II Year Course structure									
Semester - I									
Course Code	**Title of the course**	**Category**	**L**	**T**	**P**	**Credits**	**Sessional Marks**	**SEE Marks**	**Total Marks**
23MA1106	Vector Calculus & Statistical Methods	BS	2	1	0	3	40	60	100
23CH3102	Instrumentation and analytical techniques	ES	2	1	0	3	40	60	100
23CH3103	Biology for Engineers	ES	2	0	0	2	100	0	100
23CH4102	Chemical Process Calculations	PC	2	1	0	3	40	60	100
23CH4103	Momentum Transfer	PC	2	1	0	3	40	60	100
23CH4104	Mechanical Operations	PC	2	1	0	3	40	60	100
23CH4201	Momentum Transfer Lab	PC	0	0	3	1.5	50	50	100
23CH4202	Mechanical Operations Lab	PC	0	0	3	1.5	50	50	100
23TP9101	Logical Reasoning & Corporate skills	HS	0	0	2	1	50	50	100
23MC0104	Entrepreneurship Development & IPR	MC	2	0	0	0	100	0	100
Total			**14**	**5**	**8**	**21**	**550**	**450**	**1000**
Semester - II									
Course Code	**Title of the course**	**Category**	**L**	**T**	**P**	**Credits**	**Sessional Marks**	**SEE Marks**	**Total Marks**
23MA1110	Complex Variables & Regression Analysis	BS	2	1	0	3	40	60	100
23ME3104	Design Thinking	ES	1	0	2	2	40	60	100
23CH4105	Chemical Engineering Thermodynamics	PC	2	1	0	3	40	60	100
23CH4106	Chemical Technology	PC	3	0	0	3	40	60	100
23CH4107	Heat transfer	PC	2	1	0	3	40	60	100
23CH9101	Artificial Intelligence for Chemical Engineers	SC	1	0	0	1	100	0	100
23CH511*	Professional Elective-I	PE	3	0	0	3	40	60	100
23CH4203	Heat Transfer Lab	PC	0	0	3	1.5	50	50	100
23CH9201	Artificial Intelligence Lab	SC	0	0	3	1.5	50	50	100
23TP9102	Numerical Ability & Professional Communication skills	HS	0	0	2	1	50	50	100
23MC0103	Financial literacy	MC	2	0	0	0	100	0	100
Total			**16**	**3**	**10**	**22**	**590**	**510**	**1100**

VECTOR CALCULUS & STATISTICAL METHODS
(Common to CHEMICAL and CIVIL)

23MA1106 **Credits:3**

Instruction : 3 periods & 1 Tutorial/Week Sessional Marks:40
End Exam : 3 Hours End Exam Marks:60

Prerequisites: Differentiation, Integration and functions.

Course Objectives:

The aim of this course is to introduce basic fundamentals of vector calculus, formulate and solve first order partial differential equations and its applications.

Course Outcomes: At the end of the course, students will be able to do

1. Explain the characteristics of scalar and vector valued functions and provide a physical interpretation of the gradient, divergence, curl and related concepts.
2. Transform line integral to surface integral, surface to volume integral and vice versa using Green's theorem, Stoke's theorem and Gauss's divergence theorem.
3. Construct partial differential equation of a given equation and solve first order partial differential equations and their applications.
4. Analyze the basic principles of statistical measures.
5. Examine, analyze and compare probability distributions**.**

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

CO-PO-PSO Justification	
1	CO1 deals with finding the gradient, div and curl of a given vector point functions and these fundamental concepts in vector calculus are widely used in many areas of engineering.
2	CO2 deals with vector integration like line, surface and volume integrals and these are widely used in various fields of engineering.
3	CO3 deals with formation, finding solution and applications of PDE and there are widely used in various fields of engineering.
4	CO4 deals with knowledge of statistical central and dispersion measures.
5	CO5 deals with knowledge of probability distributions and is widely used in many areas of engineering.

SYLLABUS

UNIT I **10 Periods**

VECTOR DIFFERENTIATION

Scalar and vector point functions – Del applied to scalar point functions – Directional derivative – Del applied to vector point functions – Physical interpretation of divergence and curl – Del applied twice to point functions – Del applied to products of point functions.

UNIT II **10 Periods**

VECTOR INTEGRATION

Integration of vectors – Line integral , circulation, work done – Surface integral , flux – Green's theorem in the plane – Stoke's theorem – Volume integral – Gauss divergence theorem (all theorems without proofs) – Irrotational and solenoidal fields.

UNIT III **10 Periods**

PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS

Introduction – Formation of partial differential equations by eliminating arbitrary constants and functions – Solutions of a partial differential equations by direct Integration – Linear equations of the first order (Lagrange's linear equations).

APPLICATIONS : Method of separation of variables – Vibrations of a stretched string: Wave equation – One dimensional heat flow equation ($\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$), and two dimensional heat flow equation. (i.e. Laplace equation : $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$).

UNIT IV **10 Periods**

STATISITCS

Measures of central tendency : Mean, Median, Mode, Geometric mean, Harmonic mean.

Measures of dispersion : Quartile deviation, Mean deviation, Standard deviation, Variance.

UNIT V **10 Periods**

PROBABILITY AND DISTRIBUTIONS

Introduction – Basic terminology – Probability and set notations – Addition law of probability – Independent events – Baye's theorem – Random variable – Discrete probability distribution: Binomial distribution – Continuous probability distributions: Poisson distribution and normal distribution (mean , variance , standard deviation and their properties without proofs).

TEXT BOOKS:

B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

REFERENCE BOOKS:

1. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. **N. P. Bali**, Engineering Mathematics, Lakshmi Publications.
3. **George B. Thomas, Maurice D. Weir and Joel Hass**, Thomas, Calculus, 13/e, Pearson Publishers, 2013.
4. **H. K. Dass**, Advanced Engineering Mathematics, S. Chand and complany Pvt. Ltd.
5. **Michael Greenberg**, Advanced Engineering Mathematics, Pearson, Second Edition.

Instrumentation and analytical techniques

Course Code: 23CH3102 **Credits:3**

Instruction: L- 3 T-0 P-0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites:

Course Objectives:

- To understand various techniques and methods of different types of Spectrometer.
- To understand the working Principle and application of Chromatography.
- To study important methods of analysis of industrial gases.
- To understand the important radio chemical methods of analysis.
- To impart knowledge on NMR and Mass spectrometry.

Course Outcomes:

At the end of the course the students will be able to

CO1. Understand various techniques and methods of Spectral analysis.

CO2. Apply the knowledge of chromatography to separate the constituents from a complex mixture.

CO3. Able to get adequate knowledge about Gas sensor and pollution monitoring instruments.

CO4. Able to select an appropriate analyzer for an Industrial requirement.

CO5. Able to understand the working principle of NMR and Mass spectroscopy.

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **12L**

SPECTROPHOTOMETRY

Spectral methods of analysis– Beer-Lambert law – UV-Visible spectrophotometers – Single and double beam instruments , Sources and detectors – IR Spectrophotometers – Types – Attenuated total reflectance flame photometers – Atomic absorption spectrophotometers – Sources and detectors – FTIR spectrophotometers – Flame emission photometers – Fluorescence spectrophotometer.

UNIT II **12L**

CHROMATOGRAPHY

Different techniques – Techniques by chromatographic bed shape: Column chromatography-Planer Chromatography-Paper Chromatography-Thin layer Chromatography-Applications - Techniques by physical state of mobile phase: Gas chromatography – Sources- Detectors – Liquid chromatographs – sources- detectors- Applications – High-pressure liquid chromatographs – sources-detectors- Applications- Techniques by separation mechanism: Ion exchange chromatography-size-exclusion chromatography-Applications

UNIT III **12L**

INDUSTRIAL GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS

Types of gas analyzers: Oxygen, NO2 and H2S types, IR analyzers, thermal conductivity analyzers, analysis based on ionization of gases. Air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide estimation - Dust and smoke measurements**.**

UNIT IV **12L**

pH METERS AND DISSOLVED COMPONENT ANALYZERS

Selective ion electrodes- Principle of pH measurement and conductivity measurements- dissolved oxygen analyzer – Sodium analyzer – Silicon analyzer – Water quality Analyzer.

UNIT V **12L**

NUCLEAR MAGNETIC RESONANCE AND RADIATION TECHNIQUES

NMR: – Basic principles, Continuous and Pulsed Fourier Transform NMR spectrometer and Applications -.Mass spectrometry and Applications, Nuclear radiation detectors, GM counter, proportional counter, solid state detectors, Scintillation counter.

Text Books:

1. R.S. Khandpur, Handbook of Analytical Instruments, Tata McGraw Hill publishing Co. Ltd., 5 edition, 2018.
2. G.W. Ewing, Instrumental Methods of Analysis, Mc Graw Hill, 2004.
3. Liptak, B.G., Process Measurement and Analysis, CRC Press, 5 edition, 2016**.**

Reference Books:

1. Braun, R.D., Introduction to Instrumental Analysis, Mc Graw – Hill, Singapore, 2006.
2. H.H.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, Instrumental methods of analysis, CBS publishing & distribution, 1995.
3. James keeler ; Understanding NMR Spectroscopy, Second Edition John Wiley & Sons, 2010.
4. John H.Nelson , Nuclear Magnetic Resonance Spectroscopy, Prentice Hall/Pearson Education,2003.
5. Frank G. Kerry Industrial Gas Handbook: Gas Separation and Purification, Taylor and Francis group, 2007.

BIOLOGY FOR ENGINEERS

Course Code - Category: CHE 213- ES **Credits:2**

L	T	P	E	O
2	0	0	2	3

Sessional marks:100

Course Objectives:

- To discuss fundamentals of living organisms and their classification
- To gain knowledge in Biomolecules
- To understand the process of transfer of genetic information
- To gain knowledge in Enzymes and Fermentation
- To recognize the importance of biology and to enable the engineers to solve problems involving biological systems
- **Course Outcomes:**

By the end of the course, student will be able to:	
1.	Summarize the basis of life, classify organisms, and compare prokaryotic and eukaryotic cells
2.	Outline the chemical nature and functions of various Biomolecules
3.	Illustrate the basic principles of heredity, cell division and gene expression
4.	Infer the applications of enzymes and fermentation in industries
5.	Implement engineering principles to biological systems to build better solutions to mankind

SYLLABUS

Unit-I - Living world **9 Periods**

Characteristics of living organisms, Cell Theory – Cellular basis of Life, Structure of Prokaryotic and Eukaryotic cell. Five Kingdom Classification (Major Groups & Principles of Classification with each kingdom, Microorganisms and their importance to mankind.

Learning Outcomes:

At the end of the unit ,the student will be able to

- Explain the basis of life, structure of prokaryotic and eukaryotic cell and compare the major cell types.(L2)
- Classify the major groups of living organisms and identify the basis for their distinction (L2)
- Summarize the importance of microorganisms.(L2)

Unit-II- Biomolecules: **9 Periods**

Classification, Structure and Functions of Carbohydrates, Proteins, and Lipids. Nucleic acids – DNA and RNA- Chemical nature, Structure and functions. Metabolism - anabolism and catabolism

Learning Outcomes:

At the end of the unit, the student will be able to

- Interpret the chemical nature and functions of the biomolecules (L2)
- Represent the chemical nature and structure of DNA and RNA- the hereditary material (L2)
- Understand the concept of metabolism

Unit-III- Genetics and Molecular Biology: 9 Periods

DNA as the genetic material , Mendel's Laws of inheritance, Cell Division – cell cycle , Mitosis and Meiosis, Central dogma – DNA Replication, Transcription, Translation, Concept of genetic code.

Learning Outcomes:

After studying this unit, the student will be able to

- Infer the basic principles of heredity (L2)
- Represent the experiments which helped in identifying the genetic material – the blue print of life(L2)
- Relate the events in cell division to the mechanism of heredity(L2)
- Illustrate how genes are expressed (L2)

Unit-IV – Enzymes and Fermentation: 9 Periods

Classification, Properties, Mechanism of enzyme action, Factors affecting enzyme activity and applications in various Industries. Overview of Fermentation, Fermentor, and Production of different fermentative products like Ethanol, Penicillin and Biogas.

Learning Outcomes:

At the end of the unit, the student will be able to

- List different types of enzymes (L1)
- Summarize the properties of enzymes and applications of enzymes in industry. (L2)
- Illustrate the basic steps in fermentation and its applications in industry. (L2)

Unit- V- Bio-inspired Engineering: (Principles & applications): 9 Periods

Introduction to Biologically Inspired Designs , Human-organs-on-chips, 3D Bio-printing**,** Bio-robotics, Bio-filters, Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury).

Learning Outcomes:

After studying this unit, the student will be able to

- Interpret biologically- inspired designs. (L2)
- Infer the importance of biology to engineering through Bio-robotics, 3D Bio-printing (L2)
- Apply the concept of bioremediation.(L2)

Text Books:

1. **Dr. P.S. Verma, Dr. V.K. Agarwa**l "*Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*"– S. Chand Publications. (Unit 1&4)
2. **J.L.Jain, S.Jain And N.Jain** *"Fundamentals of biochemistry".* - S. Chand Publishers. (Unit 2&3)

References:

1. **L.E.J.R. Casida "***Industrial Microbiology"* New Age International Publisher.
2. **Lehninger, Nelson, Cox "***Principles of Biochemistry"* CBS Publishers.
3. **W.M. Becker** *"The World of the cell"* Global Edition.

Chemical Process Calculations

Course Code: 23CH4102 **Credits: 3**

Instruction: L- 2 T- 1 P-0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: NIL

Course Objectives: This course introduces students to the Chemical Engineering profession and process industries. Students will be introduced to chemical engineering calculations, stoichiometry and materials balance. Fundamental of energy balance will be discussed with emphasis on reactive and non-reactive processes.

Course Outcomes: At the end of the course, student will be able to

1. **Implement** mole concept and gas laws for stoichiometric calculations
2. **Use** vapor pressure data and humidity charts for engineering calculations
3. **Solve** material balance problems with and without reactions
4. **Compute** air requirement in combustion calculations
5. **Execute** energy balance calculations for unit operations and unit processes

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Stoichiometric relation & Behavior of Ideal gases: Mole concept, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, application of ideal gas law, gaseous mixtures, gases in chemical reactions.

Learning Outcomes:

- Implement mole concepts in stoichiometric relations
- Use gas laws in reactions with gases

UNIT II **9L + 3T**

Vapor pressure & Humidity and Saturation: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure of immiscible

liquids and ideal solutions, Roult's law, Nonvolatile solutes. Relative and percentage saturation or dew point, wet bulb and dry bulb temperature, use of humidity charts for engineering calculations.

Learning Outcomes:

- Find vapor pressures of pure liquids and ideal solutions
- Use Humidity relations and humidity chart for process calculations

UNIT III **9L + 3T**

Material balances: Basic Material balance principles, Material balance calculation involving drying, dissolution & mixing, Evaporation, and distillation. Tie substance, Yield, conversion, processes involving chemical reactions. Processes involving recycle, bypass and purge.

Learning Outcomes:

- Execute principles of material balance in process calculations
- Compute material balance calculations involving recycle, bypass and purge

UNIT IV **9L + 3T**

Combustion calculations: Classification of Fuels, calorific value of fuels, Air requirement and flue gases, combustion calculations, incomplete combustion.

Learning Outcomes:

- Classify fuels and indicate their calorific value
- Predict air requirements for combustion calculations

UNIT V **9L + 3T**

Energy Balances:

Thermo-physics: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non polar liquids, enthalpy and its evaluation.

Thermochemistry: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, calculation of theoretical flame temperatures.

Learning Outcomes:

- Calculate energy requirements in heating and cooling of materials without phase change
- Compute theoretical flame temperature in a reaction

Text Books:

1. Stoichiometry & Process Calculations, 2nd Edition, K. V. Narayanan and B. Lakshmikutty; PHI 2017

Reference Books:

1. Chemical process principles, Part -I, Material and Energy Balance by Hougen O A, Watson K.M. and Ragatz R.A. John Wiley and Sons, New York, 1963, 2nd Ed.
2. Basic principles and calculation in chemical engineering by D.H. Himmelblau, 5th Ed. PHI, 2001
3. Stoichiometry by B.I. Bhatt and S.M. Vora (3rd Ed.) Tata McGraw Hill publishing company Ltd. New Delhi (1996)

MOMENTUM TRANSFER

Course Code: 23CH4103 **Credits:3**

Instruction: L-2 T- 1 P- Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: Introduction to Chemical Engineering, Chemical Process Calculations

Course Objectives:

1. To provide an understanding of fluid mechanics and its scope in the chemical industry.
2. To impart fundamental concepts in fluid mechanics with the knowledge of applying basic quantitative laws and the equations of fluid flow.
3. To provide the basic knowledge on incompressible and compressible fluids, pressure drop, friction factor, Reynolds number and their relations in flow systems.
4. To provide an understanding about flow past immersed bodies and fluidization.
5. To acquaint knowledge on fluid moving machinery and flow measuring devices.

Course Outcomes: By the end of the course, student will be able to

1. Apply the basic principles of static to fluid systems.
2. Apply quantitative laws to hydrostatic and fluid flow problems.
3. Analyze the velocity distributions, frictional flow patterns in pipes and piping networks.
4. Determine the pressure drop, velocities in packed and fluidized bed columns.
5. Analyze the performance aspects of fluid machinery specifically for pumps and flow metering devices.

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **6L + 3T**

Basic concepts: Unit systems, units and dimensions, dimensional analysis Rayleigh's method, Buckingham Π-theorem, equations of state, similarity.

Fluid statics: Nature of fluids, hydrostatic pressure, pressure distribution in a static fluid, pressure measuring devices.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply dimensional analysis
- Calculate hydrostatic pressure

Basic concepts: Unit systems, units and dimensions, dimensional analysis Rayleigh's method, Buckingham Π-theorem, equations of state, similarity.

Fluid statics: Nature of fluids, hydrostatic pressure, pressure distribution in a static fluid, pressure measuring devices.

Learning Outcomes:

At the end of this unit, student will be able to

- Apply dimensional analysis
- Calculate hydrostatic pressure

UNIT II **6L + 3T**

Fluid flow phenomenon: Types of fluids, concept of stream lines, stream tubes, viscosity, rheological properties of fluids, turbulence, flow in boundary layers, its formation and growth in tubes and on plates, boundary layer separation.

Basic equations of fluid flow: Mass balance, steady state energy balance, equation of motion, momentum balance and Bernoulli's equation with correction factors

Learning Outcomes:

At the end of this unit, student will be able to

- Classify various fluids
- Identify the formation and growth of boundary layer
- Apply mass, momentum and Bernoulli's equation

UNIT III **6L + 3T**

Flow of incompressible fluids: Relation between skin friction - wall shear, laminar flow in pipes, Hagen-Poiseuille equation, turbulent flow in pipes, velocity distribution equation, friction factor, friction from changes in velocity or direction.

Flow of compressible fluids: Basic equations, Mach number, process of compressible flow, flow through variable area conduits, adiabatic and isothermal frictional flow.

Learning Outcomes:

At the end of this unit, student will be able to

- Calculate pressure drop in laminar and turbulent flow
- Evaluate pressure drop of adiabatic and isothermal frictional flow

UNIT IV **6L + 3T**

Flow past immersed bodies: Drag, drag coefficients, friction in flow through bed of solids, fluidization, mechanism of fluidization, pressure drop in fluidization, applications of fluidization.

Learning Outcomes:

At the end of this unit, student will be able to

- Calculate Drag coefficient
- Estimate pressure drop in packed and fluidized beds
- Classify various kinds of fluidization

UNIT V **6L + 3T**

Transportation and metering of fluids: Pipes, fittings, valves, positive displacement and Centrifugal pumps, fans, blowers and compressors, jet ejectors.

Flow measuring devices: venture meter, orifice meter, pitot tube, rotameter, notches and weirs.

Learning Outcomes:

At the end of this unit, student will be able to

- Classify types of pumps and fans
- Calculate capacity, head and power requirement of pumps
- Estimate volumetric flowrate using different flow meters

Text Books:

1. Warren L.McCabe and Julian C.Smith, "Unit Operations of Chemical Engineering", 7th ed., McGraw Hill, 2005.
2. R. K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", 8th ed., Laxmi publisher, 2008. (for topics Unit systems, units and dimensions, dimensional analysis, notches and weirs)

Reference Books:

1. De Nevers N., "Fluid mechanics for chemical engineers", 3rd ed., McGraw Hill.
2. J.M.Coulson, J.F.Richardson, "Chemical engineering", 5th ed., Vol –I & II,,Elseveir,1999.
3. Cengel and Cimbala, "Fundamentals of fluid mechanics", 3rded.,McGraw Hill Education,2014.
4. R. K. Rajput, " A Text Book of Fluid Mechanics and Hydraulic Machines", 3rd ed., S. Chand, 2002.

Mechanical Operations

Course Code: 23CH4104 **Credits: 3**

Instruction: L-2 T-1 P-0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: Introduction to Chemical Engineering

Course Objectives:

- To familiarize with the characteristics of solids, size reduction aspects, working of various size reduction equipment and their operations.
- To know about the different screening techniques and screening equipment and other separation methods.
- To understand the principles of filtration and the working of different filtration equipment.
- To understand the principles of settling of solids in fluids and sedimentation.
- To understand the concepts of agitation of liquids and mixing of solids.

Course Outcomes: By the end of the course, student will be able to

- Identify the size reduction equipment for various size reduction operations.
- Apply the screening techniques for different size separations.
- Analyze the filtration techniques for various filtration operations.
- Apply the principles of settling in classification of solids.
- Calculate the power consumption for various mixing operations and identify mixers for cohesive and non cohesive solids.

CO-PO –PSO Mapping:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	1	1						1	1		1	1	1
CO2	2	1	1						1	1		1	1	1
CO3	2	1	1						1	1		1	1	1
CO4	2	1	1						1	1		1	1	1
CO5	2	1	1						1	1		1	1	1

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Characteristics of solid particles: Shape, Size, differential and cumulative screen analyses, specific surface area, particle population, different mean diameters for a mixture of particles. Principles of comminution: Laws of crushing, description and working of size reduction equipment - jaw, gyratory and roll crushers, hammer mills, revolving mills, attrition mills, fluid energy mill, cutting machines, equipment operations, open and closed circuit grinding.

Learning Outcomes:

At the end of this unit, student will be able to

● Identify the characteristics of particulate solids.
● Calculate different mean diameters for a mixture of particles.
● Suggest different types of size reduction methods such as crushing, grinding milling depending on the type and size of the material.

UNIT II **9L + 3T**

Mechanical separations: screening, industrial screens - grizzly, gyratory and vibratory screens, revolving screens - trommels, capacity and effectiveness of screens, magnetic separation, electrostatic separation, froth flotation.

Learning Outcomes:

At the end of this unit, student will be able to

● Calculate the effectiveness of screens.
● Apply the principles of magnetic separation, electrostatic separation, froth flotation techniques

UNIT III **9L + 3T**

Filtration: description and working of filtration equipment, plate and frame filter press, shell and leaf filter, rotary drum filter, filter aid, centrifugal filtration, top suspended batch centrifuge, theory
of filtration, washing of cakes.

Learning Outcomes:

At the end of this unit, student will be able to

● Enumerate the theory of filtration.
● Classify the filtration techniques.
● Solve filtration problems based on filtration theory.

UNIT IV **9L + 3T**

Motion of particles through fluids: drag, free and hindered settling, settling velocities, sink and float methods, differential setting methods - jigging, cyclone separators, batch sedimentation, thickeners, flocculation, centrifugal sedimentation, gravity and centrifugal decanters.

Learning Outcomes:

At the end of this unit, student will be able to

● Identify the settling regime and calculate the settling velocities.
● Elucidate the various equipment used for classification of solids.

UNIT V **9L + 3T**

Agitation of liquids: Power consumption in agitated vessels, equipment for mixing of solids and pastes, mixers for dry powders.

Storage and conveying of solids: Storage of solids, types of conveyors –belt, chain and screw conveyors, elevators, pneumatic conveyors.

Learning Outcomes:

At the end of this unit, student will be able to

● Select appropriate conveyor from different conveying operations.
● Classify different mixers for cohesive and non cohesive solids.

Text Books:

1. W.L. McCabe, J.C. Smith and P.Harriot, “Unit Operations of Chemical Engineering”, 7th ed., McGraw- Hill Book Co., 2005.
2. J.H.Coulson and J.F.Richardson, “Chemical Engineering -Vol.2” 5th ed., Elsevier Science, 2002 (for topics of trommels, magnetic separators, electrostatic separators and froth flotation).

Reference Books:

1. R.H.Perry,“Chemical Engineer’s Hand Book”,8th ed., McGraw-Hill Book Co., 2007.
2. Brown et al., “Unit Operations”, 1st ed., CBS Publisher,2005.
3. Badger and Banchero, “Introduction to Chemical Engineering”, 1st ed.,McGraw-Hill, 2002 (for conveying topic).

MOMENTUM TRANSFER LABORATORY

Course Code: 23CH4201 **Credits:1.5**

Instruction: L-3 T- P- Sessional Marks:50

End Examination: 3 Hours End exam Marks: 50

Prerequisites: Momentum Transfer

Course Objectives:

- To improve skills in measuring the flow rates.

To familiarize with the operation of different pumps.

Course Outcomes: By the end of the course, student will be able to

1. Measure the flow rate and pressure drops by using different flow measuring devices.
2. Draw the characteristic curves for various pumps.

CO-PO –PSO Mapping:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	3	3	3					3	2		1	2	2
CO2	2	3	3	3					3	2		1	2	2

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes & Program Specific Outcomes:

List of Experiments

1. Determination of orifice coefficient.
2. Determination of venturi coefficient.
3. To study the coefficient of contraction for a given open orifice.
4. To study the coefficient of discharge in a V – notch.
5. Friction losses in fluid flow in pipes.
6. Calibration of rotameter.
7. Measurement of point velocities (Pitot tube).
8. Identification of laminar and turbulent flows (Reynolds apparatus).
9. Verification of Bernoulli equation.
10. Pressure drop in a packed bed for different fluid velocities.
11. Pressure drop and void fraction in a fluidized bed.
12. To study the characteristics of a centrifugal pump.

To study the characteristics of a reciprocating pump.

Reference Books:

1. Warren L.McCabe and Julian C.Smith, “Unit Operations of Chemical Engineering”, 7th ed., McGraw Hill, 2005.
13. Cengel and Cimbala, “Fundamentals of fluid mechanics”, 3rd ed., McGraw Hill Education, 2014.

MECHANICAL OPERATIONS LABORATORY

Course Code: 23CH4202 **Credits:1.5**

Instruction: L- 0 T-0 P-3 Sessional Marks:50

End Examination: 3 Hours End Exam Marks: 50

Prerequisites: Introduction to Chemical Engineering

Course Objectives: To understand the measuring of the average size of the given sample.

- To familiarize with the different crushing and grinding units and the concepts of equipment operation.
- To understand the various separation techniques like screening, froth floatation and sedimentation.

Course Outcomes: By the end of the course, student will be able to

1. Calculate the average size of a given sample.
2. Operate crushing and grinding equipment.
3. Apply various separation techniques for a given sample.

CO-PO –PSO Mapping:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3					3	3		1	1	1
CO2	3	3	3	3					3	3		1	1	1
CO3	3	3	3	3					3	3		1	1	1

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes & Program Specific Outcomes:

List of Experiments

1. To take a representative sample from a bulk by two methods, viz. Riffle and Cone & Quartering and to find out the average size (volume-surface mean diameter) of the sample.
2. To determine the time of grinding in a ball mill for producing a product with 80% passing a given screen.
3. To verify the laws of crushing using any size reduction equipment like jaw crusher, crushing rolls or ball mill and to find out the work Index (W_i) of the material.
4. To compare open circuit and closed circuit grinding by means of a ball mill.
5. To determine the optimum time of sieving for a given sample of material.
6. To find the effectiveness of sieve.
7. To find the screen effectiveness of a trommel.
8. To separate a mixture of coal into two fractions using sink and float method.
9. To separate a mixture of coal into two fractions using froth flotation technique.

10. To find the size analysis of a given fine sample using beaker decantation method.
11. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions.
12. To determine the collection efficiency of a cyclone separator.
13. To determine the settling velocities of various particle sizes and densities.

Learning Outcomes:

At the end of this course the student will be able to

● Determine the volume surface mean diameter of the sample using differential and cumulative analysis methods.
● Determine the effectiveness of a screen.
● Calculate the minimum thickener area.
● Calculate optimum time of sieving for a given sample.
● Separate a mixture of coal into two fractions using sink and float and froth flotation methods.
● Handle various size reduction equipments and verify the laws of crushing.

Text Book:

1. W.L. McCabe, J.C. Smith and P. Harriot, “Unit Operations of Chemical Engineering”, 7th ed., McGraw- Hill Book Co., 2005.

Reference Books:

1. R. H. Perry,“Chemical Engineer’s Hand Book”,8th ed., McGraw-Hill Book Co., 2007.
2. Brown et al., “Unit Operations”, 1st ed., CBS Publisher, 2005.

Logical Reasoning & Corporate Skills

(II Year, I Sem.)

Course Category:	Humanities	**Credits:**	1
Branch	All Branches		
Course Code:	23TP9101	**Lecture-Tutorial-Practical:**	2+2
Prerequisites:	Knowledge of LSRW Skills, Basic Maths	**Continuous Evaluation:**	
		Semester End Evaluation:	
		Total Marks:	100

Upon successful completion of the course, the student will be able to:

Course Outcomes

CO1	Enforce corporate etiquette, and precise usage of English grammar to enhance their professional communication. L3
CO2	Master negotiation skills and telephone etiquette with emotional intelligence for corporate interactions. L3
CO3	Enhance email writing skills by incorporating vocabulary acquired from storytelling, situational dialogues and reading activities by using various digital tools. L3
CO4	Use their logical thinking and analytical abilities to solve reasoning questions from number analogy and series and letter based aptitude questions company specific and other competitive tests.
CO5	Solve questions related to clock and calendar , etc.. from company specific and other competitive tests.

Contribution of Course Outcomes towards achievement of Program Outcomes& Strength of correlations

	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									M	M		M		
CO2									M	M		M		
CO3									M	M		M		
CO4	M													
CO5	M													

L- Low **M-Medium** **H-High**

PART-A: Corporate Skills

Unit-I

Corporate Etiquette – Work Place Etiquette and Conflict Resolution - Grammar Revision — CO1

Verbal Ability : Prepositions, Articles, tenses and conjunction

Unit-II

EQ – Negotiation Skills – Telephone Etiquette – MNCs Paper Model Introduction, Situational Dialogue Practice – Team Activities Related to Spoken English — CO2

Verbal Ability: Fill in the blanks (Based on the given appropriate words)

UnIt-III

E Mail Writing – Vocabulary from Story Telling Activity –MNCs Model Paper 1 Practice — CO3

Verbal Ability: Sentence arrangements

Unit-IV

Virtual Reading – Functional English – IELTS Vocabulary – News Paper Reading Using AI Based Applications — CO3

Verbal Ability: Inferred meaning (Homophones, Homonyms)

PART-B: Logical Reasoning

UNIT-I: Numerical computation: Number Series, Letter Series, Number analogy, letter analogy, word analogy	CO4
UNIT-II: Coding Decoding- Letter to letter, letter to digit, letter to number and symbol, Word to word coding, odd man out	CO4
UNIT-III: Directions-Finding distance, Direction and Shadow based problem, Blood Relations-Mixed Blood Relations, Puzzle-Based Blood Relation, Single-Person Blood Relation, Symbol based Blood Relations.	CO4
UNIT-IV: Clocks –finding Angle, Time, Mirror image, Faulty clock, Calendars – Finding day of the week, Number of odd days, Repetition of same calendar	CO5
UNIT-V : Seating Arrangement-Circular arrangement, linear arrangement ,Order Sequence and Ranking	CO5

Entrepreneurship Development & IPR

Code	Periods			Sessional	End Exam	Total	Credits
	L	T	P	Marks	Marks	Marks	
23MC0104	30			100	-	100	-

Prerequisite: Nil

Course Objectives: The course has been designed to develop the skills of entrepreneurship & to encourage the students to become an entrepreneur and to impart the basics of Intellectual property Rights.

Course Outcomes: At the end of the course the student will be able to:

CO-1 Apply various theories for the entrepreneurship development ecosystem in Indian context.

CO-2 Demonstrate the ways in which entrepreneurs perceive opportunity, manage risk, organize resources and add value.

CO-3 Identify various schemes supporting entrepreneurship.

CO-4 Recognize the importance of IP and outline concepts of Intellectual Property Rights.

CO-5 Identify the significance of practice and procedure of Patents.

PO /	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO22
CO-						1		2	1	1	2	1		1
CO-						1		2	1	1	2	1		1
CO-						1		2	1	1	2	1		1
CO-						1		2	1	1	2	1		1
CO-						1		2	1	1	2	1		1

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I **Periods: 4L+2T=6**

UNIT TITLE: Introduction to Entrepreneurship

Entrepreneurship- Concept, Nature, Functions and Importance; Entrepreneurs Characteristics, Types and Motivation; Entrepreneurial process; Enterprise- Definition and Classification (MSME Micro, Small & Medium Enterprises).

UNIT - II **Periods: 4L+2T=6**

UNIT TITLE: Entrepreneurial Journey

Creativity and Innovation, Recognizing opportunities and Generating ideas, Feasibility analysis, Industry and Competitor analysis, developing effective business model.

Class Activity:

Idea generation by students.

UNIT - III **Periods: 4L+2T=6**

UNIT TITLE: Institutional Support to Entrepreneurs

Need for Institutional support different Government & Non-Government institutions to support Entrepreneurs like, NSIC, SIDO, SSIB, SSIDC, SISIs , DTICs, industrial Estates, Specialized Institutions.

UNIT - IV **Periods: 4L+2T=6**

UNIT TITLE: INTRODUCTION TO IPR

Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights – Introduction to TRIPS and WTO. – Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.

UNIT - V **Periods: 4L+2T=6**

UNIT TITLE: Patent system in India

Patents Act 1970 & Patent system in India; Patentability; Process, & product patent; filing of the patent, patent specification, patent claims, Patent opposition, & revocation, infringement, compulsory licensing, Patent Cooperation Treaty, Patent search, and patent database.

TEXT BOOKS:

1. Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, “Entrepreneurship”, 9th Edition, Tata Mc-graw Hill Publishing Co.ltd.-new Delhi, 2014.
2. Bruce R. Barringer and R. Duane Ireland, “Entrepreneurship”, 4th Edition, Pearson Publications, New Delhi, 2011
3. N.K. Acharya, Text book on intellectual Property Rights, Asha Law House New Delhi, New Edition, 2001.

.

REFERENCE BOOKS:

1. Narayanan, V. K., Managing technology and innovation for competitive advantage, first edition, Pearson education, New Delhi, (2006)
2. Idris, K. (2003), Intellectual property: a power tool for economic growth, second edition, WIPO publication no. 888, Switzerland

COMPLEX VARIABLES & REGRESSION ANALYSIS (CHEMICAL)	
23MA1110	**Credits:3**
Instruction : 3 periods & 1 Tutorial/Week	Sessional Marks:40
End Exam : 3 Hours	End Exam Marks:60

Prerequisites: Differentiation, Integration, Complex numbers and Functions.

Course Objectives:

The aim of this course is to study the techniques of complex variables and functions together with their derivatives, contour integration and provide the foundations of probabilistic and statistical analysis.

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

1	Analyze limit, continuity and differentiation of functions of complex variables and understand Cauchy-Riemann equations, analytic functions and various properties of analytic functions.
2	Use of Cauchy's theorem and Cauchy's integral theorems and apply these in evaluation of complex contour integrals and able to represent the given functions as Taylor's and Laurent's series, and determine their intervals of convergence.
3	Compute the definite integrals by using Cauchy's residue theorem.
4	Familiar with numerical solution of ordinary differential equations.
5	Evaluate simple correlation between the two variables and fit curves by the method of least square approximation.

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

CO-PO-PSO Justification	
1	CO1 deals with properties of analytic functions and finding analytic functions, these are widely used in many areas of engineering.
2	CO2 deals with finding the values of complex contour integration and series representation of a given complex function by using Taylor's and Laurent's series, and these are used in various fields of engineering.
3	CO3 deals with finding the definite integrals by using residues.
4	CO4 deals with finding the numerical solution of a given IVP problems.
5	CO 5 deals with the knowledge of curve fitting is widely used as an aid for data visualization and regression is to summarize the relationship among two or more variables.

SYLLABUS

UNIT I **10 Periods**

FUNCTIONS OF A COMPLEX VARIABLE

Complex function – Real and Imaginary parts of complex function – Limit – Continuity and derivative of a complex function – Cauchy-Riemann equations – Analytic function, entire function, singular point, conjugate function – Cauchy-Riemann equations in polar form – Harmonic functions – Milne-Thomson method – Simple applications to flow problems – Applications to flow problems.

UNIT II **10 Periods**

COMPLEX INTEGRATION, SERIES OF COMPLEX TERMS

Complex integration – Cauchy's theorem – Cauchy's integral formula – Series of complex terms: Taylor's series – Maclaurin's series expansion – Laurent's series. (All theorems without proof)

UNIT III **10 Periods**

RESIDUES

Singularities – Residues – Calculation of residues – Residue at a pole of order m. (All theorems without proofs)

Evaluation of real definite integrals: Integration around the unit circle – Integration around a semicircle.

UNIT IV **10 Periods**

NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS

Picard's method – Taylor's series method – Euler's method, Runge - Kutta method, Predictor - Corrector methods : Milne's method,

UNIT V **10 Periods**

CORRELATION, REGRESSION ANALYSIS AND CURVE FITTING

Correlation : Definition – Karl pearson's coefficient of correlation – Measures of correlation – Rank correlation coefficients.

Regression : Simple linear regression – Regression lines and properties.

Curve Fitting : Principle of least squares – Method of least squares – Fitting of straight lines – Fitting of second degree curves and exponential curves.

TEXT BOOKS:

B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.

2. N. P. Bali, Engineering Mathematics, Lakshmi Publications.

3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas, Calculus, 13/e, Pearson Publishers, 2013.

4. H. K. Dass, Advanced Engineering Mathematics, S. Chand and complany Pvt. Ltd.

5. Michael Greenberg, Advanced Engineering Mathematics, Pearson, Second Edition.

DESIGN THINKING

23ME3203 **Credits:2**

Instruction : 1 periods & 2 Practical/Week Sessional Marks:50

End Exam Marks:50

Course Outcomes: At the end of the course the student will be able to:

CO-1 **Explain** the design thinking principles & **Identify** an opportunity and scope of the project and **prepare** the problem statement

CO-2 **Apply** the empathy tools to study the user and **summarize** finding related to problem for define phase.

CO-3 **Describe** and **define** the problem specific to the user group and **apply** Ideation tools to **generate** Ideas to **solve** the problem

CO-4 **Develop** prototypes for test phase.

CO-5 **Test** the ideas and **demonstrate** Storytelling ability to present the Ideas.

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	1	1	-	2	2	2	3	3	3	3	2	-
CO2	3	2	1	1	-	2	2	2	3	3	3	3	2	-
CO3	3	3	2	2	-	2	2	2	3	3	3	3	2	-
CO4	3	3	2	2	3	2	2	2	3	3	3	3	2	2
CO5	3	3	2	2	-	2	2	2	3	3	3	3	2	-

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

Module 1: Introduction to Design Thinking: Need of design thinking, 7 characteristics of design thinking, comparison of design thinking to other ways of thinking, tools and resources, 5 actions phases of Design thinking, 5 characteristics of action plan. Summary of 5 Thinking mindsets. 5W+H & HMW Tools.

Module 2: Empathy: Think users first, inherent needs of the user, empathize the user, effectively interviewing the users, Ask 5x why, Stake holders Map, Persona, Empathy map,

Module 3: Define: Ask the right question, different types of questions, Design Brief, Opportunity map, POV Statement

Module 4: Ideate: Communicate by drawing, Value of Drawing, rules of ideation, 5 common ideation techniques, Brainstorming, Prioritisation Map, Dot voting, idea evaluation

Module 5: Prototype to Test phase: Types of rough Prototype, need of a Prototype, Need of Prototype testing, Structured Test-Experience lab. Prototype evaluation, observers debrief, Feedback Capture grid

Week	Activity	Marks
1.	Identify an opportunity and scope of the project for providing solution through design thinking.	1
2.	Prepare the initial Problem statement for the identified problem by 5W+H & HMW Tools.	2
3.	Identify the stake holders and prepare the questionnaire to perform Interview for Empathy among stake holders.	2
4.	Apply Ask 5x why tool for identifying the cause identification of the problem.	2
5.	Prepare the Persona based on the responses received from the Stake holders	2
6.	Prepare the Empathy Map/ Customer Journey Map for summarizing pains & gains of stakeholders and insights	2
7.	Prepare the Point of View statement based on user insights and Re-define the problem statement using HMW tool based on the of the customer	2
8.	Perform Brainstorming Session to generate Ideas.	2
9.	Cluster and shortlist the ideas to prepare the prototype	2
10.	Prepare the prototypes for the shortlisted ideas	4
11.	Test the prototype with user and record the responses in feedback capture Grid	2
12	Modify the prototype as per the user feedback.	2

TEXT BOOKS:

1. Daniel Ling "*Complete Design Thinking Guide for Successful Professionals*", Emerge Creatives Group LLP, Print ISBN: 978-981-09-5564-9.
2. Michael Lewrick, Patrick Link, Larry Leifer, *The Design Thinking Toolbox*, John Wiley & Sons, 2020.

REFERENCE BOOKS:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins e-books, 2009.
2. Jeanne Liedtka, Andrew King, And Kevin Bennett, "Solving Problems with Design Thinking" , Columbia University Press Publishers, E-ISBN 978-0-231-53605-9
3. Idris Mootee, *"Design Thinking for Strategic Innovation"* , 2013 John Wiley & Sons
4. Michael G. Luchs, Scott Swan, Abbie Griffin , *"Design Thinking: New Product Development Essentials from the PDMA",* ISBN-13 : 978-1118971802

5. Beverly Rudkin Ingle, *"Design Thinking for Entrepreneurs and Small Businesses"*, Apress, ISBN: 9781430261827
6. Jose Betancur *"The Art of Design Thinking: Make More of Your Design Thinking Workshops",* ISBN: 9781522095378

WEB RESOURCES:

1. https://dschool.stanford.edu/resources/design-thinking-bootleg
2. https://www.ideo.com/post/design-thinking-for-educators
3. https://onlinecourses.nptel.ac.in/noc22_mg32/preview
4. https://onlinecourses.swayam2.ac.in/imb23_mg65/course

Proposed Design Thinking Lab Evaluation – 100M

Internal Evaluation: 50 M

Continues Assessment of Activities: 25 M

Internal Exam- Objective/ Written test: 20 M

Attendance: 5 M

External Evaluation: 50M

Prototype Validation: 20 M

Report: 10M

Presentation: 10M

Viva: 10M

CHEMICAL ENGINEERING THERMODYNAMICS

Course Code: 23CH4105 **Credits:3**

Instruction: L- 2 T-1 P-0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: Physical Chemistry and Chemical Process Calculations.

Course Objectives:

- To provide knowledge on the first law and second law of thermodynamics.
- To impart knowledge on different balance equations.
- To acquaint knowledge on chemical reaction equilibria.

Course Outcomes:

1. Apply the first law of thermodynamics to various systems.
2. Apply the second law of thermodynamics to various systems.
3. Develop balance equations on various equipments.
4. Apply the fugacity concepts to non-ideal solutions.
5. Compute equilibrium constant for a chemical reaction.

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

The first law and other basic concepts: Joule's experiments, internal energy, the first law of thermodynamics, thermodynamic state and path functions, enthalpy, steady-flow process, equilibrium, the phase rule, the reversible process, constant-V and constant-P processes, heat Capacity, Ideal Gas.

Learning Outcomes: At the end of this unit, student will be able to

● Calculate the heat, work and internal energy of closed systems.

● Estimate the enthalpy for open systems

UNIT II **9L + 3T**

The Second Law of Thermodynamics: Statement of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and ideal-gas scale, entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics.

Learning Outcomes: At the end of this unit, student will be able to

● Calculate the heat and work done by a heat engine.

● Estimate the entropy of a system

UNIT III **9L + 3T**

Volumetric properties of pure fluids: PVT behavior of pure substances, virial equations, the ideal gas, application of the virial equations, cubic equations of state, generalized correlations for gases, generalized correlations for liquids

Thermodynamic Properties of Fluids: Property relations for homogeneous phases, residual properties, two-phase systems, thermodynamic diagrams.

Learning Outcomes: At the end of this unit, student will be able to

● Estimate the pressure and volume using the virial equations.

● Correlate the thermodynamic properties using Maxwell relations.

UNIT IV **9L + 3T**

Thermodynamics of Solution–Theory: Fundamental property relation, chemical potential and phase equilibria, partial properties, ideal gas mixtures, fugacity and fugacity coefficient–pure species, species in solution, generalized correlations for the fugacity coefficients

Thermodynamics of Solution–Applications: Liquid-phase properties from VLE data, models for the excess Gibbs Energy.

Learning Outcomes: At the end of this unit, student will be able to

• Apply the concepts of partial properties to estimate the properties in a solution

• Estimate the compositions of non-ideal gas mixtures Model the excess Gibbs free energy.

UNIT V **9L + 3T**

Chemical Reaction Equilibria: Reaction coordinate, application of equilibrium criteria to chemical reactions, standard Gibbs energy change and the equilibrium constant, effect of temperature on the equilibrium constant, evaluation of equilibrium constants, relation of equilibrium constants to composition, equilibrium conversions for single reactions, phase rule and Duhem's theorem for reacting systems, multi reaction equilibria.

Learning Outcomes: At the end of this unit, student will be able to

• Evaluate the equilibrium constants

• Analyze the effect of temperature, pressure and concentration on equilibrium constant.

Text Books:

1. J. M. Smith, H. C. Van Ness and M. M. Abbott, “Introduction to Chemical Engineering Thermodynamics” 6th ed., McGraw-Hill International Editions, 2000

Reference Books:

1. Y. V. C. Rao, “Chemical Engineering Thermodynamics”, University Press (India) Ltd., Hyderabad, 1997.
2. K. V. Narayanan, “A Text book of Chemical Engineering Thermodynamics”, PHI publications, 2009.
3. Michael M. Abbott and Hendrick C.VanNess, “Schaum Outline of Theory and Problems of Thermodynamics”, 3rd ed., McGraw-Hill education, 2013.

CHEMICAL TECHNOLOGY

Course Code:23CH4106	**Credits:3**
Instruction: L-3 T- 0 P- 0	Sessional Marks:40
End Examination: 3 Hours	End exam Marks: 60

Prerequisites: Engineering chemistry, Organic chemistry.

Course Objectives:

- To know about the inorganic chemical manufacturing processes of sulphur, nitrogen phosphorus, chloro-alkali and cement industries.
- To understand organic chemical manufacturing processes of coal, petroleum, vegetable oils, soaps, paints, pulp, cane sugar and polymerization industries.

Course Outcomes: By the end of the course, the student will be able to

1. Outline the manufacturing of sulphur and nitrogen product industries.
2. Describe the manufacturing of phosphoric acid, chloro-alkali and cement industries.
3. Illustrate the manufacture of coal chemicals and petroleum products.
4. Enumerate extraction of vegetable oils and manufacture of paints and varnishes.
5. Describe the manufacture of pulp, cane sugar and polymerization products

CO-PO –PSO Mapping:

CO	**PO**												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2					1	1		1	1		1	2	3
CO2	2					1	1		1	1		1	2	3
CO3	2					1	1		1	1		1	2	3
CO4	2					1	1		1	1		1	2	3
CO5	2					1	1		1	1		1	2	3

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Sulphur and Sulphuric Acid: Sources of sulphur - sulphuric acid, different processes of manufacturing-contact process, DCDA process for sulphuric acid manufacture.

Nitrogen industries: Manufacture of ammonia, nitric acid and urea, manufacture of nitrogen and oxygen gases

Learning Outcomes:

At the end of this unit, student will be able to

- Understand the productions of inorganic products
- Differentiate the best suitable method for these fertilizer products

UNIT II **9L + 3T**

Phosphorous and Phosphoric Acid: Methods for production of phosphoric acid.

Chloro-Alkali Industries: - Manufacture of soda ash, caustic soda and chlorine.

Cement: Types of cement, manufacture of Ordinary Portland Cement [OPC], slag cement.

Learning Outcomes:

At the end of this unit, student will be able to

- Understand the productions of various inorganic products and its importance to the socio-economic conditions
- Select suitable method for the production of phosphorous, alkali compounds as well as cement

UNIT III **9L + 3T**

Coal And Coal Chemicals: Types of coal, different uses, distillation of coal, treatment of products, low and high temperature carbonization of coal, coal tar distillation.

Petroleum: Origin, classification, composition of crude oil, production of crude oil, distillation of crude petroleum, refining-methods, uses of products.

Learning Outcomes:

At the end of this unit, student will be able to

- Recognize the fossil fuel importance to the society
- Extract various products from distillation coal and petroleum

UNIT IV **9L + 3T**

Vegetable Oils: Extraction, purification, hydrogenation of oils. Manufacture of fatty acids and soaps, detergents- classification and manufacture.

Paints and Varnishes: Constituents of paints, manufacturing procedures, varnishes.

Learning Outcomes:

At the end of this unit, student will be able to

- Adopt the techniques for the production of edible oils
- Utilize the paints and varnish to requirement of specific applications

UNIT V **9L + 3T**

Pulp and Paper: Kraft process and sulphite process, production of paper,

Cane Sugar: Refining, manufacture of sucrose, production of ethanol by fermentation. Manufacture of penicillin.

Polymerization: Different methods, manufacture of polyethylene, phenol formaldehyde, SBR, 6-nylon, 6,6-nylon.

Learning Outcomes:

At the end of this unit, student will be able to

- Select suitable method to increase the yield of paper, sugar and ethanol
- Produce various hydrocarbons by polymerization technology.

Text Books:

1. Gopala Rao, M. and Marshall Sitting, *Dryden's out lines of chemical Technology*, 3rd Edition, East West Press Pvt. Ltd.

Reference Books:

1. Austin, G.T, Shreve's, *Chemical Process Industries*,5th edition, Mcgraw Hill Publishers
2. Kirk R .E. and Othmer D. F., *Encyclopedia of Chemical Technology, 4th edition,* Inter Science.

HEAT TRANSFER

Course Code: 23CH4107 **Credits: 3**

Instruction: L- 2 T- 1 P- 0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: Engineering Mathematics, Chemical Process Calculations.

Course Objectives: The course is intended to

- familiarize the three modes of heat transfer and also to differentiate steady and unsteady state heat conduction.
- acquaint the heat transfer with and without phase change
- envisage the fundamental principles of radiation
- familiarize the operation of different heat transfer equipments.
- impart knowledge on the principles of evaporation and effects of evaporators

Course Outcomes: At the end of the course, the student will be able to

1. Implement the basic laws of conduction to steady state and unsteady state problems.
2. Predict convective heat transfer coefficients at various conditions.
3. Compute heat loss / gain due to radiation.
4. Classify various heat transfer equipments.
5. Perceive the performance of different Evaporators.

CO-PO –PSO Mapping:

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

Correlation levels → 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Modes of heat flow: Conduction, convection and radiation.

C**onduction:** Basic laws of conduction, thermal conductivity; steady-state conduction – compound resistances in series, heat flow through a cylinder and a sphere; critical insulation thickness. unsteady-state conduction – one dimensional heat flow with constant surface temperature, heat flow with variable surface temperature, semi-infinite solid.

Learning Outcomes: At the end of this unit, student will be able to

- Classify the various modes of heat transfer

- Calculate heat transfer rate for steady state conduction
- Construct heat transfer rate for steady state conduction

UNIT II **9L + 3T**

Convection: Principles of heat flow in fluids – typical heat exchange equipment, counter current and parallel flows, energy balances, heat flux and heat transfer coefficients, LMTD.

Heat transfer to fluids without Phase change: Boundary layers, laminar flow heat transfer, heat transfer in turbulent flow, estimation of wall temperature, cross-sections other than circular, heating and cooling of fluids outside tubes, natural convection.

Heat transfer to fluids with Phase change: heat transfer from condensing vapors, heat transfer to boiling liquids

Learning Outcomes: At the end of this unit, student will be able to

- Calculate heat transfer in laminar flow and turbulent flow
- Calculate heat transfer by natural and forced convection
- Differentiate drop and film wise condensations

UNIT III **9L + 3T**

Radiation: Fundamental facts concerning radiation, emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, combined heat transfer by conduction-convection-radiation

Learning Outcomes: At the end of this unit, student will be able to

- Categorize the laws of radiation
- Calculate radiation between the surfaces
- Compute combined heat transfer by conduction, convection and radiation

UNIT IV **9L + 3T**

Heat-exchange equipment: General design of heat exchange equipment, shell and tube heat exchangers, plate-type exchangers, extended surface equipment, scraped-surface exchangers, heat transfer in agitated vessels, heat transfer in packed beds.

Learning Outcomes: At the end of this unit, student will be able to

- Understands the design of heat exchanger
- Estimates heat transfer coefficients in shell and tube heat exchanger
- Categorize types of heat exchangers

UNIT V **9L + 3T**

Evaporation: Evaporation, types of evaporators, capacity and economy of evaporators, boiling point elevation and Duhring's rule, material and energy balances in single effect and multiple effect evaporators, methods of feeding and economy of multiple effect evaporators.

Learning Outcomes: At the end of this unit, student will be able to

- Compute capacity and economy of evaporators
- Classify the feeding methods of multiple effect evaporators

Text Books:

1. W. L. McCabe, J. C. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 7th Edition McGraw Hill International Edition, Singapore (2005).

Reference Books:

1. D. Q. Kern, *Process Heat Transfer*, Tata McGraw Hill, New Delhi.
2. Holman. J.P., *Heat Transfer*, 9th Edition Tata McGraw Hill Book Co., New Delhi, 2008.
3. NecatiOzisik, *Heat Transfer: A Basic Approach*, Vol. 1, McGraw Hill, 1985.

4. Robert W. Serth, *Process Heat Transfer: Principles and Applications*, Academic Press, 2007.

Artificial Intelligence for Chemical Engineers

Course Code:23CH9101 **Credits:1**

Instruction: L- 1 T-0 P-0 Sessional Marks:100

End Examination: 0 Hours End exam Marks: 00

Prerequisites: Engineering Mathematics and Problem solving and programming with C

Course Objectives:

1. To provide knowledge on graphical representation of data
2. To acquaint knowledge on dispersion of the datasets
3. To get familiarized with hypothesis testing
4. To build supervised models for accurate results
5. To build unsupervised and reinforced models for clustering and dimensionality reduction

Course Outcomes:

The student will be able to

1. Communicate the data effectively in graphical forms
2. Identify the patterns and relate the variables in the data
3. Determine the validity of the data set
4. Predict and categorize the outcomes accurately using supervised learning techniques
5. Analyze and cluster the unlabeled datasets using unsupervised learning

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I **6L + 0T**

Descriptive Statistics: Graphical approach

Frequency tables, relative frequency tables, grouped data, pie chart, bar chart, histograms, ogives, stem and leaf plots, box plots, dot diagram, scatter plots, Pareto diagram.

Learning outcomes:

At the end of this unit, student will be able to

1. Identify the importance of graphical representation
2. Represent the data visually in different forms
3.

UNIT II **6L + 0T**

Measure of Central Tendency and Dispersion

Arithmetic mean, median and mode, variance, standard deviation, quartiles, range, mean absolute deviation, coefficient of variation, Z scores, normal distribution, confidence interval estimation.

Learning outcomes:

At the end of this unit, student will be able to

1. Find the range of the data set.
2. Analyze the data set.

UNIT III **6L + 0T**

Probability Distribution and Inferential Statistics

Random variables, probability distributions, hypothesis testing, single sample test, two sample test, Type I error, Type II error.

Learning outcomes:

At the end of this unit, student will be able to

1. Test the data set for its consistency
2. Take a decision on the data set on its accuracy

UNIT IV **6L + 0T**

Supervised Learning

Linear regression, ridge regression, logistic regression, multiple linear regression, goodness of fit, bias–variance trade off, k-nearest neighbors algorithm, linear discriminant analysis, classification and regression trees and pruning, random forest.

Learning outcomes:

At the end of this unit, student will be able to

1. Predict the numerical values based on different data sets
2. Classify the dataset into different categories

UNIT V **6L + 0T**

Unsupervised Learning and Reinforced learning

Cluster analysis – K Means, hierarchical, DBSCAN., Dimensionality reduction - PCA.

Reinforcement Learning: Agents, Model based and model free approaches.

Learning outcomes:

At the end of this unit, student will be able to

1. Cluster the data into labels based on their similarities
2. Reduce the dimensions of the data set.

Text Books:

1. Daniel J. Denis, Applied univariate, bivariate and multivariate statistics using Python, John Wiley & Sons, Inc., New Jersey, 2021 (for unit - I, IV and V)
2. CR Kothari, Research methodology - methods and techniques, New Age International, New Delhi, 2004 (for unit II and III)

Reference Books:

1. Quantrile Thomas and Liu YA, Artificial Intelligence in Chemical Engineering, Academic press, 1991.
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence - A modern approach, 3rd edition, Pearson publications, New York, 2020

Heat Transfer Lab

Course Code: 23CH4203 **Credits:1.5**

Instruction: L- 0 T-0 P-3 Sessional Marks:50

End Examination: 3 Hours End exam Marks: 50

Prerequisites: Heat Transfer

Course Objectives:

1. To understand the basic heat transfer principles.
2. To impart knowledge in handling various heat transfer equipments

Course Outcomes: At the completion of the course, the student will be able to

1. Determine the heat transfer coefficients.

Operate various heat transfer equipments.

CO-PO –PSO Mapping:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3					3	2		1	2	3
CO2	3	3	3	3					3	2		1	2	3

Correlation levels1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes & Program Specific Outcomes:

List of Experiments

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of the thermal conductivity of a metal rod.
3. Determination of the natural convective heat transfer coefficient for a vertical rod.
4. Determination of critical heat flux point for pool boiling of water.
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
7. Study of the temperature distribution along the length of a pin fin under natural and forced convection conditions
8. Determination of Stefan-Boltzmann constant.
9. Determination of emissivity of a given plate at various temperatures.
10. Determination of radiation constant of a given surface.
11. Estimation of unsteady state film heat transfer coefficient between the medium in which the body is cooled.

Study of electrical analog of heat conduction

Text Book:

1) W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th edition, 2005, McGraw-Hill.

Reference Books:

1) Donald Q. Kern, Process heat transfer, 2008, Tata McGraw-Hill.

Artificial Intelligence Laboratory

Course Code:23CH9201 **Credits:1.5**

Instruction: L- 0 T-0 P-3 Sessional Marks:50

End Examination: 3 Hours End exam Marks: 50

Prerequisites: Engineering mathematics, Problem solving and programming with C laboratory

Course Objectives:

1. To impart knowledge on modern tools
2. To provide hands on experience on AI tools

Course Outcomes:

1. Develop programs in a software / tool
2. Apply artificial intelligence techniques to solve problems

CO-PO –PSO Mapping:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	2	1	3	3				3	3		3	3	3
CO2	2	3	3	3	3				3	3		3	3	3

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

LIST OF EXPERIMENTS

Tools: MS Excel / Python / MATLAB / R

1. Perform Statistical analysis (Mean, Median, Mode and Standard deviation) on a dataset.
2. Create a dataset of sales data for different products and analyze the total sales and average sales for each product.
3. Perform Visualization using bar plot, scatter plot and pie chart.
4. Perform Visualization using Box Plot, Correlogram, and Heatmap.
5. Visualize geospatial data using choropleth map.
6. Perform Simple Linear Regression and estimate the mean absolute error, mean squared error and R^2
7. Perform multiple Linear Regression and estimate the mean absolute error, mean squared error and R^2
8. Perform logistic regression on a particular dataset.
9. Perform k-nearest neighbors algorithm and estimate the goodness of fit.
10. Perform random forest algorithms for regression and classification of the dataset and estimate the goodness of fit.
11. Perform dimensionality reduction operation using PCA on a Dataset.
12. Perform K-Means clustering operation and visualize the clusters.

Open Datasets:

1. https://archive.ics.uci.edu/datasets
2. https://www.kaggle.com/datasets

Reference Books:

1. Quantrile Thomas and Liu YA, Artificial Intelligence in Chemical Engineering, Academic press, 1991.
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence - A modern approach, 3rd edition, Pearson publications, New York, 2020
3. David L Poole and Alan K Mackworth, Python code for Artificial Intelligence, 2024 https://aipython.org

Numerical Ability & Professional Communication skills
(II Year II Sem.)

Course Category:	Humanities	**Credits:**	2
Branch	All Branches		
Course Code:	23CR9102	**Lecture-Tutorial-Practical:**	2+2
Prerequisites:	Knowledge of LSRW Skills, Basic Maths	**Continuous Evaluation:**	
		Semester End Evaluation:	
		Total Marks:	100

Upon successful completion of the course, the student will be able to:

Course Outcomes

CO1	Comprehend the essentiality of LSRW skills in paper presentations, seminars, workshops, conferences etc. with teams. **(L2),** To solve different types of questions based on vocabulary, structure, grammar and verbal reasoning
CO2	Attain the knowledge of soft skills in various conditions**(L3),** Solve questions based on sentence completion and fill in the blanks
CO3	Explore diverse fields through English **(L4),** To solve different types of questions based on vocabulary, structure, grammar and verbal reasoning
CO4	Use their logical thinking and analytical abilities to solve Quantitative aptitude questions from company specific and other competitive tests.
CO5	Solve questions related to Time and distance and time and work etc. from company specific and other competitive tests.

Contribution of Course Outcomes towards achievement of Program Outcomes& Strength of correlations		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
	CO1									M	M		M		
	CO2									M	M		M		
	CO3									M	M		M		
	CO4	M													
	CO5	M													
	L- Low						**M-Medium**						**H-High**		

PART-A: Professional Communication skills

UNIT-1	Abstract Preparation – Noticing Key Words –Literature Survey – Using Academic Verbs Verbal Ability : Sentence correction	CO1
UNIT-2	Organizational Skills – Time Management – IELTS Test Papers Exercises Verbal Ability : sentence completion	CO2

UNIT-3	Meeting Skills – Arranging a Meeting – Prior to Meeting, During Meeting and After Meeting Process – Note Making – Note Taking Verbal Ability : Error Identification	CO3
UNIT-4	Analogy – Origin of the Words – Eponyms – MNCs Question Papers Verbal Ability : vocabulary	CO4

PART-B : Numerical Ability

UNIT-I: **Numerical computation-** Applications based on Numbers –Classification of Number System, Prime and Composite, Even and Odd Numbers, Divisibility Rule, Remainder Theorem, Finding Highest power, LCM &HCF	CO4
UNIT-II: Numerical estimation – I Averages, Ratio Proportion, Application of Ratios (Ages)**,**Partnerships, Shares and dividends,	CO4
UNIT-III: Numerical estimation – II Percentages and its Applications, Profit Loss and Discount, Simple interest and Compound Interest	CO4
UNIT-IV: Time and work, Application of Time-work (Pipes & Cisterns), Time and Distance, circular Tracking, concept of Boats & steams.	CO5
UNIT-V : Mixtures and allegations, application of percentage and Ratios and Averages in Mixtures,	CO5

FINANCIAL LITERACY

Code	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
	L	T	P				
	30	-	-	100	-	100	-

Prerequisite: xxx

Course Objectives: The course has been designed to give familiarity with different aspects of financial literacy such as savings, investment, taxation, and insurance and understand the relevance and process of financial planning.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Recognize the role of saving money in reaching financial goals and identify components of a spending plan .
CO-2	Describe the importance of banks and their purpose as financial institutions.
CO-3	Apply the concept of investment planning.
CO-4	Ability to analyse banking and insurance products.
CO-5	Estimate Personal tax.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1						1		1			2	2
CO-2						1		1			2	2
CO-3						1		1			2	2
CO-4						1		1			2	2
CO-5						1		1			2	2

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I **Periods: 4L+2T=6**

UNIT TITLE: Introduction to Financial Planning

Introduction to saving: Benefits of Savings-Saving vs Investment, Investment vs Gambling-Time value of money-Management of spending and financial discipline.

UNIT - II **Periods: 4L+2T=6**

UNIT TITLE: Banking and Digital Payment

Banking products and services -Savings account, Current Account, Fixed deposits, Recurring deposits-Digitisation of financial transaction- Modes of digital payments: Debit cards, Credit cards, Net banking and UPI,-Digital Wallets-Role of RBI in banking sector.

UNIT - III **Periods: 4L+2T=6**

UNIT TITLE: Financial Markets and Investment Planning

Financial Markets: Primary and Secondary markets- Securities and its types, i.e., Equity, Debentures or Bonds, IPOs and FPOs-Mutual Funds: Types of Mutual Funds-Stock Market, DEMAT.

UNIT - IV **Periods: 4L+2T=6**

UNIT TITLE: Insurance Services: Life Insurance

Policies- Term insurance, Endowment policies, Pension policies-Health Insurance Plans-ULIP-General Insurance-Understanding of Ponzi Schemes.

UNIT - V **Periods: 4L+2T=6**

UNIT TITLE: Personal Tax

Introduction to basic tax structure in India for personal taxation-Basic concepts of Income Tax- Exemption and Deduction for individual-Income Tax Act, 1961-E-Filling.

TEXT BOOKS:

1. Introduction to Financial Planning (4th Edition 2017)- Indian Institute of Banking & Finance.
2. Sinha, Madhu. Financial Planning: A Ready Reckoner July 2017, McGraw Hill.

REFERENCE BOOKS:

1. Halan, Monika, Lets Talk Money: You've Worked Hard for It, Now Make It Work for You, July 2018 Harper Business.
2. Pandit, Amar The Only Financial Planning Book that You Will Ever Need, Network 18 Publications Ltd.

WEB RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc21_mg40/preview
2. https://corporatefinanceinstitute.com/resources/management/financial-literacy/

Professional Elective-I

POLYMER TECHNOLOGY

Course Code: 23CH5111 **Credits:3**

Instruction: L- 3 T- 0 P- 0 Sessional Marks:40
End Examination: 3 Hours End exam Marks: 60

Prerequisites: Organic Chemistry

Course Objectives: The course is intended to

- provide basic knowledge on polymers and their classification.
- familiarize chemistry and methods of polymerization.
- acquaint knowledge on processing equipment for polymerization.
- familiarize the manufacturing processes of various polymer compounds

Course Outcomes: At the end of the course, the student will be able to

1. Classify the polymers and determine the molecular weight of a polymer.
2. Interpret the kinetics of polymerization, characterization and impact of various properties on degradation of polymer.
3. Illustrate the methods of polymerizations and role of specific additives in the polymerized products.
4. Demonstrate various processing equipments are used for polymer products.
5. Optimize the suitable manufacturing process for a polymer compound

CO-PO –PSO Mapping:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2	1							1	1		1	3	2
CO2	2	1							1	1		1	3	2
CO3	2	1					1		1	1		1	3	2
CO4	2	1							1	1		1	3	2
CO5	2	1							1	1		1	3	2

Correlation levels → 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Introductory Concepts and Fundamentals: Definitions and concepts of plastics and polymers, comer, co-monomer, mesomer, co-polymer, functionality, visco-elasticity, classification of polymers, methods of determining molecular weight of polymers: Methods based on colligative properties, Sedimentation velocity method, Sedimentation equilibrium method, Gel-chromatography method, Light scattering analysis method, End-group analysis method.

Learning Outcome: At the end of the unit, student will be able to

- Classify polymers based on its properties and method of polymerization
- Determine the molecular weight of polymers based on various methods

UNIT II **9L + 3T**

Chemistry of Polymerization: Elementary concepts of addition polymerization, condensation polymerization and co- polymerization, glass transition and crystalline melting temperatures of the polymers, methods for determining glass transition temperature, degradation of polymers due to mechanical, hydrolytic, thermal and backbone effects.

Learning Outcome: At the end of the unit, student will be able to

- Outline the methods and identify the kinetics of polymerization
- Differentiate the glass transition and crystalline melting temperatures
- Summarize the various degradations of polymers

UNIT III **9L + 3T**

Methods of Polymerization: Mass, solution, emulsion and suspension polymerization, Role of the of the various additives: initiators, catalysts, inhibitors, solvents, fillers, reinforcing agents, stabilizers, plasticizers, lubricants, blowing agents, coupling agents, flame retardants, photo and bio-degradants

Learning Outcome: At the end of the unit, student will be able to

- Illustrate various methods of polymerizations
- Infer the role of specific additives in the polymerization

UNIT IV **9L + 3T**

Processing Equipment: Mixing and compounding, extrusion, calendaring, laminating, molding, compression, transfer, injection molding, blow molding.

Learning Outcome: At the end of the unit, the student will be able to

- Demonstrate various processing equipments
- Apply appropriate processing techniques as per the polymer product specifications

UNIT V **9L + 3T**

Manufacturing Processes of Addition Products: Polyethylene (LDPE and HDPE), Polypropylene, PVC and its copolymers, Polystyrene and its copolymers

Manufacturing Processes of Condensation Products: Polyesters: PMMA, PET, PF and UF resins.

Learning Outcome: At the end of the unit, the student will be able to

- nominate manufacturing method for addition polymer products
- Select appropriate manufacturing methods for condensation polymer products

Text Books:

1. R. Sinha, *Outlines of Polymer Technology: Manufacture of Polymers*, 2004, Prentice Hall India Pvt. Ltd. (UNIT – I, II, III and V).
2. R. Sinha, *Outlines of Polymer Technology: Processing Polymers*, 2004, Prentice Hall India Pvt. Ltd. (UNIT – IV).

Reference Books:

1. Billymeyer, F. W. Jr., *Textbook of Polymer Science*, 3rd edition, 2006, John Wiley & Sons
2. Anil Kumar. Gupta, R.K. *Fundamentals of Polymer Engineering*,2nd Ed, 2003, Marcel Dekker.

Introduction to sustainability

Course Code: R23CH5112 **Credits:3**

Instruction: L- 3 T- 0 P-0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: Nil

Course Objectives: The students are intended to

- Learn the basics of sustainability and its importance
- Correlate the relation between natural systems and waste generation
- Understand the importance of individual and systems in sustainability

Gain knowledge on approaches to sustainability

Course Outcomes: At the end of the course the students are able to

1. Summarize the need and importance of sustainability
2. Illustrate the conservation of resources with the help of natural systems
3. Identify the methods of sustainability at different levels
4. Implement sustainability methods in industrial environment
5. Select various energy conservation methods to bring sustainability

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Basic Information on Sustainable Issues: Definition of Sustainability, Sustainable development vs. economic growth, People's participation, Measuring sustainability - Carrying capacity

Learning Outcomes: At the end of this unit, student will be able to

- Recognize the importance of sustainability
- Summarize the importance of importance of sustainable development

UNIT II **9L + 3T**

Natural System and Culture of waste: Water cycle, Carbon Cycle, Waste – generation & treatment, Conservation of resources – energy and water.

Learning Outcomes: At the end of this unit, student will be able to

- Indicate the need of water cycle and carbon cycle

- Justify the conservation of resources like water and energy

UNIT III **9L + 3T**

Sustainability in the Built Environment: Sustainability at the individual level, public level, Environment sustainability

Learning Outcomes: At the end of this unit, student will be able to

- Explain the requirements of environment sustainability
- Illustrate the participation of individual and public in sustainability

UNIT IV **9L + 3T**

Industrial Approach to Sustainability: Sustainability in industry, Industrial ecology, Design for the environment – different approaches

Learning Outcomes: At the end of this unit, student will be able to

- Show the importance of sustainability in Industry
- Develop various approaches to industrial sustainability

UNIT V **9L + 3T**

Energy Sustainability: Brief technical information on energy conversion equipment, Non-conventional sources for energy generation

Learning Outcomes: At the end of this unit, student will be able to

- Choose different energy conservation equipment
- Select various non-conventional sources of energy generation

Text Books:

1. Introduction to Sustainability - Road to a Better Future, Nolberto Munier, Springer, 2005

Reference Books:

1. Introduction to Sustainability, Robert Brinkmann, John Wiley & Sons Ltd, 2016

ENERGY ENGINEERING

Course Code:23CH511* **Credits:3**

Instruction: L-3 T- 0 P- 0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: Chemical Technology, Engineering chemistry.

Course Objectives:

- To provide knowledge to conventional and non-conventional energy resources and their applications, concept of fuel cells, nuclear energy, energy storage and conservation.

Course Outcomes: By the end of the course, the student will be able to

1. Explain the various conventional and non-conventional energy resources available, production and use.
2. Identify the scenario of oil and gases, characteristics and applications.
3. Discuss the sustainability in application of non-conventional energy resources
4. Elucidate the concept of fuel cells, biofuels and nuclear energy with future applications.
5. Substantiate the Energy Storage, Distribution and conservation methodology for sustainability.

CO-PO –PSO Mapping:

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

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Introduction: Conventional energy resources, the present scenario, scope for future development.

Coal: Origin, occurrence and reserves, classification, ranking, analysis and testing, coal carbonization, manufacture of coke, coal gasification, coal liquefaction.

Learning Outcomes:

At the end of this unit, student will be able to

- State various conventional energy sources
- Explain the manufacturing process of coke and coal gasification process

UNIT II **9L + 3T**

Oil and Gases: Origin and formation of petroleum and gases, reserves and deposits of world, Indian Petroleum Industry, Fractionation of petroleum. Fuels derived from oil and gases, Characteristics, production methods and uses.

Learning Outcomes:

At the end of this unit, student will be able to

- Summarize the petroleum reserves and deposits across the world.
- Describe the fractionation process of petroleum.

UNIT III **9L + 3T**

Non-conventional energy sources: Solar energy, solar radiation, principles of heating and cooling, photo voltaic cells. Wind energy, hydrogen energy, geothermal and ocean thermal energy.

Learning Outcomes:

At the end of this unit, student will be able to

- Explain the applications of various non conventional energy sources
- Classify solar energy and solar radiation

UNIT IV **9L + 3T**

Bio Fuels: Introduction, Bio mass conversion technologies, Wet processes, dry processes, Bio-gas generation, Factors affecting bio-digestion, Classification of biogas plants, Production methods, characteristics, uses of biodiesel, bio-ethanol, Second generation biofuel feed stocks.
Fuel Cells: Working principle, Types, Advantages, Current and Future Applications.
Nuclear Energy: Nuclear fuel processing, nuclear reactions and nuclear reactors.

Learning Outcomes:

At the end of this unit, student will be able to

- Infer the Biomass conversion technologies and Bio gas generation processes.
- Enumerate the current and future applications of Fuel cells
- Describe nuclear reactions and nuclear reactors.

UNIT V **9L + 3T**

Energy Storage and Distribution: Mechanical Energy Storage, Hydroelectric Storage, Compressed Air Storage and Energy Storage via Flywheels, Electric Storage, Chemical Storage and Thermal Energy Storage.

Energy Conservation: Conservation methods in process industries, Theoretical analysis, practical limitations, equipment for energy saving / recovery.

Learning Outcomes:

At the end of this unit, student will be able to

- Summarize different energy storage methods.
- Identify and characterize energy conservation methods in process industries

Text Books:

1. S. Rao, B. B. Parulekar ,*Energy Technology*, 3rd Ed., Khanna Publishers, 1994. **(UNIT-I &V)**
2. G. D. Rai, *Non-Conventional energy sources*, 18thEd.,Khanna Publisher, 2017.**(UNIT-III)**
3. S. Sarkar, *Fuels and Combustion*, Universities Press, 3rdEd., 2009. **(UNIT-IV)**
4. Nelson. W. L, *Petroleum refining Engineering*, 4thEd., McGraw Hill, New York, 1969. **(UNIT-II)**

Reference Books:

1. S. B. Pandy, *Conventional Energy Technology*, Tata McGraw Hill.
2. S. Srinivasan, *Fuel Cells: From Fundamentals to Applications*, Springer, 2006.
3. O. P. Gupta, *Fundamentals of Nuclear power reactors*, Khanna Publishers, New Delhi, 1983.
4. Harker and Backhusst, *Fuels and energy*, Academic press, London 1981.

MEMBRANE TECHNOLOGY

Course Code: 23CH5114 **Credits: 3**

Instruction: L- 3 T- 0 P- 0 Sessional Marks:40

End Examination: 3 Hours End exam Marks: 60

Prerequisites: Introduction to Chemical Engineering

Course Objectives: To acquaint the new technologies and modelling approach of membrane technologies and their applications in real practical problems.

Course Outcomes: At the end of the course, the student will be able to

1. Differentiate the principles and properties of membrane materials.
2. perceive the techniques of preparation for synthetic membranes.
3. determine the transport phenomena in membranes.
4. Comprehend the mechanisms for membrane processes.
5. acquaintance the knowledge of various membrane configurations and about membrane fouling.

CO-PO –PSO Mapping:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	1							1	1		1	3	2
CO2	3	1	1	1					1	1		1	3	2
CO3	3	2	1	1					1	1		1	3	2
CO4	3	2	1	1					1	1		1	3	2
CO5	3	2	1	1					1	1		1	3	2

Correlation levels → 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping of Course Outcomes with Program Outcomes &Program Specific Outcomes:

SYLLABUS

UNIT I **9L + 3T**

Introduction to Membranes: Definition of membrane, membrane types, membrane separation processes, advantages and limitations of membrane technology compared to other separation processes, membrane materials and properties.

Learning Outcome: At the end of this unit, student will be able to

- Describe the function and applications of the membrane
- acquaintance of membrane technology dominance over the other technologies

UNIT II **9L + 3T**

Preparation of Synthetic Membranes: phase inversion membranes, preparation techniques for immersion precipitation, synthesis of asymmetric and composite membranes, influence of various parameters on membrane morphology and synthesis of inorganic membranes.

Learning Outcome: At the end of this unit, student will be able to

- Get the knowledge for the preparation of membranes using various precursors as well as techniques.

- enumerate the various parameters effected the morphology of membranes

UNIT III **9L + 3T**

Transport in Membranes: Introduction, driving forces, transport through porous membranes, transport through non-porous membranes, transport through ion-exchange membranes.

Learning Outcome: At the end of this unit, student will be able to

- Identify the concept of fouling and its classification at constant pressure.
- Differentiate the feasibility of transport mechanism with other separations

UNIT IV **9L + 3T**

Membrane Processes: Pressure driven membrane processes, concentration as driving force.

Learning Outcome: At the end of this unit, student will be able to

- Bifurcate low and high pressure driven processes and determination of average pore size.
- Differentiate pressure and concentration driven membrane processes.

UNIT V **9L + 3T**

Modules, Polarization Phenomena and Fouling: Introduction, membrane modules, comparison of the module configuration**,** concentration polarization, membrane fouling.

Learning Outcome: At the end of this unit, student will be able to

- Analyze the concentration polarization and its effect on membrane fouling
- Classify membrane modules and their configuration.

Text Books:

1. Mulder M, *Basic Principles of Membrane Technology*, Kluwer Academic Publishers, London, 1996.
2. Kaushik Nath, *Membrane Separation Processes*, Prentice-Hall Publications, New Delhi, 2008.

Reference Books:

1. Munir Cheryan, *Ultrafiltration and Microfiltration*, 2nd edition, Technomic Publishing Co (1998).
2. J. D. Seader and Ernest J. Henley, *Separation process principles,*2nd edition, Wiley India
3. R. E. Kesting, *Synthetic Polymeric membranes*, 2nd edition, McGraw Hill (1985)
4. Richard W. Baker, *Membrane Technology and Research*, Inc. (MTR), Newark, California, USA, 2004.