessment and Faculty Competence.
3. Promote Research Culture amongst Students and Faculty through Projects and Consultancy.
4 To make students Socially Responsible Citizen.

Vision of the Department

To achieve excellence in chemical engineering education and research"

Mission of the Department

1. To impart quality education preparing students for careers in conventional chemical engineering as well as niche areas such as advanced materials, environmental, biochemical and energy systems engineering.

2. To create a vibrant research environment for carrying out multidisciplinary research in collaboration with organizations of national and international repute.

3. To inculcate entrepreneurship and managerial skills with effective industry – institute interaction.

4. To foster holistic development of students and contribute to the society by addressing social, economic and environmental aspects

B.Tech. Chemical Structure Pattern B20 (applicable w.e.f. AY 20-21)

Second Year Module -III

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	MD2201	DATA SCIENCE	3	2	1	5
S2	MD2202	APPLIED ELECTRONICS	3	2	1	5
S3	MD2203	MECHANICAL AND SYSTEM ENGINEERING	3	2	1	5
S4	CH2089	SOFTWARE DEVELOPMENT PROJECT – I	-	-	-	3
S5	CH2081	ENGINEERING DESIGN AND INNOVATION – III	-	-	-	4
S6	CH2265	ENGINEERING DESIGN I	-	2	-	1
S7	CH2267	SOFTWARE DESIGN I	-	2	-	1
S8	Audit	GENERAL PROFICIENCY		-		0
		Total	14	16	3	24

Second Year Module - IV

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH2201	FLUID FLOW OPERATIONS	3	2	1	5
S2	CH2203	CHEMICAL PROCESSES	3	2	1	5
S3	CH2202	PARTICULATE TECHNOLOGY	3	2	1	5
S4	CH2204	PHYSICAL AND ORGANIC CHEMISTRY	3	2	0	4
S5	CH2282	ENGINEERING DESIGN AND INNOVATION – IV	-	-	-	4
S6	CH2265	ENGINEERING DESIGN I	-	2	-	1
		Total				24

Second Year Module - IV

FF No. : 654

CH2201::FLUID FLOW OPERATIONS

Course Prerequisites: Introduction to vectors and tensors; Basic principles of fluid dynamics, heat transfer and mass transfer.

Course Objectives:

1. To understand different properties of fluids and flow behaviours
2. To learn to apply the hydrostatic law for pressure measurement
3. To learn to apply the principles of mass, momentum and energy conservation to solve fluid flow problems
4. To understand dimensional analysis methods to correlate different process flow parameters
5. To understand the development of hydrodynamic boundary layers and its impact on momentum transport.
6. To learn fluid transportations systems and power requirement in the transportations of fluids

Credits: 5 **Teaching Scheme Theory: 3** Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

SECTION-1
Fluids and properties of fluids, Newton's law of viscosity, rheological classification of fluids, types of flow, lines to describe the flow The basic equation of fluid statics, pressure-depth relationship, pressure forces on surfaces, pressure measurements, pressure measuring devices. Mass, momentum and energy balance equations, venturi meter, orifice meter, pitot tube for velocity measurement, variable area meter.
SECTION-1I

Fundamental dimension of quantities, dimensional homogeneity , Reyleigh's method and Buckingham's π method, , concept of hydrodynamic boundary layer, growth over a flat plate, change in nature of boundary layer, and different thicknesses of boundary layer, drag on flat plate, coefficient of drag and its variation, hydrodynamic, thermal and concentration boundary layers.

Shell balance based solutions for laminar flow through circular tube (Hagen Poiseuelle equation), on inclined plane, Darcy-Weisbach equation, friction factor chart

Minor losses and major losses in pipes, concept of equivalent pipe, series and parallel pipe systems, different pipe fittings and valves, transportation of fluids, centrifugal pump.

List of Tutorials: (Any Three)

1) Examples on properties of fluids
2) Examples on rheology of fluids
3) Examples on hydrostatics
4) Examples on continuity equation
5) Examples on mechanical energy balance
6) Examples on dimensional analysis
7) Examples on laminar flow through pipe
8) Examples on frictional losses in pipes
9) Examples on Minor losses in pipe
10) Examples on power requirement in liquid transportation

List of Practicals: (Any Six)

1) Determination of viscosity of liquids
2) Pressure measurements by manometers
3) Reynolds experiment
4) Verification of Bernoulli principle
5) Calibration of venturimeter
6) Calibration of orificemeter
7) Calibration of rotameter
8) Friction in flow through pipes
9) Characteristics of centrifugal pump
10) Minor losses in pipes
11) Verification of Stokes's law

List of Projects:

1. Design of orifice meter
2. Design of rotameter
3. Design of venturimeter
4. Analysis of water requirements of dairy industry
5. Design of Reynolds setup for flow characterization
6. Design of a Bernoulli law verification setup
7. Analysis of the viscous flow through a circular pipe
8. Simulation of the energy losses in pipeline systems
9. Design of an automatic irrigation system
10. Rheology of fluids

List of Course Seminar Topics:

1. Different flow behaviours in fluid processing
2. Role of fluid mechanics in vehicle design
3. Pressure measuring devices
4. Flow measuring devices
5. Fluid processing in petroleum industry
6. Rheology of solid liquid suspensions
7. Governing equations for fluid processing and mathematical analysis
8. Gravity separators
9. Processing of polymers
10. Energy losses in the flow systems

List of Course Group Discussion Topics:

1. Fluid statics and fluid dynamics
2. Laminar and Turbulent flow
3. Empirical models and first principle models
4. Hydro power plants and thermal power plants
5. Variable area meters and variable head meters
6. Major and minor energy losses
7. Rheology and rheometry
8. Pumps for various applications
9. Computational tools for fluid mechanics
10. Irrigation systems

List of Home Assignments:

Design:

1. Design of cavitation device by using orifice meter
2. Design of cavitation device by using Venturimeter
3. Design of rotameter for liquid flow measurement
4. Design of viscometer for the Newtonian fluids

Case Study:

1. Modern sensors for flow measurements
2. Modern pressure sensors for pressure measurements
3. Pumps used in petroleum industry
4. Pumps used in polymer processing

Blog

1. Fluid mechanics in everyday life
2. Modern sensors for flow measurements
3. Wastewater treatment
4. Aerodynamics

Surveys

1. Valves used in process industry
2. Water pollution in sugar industry
3. Pumps requirement for agriculture sector
4. Rain water harvesting

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*	*LAB*	*CP*	*VIVA*	*SEM*	*GD*
10	*10*	*10*	*10*	*10*	*20*	*15*	*15*

MSE - Mid Semester Examination
ESE - End Semester Examination
HA - Home Assignment
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
SEM - Seminar
GD - Group Discussion

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

1. Warren Lee McCabe, Julian Smith, Peter Harriott ; Unit Operations in Chemical Engineering., 7th edition, McGraw Hill Publications
2. Bansal R.K.; A Textbook of Fluid Mechanics and Hydraulic Machines., 9th edition, Laxmi Publications (P) Ltd
3. Coulson J.M. and Richardson J.F.; Chemical Engineering Vol. 2, Pergamon Press, 5th ed.

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

1. Den M.M.; Process Fluid Mechanics; 1980., Prentice Hall

2.Yunus A.Cengel and John M. Cimbala.; Fluid Mechanics-Fundamentals and Applications; 3rd edition, Tata McGraw Hill

Moocs Links and additional reading material: www.nptelvideos.in
https://nptel.ac.in/courses/103/104/103104043/
https://nptel.ac.in/courses/103/103/103103133/

Course Outcomes:

1)Determine various properties and flow behaviours.
2) Select and use manometers for pressure measurement.
3) Solve fluid flow problems by using conservation equations of mass, momentum, and energy.
4) Develop correlations using dimensional analysis.
5)Design the pipe size and flow meters requirements under laminar and turbulent flow conditions.
6) Determine the power requirements of pumping and transportation of fluids.

CO PO Map

co/po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso13	pso14
co1	2	2	2	2	1	1	1	0	1	0	1	0	3	1
co2	2	2	2	2	1	1	0	0	1	0	1	0	1	1
co3	2	3	3	2	2	1	0	0	1	0	1	0	3	1
co4	1	2	3	3	0	1	0	0	1	0	1	0	1	1
co5	3	3	3	3	2	1	0	0	1	0	1	0	2	1
co6	3	3	3	3	2	1	0	0	1	0	1	0	2	1

CO attainment levels

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

Future Courses Mapping:

Heat Transfer, Mass Transfer, Reaction Engineering, Process Instrumentation and Control, Plant Engineering, Process Equipment Design,

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

FF No. : 654

CH2203::CHEMICAL PROCESSES

Course Prerequisites: Chemistry, Mathematics, Basic of Thermodynamics

Course Objectives:

1. To understand material balance over a unit operation without chemical reaction.

2.To understand material balance over a unit operation with chemical reaction.

3.To understand energy balance over a unit.

4.To understand steady state, unsteady state, recycle, by-pass, purge adiabatic, isothermal, operations and material and energy balance for them

5. To learn about unit process, yield and process flow diagram of a chemical process.

Credits: 5 **Teaching Scheme Theory: 3** Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance: The study of the subject will help to understand basic calculations required in the design of chemical plants and to do complete material and energy balance of chemical plants. This subject also gives an overview of all unit operations and helps to understand all unit operations and processes in chemical industries.

SECTION-1
Topics and Contents *Chemical calculations including mole, equivalent weight, solids, liquids, solutions and their properties, properties of gases. Non ideal calculations, for gas and liquid mixtures, Process flow sheet, Concept, Material balance calculations, Material balance of unit operations such as distillation, crystallization. Recycling, bypass and purge operations, material balance of unsteady state processes, Mass balance with chemical reactions, single, multiple reactions, excess and limiting reactants, conversion, yield and selectivity. Material balance with recycle, bypass and purge operation. Material balance of unsteady state processes with chemical reaction. Chlor-Alkali Industry : Chlor-alkali chart and importance of chlor-alkali industry, Manufacturing of soda ash, caustic soda, chlorine and engineering problems*

SECTION-1I

Topics and Contents

Sensible heat changes in gases, liquids and solids, latent heat of phase change, Enthalpy changes in pure substances and their mixtures, Heat of solutions, Heat of crystallisation, energy balance of unit operations, Standard heat of formation and combustion, effect of temperature on heat of formation and Heat of reaction. Energy balance unit processes, Psychometric calculations, calculations for n number of reactions, simultaneous material and energy balance, Nitrogen industry : Role of nitrogen in fertilizers, manufacturing of ammonia, nitric acid, urea. Sulfur industry: Importance, manufacturing of sulfur by Frasch process, technology for the manufacturing of sulfuric acid, Petroleum industry : Overview of refinery process

List of Tutorials: (Any Three)

1) Solve problems based on units and conversions
2)Solve problems based on material balance without chemical reaction.
3)Solve problem of recycle without chemical reaction
4)Solve problem of bypass and purge
5)Solve problems based on material balance with chemical reaction
6)Solve problem of bypass and purge with chemical reaction
7)Solve problems based on energy balance
8)Solve problems based on unit operations
9)Draw flow sheet for a chemical process
10)Study a complete process with PFD

List of Practicals: (Any Six)

1) Draw process flow diagram
2)Material balance on unit process at steady state
3)Material balance on unit process at unsteady state
4)Material balance on unit operation
5)Energy balance on unit operation
6)Energy balance on unit process
7)Recycle without chemical reaction on unit operation
8)Recycle with chemical reaction on unit operation
9)Finding standard heat of formation from data
10)Combine material and energy balance.

List of Projects:

1.Preparation of process flow sheet
2. Study of Soda Ash process and its material balances.
3.Study of Caustic Soda and its material balances.
4.Study of Urea manufacturing process and its material balances.
5.Study of ammonia manufacturing process and its material balances.
6.Study of sulfur manufacturing process and its material balances.
7.Detail study of sugar manufacturing plant
8.Detail study of paper and pulp industry
9.Study of nitric acid manufacturing process.
10.Study of sulfuric acid manufacturing process.

List of Course Seminar Topics:

1. Process flow diagram
2. Different unit systems
3. Humidification
4.Heat of reaction
5.Heat capacity at constant pressure
6.Different gas laws used in chemical operations
7.recycle & bypass operations
8.conversion and yield of a chemical process
9.Enthalpy changes for pure substance and their mixtures
10.material & energy balance of evaporator

List of Course Group Discussion Topics:

1.New trends in the petroleum industry.
2.New trends in the chloro alkali industry.
3.New trends in the nitrogen industry.
4.New trends in the sulfur industry.
5.overveiw of refinery processes.
6.Steady Vs unsteady state material balance
7.New separation techniques.
8.Humidification and dehumidification
9.Material Vs energy balance
10.Different gas laws.

List of Home Assignments:

Design:

1.Material & energy balance for extraction operation
2.Material & energy balance of reactor
3.Material & energy balance of drier
4.Material balance with chemical reaction
5.material & energy balance of distillation column

Case Study:

1.Energy balances of process; steady state.
2.Material balances of process with recycle; steady state.
3.Combine material and energy balance.
4.Material balances of process with purge; steady state.
5.Material balances of process with bypass; steady state.

Blog

1.Importance of petroleum industry.
2.Steady state energy balance
3.Steady state material balance without reaction.
4.Steady state material balance with reaction.
5.Unsteady state material balance.

Surveys

1.Review of petroleum industry products, equipment, cost.
2.Market survey of a chemical process.
3.Material balance of a membrane process.
4.Material balance of a multi effect evaporator.
5.Material balance of an unsteady state process.

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*	*LAB*	*CP*	*VIVA*	*SEM*	*GD*
10	*10*	*10*	*10*	*10*	*20*	*15*	*15*

MSE - Mid Semester Examination
ESE - End Semester Examination
HA - Home Assignment
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
SEM - Seminar
GD - Group Discussion

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

1. Bhatt B. I. and Thakore S. M.; Stoichiometry, Tata McGraw-Hill Publication, Fifth Edition, 2010 .
2. Himmelblau D. M.; Basic Principles and Calculations in Chemical Engineering , Tata McGraw-Hill Publication, 7th Edition, 1997.
3. 'Dryden Outline of Chemical. Technology', Rao, M. Gopala, , 3rd Edition, East West Publishers,1997.
4

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

1. Hougen O. A. and Watson K. M.; Chemical Process Principles (Part I), CBS Publishers New Delhi, 2nd Edition, 2001.

2. 'Chemical Process Design and Integration', Smith, R., 3rd Edition, Wiley, 2005.

3. 'Unit Processes in Organic Synthesis', Groggins, P.H., 3rd Edition, McGraw-Hill Book Co., 1958.
4. 'Shreve's Chemical Process Industries', Austin, George T., 5th Edition, McGraw-Hill, 1984.

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

Course Outcomes:

1) Determine the quantities of chemicals in different mode i.e. moles and equivalent mass and able to convert various physical quantities in different unit systems
2)Formulate, analyze and solve steady state and unsteady state material balances for unit operations and unit processes.
3)Make material balances for recycling, by-passing and purging operations
4)Perform energy balances for unit operations
5)Perform energy balances for unit processes and Psychrometric calculations
6)Apply knowledge of process fundamentals of chemical technology in process industries.

CO PO Map

co/ po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso13	pso14
co1	**2**	**1**	**3**	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**2**	**1**
co2	**2**	**2**	**3**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**3**	**1**
co3	**2**	**2**	**3**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**3**	**1**
co4	**2**	**2**	**3**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**3**	**1**
co5	**2**	**2**	**3**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**3**	**1**
co6	**2**	**2**	**3**	**2**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**3**	**1**

CO attainment levels

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

Future Courses Mapping:

Mass transfer operations, Separation Techniques, Chemical reaction kinetics, Chemical reaction engineering, Process Equipment design

Job Mapping:

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

FF No. : 654

CH2202::PARTICULATE TECHNOLOGY

Course Prerequisites: Basic science and knowledge of mathematics

Course Objectives:

1. Identify the important physical mechanisms occurring in processes involving particles
2. Discuss unit operations and its role in chemical industries and characterization of particulate solids
3. Understand size reduction, particle dynamics, separation of particles and handling
4. Understand mixing of solids, selection and working of different industrial mixers
5. Formulate and solve mathematical descriptions of settling, filtration and fluidization processes

Credits: 5 **Teaching Scheme Theory: 3** Hours/Week

Tut: 1 Hours/Week

Lab:**2** Hours/Week

Course Relevance: It is a branch of science and engineering dealing with description and study of the processing, handling, characterization, conversion and various applications of particulate materials, both dry and wet in size ranging from centimetres to micron. It deals with mixing and agitation in chemical processes. It involves motion of particles through fluids and separation of solids from liquid and gas by different filtration equipment.

SECTION-1

Solid handling and transportation

Particle characterization: Relevance of fluid and particle mechanics, Measurement of particle size, Particle size distribution, Mean particle size, Relationship among shape factors and particle dimensions, Particles in mixtures

Particulate solids in bulk:General characteristics, Agglomeration, Resistance to shear and tensile forces, Angles of repose and of friction, Flow of solids in hoppers, Flow of solids through orifices

Screen analysis: Standard screen series, industrial screening equipment, calculation of effectiveness of screening

Storage of Solids: Bin and silos storage, Pressures in bins and silos, Flow out of bins

Conveyors: conveying equipment (Screw conveyors, Belt Conveyors, Chain and Flight conveyors, bucket elevators, pneumatic conveyors), Design calculation of Belt Conveyors

Mixing:Necessity of mixing and agitation in chemical industries,agitator selection, Calculation of power consumption in agitation, Mixers for cohesive solids, mixing equipment of free flowing solids, calculation of power requirement and mixing index of solid mixers

Size reduction and enlargement:Size reduction equipment,Crushing efficiency, Empirical relationships, Open circuit and closed circuit grinding, Nucleation and growth of particles

Separation of suspended solid particles from fluids:Froth flotation, magnetic separator, fiber and fabric filter, electrostatic precipitators, cyclone separator, hydro cyclone, Mineral jig, scrubbers, centrifuges, centrifugal clarifier

SECTION-1I

Topics and Contents

Motion of particles through fluids: Drag force, Drag coefficients, skin and form drag, Stoke's law, Newton's law, Criterion for settling regime, Free and hindered settling

Flow through packed beds:Void fraction, superficial velocity, channeling, Ergun equation and its derivation, Kozeny Carman equation, Burke-Plummer equation , Darcy's law and permeability, characteristics of fluidized systems, minimum fluidization velocity, types of fluidization, applications of fluidization technique, spouted beds and fixed bed

Filtration: Classification of filtration, Filter media and filter aids, filtration equipments, pressure drop through filter cake, filter medium resistance, specific cake resistance, continuous filtration, washing and dewatering of filter cakes , Centrifugal filtration

Membrane filtration: Classification, Nature of synthetic membranes, Cross flow microfiltration, Ultrafiltration, Reverse osmosis, Electro dialysis, Dialysis, Membrane Fouling

Gravity Settling Processes: Gravity classifier, sorting classifier, Clarifiers and thickeners, sedimentation, kynch theory of sedimentation, Design of thickeners

List of Tutorials: (Any Three)

1). Calculation of mixed particle sizes and size analysis.
2). Calculation of particle size distribution and mean average diameter.
3). Calculation of power requirement in crushing using crushing law.
4). Calculation of effectiveness of screening.
5). Calculation of criterion for settling and terminal velocity of particle.
6). Calculation of belt thickness, angle of idlers etc. for design of belt Conveyors.
7). Calculation of power requirement in agitation.
8). Calculation of minimum fluidization velocity.
9) Calculation of mixing index and standard deviation of solid mixing.
10) Calculation of area and depth of continuous thickener.

List of Practicals: (Any Six)

1) Cyclone Separator: To determine efficiency of cyclone separator. Properties of solids: To determine Avg. Particle size, Specific surface of mixture and No. of particles in the mixture
2) Screening: To determine the effectiveness of screen.
3) Sedimentation: To determine area of thickener by conducting batch sedimentation test
4) Centrifugal sedimentation of fine particles slurry.
5) Ball mill: To determine crushing law constant (by using Rittingers law, Bonds law and Kicks law).
6) Jaw Crusher: To determine crushing law constant (by using Rittingers law, Bonds law and Kicks law).
7) Vacuum Leaf Filter: To determine filter medium resistance and cake resistance by using vacuum leaf filter.
8) Fluidization: To determine minimum fluidization velocity and verify with Ergun Equation
9) Membrane separation
10) Drag Coefficient: To determine terminal settling velocity and compare with theoretical settling velocity

List of Projects:

1. Design of a filter
2. Design of gravity sedimentation process.
3. Design of fluidization process.
4. Design of conveyor (belt, chain,flight etc.)
5. Review on recent trends in filtration.
6. Plant design of STP.
7. Plant design of ETP plant.
8. Review on recent trends in gas-solid separation
9. Design of hydro-cyclone separator
10. Design of centrifugal and sedimentation process
11. Screen efficiency determination
12 Design of gas solid separator
13 Design of liquid- solid separator

List of Course Seminar Topics:

1. Properties of solids and it's effects on its performance
2. Screening equipments and factors affecting its effectiveness
3. Crushing equipments and their industrial applications
4. Grinding equipments and their industrial applications
5. Ultrafine grinding equipments and factors affecting their efficiency
6. Separation of solid from gases
7. Various conveyors used in transportation of bulk solids
8. Filtration operation and industrial filters
9. Sedimentation & batch sedimentation equipments
10. Fluidized bed and its applications

List of Course Group Discussion Topics:

1. Issues in Storage of solids and their remedies
2. Industrial screening equipments
3. Applications of screw conveyors and belt conveyors
4. Applications of chain conveyors and flight conveyors
5. Mixers used for cohesive solids and non cohesive solids
6. Open circuit versus closed circuit grinding
7. Selection and Optimization of Filter Aid , Filter Media and equipments
8. Membrane separation for gases
9. Membrane separation for liquids
10. Dialysis and electrodialysis

List of Home Assignments:

Design:

1.Thickener
2.Fluidized bed
3.Filtration unit
4.Belt conveyor
5.Membrane process

Case Study:

1.Importance of Particulate technology in Cement industry
2.Importance of Particulate technology in food industry
3.Importance of Particulate technology in pharmaceutical industry
4.Importance of Particulate technology in paint industry
5.Importance of Particulate technology in ceramic industry

Blog
1.Membrane fouling and its remediation
2.Reverse osmosis and it's advantages and drawbacks
3.Different filter media in filtration operation
4.Powder technology in glass industry
5.Powder technology in coal chemicals

Surveys
1.Equipments used for centrifugal separations
2.Membrane separation in wastewater treatment
3.Equipments used for cross flow filtration
4.Membrane fouling and its remediation
5. Various Mixers used in industries

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*	*LAB*	*CP*	*VIVA*	*SEM*	*GD*
10	*10*	*10*	*10*	*10*	*20*	*15*	*15*

MSE - Mid Semester Examination
ESE - End Semester Examination
HA - Home Assignment
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
SEM - Seminar
GD - Group Discussion

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

1. McCabe W. L. and Smith J. C.; Unit Operations of Chemical Engineering; 5th Edition;McGraw Publications.

2. Coulson J. M. and Richardson J.F.; Chemical Engineering Vol. 2, 5th Edition Pergamon Press, 2002.

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

1. Badger W. L. and Banchero J. T.; Introduction to Chemical Engineering; McGraw Hill Publications, 1997.

2. Foust A.S.; Principles of Unit Operations; John Wiley and Sons, 1965.

3. Stanley Walas, Butterworth-Heinemann; Chemical Process Equipment Selection and Design; 1990

Moocs Links and additional reading material: www.nptelvideos.in
https://swayam.gov.in/nd1_noc19_ch29/preview

Course Outcomes:
Student should be able to
1) Recognize basic principles of particle size measurement, bulk solid characteristics, screening and select suitable size reduction equipment.
2) Select suitable solid-solid, solid-fluid separation technique and storage tank.
3) Select and design suitable solid conveying system, agitators and solid-solid mixing process.
4) Design gas solid and liquid solid separation operation .
5) Describe concept of sedimentation and design sedimentation unit.
6) Describe concept of particles through fluids, flow through packed bed and design fluidized bed

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

CO attainment levels

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

Future Courses Mapping:
Nano technology, food and beverages technology, paint technology, separation technology

Job Mapping:
Particulate technology or powder technology plays vital role in the following industries: Coal chemicals, ceramics, Fertilizer, food and beverages, plastics, biomedical, explosives, paint, glass industry, nuclear industry, pharmaceuticals and aerospace

FF No. : 654

CH2204::PHYSICAL AND ORGANIC CHEMISTRY

Course Prerequisites: Fundamentals of Chemistry such as chemical bonding, physical and chemical changes, organic reactions, conventional and analytical tools and preliminary knowledge of concepts like AI.

Course Objectives:

1. To understand structure-activity relationship
2. To understand reaction mechanism
3. To study reaction kinetics
4. To study reaction thermodynamics
5. To study surface and electrochemical behavior of materials
6. To study theory and practice of modern analytical tools
7. To study application of AI and ML to Chemistry

Credits:.4. **Teaching Scheme** Theory: 3 Hours/Week
Tut: 0 Hours/Week
Lab: 2 Hours/Week

Course Relevance: The study of the subject will help understand chemistry and mechanism underlying physical and chemical changes in the reactions brought about in industry. Moreover, an understanding about synthesis, characterization and application of state-of-the-art tools like AI & Machine learning in Chemistry too will take place which is vital from an industrial point of view.

SECTION-1

Chemical Kinetics, Surface Chemistry, Electrochemistry

Physical Chemistry: Kinetics: The rates of chemical reactions- experimental techniques. Chemical Kinetics: steady state approximation, integrated rate laws. The temperature dependence of reaction rates. Numerical on reaction rates. Surface Chemistry and Enzyme Catalysis: Adsorption and Chemisorptions, adsorption isotherms (Langmuir, Freundlich, B.E.T.), Chemisorptions and Catalysis. Thermodynamics-I**:** First law of thermodynamics-basic terms, Volumetric properties of pure fluids- PVT behavior of pure substances, virial equation of state, the ideal gas, application of virial equations. Thermodynamics-II: Heat effects, latent heat of pure substances, standard heat of reaction, standard heat of formation, temperature dependence of $\Delta H°$, Second law of thermodynamics, entropy, entropy changes of an ideal gas, Third law of thermodynamics.

Electrochemistry**:** Equilibrium properties of electrolyte, Electrode potentials and applications, Electrochemical and Electro-analytical techniques, Bio electrochemistry.

SECTION-1I

Bonding, Reactions, Stereochemistry, safety, Biocatalysis & Instrumental analysis

Organic Chemistry: Electronic structure and Bonding, Acids and bases, Acidity and basicity of organic compounds, pKa and pK_b terms. Basics of Chemical Safety Engineering, Chemical Hygiene and Material Handling. Formation of Aliphatic Carbon-Carbon Bonds: Base Catalyzed Reactions, Formation of Aliphatic Carbon-Carbon Bonds: Acid Catalyzed Reactions, Electrophilic Aromatic Substitution, Nucleophilic Aromatic Substitution, Molecular Rearrangements, Organometallic Reagents. Stereochemistry: Basic concepts of Stereochemistry, conformational isomerism of ethane, propane, butane, cyclohexane. Optical isomerism. Resolution and diastereoselectivity. Heterocyclic compounds: Structure and synthesis. Synthesis of Some Naturally Occurring Compounds. Instrumental method of chemical analysis, Introduction to biocatalysis & biotransformation. Retrosynthetic biocatalysis, Applications of Computers in Chemistry - Introduction to Artificial Intelligence and Machine learning Algorithms, Quantitative structure-activity relationships and a glance at futuristic modeling techniques

List of Practicals: (Any Six)

1. Study of adsorption of acetic acid on activated charcoal from solution.

2. To standardize $Na_2S_2O_3$ solution by preparing $K_2Cr_2O_7$ and to estimate percentage of Cu from brass.

3. To study the effect of concentration of the reactants on the rate of hydrolysis of an ester and study of kinetics of the reaction.

4. Determination of strength of HCl solution by titrating against NaOH using P^Hmetry.

5. Calculation of Heat of reaction using calorimeter.

6. Determination of the amount of glucose in the solution by hypoiodite method.

7. Determination of the amount of acetamide in the solution.

8. Oxidation of an organic compound using oxidizing agent- Theory explanation, and analysis of product.

9. Synthesis of p-nitroacetanilide from acetanilide– Theory explanation, and analysis of product.

10. Methyl orange- Theory explanation and analysis of product.

List of Projects:

1.Project on kinetics of chemical reaction determination.

2. Project on waste water treatment.

3. Project on organic compound preparation and analysis.

4. Project on extraction of organic compounds.

5. Project on alternate method determination of organic compound synthesis.

6. Project on biocatalyst application for different chemical processes.

7. Alcohol from Potatoes and Agriculture Waste

8. Caffeine from Waste Tea and Coffee

9. Food dyes and their chemistry

10. Environmental toxicology

11. Pesticides and their chemical influence

12. Climate chemistry

13. synthesis and characterization of natural products

14. developing novel synthetic methodologies for bioactive complex molecules

15. combining organic chemistry, engineering, and biology to solve problems in medicinal chemistry

List of Course Seminar Topics:

1.Biocatalysts for industrial application
2. Adsorption isotherms - their merits and limitations
3. Study of Correlation between chemical kinetics and thermodynamics of selective reactions
4. Application of electroanalytical tools in characterizations of sample matrices
5. Study of effect of surface chemistry of materials on properties and applications
6. Organometallic reagents and their applications in selective reactions
7. Retrosynthetic biocatalysis and its applications
8.Synthesis and applications of naturally occurring compounds
9. Applications of computers in Chemistry
10. Modern analytical techniques vis-a-vis classical techniques

List of Course Group Discussion Topics:

1, Chemistry as a subject and as a central science
2. Scientific Measurements and their Importance in Chemistry
3. Measurement of physical quantities using appropriate instruments
3. Enthalpy changes in some physical and chemical processes
4. Similarities between transition metals and representative metals
5. Experimental determination of order of reaction
6. Dynamic nature of chemical equilibrium and applications of equilibrium constant
7. Separation and purification of organic compounds
8. Contribution of alkanes to the Greenhouse effect
9. Ecological threats - causes and effects
10. Industrial waste - cause, effect, treatment
11. Biocatalysts - advantages & limitations
12. Machine learning for process design, optimization, structural elucidation

List of Home Assignments:

Design:

1.Semi-batch/batch reactor for Cu metal nanoparticles synthesis
2.Method development for following kinetics of a reaction using spectroscopy
3. Designing a catalyst and its application
4. Analytical method/technique
5. Machine learning Algorithm for chemical mapping

Case Study:

1. A case study on Innovative catalysts for family of reactions
2. Kinetics and thermodynamics study of biocatalyzed reaction
3. Retrosynthesis in chemical industry
4. Application of AI elucidation of structure of molecules
5. Green synthesis, characterization and applications of nanocatalysts

Blog
1.chemical catalysis vis-a-vis Biocatalysis
2. Comparative advantages of modern analytical tools over classical tools
3. Naturally occurring compounds of industrial importance
4. Effect of surface chemistry on catalytic activity
5. Artificial Intelligence - most sought after tool for chemists

Surveys
1.Functionlized catalysts for industrial applications
2. Kinetic study of biocatalyzed reactions
3. Spectroscopic examination of organic reactions
4. Electrochemical analytical tools for following chemical catalyzed reactions
5. Application of AI in chemical mapping

Suggest an assessment Scheme:

MSE	*ESE*	*HA*	*LAB*	*CP*	*VIVA*	*SEM*	*GD*
10	*10*	*10*	*10*	*10*	*20*	*15*	*15*

MSE - Mid Semester Examination

ESE - End Semester Examination

LAB – Laboratory

CP- Course Project

HA - Home Assignment

VIVA - Viva voice

SEM – Seminar

GD – Group Discussion

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

1. B. H. Puri and L.R Sharma.; Principles of Physical Chemistry, 7th Edition, S. Chand Company, New Delhi, 1994.

2. G. M Barrow.; Physical Chemistry, 6th Edition, Tata McGraw Hill, 1998.

3. B.K.Sharma; Instrumental method of analysis, 6th Edition, Goel Publishing House, 1995

4. J.Clayden, N.Greeves, S.Warren, P, Wothers; Organic Chemistry, 3rd Edition, Oxford University Press.

5. Zdzislaw Hippe; Artificial Intelligence in Chemistry - Structure elucidation and simulation of organic reactions. 6the edn, Elesevier

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

1. D.P Julio; P.W Atkins; Physical Chemistry, 8th edition, Oxford University Press, 2006.

2. J.M. Smith, H.C Van Ness, M.M. Abbot;. Introduction to Chemical Engineering Thermodynamics, 7th Edition, Tata McGraw Hill, 2005.

3. S.Warren; Organic Synthesis, The Disconnection Approach, John Wiley, 2004.

4. J.M. Coxon, R.O.C.Norman; Principles of Organic Synthesis, '3rd edition Blackie Academic and Professional, 1993.

5. Hugh M. Cartwright, Applications of Artificial Intelligence in Chemistry, 3rd edn, Oxford Science Publications

Moocs Links and additional reading material: www.nptelvideos.in
https://www.coursera.org/learn/physical-chemistry
https://www.coursera.org/learn/spectroscopy
https://www.coursera.org/learn/basic-chemistry
https://www.coursera.org/learn/high-throughput
https://www.coursera.org/learn/thermodynamics-intro
https://www.mooc-list.com/course/machine-learning-coursera
https://www.classcentral.com/course/udacity-introduction-to-artificial-intelligence-301

Course Outcomes:

1. Find out the rate of chemical reaction and different kinetic parameters e.g. order or reaction, michaelis menten kinetics and rate constant etc.

2. Get adsorption isotherms and its study e.g. surface area determination Find out the structure and catalytic properties of metals etc.

3. Find out different thermodynamic parameters of chemicals. Calculation and application of virial equations to calculate volumetric parameters.

4. To select the reagents and physical and chemical conditions to carry out the desired reaction.

5. Get the stereo chemical structure and optical activity of organic compounds, synthesis mechanism of heterocyclic compounds and spectro-photochemical behavior of organic compounds.

6. Find out the effect of solvents on the reaction rate, the product formation and synthesis mechanism of some natural compounds.

CO PO Map

co/ po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso13	pso14
co1	1	2	1	0	1	1	1	2	1	2	1	0	0	0
co2	1	1	1	1	2	2	1	1	1	1	1	1	2	1
co3	2	3	1	1	2	1	2	1	1	3	1	0	0	0
co4	1	1	2	1	1	1	1	1	1	2	1	1	2	2
co5	2	1	1	2	0	1	2	1	2	1	1	0	0	0
co6	1	1	1	0	1	1	2	1	2	1	1	1	2	1

CO attainment levels

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

Future Courses Mapping:
Advanced Physical Chemistry, Advanced Organic Chemistry, Application of AI to Chemical sciences

Job Mapping:
Chemists, Analysts, Process designer,

FF No. : 654

CH2281::ENGINEERING DESIGN AND INNOVATION III

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.Potable Water
8. Solar based
9. Modeling and Simulation
10. Wastewater treatment
11. Air pollution
12. Solid waster 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 –

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

CH2265 :: ENGINEERING DESIGN

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

Course Objectives:

The Students will be able to

7. Do literature search appropriately with available tools
8. Defining of project title/idea
9. Allocation of tasks among the team members
10. Team spirit development
11. Write a report, research paper with required format
12. Present work effectively with concrete results

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

Tut: …….2 Hours/Week

Lab: **…….** 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
10. Solar based
11. Modeling and Simulation
10. Wastewater treatment
11. Air pollution
12. Solid waster 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

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

B.Tech. Chemical Structure Pattern C20 (applicable w.e.f. AY 20-21)

Third Year Module - V

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH3201	CHEMICAL REACTION ENGINEERING	3	2	1	5
S2	CH3203	SEPARATION TECHNIQUES	3	2	1	5
S3	CH3205	PROCESS EQUIPMENT DESIGN	3	2	1	5
S4	CH3207	MODELING AND SIMULATIONS	3	2	-	4
S5	CH3281	ENGINEERING DESIGN AND INNOVATION – V	-	8	-	4
S6	CH3265	ENGINEERING DESIGN I	1	-	-	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	CH3202	INSTRUMENTATION AND PROCESS CONTROL	3	2	1	5
S2	CH3204	TRANSPORT PHENOMENA	3	2	1	5
S3	CH3206	PLANT ENGINEERING AND PROJECT ECONOMICS	3	2	1	5
S4	CH3210	OPTIMIZATION TECHNIQUES	3	2	0	4
S5	CH3282	ENGINEERING DESIGN AND INNOVATION – VI	-	8	-	5
S7	CH3272	GP	-	-	-	-
		Total	13	16	3	24

FF No. : 654

CH3201::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 heterogeneous reactions
3. Demonstrate catalytic phenomena with extensions to surface chemistry,
4. Selection of a model for gas-solid non catalytic reactions and apply it to design reactors
5. Determine fluid -fluid reaction rate equations and apply to equipment design
6. Design various types of catalytic reactors

Credits:5 **Teaching Scheme Theory:3** Hours/Week

Tut:1 Hours/Week

Lab: 2Hours/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, mixing of two miscible fluids. 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, Catalyst deactivation (Poisoning), Mechanism of deactivation, Rate equation for deactivation, Regeneration of catalyst.

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, Slurry reactor, Trickle bed reactor, Experimental methods for finding rates.

List of Tutorials: (Any Three)

1) Problems based on determination of RTD curves for non ideal reactors
2) Different moments of RTD
3) Zero parameter model
4) One parameter model
5) Two parameter model
6) Determination of global rate of heterogeneous reactions using Langmuir Hinshelwood approach/Pseudo steady state hypothesis
7) Determination of physical properties of catalyst i.e surface area, pore volume, pore volume distribution
8) Design of fluid particle reactor
9) Design of fluid fluid reactor
10) Design of packed bed of fluidized bed reactor

List of Practicals: (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 Course 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

List of Course Group Discussion Topics:

1. Factors affecting the performance of heterogeneous reactors
2. Fixed bed reactor versus Fluidised Bed reactor based on design features,applications, economics, advantages and disadvantages
3. Slurry reactor versus Trickle bed reactor based on design features,applications, economics advantages and disadvantages
4. Models used for CSTR and PFR
5. Catalyst deactivation causes and it's regeneration methods
6. Speciality chemicals and their applications
7. Selection criteria for packed and plate column,
8. Heat effects during catalytic reactions and provisions to change in isothermal operation
9. Isothermal versus non isothermal operations in chemical reactor
10. Adiabatic and non adiabatic reactors
11. spray and bubble column reactors for fluid fluid reactions
12. How fluid flow pattern within the reactor influence the performance of reactor
13. Advantages of heterogeneous catalyst over homogeneous catalyst
14. Applications of multiphase reactors
15. Different ways to minimize cost of a manufacturing process

List of Home Assignments:

Design:

1.Design of fixed bed reactor
2. Design of fluidised bed reactor
3. Design of Trickle bed reactor
4.Design of slurry reactor
5. Design of solid fluid reactors

Case Study:

1. Catalytic reactors used in petroleum industries
2. Synthesis of nanoparticles by various methods
3.Fisher Tropsch reaction in slurry reactor
4. Challenges in manufacturing of polymers
5.Coal hydrogenation in slurry reactor

Blog

1. Any advanced technique used in process intensification in a chemical process
2. Modern reactors in chemical industries
3. Heat exchange facilities for highly exothermic reactions in fixed bed reactor
4. Recent trends in chemical reaction engineering
5. Softwares used in chemical reaction engineering

Surveys

1. Reactors used in Polymer industries
2.Digitalisation in Chemical industries
3.Membrane reactors and it's applications in chemical industries
4.Polymers and it's applications
5.Nano bio materials and it's application

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*	*LAB*	*CP*	*VIVA*	*SEM*	*GD*
20	*20*	*10*	*20*	*10*	*10*	*5*	*5*

MSE - Mid Semester Examination
ESE - End Semester Examination
HA - Home Assignment
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
SEM - Seminar
GD - Group Discussion

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 Reactor Design. Vols. I & II, John Wiley and Sons, NY, 1984

Moocs Links and additional reading material: www.nptelvideos.in
https://www.classcentral.com/course/swayam-chemical-reaction-engineering-ii-12900

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

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

CO attainment levels

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

F No. : 654

CH3203::SEPARATION TECHNIQUES

Course Prerequisites: Heat Transfer, Chemical Engineering Thermodynamics, Process Calculation

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: 5 **Teaching Scheme Theory: 3** 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, Lewis Sorrel method, 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, packed column design, 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 Tutorials: (Any Three)
1) To calculate number of stages of a distillation column using Lewis Sorel method
2) To calculate number of stages of a distillation column using Mc Cabe Thiele method
3) To Generate enthalpy-concentration diagram
4) To calculate number of stages of a distillation column using Ponchon Savarit method
5) To prepare input data (eg, ternary diagram) for liquid liquid extraction design
6) To calculate number of stages for solvent extraction column
7) To calculate number of stages for solid-liquid extraction column
8) To generate and study adsorption isotherms
9) To calculate number of stages for adsorption column
10) To study kinetics of Ion-exchange equilibria

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:

1. Production of ethanol to blend in gasoline
2. Oil and gas value chain
3. Solar distillation
4. Industrial application of leaching operation
5. Multicomponent distillation
6. Ion exchange resins and its industrial application
7. Role of vacuum distillation unit in refinery
8. Solvent Extraction: A potential separation technique
9. Importance of isotherms and breakthrough curve in adsorption
10. Pressure swing adsorption and applications
11. Atmospheric distillation unit in refinery
12. Finer selection of solvents for solvent extraction
13. Separation techniques in Fertilizer industry
14. Separation applications by Ion exchange process
15. Separation Techniques in pharmaceutical industry

List of Course Group Discussion Topics:

1. Distillation - A Boon or Curse to Separation?
2. Distillation or solvent extraction - path to separation of close boiling mixtures
3. Where to compromise – Cost of Separation or Purity?
4. Azeotropic distillation or Extractive distillation
5. Importance of Separation Technologies in Refinery
6. Challenges and opportunities in multicomponent distillation
7. Government policy on emission/discharge from Chemical industries
8. Zero discharge in chemical industry - role of mass transfer
9. Scope of improvement in leaching operation
10. Adsorption – an intermediate solution to separation
11. Critical use of leaching operation in metallurgy
12. Role of adsorption and other competing processes in ETP plants
13. Role of separation techniques in Swachh Bharat Aviyan
14. Membrane separation as an alternative to conventional separations
15. Limitation of solvent extraction process in small scale industries

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

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

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*	*LAB*	*CP*	*VIVA*	*GD*
15	*15*	*10*	*30*	*10*	*10*	*10*

MSE - Mid Semester Examination
ESE - End Semester Examination
HA - Home Assignment
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
SEM - Seminar
GD - Group Discussion

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. Dutta B. K.; Principles of Mass Transfer and Separation Processes; Prentice-Hall of India Private Ltd., 2007

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

1. McCabe W. L., Smith J. C., Harriett P.; Unit Operations of Chemical Engineering; Fourth edition, McGraw-Hill, 1985.
2. Wankat. P.C.; Separations in Chemical Engineering: Equilibrium Staged Separations; Prentice Hall, NJ, US, 1988
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) generate VLE data for ideal and non-ideal system
2) carry out process design of distillation column and analyze implications of factors affecting distillation column and also the implications of non-ideal phase behavior
3) select suitable solvent for liquid-liquid extraction and design liquid-liquid extraction column and select equipment required for given separation
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

FF No. : 654

CH3205::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: 03 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.

SECTION-1

Topics and Contents

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. Flanged joints: Gasket: types, selection, and design, bolt design and selection, flange dimensions flange rating calculation. Condenser Design and support design: 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

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, Various types of roofs used for storage vessels. Storage of gases- spherical vessels. 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, safety devices.

List of Tutorials: (Any Three)

1)Heat exchanger design for SATHE

2) Heat exchanger design for double pipe HE.

3) Heat exchanger design for Plate type HE.

4) Design hydraulic plate design

5) Design of vaporiser

6)Design of reboiler

7)Design of condenser

8) auxiliary equipment

9) Pack column

10)supports for equipment

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.

1.

List of Projects:

1. Optimisation of Shell and Tube heat exchanger considering particular heating or cooling objective

2. Optimisation of Plate type heat exchanger considering particular heating or cooling objective

3. Optimisation of Double pipe heat exchanger considering particular heating or cooling objective

4. Optimisation of Helical tube type heat exchanger considering particular heating or cooling objective

5. Optimisation of evaporator to obtain thick liquor with particular concentration considering various industrial needs

6. Optimisation of tray/packed column for separation by using distillation, absorption, etc operations with an industrial example.

7. Condenser design for multicomponent vapor mixtures.

8. Design of multi-effect evaporator.

9. Design of extractive distillation system

10.Design of extractive distillation system

11. Design of liquid-liquid separator.

12. Design of liquid-liquid separator.

List of Course Seminar Topics:

1. Shell and Tube heat exchangers : Basic need, design, application, limitation
2. Double pipe heat exchanger for process industry
3. Plate type heat exchanger for efficient operation
4. Graphite exchanger for highly corrosive application
5. BS standards, TEMA standards, IS standard for Design
6. Evaporators in Chemical Industry
7. Reboilers for process industry
8. Condensers important aspect of chemical plant
9. Pack column for process industry
10. plate column for purification of product
11. Flanges and gasket for equipment
12. Supports for Chemical Equipment
13. Agitated vessels for efficient reactor
14. Agitators for Chemical Reactor
15. Dryers for Chemical products
16. Liquid-liquid and gas-liquid separators

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.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

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*	*LAB*	*CP*	*VIVA*	*GD*
15	*15*	*10*	*20*	*10*	*20*	*10*

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	2	2	2	2	2	1	1	2	2	2	0	1	3	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 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

FF No. : 654

CH3207::MODELING AND SIMULATIONS

Course Prerequisites:

Basic Mathematics

Course Objectives:

Students will be able to,

1. Learn basic process modeling methods.
2. Learn about various types of mathematical models.
3. Learn about input-output models and process dynamics.
4. Learn to model chemical reactors, separation devices and towers.
5. Learn about simulation basics and commercial softwares used in practice.

Credits: 4 **Teaching Scheme Theory: 3** Hours/Week

Tut: 0 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

1. The knowledge gained in this course is useful for design, plant engineering, higher education and to acquire basic engineering skills for industrial entry level jobs.
2. Short-cut, rough or approximate model with some empiricism are useful in industrial design practice.
3. Full fledged models derived as state space models are a first step to model chemical process systems for control system design.

SECTION-1
Topics and Contents Role of process dynamics in chemical process modeling and chemical process control; State variables and state equations for chemical process, Importance of state-space representations. Selection of state variables, examples from chemical process engineering, Lumped parameter and distributed parameter models. Basic model building, transport equations; chemical equilibrium, reaction kinetics, property estimation in mathematical models. Input-output models, Degrees of freedom analysis; process dynamics and its role in process control. Total continuity; component continuity equations and energy equation.

SECTION-1I

Topics and Contents

Batch reactor; reactor with mass transfer; multicomponent flash drum; batch distillation with holdup; ideal binary distillation column; multicomponent distillation column; pH system; equilibrium and titration model. Modeling the CSTR; nonisothermal CSTR; Single-Component Vaporizer; Process simulation, Scope of process simulation, Steady state and dynamic simulation, Formation of problem, Process simulation approaches for steady state and dynamic simulation, Process simulator, Structure of process simulator, Integral process simulation, Simulation tools

List of Tutorials: (Any Three)

1) To model a mixing tank heated by steam.
2) Modeling of batch reactor.
3) Modeling of a vaporiser.
4) Modeling of three CSTRs in series.
5) Modeling a nonisothermal CSTR.
6) Modeling a batch distillation column.
7) Modeling a binary distillation column.
8) Modeling a pH system,
9) Modeling a flash separator.
10) Modeling a decanter.

List of Practicals: (Any Six)

1) MATLAB based simulation of a heated mixing tank.
2) MATLAB based simulation of a batch reactor.
3) MATLAB based simulation of a flash separator.
4) MATLAB based simulation of a CSTR.
5) MATLAB based simulation of a nonisothermal CSTR.
6) MATLAB based simulation of a gas-liquid separator.
7) MATLAB based simulation of a liquid-liquid separator.
8) MATLAB based simulation of a batch distillation column.
9) MATLAB based simulation of a plug flow reactor.
10) MATLAB based simulation of a gas-liquid separator.

List of Course Projects:

1. Modelling three CSTRs in series.
2. Various model derivations for heating/ cooling jacket of a CSTR.
3. Chemical equilibrium model of a chemical reaction.
4. Input-output model of a CSTR and multiplicity of steady states.
5. Process dynamics of a CSTR and its transfer function.
6. State space model of a non isothermal CSTR.
7. Single stage equilibrium model of a binary distillation column and DOF analysis.
8. State space model for a crystallizer.
9. State space model for a binary distillation column and process identification.
10. State space model of a shell and tube heat exchanger as a reboiler.

List of Course Seminar Topics:

1. Modeling an extractive distillation column.
2. LLE for a decanter design.
3. Modeling a steam distribution system.
4. SLE for a crystalliser.
5. Modeling an azeotropic mixture separation.
6. Modeling a distillation sequence.
7. Nonidealities in VLE of distillation column.
8. Modeling a cogeneration plant.
9. Heat-integrated distillation sequence.
10. Pre-fractionating distillation column.
11. Distillation column with side rectifier
12. Distillation column with side stripper
13. Steam distribution system
14. Cogeneration plant
15. Trigeneration plant

List of Course Group Discussion Topics:

1. Comparison between packed and plate towers.
2. Pervaporation and applications.
3. Azeotropic distillation.
4. Membrane distillation.
5. Distillation sequencing in refinery plants.
6. Pinch point technique for heat integration.
7. Hollow fibre membrane reactor.
8. Equilibrium staged separation processes.
9. Rate governed processes.
10. Vapor liquid liquid equilibrium in distillation sequences.
11. State space theory and control system design
12. Chemical equilibrium for design of chemical reactors
13. Multicomponent distillation
14. Modeling of CSTR
15. Batch reactor design

List of Home Assignments:

Design:

1. Design of a decanter using equilibrium relations.
2. Two CSTRS with a bypass and a recycle.
3. Batch adsorber.
4. Ion exchange column design.
5. Vaporiser design.

Case Study:

1. Separation of a binary azeotrope.
2. Chemical equilibrium and crystallizer design.
3. Plug flow crystallizer.
4. Industrial design of pervaporation units.
5. Chemisorption and separator design.

Blog

1. Coffee extraction plant
2. Distillation control.
3. Multicomponent distillation.
4. Adsorber control system design.
5. Heat exchanger network design.

Surveys

1. Control of a nonisothermal reactor.
2. Catalan number sequences and separation sequences.
3. Supercritical extraction.
4. Electrochemical models of batteries.
5. Heat integration of a chemical reactor cascade.

Suggest an assessment Scheme:

MSE	*ESE*	*HA*	*LAB*	*CP*	*VIVA*	*GD*
15	*15*	*10*	*20*	*10*	*20*	*10*

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

1. Luyben W. L., "Process Modeling, Simulation and Control for Chemical Engineering", McGraw Hill Book Company, Singapore, 1990.
2. Seborg D. E., T. F. Edger, D. A. Mellichamp, "Process Dynamics and Control", John Wiley, Indian Edition, 1989.
3. Finlayson, B. A., "Introduction to Chemical Engineering Computing", John Wiley & Sons, New Jersey, 2006.

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

1. Ogunnaike B. A., W. H. Ray; "Process Dynamics, Modeling and Control", Oxford University Press, New York, 1994

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

1. https://www.coursera.org/learn/modeling-simulation-natural-processes
2. https://www.coursera.org/lecture/modeling-simulation-natural-processes/modeling-and-simulation-F7vas

Course Outcomes:

1) Apply basic chemical engineering knowledge to derive simple models.
2) Apply theory of differential equations to derive lumped and distributed parameter models.
3) Apply state space theory to derive process control models.
4) Derive various models for chemical process equipment stages,
5) Set up simulation models and obtain numerical outputs for design and control.
6) Gain basic knowledge of commercial software and do simple problems.

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

CO attainment levels

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

Future Courses Mapping:

Process dynamics and control; advanced process control; chemical process simulation laboratory course.

Job Mapping:

Current industrial design practices in chemical industries expect knowledge of process simulation using MS-Excel, MATLAB software. Putting basic design and simulation model into computer software and preparing initial design/ project related reports is a necessary skill for entry level jobs.

FF No. : 654

CH3281::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.Potable Water
12. Solar based
13. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waster 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

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

CH3265::ENGINEERING DESIGN I

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

Course Objectives:

The Students will be able to

7. Do literature search appropriately with available tools
8. Defining of project title/idea
9. Allocation of tasks among the team members
10. Team spirit development
11. Write a report, research paper with required format
12. Present work effectively with concrete results

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

Tut: ……2 Hours/Week

Lab: **02** 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 waster management
13. 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

19. https://nptel.ac.in/courses/103/103/103103039/#watch
20. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
21. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
22. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
23. https://www.coursera.org/learn/uva-darden-project-management
24. 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

CH3202::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: 5 **Teaching Scheme Theory: 3** 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.

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, ratio control, selective control etc. Introduction to digital control.

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 Tutorials: (Any Three)

Problems on

1. Solution of ordinary differential equations using laplace transforms
2. First order systems
3. Second order systems
4. Systems with dead time
5. Block diagram reduction
6. Dynamic response of PID controlled systems
7. Routh test
8. Root locus
9. Bode analysis

10. Data science techniques in 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 behaviour 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

List of Course Seminar Topics:

1. Air & water quality measurement
2. Electrical methods for temperature measurement
3. Process Instrumentation & control in sugar industry
4. Process Instrumentation & control of polyetheylene (fluidized bed) plant
5. Process Instrumentation & control of ethylene oxide plant
6. Process Instrumentation & control of styrene plant
7. Model predictive control
8. Heat exchanger control
9. Process Instrumentation & Control of crude atmospheric distillation unit
10. Process Instrumentation & Control of Fluid Catalytic Cracker plant

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

List of Home Assignments:

Design:

1. PID controller tuning using Root locus
2. PID Controller tuning using Bode plot
3. PID controller tuning using Ziegler-Nichols open loop method
4. PID Controller tuning using Cohen-Coon method
5. Digital PID controller implementation with anti-reset windup & derivative overrun compensation

Case Study:

1. Control of highly nonlinear processes
2. Use of nanotechnology in process instrumentation
3. Big data analytics in chemical industry
4. BASF Verbund
5. Machine learning in chemical industry

Blog

1. Internet of Things in Chemical Industry
2. Batch process control
3. Advanced process control in chemical industry
4. Process control in plant-on-chip systems
5. Deep learning in chemical industry

Surveys

1. Real time optimization (RTO) systems
2. Sustainability through process control
3. On-line analyzers in chemical industry
4. Batch process control
5. Statistical process control

Suggest an assessment Scheme:

MSE	*ESE*	*HA*	*LAB*	*CP*	*VIVA*	*SEM*
15	*15*	*10*	*30*	*10*	*10*	*10*

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

LAB - Laboratory

CP - Course Project

VIVA - Viva voice

SEM - Seminar

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

1. 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/

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

CH3204::TRANSPORT PHENOMENA

Course Prerequisites:

Introduction to vectors and tensors; basic theory of fluid flow operations, heat transfer and mass transfer.

Course Objectives:

The student should 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.

Credits: 4 **Teaching Scheme Theory: 3** Hours/Week

Tut: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

1. Chemical engineering systems where space dimensions are considered are studied within 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.

4. 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.

5. 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
Topics and Contents *Newton's law of viscosity, temperature and pressure dependence of viscosity for gases and liquids. Basics of momentum transport, combined momentum flux. Equation of continuity, equation of motion. Shell momentum balances and boundary conditions. Shell momentum balances for flow of falling film, flow through circular tube, flow through annulus, flow of two adjacent immiscible fluids etc. Fourier law of energy transport. Dependence of thermal conductivity on temperature, pressure. Shell energy balances for heat conduction: Heat flux and temperature distribution for heat sources such as electrical, nuclear, viscous. Heat flux through composite walls.*
SECTION-1I
Topics and Contents *Fick's law of diffusion. Temperature and pressure dependence of diffusivity. Shell mass balances for diffusion through stagnant film, diffusion with homogeneous and heterogeneous chemical reaction, diffusion and chemical reaction inside a porous catalyst etc. Turbulent transport phenomena, Boundary layer theory. Macroscopic momentum, energy and mass balances. Use of macroscopic balances to solve steady state and unsteady state problems.*

List of Tutorials: (Any Three)

1) Shell momentum balance for flow of falling film.
2) Shell momentum balance for flow through a circular tube.
3) Shell momentum balance for flow through annulus.
4) Shell energy balance for heat conduction with an electrical heat source.
5) Shell energy balance for heat conduction with a nuclear heat source.
6) Shell energy balance for heat conduction with a viscous heat source.
7) Shell mass balance for diffusion through a stagnant gas film.
8) Shell mass balance for diffusion with a heterogeneous chemical reaction.
9) Shell mass balance for diffusion with a homogeneous chemical reaction.
10) Shell mass balance for diffusion with diffusion into a falling liquid film.

List of Practicals: (Any Six)

1) Shell momentum balances: Cartesian coordinate system

2) Shell momentum balances: Cylindrical coordinate system

3) Shell momentum balances: Spherical coordinate system

4) Shell energy balances: Cartesian coordinate system

5) Shell energy balances: Cylindrical coordinate system

6) Shell energy balances: Spherical coordinate system

7) Shell mass balances: Cartesian coordinate system

8) Shell mass balances: Cylindrical coordinate system

9) Shell mass balances: Spherical coordinate system

10) Dimensional analysis

List of Projects:

1. Macroscopic momentum balances
2. Macroscopic energy balances
3. Macroscopic mass balances
4. Combined mass, energy, momentum macroscopic balances
5. Dimensional analysis and scale up
6. Coordinate transformations – rectangular to cylindrical
7. Coordinate transformations – rectangular to spherical
8. Equations of motion – Cartesian coordinate – Application.
9. Equations of motion – Cylindrical coordinate – Application.
10. Equations of motion – Spherical coordinate – Application.

List of Course Seminar Topics:

1. Transport phenomena in aqueous solutions.
2. Transport phenomena in porous media.
3. Colloid transport phenomena.
4. Electrokinetic transport phenomena.
5. Transport phenomena in biochemical systems.
6. Transport phenomena in nanofluidics.
7. Interfacial transport phenomena.
8. Transport phenomena in liquid extraction.
9. Transport phenomena in polymeric systems.
10. Transport phenomena in fuel cells.

List of Course Group Discussion Topics:

1.Transport phenomena in multiphase systems.
2. Transport phenomena in biological systems.
3. Convective transport processes.
4. Transport phenomena in biomedical systems.
5. Transport phenomena in materials processing.
6. Transport phenomena of ions in electrolytic systems.
7. Transport phenomena in bubbles and drops.
8. Transport phenomena in rotary kilns.
9. Transport phenomena in micro process engineering.
10. Transport phenomena in artificial membranes.

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. Transport phenomena in polymeric membrane fuel cells.
2. Design of an electrolytic absorptive reactor.
3. Problems in food process engineering.
4. Design of hollow fiber membrane reactor.
5. Transport phenomena in polymer blends.

Blog

1. Transport phenomena in biomaterials.
2. Transport phenomena in two-phase micro-channel heat sinks.
3. Design of ultrafiltration unit based on transport phenomena model.
4. A linear theory of transdermal transport phenomena.
5.Ionic transport phenomena in nanofluidics.

Surveys

1. Transport phenomena with single aerosol particles.
2. Transport phenomena during convective drying with superheated steam and moist air.
3. Natural gas conversion in monolithic catalysts: interaction of chemical reactions and transport phenomena.
4. Transport phenomena in chemical vapor-deposition systems.
5. Transport phenomena and reaction in fluidized catalyst beds.

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.

The topics given for individual assessment items are based on the degree of difficulty of problems asked.

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.

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

1. https://www.edx.org/course/the-basics-of-transport-phenomena
2. https://www.edx.org/course/advanced-transport-phenomena-2
3. https://www.edx.org/course/analysis-of-transport-phenomena-i-mathematical-met?utm_source=mitopenlearning-mit-open-learning&utm_medium=affiliate_partner
4. https://www.edx.org/course/analysis-of-transport-phenomena-ii-applications?utm_source=mitopenlearning-mit-open-learning&utm_medium=affiliate_partner

Course Outcomes:
The student will learn to,
1. Solve shell momentum balance problems for simple systems.
2. Solve shell energy balance problems for simple systems.
3. Solve shell mass balance problems for simple system.
4.Set up and solve macroscopic momentum balances for a given system.
5. Set up general equations of continuity and motion.
6. 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	2	1	2	1	1	0	0	0	0	1	0	0	0	1
CO: 2	2	1	2	1	1	0	0	0	0	1	0	0	0	1
CO: 3	2	1	2	1	1	0	0	0	0	1	0	0	0	1
CO: 4	1	1	2	1	0	0	0	0	0	1	0	0	0	0
CO: 5	1	1	2	1	0	0	0	0	0	1	0	0	0	0
CO: 6	1	1	2	0	0	0	0	0	0	1	0	0	0	0

CO attainment levels

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

Future Courses Mapping:

Mention other courses that can be taken after completion of this course
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:
What are the Job opportunities that one can get after learning this course
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

CH3206::PLANT ENGINEERING AND PROJECT ECONOMICS

Course Prerequisites: Chemical Processes, Process equipment design

Course Objectives:

The student will be able to

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

Credits:.5..... **Teaching Scheme Theory: 3** Hours/Week

Tut: 1 Hours/Week

Lab: **2.** Hours/Week

Course Relevance: The study of the subject will help to understand general design considerations, health and safety considerations, different flow diagrams, different types of cost estimations of chemical plants. Move Over this subject also deals with different types of interests, taxes, cash flows, insurance, depreciation and profitability analysis.

SECTION-1

Topics and Contents

Chemical Engineering Plant Design; General Overall Design Considerations, Practical Design Considerations, Basic engineering in process, thermodynamic and kinetic feasibility, process feasibility, capacity identification, and selection process specification equipment specification material selection, Engineering Flow Diagrams: BFD, PFD, and P & ID, Pilot Plant. Health and Safety Considerations; General Design Considerations: Health and Safety Hazards, Loss Prevention: Hazard Assessment Techniques: HAZOP, HAZAN, Fault Tree Analysis, etc., Environmental Protection, Plant Location, Plant Layout, Process Design, Patent considerations Importance of laboratory development to pilot plant, scale up methods.

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

Project Financing and Profitability Analysis: Project Financing Greenfield projects, Add-on projects, ongoing business Interest & Investment Costs: Types of interest: simple interest, ordinary and exact simple interest, nominal and effective interest rates, compound interest, continuous interest. Loan repayment, Periodic payments, annualized cost, capitalized cost, Present worth and discount, annuities, costs due to interest on investment; Borrowed capital versus owned capital, source of capital, income-tax effects, design-engineering practice for interest and investment costs. Taxes and Insurance: Types of taxes: property taxes, excise taxes, income taxes. Insurance, types of insurance. Profitability, Project Evaluation: Break even analysis, incremental analysis, ratio analysis, discounted profit flow technique. Feasibility report, Annual report, alternative investments, and replacements. 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, appreciation of depreciation concept, depreciation rates, the depreciation schedule.

List of Tutorials: (Any Three)

1) Draw flow sheet for a chemical process
2) Study a complete process with PFD
3) Draw plant layout of a chemical process
4) Solve problems based on cost index
5)Solve problems based on capital investment
6)Solve problems based on total product cost estimation
7)Solve problem of different interest rates
8)Solve problems based on cash flow
9)Solve problems based on profitability analysis
10)Solve problems based on depreciation

List of Practicals: (Any Six)

1) To do literature survey of a chemical plant
2)To do material balance of a chemical plant
3)To do energy balance of a chemical plant
4)To do plant layout of a chemical plant
5)To do HAZOP analysis of a chemical plant
6)To do fault tree analysis of a chemical plant
7)To determine costs of various equipments.
8)To estimate the cost of a chemical plant.
9)To estimate capitalized cost of a chemical plant
10) To determine depreciation of various equipments.

List of Projects:
1.General Overall Design Considerations
2.Plant layout of a chemical plant
3.HAZOP analysis of a chemical plant
4.Fault tree analysis of a chemical plant
5.Fixed Capital investment of a chemical plant
6.Capital cost estimation of a chemical plant
7.Cost index of equipments
8.Types of interest, present worth
9.Cash flow calculations
10.Estimation of depreciation of equipments

List of Course Seminar Topics:
1.Factors affecting plant location
2.Different Types of plant layouts
3.Loss prevention methods
4.Different types of plant design
5.Scale up of a chemical plant
6.Different failure modes in chemical plants
7.Factors affecting on cost estimation of a chemical plant
8.Different design steps in a chemical plant design
9.Equipment specification sheet
10.Feasibility study

List of Course Group Discussion Topics:
1.Different Types of Taxes in India
2.Importance of Plant location & layout
3.Importance of Time value of money
4.Profitability analysis
5.Today's need- HAZOP
6.Safety consideration in chemical industry
7.Annuities & its applications
8.Various methods of calculating depreciation
9.Cash flow in chemical industry
10.Role of EPA

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.Profitability analysis of chemical plants
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. GST

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*	*LAB*	*CP*	*VIVA*	*SEM*
15	*15*	*10*	*30*	*10*	*10*	*10*

MSE - Mid Semester Examination
ESE - End Semester Examination
HA - Home Assignment
LAB - Laboratory
CP - Course Project
VIVA - Viva voice
SEM - Seminar
GD - Group Discussion

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

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

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

1. Mahajani V.V., Mokashi S. M. "Chemical Project Economics", Macmillan India Publication , 1st Edition, 2005 .
2 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:
1) The student will be able to describe & design engineering design, drawings and documentation
2) The student will be able to do and describe health & safety analysis
3) The student will be able to estimate & predict cost estimation of chemical plant
4)The student will be able to estimate & describe different types of interest
5) The student will be able to estimate & describe taxes, insurance, profit analysis
6) The student will be able to describe and calculate depreciation

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

CO: 6	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**2**	**1**	**1**

CO attainment levels

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

Future Courses Mapping:

Project Management

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

FF No. : 654

CH3210::OPTIMIZATION TECHNIQUES

Course Prerequisites: Basics of Mathematics

Credits:4 **Teaching Scheme Theory: 3** Hours/Week

Tut: 0 Hours/Week

Lab: 2 Hours/Week

Course Relevance:

SECTION-1
Introduction: Introduction to process optimization; formulation of various process optimization problems and their classification, basic concepts of optimization-convex and concave functions, necessary and sufficient conditions for stationary points. **Unconstrained One Dimensional Optimization:** Optimization of one dimensional functions, Bracketing methods: Exhaustive search method, Bounding phase method. Region elimination methods: Interval halving method, Fibonacci search method, Golden section search method. **Unconstrained Multi Variable Optimization:** Optimality criteria, Direct search methods: Evolutionary optimization method, Powell's conjugate direction method. Gradient-based methods: Cauchy's (steepest descent) method, Newton's method.
SECTION-1I

Constrained Linear Optimization Algorithms: Penalty function method, method of multipliers, Sensitivity analysis, Direct search for constraint minimization: Variable elimination method, complex search method.

Constrained Non-Linear Optimization Algorithms: Software assisted methods for solution of non-linear objective functions and/or constraints, MS Solver utility.

Optimization with Libraries and Packages: Excel for linear and non-liner optimization, MATLAB functions and utilities for optimization, Python library for Optimization

List of Practical: (Any Six)

1. Simulation on optimization of one dimensional functions.
2. Simulation with direct search methods.
3. Simulation with bracketing methods.
4. Simulation with Newton-Rapson methods.
5. Simulation with bisection method.
6. Simulation with secant methods.
7. Simulation with cubic search methods.
8. Simulation with root finding methods.
9. Simulation for constrained optimization.

List of Projects:

1. Optimization of chemical reactor system.
2. Optimization of distillation system.
3. Optimization of bioreactor.
4. Optimization with data analysis
5. Optimization of Adsorbers
6. Optimization of Absorbers

List of Course Seminar Topics:

1. Direct search methods.
2. Newton-Rapson methods.
3. Bisection method.
4. Secant methods.
5. Root finding methods

List of Course Group Discussion Topics:

1. constrained optimization.
2. Bisection method.
3. Secant methods.
4. Root finding methods
5. Constrained optimization.

List of Home Assignments:

Case Study:

1. Distillation Column
2. Reactors
3. Series of equipment

Blog

1. Solar energy harvesting
2. Green technology
3. Efficient way to energy
4. Chemical synthesis
5. Solid waste management

Surveys

1. Thermochemical conversion
2. Biochemical Conversion
3. Carbon capture
4. Solid waste management

Suggest an assessment Scheme:

MSE	*ESE*	*HA*	*LAB*	*CP*	*VIVA*	*GD*
15	*15*	*10*	*20*	*10*	*20*	*10*

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

1.T.F.Edgar and D.M.Himmelblau, optimization of chemical processes, McGraw Hill International editions, Chemical engineering series, 1989.

2. Kalyanmoy Deb ,Optimization for engineering design, Prentice Hall of India,2008.

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

1. G.S. Beveridge and R.S. Schechter, Optimization theory and practice, McGraw Hill, Newyork, 1970.
2. Rekllitis, G.V., Ravindran, A., and Ragdell, K.M., Engineering Optimization- Methods and Applications, John Wiley, New York, 1983.
3. S.S. Rao, Optimization Theory and Applications, Associated Press, 2009.

The student will be able to –

1. Formulate engineering optimization problem from plant data.
2. Solve one dimensional unconstrained optimization problems.
3. Solve multi-dimensional unconstrained optimization problems.
4. Solve multi variable linear constrained optimization problems.
5. Solve multi variable non-linear constrained optimization problems.
6. Apply specific software / packages o solve optimization problems.

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

Job Mapping:

Energy industry

Environmental chemical industry

Biofuel based industry

FF No. : 654

CH3282::ENGINEERING DESIGN AND INNOVATION VI

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

Course Objectives:

The Students will be able to

13. Do literature search appropriately with available tools
14. Defining of project title/idea
15. Allocation of tasks among the team members
16. Team spirit development
17. Write a report, research paper with required format
18. 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
14. Solar based
15. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waster 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

25. https://nptel.ac.in/courses/103/103/103103039/#watch
26. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
27. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
28. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
29. https://www.coursera.org/learn/uva-darden-project-management
30. 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

CH3266::ENGINEERING DESIGN II

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

Course Objectives:

The Students will be able to

19. Do literature search appropriately with available tools
20. Defining of project title/idea
21. Allocation of tasks among the team members
22. Team spirit development
23. Write a report, research paper with required format
24. Present work effectively with concrete results

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

Tut: … 2 Hours/Week

Lab: **……** 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
16. Solar based
17. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waster 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

31. https://nptel.ac.in/courses/103/103/103103039/#watch
32. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
33. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf
34. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
35. https://www.coursera.org/learn/uva-darden-project-management
36. 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

B.Tech. Chemical Structure Pattern D20 (applicable w.e.f. AY 20-21)

Final Year Module -VII

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH4202	PROJECT MANAGEMENT	2	-	-	2
S2	CH4203	PLANT ENGINEERING AND PROJECT ECONOMICS	2			2
S3	CH4205	TRANSPORT PHENOMENA	2	-	-	2
S4	CH4289	MAJOR PROJECT	-	20	-	10
OR						
S1	CH4293	INDUSTRY INTERNSHIP	-	-	-	16
	CH4291	RESEARCH INTERNSHIP				
	CH4294	INTERNATIONAL INTERNSHIP				
	CH4295	CAPSTONE PROJECT				
Total						16

Final Year Module -VIII

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH4208	PETROLEUM ENGINEERING	2	-		2
S2	CH4204	INDUSTRIAL POLLUTION CONTROL	2			2
S3	CH4206	NANOSCIENCE AND NANOTECHNOLOGY	2			2
S4	CH4288	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

FF No. : 654

CH4201::PROJECT MANAGEMENT

Course Prerequisites:

Course Objectives: Understand basics of project management and understand concepts of project conceptualization, feasibility analysis, project planning, implementation & control planning

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

Tut: ……... Hours/Week

Lab: **……...** Hours/Week

Course Relevance:.....

SECTION-1
Topics and Contents Introduction: Definition & Characteristics of Project, Performance Parameters: Time, Cost & Quality. Difference with respect to Standard Routine Production. Classification of Projects: Sector based, Investment based, Technology based, Causation based, Need based (BMERD) - Balancing, Modernization, Replacement, Expansion & Diversification Project Life Cycle Phases – Concept/Initiation Phase: Parameters Involved in Project Identification. Sources of New Project Ideas. Governmental Framework for Identification of Opportunities, Incentives from state & central govt.; Import-substitution projects Project Conceptualization & Feasibility Analysis Project Definition Phase: Project Formulation & Feasibility. Types of Feasibility Studies – Pre-feasibility, Support/Functional, Feasibility Study. Preparation of Project Feasibility Report & Specification; Aspects of Project Feasibility Managerial/Organization: Promoters Background, Criteria of Evaluation, Marketing/Commercial: Demand & Supply, Competition, Market Survey, Porter's 5 Forces, Operational/Technical: Process, Technology, Location, Capacity, Labour, Raw Material & Utility Availability. Financial: Cost of Project, Means of Finance, Financial Projections – Profit & Loss Account, Balance Sheet, Funds Flow Statement, Cash Flow Statement, Schedule of Fixed Assets, Schedule of Term Loans. Socio-Economic: Socio-Cost Benefit Analysis. Effective Rate of Protection, Domestic Resource Cost
SECTION-1I

Topics and Contents

Project Planning, Implementation & Control Planning & Organization Phase: Project Planning, Scheduling & Monitoring, Statement of Works, Project Specifications, Work Breakdown Structure, Network Analysis & Duration Estimating Network Diagrams – PERT/CPM, Estimate Activity Times, Milestone Scheduling. Project Organization & Management. Project Organization Structure, Role of Project Manager.

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.
Mid semester
End semester
Home assignment
CVV

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

1. Narendra Singh; Project Management & Control; Himalaya Publishing House, Mumbai
2. S. Choudary, Project Management, Tata McGraw Hill

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

1. Maylor, Project Management, Pearson Education,
2. Gopal & Ramamurthy; Project Management Handbook; Macmilan.
3. Project Management Body of Knowledge

Moocs Links and additional reading material:

www.nptelvideos.in

Course Outcomes:

Students will be able to:

1. Learn the basic concepts of project and project management
2. Ascertain the feasibility of small and medium projects with respect to managerial, marketing, operational, financial and socio-economic perspectives
3. Plan and schedule small and medium projects to achieve the triple constraint of time, cost
4. Understand the concepts of project risk
5. Monitor the progress of projects to determine variances and recommend corrective actions

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

CO attainment levels

CO1-3; CO2-3; CO3-4; CO4-4; CO5-4; CO6-4

Future Courses Mapping:

Advanced project management courses

Job Mapping:

Better growth opportunities for higher Management positions.

FF No. : 654

CH4203:: PLANT ENGINEERING AND PROJECT ECONOMICS

Course Prerequisites: Chemical Processes, Process equipment design

Course Objectives:

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, appreciation of depreciation concept, 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 Course Seminar Topics:

1.Loss prevention methods
2.Different failure modes in chemical plants
3.Factors affecting on cost estimation of a chemical plant
4. Importance of cost index
5. Different types of cost indices
6. Fault tree analysis
7. Personal safety measures in chemical industries
8. Break even point
9.Cummulative cash position
10.Different methods of depreciation calculations

List of Course Group Discussion Topics:
1.New trends in plant cost estimation
2.Importance of MSDS
3.Importance of Time value of money
4.Profitability analysis
5.Today's need- HAZOP
6.Safety consideration in chemical industry
7.Annuities & its applications
8.Various methods of calculating depreciation
9.Cash flow in chemical industry
10.Role of EPA

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", 4th Edition, McGraw Hill, 1990.

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

1.Mahajani V.V., Mokashi S. M. "Chemical Project Economics", Macmillan India Publication , 1st Edition, 2005 .
2 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

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 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*

FF No. : 654

CH4205::TRANSPORT PHENOMENA

Course Prerequisites:

Introduction to vectors and tensors; basic theory of fluid flow operations, heat transfer and mass transfer.

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: 3** Hours/Week

Tut: 1 Hours/Week

Lab: -- Hours/Week

Course Relevance:

1. Chemical engineering systems where space dimensions are considered are studied within 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.

4. 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.

5. 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
Topics and Contents *Newton's law of viscosity, temperature and pressure dependence of viscosity for gases and liquids. Basics of momentum transport, combined momentum flux. Equation of continuity, equation of motion. Shell momentum balances and boundary conditions. Shell momentum balances for flow of falling film, flow through circular tube, flow through annulus, flow of two adjacent immiscible fluids etc. Fourier law of energy transport. Dependence of thermal conductivity on temperature, pressure. Shell energy balances for heat conduction: Heat flux and temperature distribution for heat sources such as electrical, nuclear, viscous. Heat flux through composite walls.*
SECTION-1I
Topics and Contents *Fick's law of diffusion. Temperature and pressure dependence of diffusivity. Shell mass balances for diffusion through stagnant film, diffusion with homogeneous and heterogeneous chemical reaction, diffusion and chemical reaction inside a porous catalyst etc. Turbulent transport phenomena, Boundary layer theory. Macroscopic momentum, energy and mass balances. Use of macroscopic balances to solve steady state and unsteady state problems.*

List of Tutorials: (Any Three)

1) Shell momentum balance for flow of falling film.

2) Shell momentum balance for flow through a circular tube.

3) Shell momentum balance for flow through annulus.

4) Shell energy balance for heat conduction with an electrical heat source.

5) Shell energy balance for heat conduction with a nuclear heat source.

6) Shell energy balance for heat conduction with a viscous heat source.

7) Shell mass balance for diffusion through a stagnant gas film.

8) Shell mass balance for diffusion with a heterogeneous chemical reaction.

9) Shell mass balance for diffusion with a homogeneous chemical reaction.

10) Shell mass balance for diffusion with diffusion into a falling liquid film.

List of Course Seminar Topics:

1. Transport phenomena in aqueous solutions.

2. Transport phenomena in porous media.

3. Colloid transport phenomena.

4. Electrokinetic transport phenomena.

5. Transport phenomena in biochemical systems.

6. Transport phenomena in nanofluidics.

7. Interfacial transport phenomena.

8. Transport phenomena in liquid extraction.

9. Transport phenomena in polymeric systems.

10. Transport phenomena in fuel cells.

List of Course Group Discussion Topics:

1.Transport phenomena in multiphase systems.

2. Transport phenomena in biological systems.

3. Convective transport processes.

4. Transport phenomena in biomedical systems.

5. Transport phenomena in materials processing.

6. Transport phenomena of ions in electrolytic systems.

7. Transport phenomena in bubbles and drops.

8. Transport phenomena in rotary kilns.

9. Transport phenomena in micro process engineering.

10. Transport phenomena in artificial membranes.

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. Transport phenomena in polymeric membrane fuel cells.

2. Design of an electrolytic absorptive reactor.

3. Problems in food process engineering.

4. Design of hollow fiber membrane reactor.

5. Transport phenomena in polymer blends.

Blog

1. Transport phenomena in biomaterials.

2. Transport phenomena in two-phase micro-channel heat sinks.

3. Design of ultrafiltration unit based on transport phenomena model.

4. A linear theory of transdermal transport phenomena.

5.Ionic transport phenomena in nanofluidics.

Surveys

1. Transport phenomena with single aerosol particles.

2. Transport phenomena during convective drying with superheated steam and moist air.

3. Natural gas conversion in monolithic catalysts: interaction of chemical reactions and transport phenomena.

4. Transport phenomena in chemical vapor-deposition systems.

5. Transport phenomena and reaction in fluidized catalyst beds.

Suggest an assessment Scheme:

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. 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.

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

1. https://www.edx.org/course/the-basics-of-transport-phenomena
2. https://www.edx.org/course/advanced-transport-phenomena-2
3. https://www.edx.org/course/analysis-of-transport-phenomena-i-mathematical-met?utm_source=mitopenlearning-mit-open-learning&utm_medium=affiliate_partner
4. https://www.edx.org/course/analysis-of-transport-phenomena-ii-applications?utm_source=mitopenlearning-mit-open-learning&utm_medium=affiliate_partner

Course Outcomes:

The student will learn to,

1. Solve shell momentum balance problems for simple systems.

2. Solve shell energy balance problems for simple systems.

3. Solve shell mass balance problems for simple system.

4.Set up and solve macroscopic momentum balances for a given system.

5. Set up general equations of continuity and motion.

6. 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	PSO:12	PSO:13
CO:1	2	1	2	1	1	1	1	1	1	1	0	3	1
CO:2	2	1	2	1	1	1	1	1	1	1	0	3	1
CO:3	2	1	2	1	1	1	1	1	1	1	0	3	1
CO: 4	2	1	2	1	1	1	1	1	1	1	0	3	1
CO: 4	2	1	2	1	1	1	1	1	1	1	0	3	1
CO: 4	2	1	2	1	1	1	1	1	1	1	0	3	1

CO attainment levels

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

Future Courses Mapping:

The scope of transport phenomena is such that it covers all chemical engineering subdisciplines and finds applications in real life problems.

Advance Transport Phenomena

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 troubleshooting.

FF No. : 654

CH4289::MAJOR PROJECT

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

Course Objectives:

The Students will be able to

13. Do literature search appropriately with available tools
14. Defining of project title/idea
15. Allocation of tasks among the team members
16. Team spirit development
17. Write a report, research paper with required format
18. 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. 7.Potable Water
8. Solar based
9. Modeling and Simulation
10. Waste water treatment
11. Air pollution
12. Solid waster management
13. 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

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

FF No. : 654

CH4208::PETROLEUM ENGINEERING

Course Prerequisites: Basics of Chemical technology, Chemistry

Course Objectives:

1. Comprehend properties of petroleum products.
2. Understand pre-refining operation based on feed composition.
3. Comprehend cracking and reforming processes.
4. Understand coking and additive production processes.
5. Comprehend product refining operation and effect of additives.
6. Understand safety aspect during handling petroleum product.

Credits: 04

Teaching Scheme Theory: 02**..** Hours/Week

Tut: .... Hours/Week

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

Course Relevance:

Petroleum is major portion of chemical engineering industry. Knowing different properties of petroleum is of crucial for processing and selecting proper process to get maximum output in term of quality and quantity of product. This course will enable to understand petroleum feed, product qualities, different process to process crude for product, different additives for getting better product with understanding safety aspect involved during process.

SECTION-1

Topics and Contents

Petroleum composition, specifications of petroleum and some petroleum products such as LPG, Gasoline, Kerosene, Diesel oil and Engine oil.

Pre- refining operations: Settling, Moisture removal, Storage, Heating through exchangers and pipe seal heaters, Atmospheric distillation, Vacuum distillation

Significant conversion units such as, Reforming, Catalytic-Cracking, Hydro-cracking.

SECTION-1I

Topics and Contents

Coking and Thermal Processes: Delayed coking, Flexi coking, Fluid coking.

Additives Production such as Ether and Isobutylene production

Refining of petroleum products such as Acid refining, Chemical refining, Hydro-refining, HDS, HDM, HAD.

Blending, Additives, Storage of products, Transportation, Housekeeping, Marketing of petroleum and petroleum products, Safety norms for petroleum products.

List of Tutorials: (Any Three)

1) Specification of petroleum

2) Specification of Gasoline, diesel, kerosene, engine oil etc.

3) Pre refining processes

4) atmospheric distillation

5) vacuum distillation

6) Coking

7) Thermal process for cracking

8) refining petroleum product

9) Additives in Petroleum products

10) Safety norms for handling petroleum product

List of Practicals: (Any Six)

1) Study of world oil reservoirs.

2. Study of Indian oil reservoirs.

3. Study of Indian oil refineries.

4. Study of pre-refinery crude oil operations.

5. Study of properties of petroleum products.

6. Study of different additives and blending chemicals.

7. Study of post refinery crude oil operations.

8. Study of recent trends in petrochemicals in terms of packaging materials.

9. Study of recent trends in petrochemicals in terms of catalyst.

10. Study of recent trends in petrochemicals in terms of distillation.

11. Study of recent trends in marketing of petroleum products.

12. Study of safety norms of petroleum product.

List of Projects:

1. A project on design of fire heaters
2. A project on design of multistage atmospheric distillation column
3. A project on design of vacuum distillation column
4. A project on properties of gasoline.
5. A project on properties of diesel.
6. A project on properties of kerosene.
7. A project on properties of lubricating oil.
8. A project on overview of refinery processes.
9. A project on design of pipe still heater.
10. A project on gas to liquid technology.
11. A project on purification of natural gas.
12. A project on liquefaction of natural gas.

List of Course Seminar Topics:

1. Origin and composition of crude oil
2. Reserves and deposit of crude oil
3. Thermal properties and test methods for natural gas
4. Thermal properties and test methods for gasoline
5. Thermal properties and test methods for diesel
6. Thermal properties and test methods for lube oil/engine oil
7. Pretreatment of crude oil
8. Heating of crude- Pipe still heater
9. Distillation of crude oil
10. Blending and additives of gasoline
11. Catalytic cracking of crude oil
12. Hydro cracking of crude oil
13. Reforming
14. Marketing of petroleum and petroleum products
15. Storage of petroleum and petroleum products
16. Transportation of petroleum and petroleum products

List of Course Group Discussion Topics:

1. Properties of gasoline and its effect on engine performance
2. Properties of diesel and its effect on engine performance
3. Need and pretreatment of crude oil
4. Atmospheric distillation Vs Vacuum distillation
5. Catalytic cracking Vs hydro cracking
6. Hydro treating and its importance in petroleum refinery
7. Fall in Crude Oil Prices and its Implications
8. Different modes of transportation of petroleum products and Safety norms
9. Different modes of storage of petroleum products and Safety norms
10. Sulfuric acid alkylation Vs hydrofluoric acid alkylation
11. Isomerization process and its importance in petroleum refinery
12. Wax in crude and its purification
13. Gasoline treatment and its need

List of Home Assignments:

Design:

1. Design of pipe still heater
2. Design of multistage atmospheric distillation column
3. Design of solvent extraction process
4. Design of H2S absorption column
5. Design of multicomponent distillation column in refinery

Case Study:

1. Oil industry safety and fire incidents
2. India's dependency on crude oil and analysis of alternative sources
3. Refineries and modernization
4. Evolution of FCC unit configuration
5. Petroleum feed condition effect on product

Blog

1. Where Would We Be Without...Petroleum Products?
2. How Much Oil is Left in the World?
3. OPEC: 15 key insights
4. Snapshot of Gasoline market dynamics: 2019
5. Uniqueness of multicomponent distillation column for petroleum refining.

Surveys

1. Reserve and deposits of world
2. Petro Glimpses and Petroleum industries in India
3. World energy requirement and fissile fuel
4. How long crude oil will last?
5. fossil verses other energy resources

Suggest an assessment Scheme:

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. Gary James, Handwerk, Glenn, Kaiser, Mark; Petroleum Refining: Technology and Economics; 5th Edition, Taylor and Francis - CRC Press, 2005.

2. Nelson W. L.; Petroleum refinery Engineering; 3rd Edition, John Wiley and Sons New York, 1985.

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

Coursera course :
https://www.coursera.org/learn/oilandgas?utm_source=gg&utm_medium=sem&utm_content=94-BrandedSearch-IN&campaignid=1776545273&adgroupid=71792235071&device=c&keyword=courseera&matchtype=b&network=s&devicemodel=&adpostion=&creativeid=442149625903&hide_mobile_p

romo=&gclid=CjwKCAjw26H3BRB2EiwAy32zhWC7Rb6-M2q5nCMXB1k_aU0T1hlGthE1haYkrqYJt0W8hO3UNdBeghoCeS8QAvD_BwE

Udemy coourse: https://www.udemy.com/courses/search/?src=ukw&q=petroleum

Course Outcomes:

The student will be able to –

1. Find out composition, main characteristics and new trends of petroleum products
2. Select pre-refining operation depending on feed composition
3. Describe cracking and reforming processes
4. Describe coking and additive production processes
5. Select product refining operations and additives to increase quality of petroleum products
6. Develop knowledge of safety during storage, transportation and marketing of petroleum product

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	1	1	1	1	1	0	1	1	1
CO2	1	1	1	1	1	1	1	1	1	1	0	1	1	1
CO3	1	1	1	1	1	1	1	1	1	1	0	1	1	1
CO4	1	1	1	1	1	1	1	1	1	1	0	1	1	1
CO5	1	1	1	1	1	1	1	1	1	3	0	1	1	1
CO6	1	1	1	1	1	1	1	1	1	2	0	1	1	1

CO attainment levels

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

Future Courses Mapping:

Advances in Petroleum field

Job Mapping:

Petroleum refinery jobs

Designing companies for petroleum refinery

FF No. : 654

CH4204::INDUSTRIAL POLLUTION CONTROL

Course Prerequisites:

Course Objectives:

To understand Pollution Control in Process Industries

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

Tut: ……... Hours/Week

Lab: **……...** Hours/Week

Course Relevance:.....

SECTION-1
Pollution and its measurement*: Types of pollutions, pollution control aspects, industrial emissions of liquids and gaseous pollutants, environmental legislations, Industrial waste water analysis, industrial gaseous effluent analysis, particle size distribution* ***Removal of organic matter:*** *Biological oxidation, bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, biological oxidation units, anaerobic treatment* ***Removal of chromium****: Control methods, reduction precipitation, lime coagulation, adsorption* ***Removal of mercury****: Removal of mercury from gaseous streams, removal of mercury from liquid streams* ***Removal of particulate matter****: particulate dynamics, separation of particulate matter from effluent gases, preliminary methods of separation* ***Removal of phenolic effluents****: sources of phenol, treatment, removal*
SECTION-1I

Removal of sulphur dioxide*: effects of sulphur dioxide, control methods, reduction of sulphur dioxide concentration, wet process.*

Removal of oxides of nitrogen*: analysis of NOx, control measures.*

Waste water treatment processes: *Design concepts for primary treatment, grid chambers and primary sedimentation basins, biological treatment, Bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, process design relationships and analysis, determination of kinetic coefficients, activated sludge process.*

Pollution Control in Process Industries : *Study of environment pollution from process industries and their abatement. Fertilizer, paper and pulp, petroleum and petrochemicals, tanning industries, sugar industries etc*

List of Practicals: (Any Six)

1. Determination of acidity of various water samples.
2. Determination of the alkalinity of various water samples.
3. Determination of the chloride content in the given water samples.
4. Determination of the optimum coagulant dose for the removal of maximum turbidity
5. Determination of the hardness of the given water sample
6. Determination of the iron content of water samples
7. Determination of Dissolved oxygen of water
8. Determination of Biochemical oxygen demand (B.O.D.) of given Water / wastewater samples (BOD_5)
9. Determination of Chemical oxygen demand (COD) of a given sample.
10. Determination of sulphate content of the given water sample

List of Projects:

1. Solid waste management
2. Water pollution control
3. Gaseous Pollution
4. Particulate pollution

List of Course Seminar Topics:

1. Pollution control in Dairy industry
2. Pollution control in Pharma Industry
3. Pollution control in Sugar Industry
4. Pollution control in petroleum industry

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. Kiely Gerard; Environmental Engineering; Special edition 2007.,TataMcGraw-Hill International
2. Metcalf and Eddy; Wastewater Engineering,; 3rd edition., Tata McGraw Hill Publishers
3. Rao C.S; Environmental Pollution Control Engineerin;, 2nd edition., New Age International (P) Ltd
4 Sasikumar K.; Solid Waste Management; 1st edition2009, Prentice Hall India Learning Private Limited

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

1.Flagan R.C. and Seinfield J.H; Fundamentals of Air Pollution Engineering; 1988., Prentice Hall
2. Crowford Martin; Air Pollution Control Theory; 1st edition. McGraw Hill Publishers

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

Course Outcomes:
The student will be able to –
1.Identify hazardous pollutants in the plant or area.
2. Design reduction method and pollution treatment technique.
3. Develop the analysis techniques for different pollutants.
4. To determine the pollution level with respect to the pollution standards.
5. Analyze the impact of various factors on the environment.
6. Determine the suitability of water for different usage.

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	1	1	1	1	1	0	1	1	1
CO2	1	1	1	1	1	1	1	1	1	1	0	1	1	1
CO3	1	1	1	1	1	1	1	1	1	1	0	1	1	1
CO4	1	1	1	1	1	1	1	1	1	1	0	1	1	1
CO5	1	1	1	1	1	1	1	1	1	1	0	1	1	1
CO6	1	1	1	1	1	1	1	1	1	1	0	1	1	1

CO attainment levels

CO	Attainment level
1	3

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

Future Courses Mapping:

Advance Industrial Pollution Control

Job Mapping:
Pollution control boards, regulatory boards

FF No. : 654

CH4206::NANOSCIENCE AND NANOTECHNOLOGY

Course Prerequisites:

None

Course Objectives:

1. To get an overview of the state of the art, historical development and future trends in nanoscience and nanotechnology
2. To understand the various characterization techniques which lie at the heart of the development of the field
3. To understand various methods of synthesis and industrial production of nanosystems

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

Course Relevance:

The course aims to provide an overview of the highly multidisciplinary field of nanoscience and nanotechnology which has a vast range of applications.

SECTION-1
Section I: Overview, Physics of Nanomaterials, Characterization *Introduction: Histroical development of nanotechnology. Overview of nanotechnology. Global trends. Overview of typical products in market utilizing nanotechnology.* *Physics of Nanomaterials: Coverage of physics of materials appropriate for applications to nanotechnology* *Characterisation of Nanomaterials: Microscopy techniques, spectroscopy techniques, XRD etc*
SECTION-1I

Section II: Synthesis, Applications, Socio-Economic & Environmental Aspects

Synthesis / Fabrication of nanomaterials: Top-down and bottom-up approaches for synthesis of nanomaterials. Industrial scale production of nanomaterials.

Applications of Nanotechnology: Current and potential applications of nanotechnology. Biological nanomaterials. Nanoelectronics. Nanomachines& nanodevices etc.

Research directions.

Economic, environmental and societal aspects of nanotechnology.

List of Course Seminar Topics:

1. Risk potential and analysis of nanomaterials
2. Nanotechnology for waste water treatment
3. Opportunities in nanotechnology
4. Nanofluids for lubrication
5. Application of functionalized nanoparticles for remediation of organic pollutants
6. Study of characterization tools for surface topography
7. wearable electronics
8. Nanotechnology in diagnosis and treatment
9. lab on a chip
10. Design and development of nanocatalysts for host of applications
11. Electron microscopy and its history
12. Advancements in quantum sensors for Bio applications
13. Quantum computers in surface metrology
14. Quantum polymers, their properties and applications
15. Plasma technology and its applications in reference to nanosynthesis
16. Advanced analytical tools for nanomaterials characterization

List of Home Assignments:

Design:

1. Nanomaterials for heat exchange applications
2. Polymer based nanocomposites
3. Nanoadsorbents for contaminants remediation
4. Measuring the flow of nanoparticles using flow meters
5. Design of a carbon nanotube manufacturing plant

Case Study:

1. Materials innovation for 3D printing
2. Additive manufacturing and its benefits to aerospace industry
3. Carbon nanotube sensors for gas detection
4. Optical fiber sensor to monitor energy storage
5. Machine learning in nanotechnology

Blog

1. Is it too soon to call 3D printing a clean technology?
2. How could Graphene be used in future optical communications?
3. Can Nanodiamonds be used for next generation energy storage?
4. How can nanophotovoltaics help in the maximum efficiency of energy generation?
5. Applications of deep learning in nanotechnology

Surveys

1. comparison between particle analysis techniques
2. Application of nanoparticles in the remediation of heavy metals
3. Nanomaterials in protective coatings
4. Nanotechnology in agriculture
5. Career opportunities for chemical engineers in nanotechnology

Suggest an assessment Scheme:

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

MSE - Mid Semester Examination

ESE - End Semester Examination

HA - Home Assignment

VIVA - Viva voice

SEM - Seminar

Text Books:

1. R. W. Kelsall et al, "Nanoscale Science and Technology", John Wiley and Sons, 2005.
2. C. P. Poole Jr, F. J. Owens, "Introduction to Nanotechnology", Wiley India, 2006.
3. D. J. Griffiths, "Introduction to Quantum Mechanics", D.J. 2nd ed. Pearson, 2005.

Reference Books:

1. B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer, 2004.

Moocs Links and additional reading material:

1. P. Haridoss, "Nanotechnology: Science and Applications', NPTEL, [Online]. Available: https://nptel.ac.in/courses/113/106/113106093/
2. A. Subramaniam and K. Balani, "Nanostructures and Nanomaterials: Characterization and Properties", NPTEL, [Online]. Available: https://nptel.ac.in/courses/118/104/118104008/

Course Outcomes:

The student will be able to –

1. describe history of nanotechnology
2. understand basics of physics and chemistry involved in nanotechnology
3. explain the major characterization techniques used in nanotechnology
4. classify and describe various nanosynthesis methods
5. analyze any given nanotechnology product / process in terms of characterization techniques, synthesis methods and applications
6. analyze current and future trends

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	**4**
4	**4**
5	**4**
6	**3**

Future Courses Mapping:
None

Job Mapping:

1. *Research organisations carrying out nanosystems research*
2. *Industrial research divisions*
3. *Postgraduate education*
4. *Entrepreneurship in nanomaterials manufacturing*

FF No. : 654

CH4288::MAJOR PROJECT 2

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

Course Objectives:

The Students will be able to

19. Do literature search appropriately with available tools
20. Defining of project title/idea
21. Allocation of tasks among the team members
22. Team spirit development
23. Write a report, research paper with required format
24. 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
1. Personal Health
2. Social health
3. Hygiene
4. Energy
5. Environment
6. 7.Potable Water
7. Solar based
8. Modeling and Simulation
9. Waste water treatment
10. Air pollution
11. Solid waster management
12. 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

37. https://nptel.ac.in/courses/103/103/103103039/#watch
38. https://www.honeywellprocess.com/en-US/explore/solutions/integrated-technology/Pages/leap.aspx
39. https://www.gtu.ac.in/uploads/GIC%20Compendium%20IDP-UDP.pdf

40. https://www.udemy.com/course/leadership-psychology-cultivate-creativity-and-innovation/
41. https://www.coursera.org/learn/uva-darden-project-management
42. 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 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

FF No. : 654

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
digital record duly signed by competent authority.
3. Total Internship period is minimum 16 weeks or 4 months.
4. Internship undertaken is to be Research Internship.
5. Students need to submit monthly reports on Research Project.
6. Final presentation (CVV) would be conducted at the end of semester.
7. 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
digital record duly signed by competent authority.
3. Total Internship period is approximately 16 weeks or 4 months.
4. Internship undertaken to be taken outside India as Industrial Internship or Research
Internship.
5. Students need to submit monthly reports on Industry Project/Research Project.
6. Final presentation (CVV) would be conducted at the end of semester.
7. 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

CH4295::CAPSTONE PROJECT

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 Educational Objectives (PEOs)

Graduates of the B. Tech. chemical engineering program should be able to utilize the expertise gained from the program to:

1. Pursue industrial and research careers in a global environment.

2. Successfully undergo a postgraduate program.

3. Contribute to multidisciplinary fields such as food and biotechnology, nanotechnology and advanced materials, energy and environmental engineering, product design etc.

4. Demonstrate a zeal for life-long learning.

5. Function effectively in teams, displaying ethical conduct.

PROGRAM OUTCOMES:

Engineering Graduates will be able to:

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

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

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

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

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

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

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

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

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

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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

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

PROGRAM SPECIFIC OUTCOMES

Engineering Graduates will be able to:

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

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