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 'B22/C22/D22'

Effective from Academic Year 2022-23

B.Tech. Chemical Structure Pattern B22 (applicable w.e.f. AY 22-23)

Second Year Module -III

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	MD2201	DATA SCIENCE	2	2	1	4
S2	CS2221	INTERNET OF THINGS	2	2	1	4
S3	ME2205	3D PRINTING	2	2	1	4
S4	CS2218	OBJECT ORIENTED PROGRAMMING			-	4
S5	CH2285	ENGINEERING DESIGN AND INNOVATION – I	-	8	-	6
S6	CH2291	DESIGN THINKING-3	-	-	1	1
		Total	14	16	3	23

Second Year Module - IV

Subject head	Course code	Course name	Contact hours per week			Credits
			Theory	Lab	Tut	
S1	CH2221	FLUID FLOW OPERATIONS	2	2	1	4
S2	CH2223	CHEMICAL PROCESSES	2	2	1	4
S3	CH2222	PARTICULATE TECHNOLOGY	2	2	1	4
S4	CH2224	PHYSICAL AND ORGANIC CHEMISTRY	2	2	1	4
S5	CH2286	ENGINEERING DESIGN AND INNOVATION – I	-	12	-	6
S6	CH2292	DESIGN THINKING-3	-	-	1	1
		Total				23

FF No. : 654

CH2221::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 behaviors
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 the development of hydrodynamic boundary layers and its impact on momentum transport.
5. To learn to apply the equations of laminar flow for pressure drop and power requirements.
6. To learn fluid transportations systems and power requirement in the transportations of fluids

Credits: 4

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

Course Relevance:

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.*

SECTION-1I

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

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 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 Course 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 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.

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

ESE - End Semester Examination
HA - Home Assignment
CP - Course Project
VIVA - Viva voice
SEM - Seminar

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

1. 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. 1, 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. Determine the effect of boundary layer formation on the fluid flow.
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

CH2223:: 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 process flow sheets for production of specific chemical products.
4. To understand energy balance over a unit.
5. To understand steady state, recycle, by-pass, purge, BFD, PFD, manufacturing processes and material and energy balance for them

Credits: 4 **Teaching Scheme Theory: 2** 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
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, Mass balance with chemical reactions,single, multiple reactions, excess and limiting reactants, conversion, yield and selectivity. *Material balance with recycle, bypass and purge operation. Chlor-Alkali Industry: Chlor-alkali processes and PFD, Manufacturing of soda ash, caustic soda*

SECTION-1I

Sensible heat changes in gases, liquids and solids, latent heat of phase change, Enthalpy

changes in pure substances and their mixtures, Heat of solutions, 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,

Simultaneous material and energy balance. Nitrogen industry: PFD and manufacturing of urea, ammonia, nitric acid Sulfur industry: PFD and manufacturing of sulfur and sulfuric acid, Petroleum industry: Overview of refinery process

List of Practicals: (Any Six)

1. Draw process flow diagram
2. Material balance on unit process at steady state
3. Material balance with simultaneous equation
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. Prepare conversion of units chart.
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. Extraction and Its material balance
3. Humidification
4. Heat of reaction
5. Distillation and Its material balance
6. Different gas laws used in chemical operations
7. Recycle & bypass operations
8. Drying and Its material balance
9. Reactor and Its material balance
10. Material & energy balance of evaporator
11. Crystallization and Its material balance
12. Absorption and Its material balance

List of Home Assignments:

Design:

1. Material balance of reactor in sulfuric acid manufacturing
2. Material balance of reactor in nitric acid manufacturing
3. Material balance of reactor in phosphoric acid manufacturing
4. Material balance of reactor in soda ash manufacturing
5. Material balance of reactor in urea manufacturing

Case Study:

1. Separation processes used in ammonia manufacturing.
2. Separation processes used in ammonium nitrate manufacturing.
3. Separation processes used in ethanol manufacturing.
4. Separation processes used in cement manufacturing.
5. Separation processes used in methanol manufacturing.

Blog

1. Importance of petroleum industry.
2. Importance of Chloro alkali industry.
3. Importance of sulfur industry.

4. Importance of fertilizer industry.
5. Importance of the food industry.

Surveys

1. Review of petroleum industry products, equipment, cost.
2. Market survey of a chemical process.
3. Review of soaps and detergents industry products, equipment, cost.
4. Review of paint industry products, equipment, cost.
5. Review of sugar industry products, equipment, cost.

Suggest an assessment Scheme:

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

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

ESE - End Semester Examination
HA - Home Assignment
CP - Course Project
VIVA - Viva voice
SEM – Seminar

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

1. 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.

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:

Course Outcomes:

Student should be able to

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 material balances for unit operations and unit processes.
3. Perform material balances for recycling, by-passing and purging operations
4. Perform energy balances for unit operations
5. Perform energy balances for unit processes
6. Apply knowledge of chemical technology in unit operations and unit processes happening in chemical industry

CO PO Map

co/ po	po1	po2	po3	po4	po5	po6	po7	po8	po9	po10	po11	po12	pso13	pso14
CO:1	2	1	3	1	1	1	1	0	0	1	1	1	2	1
CO:2	2	2	3	2	2	1	1	0	0	1	1	1	3	1
CO:3	2	2	3	2	2	1	1	0	0	1	1	1	3	1
CO:4	2	2	3	2	2	1	1	0	0	1	1	1	3	1
CO:5	2	2	3	2	2	1	1	0	0	1	1	1	3	1
CO:6	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

CH2222::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:4 **Teaching Scheme Theory: 2** 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 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 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.

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

ESE - End Semester Examination
HA - Home Assignment
CP - Course Project
VIVA - Viva voice
GD - Group Discussion

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

1. 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 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

CH2224::PHYSICAL AND ORGANIC CHEMISTRY

Course Prerequisites: Fundamentals of Chemistry such as chemical bonding, physical and chemical changes, organic reactions, conventional and analytical tools

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: 2 Hours/Week
Tut: 1 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 ΔH°, 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.

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,

List of Tutorials

1. BET Adsorption Isotherm
2. Standard Electrode Potential and Applications of Electrode Potential
3. Study of Biocatalysis and its Applications.
4. Gas Chromatography.
5. Artificial Intelligence and Machine learning.
6. Numericals on heat of reactions.

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 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 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
4. Enthalpy changes in some physical and chemical processes
5. Similarities between transition metals and representative metals
6. Experimental determination of order of reaction
7. Dynamic nature of chemical equilibrium and applications of equilibrium constant
8. Separation and purification of organic compounds
9. Contribution of alkanes to the Greenhouse effect
10. Ecological threats - causes and effects
11. Industrial waste - cause, effect, treatment
12. Biocatalysts - advantages & limitations
13. 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:

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

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

ESE - End Semester Examination
HA - Home Assignment
CP - Course Project
VIVA - Viva voice
GD - Group Discussion

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

1. 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

CH2286::ENGINEERING DESIGN AND INNOVATION I

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: 06 **Teaching Scheme Theory: …..** Hours/Week

Tut: ……... Hours/Week

Lab: **12** 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 waste management
13. Low-cost product development

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

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

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

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

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

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

Course Outcomes: The student will be able to –

1. Apply chemical engineering knowledge.
2. 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 and write report

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

CH2292::DESIGN THINKING 3

Course Prerequisites: Basic principles of Science

Course Objectives:

To provide ecosystem for paper publication and patent filing

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

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

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

List of Project areas:

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

Suggest an assessment Scheme:
Based on the quality of paper publication they are assessed.

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

Course Outcomes: The student will be able to –

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

CO PO Map

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

CO4	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**3**	**1**	**1**	**1**	**1**
CO5	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**
CO6	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**3**	**0**	**1**	**0**	**0**
CO7	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**

CO attainment levels

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

Future Courses Mapping:

Next semester project, BTech course project

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