PAAVAI ENGINEERING COLLEGE (AUTONOMOUS), NAMAKKAL-637 018

DEPARTMENT OF CHEMICAL ENGINEERING

REGULATION-2023, CURRICULUM (Choice Based Credit System)

(Applicable to the Candidates admitted from the academic year 2023-2024 onwards)

SEMESTER III							
S.No	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
Theory							
1	BS	MA23301	Transform Techniques and Partial Differential Equations	3	1	0	4
2	BS	CH23301	Physical Chemistry	3	0	0	3
3	PC	CM23301	Fluid Mechanics	3	0	0	3
4	PC	CM23302	Chemical Process Calculations	3	0	0	3
5	MC	MC23301	Environmental Sciences and Sustainability	2	0	0	0
Theory Cum Practical							
6	ES	CM23303	Thermal Engineering	3	0	2	4
Practical							
7	BS	CH23302	Physical Chemistry Laboratory	0	0	4	2
8	PC	CM23304	Fluid Mechanics Laboratory	0	0	4	2
9	EE	GE23301	Professional Development I	0	0	2	1
			TOTAL	**17**	**1**	**12**	**22**
SEMESTER IV							
S.No	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
Theory							
1	BS	MA23401	Statistics and Numerical Methods	3	1	0	4
2	PC	CM23401	Chemical Process Industries	3	0	0	3
3	PC	CM23402	Mechanical Operations	3	0	0	3
4	PC	CM23403	Process Organic Synthesis	3	0	0	3
5	MC	MC23402	Human Values and Gender Equality	2	0	0	0
Theory Cum Practical							
6	PC	CM23404	Heat Transfer	3	0	2	4
Practical							
7	PC	CM23405	Mechanical Operations Laboratory	0	0	4	2
8	PC	CM23406	Organic Chemistry Laboratory	0	0	4	2
9	EE	GE23401	Professional Development II	0	0	2	1
			TOTAL	**17**	**1**	**12**	**22**

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
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BOARD OF STUDIES
Chemical Engineering
17/5/24
AUTONOMOUS

MA23301	TRANSFORM TECHNIQUES AND PARTIAL DIFFERENTIAL EQUATIONS	3	1	0	4

(Common to Aero, Agri, BME, Biotech, Civil, Chemical, EEE, Food, Pharma, Mech, MCT, R&A)

COURSE OBJECTIVES

To enable the students to

1	develop the knowledge of periodic and non-periodic functions and their representations using fourier series.
2	acquaint the student with Fourier transform techniques used in wide variety of situations.
3	introduce the basic concepts of PDE for solving standard partial differential equations.
4	acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
5	develop Z transform techniques for discrete time systems.

UNIT I	FOURIER SERIES	12

Dirichlet's conditions; General Fourier series; Odd and even functions; Half range series; Statement of Complex form of Fourier Series; Parseval's identity; Harmonic Analysis.

UNIT II	FOURIER TRANSFORMS	12

Fourier integral theorem (without proof); Fourier transform pair; Sine and Cosine transform - Properties; Transforms of elementary functions; Convolution theorem; Parseval's identity.

UNIT III	PARTIAL DIFFERENTIAL EQUATIONS	12

Formation of partial differential equations; Lagrange's linear equation; Solutions of four standard types of first order partial differential equations; Linear partial differential equations of second order with constant coefficients.

UNIT IV	FOURIER SERIES SOLUTION TO PARTIAL DIFFERENTIAL EQUATIONS	12

Solutions of One-dimensional wave and heat equation; Steady state two-dimensional heat equation.

UNIT V	Z -TRANSFORMS AND DIFFERENCE EQUATIONS	12

Z-transforms - Elementary properties; Inverse Z-transform; Method of partial fraction ; Residue method; Convolution theorem; Solution of difference equations by Z-transform.

	TOTAL PERIODS	60

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	classify the properties of periodic and non-periodic vibrations with the help of Fourier series.	Applying (K3)
CO2	apply the Fourier transform to convert the function from frequency	Applying (K3)

	domain to time domain.	
CO3	demonstrate partial differential equations that occur in many engineering applications.	Applying (K3)
CO4	apply Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	Applying (K3)
CO5	apply knowledge of Z transform to analyse linear time invariant systems.	Applying (K3)

TEXT BOOKS

1. Veerarajan T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Grewal. B.S, "Higher Engineering Mathematics", 44th Edition, Khanna Publications, New Delhi, 2018.

REFERENCES

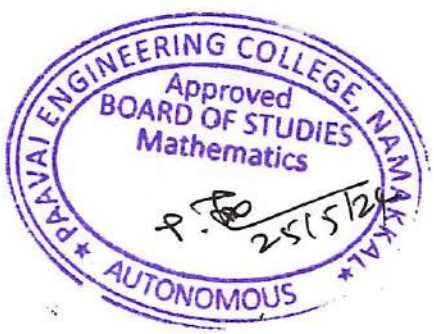
1. Erwin Kreyszig , "Advanced Engineering Mathematics ", 10th Edition, Wiley Publications, New Delhi, India, 2016.
2. Ramana. B.V., "Higher Engineering Mathematics", Tata Mc-Graw Hill Publishing Company limited, New Delhi, 2010.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. Wylie. R.C. and Barrett. L.C., "Advanced Engineering Mathematics", Tata Mc-Graw Hill Publishing Company limited, 6th Edition, New Delhi, 2012.

CO-PO MAPPING :

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

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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



CH23301	PHYSICAL CHEMISTRY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand chemical kinetics and the rate of reactions and their mechanism.
2	distinguish the basic of catalysis and bio-catalysis reactions.
3	acquire knowledge on adsorption and surface chemistry.
4	get knowledge on the types of solution and their kinetics and electro-kinetic behaviors.
5	understand distribution of solutes between immiscible liquid phases.

UNIT I CHEMICAL KINETICS 9

Rate of a reaction – Order of a reaction, Integrated rate expressions: Zero order – First order – Second order and Third order reactions, Half-life time, Methods of determining order of a reaction, Order and molecularity, Mechanism of complex reactions, Effects of temperature and a catalyst, Arrhenius equation, Theories of reaction rates: Collision theory – Activated complex theory (ACT) – Eyring equation.

UNIT II CATALYSIS 9

General characteristics of catalytic reactions, Acid-Base catalysis, Enzyme catalysis: The Michaelis-Menten equation – effect of temperature on enzyme catalysis, Heterogeneous catalysis: Surface reactions – Kinetics of surface reactions: Unimolecular surface reactions – Bimolecular surface reactions, Auto catalysis and Oscillatory reactions.

UNIT III SURFACE CHEMISTRY 9

Adsorption by solid: Chemisorption – Application of adsorption – adsorption of gases by solids – factors influencing adsorption, The Freundlich adsorption isotherm – The Langmuir theory of adsorption – The BET theory of adsorption of multilayer adsorption: derivation of the BET equation, Types of adsorption isotherms, Adsorption from solution: The Gibbs adsorption isotherm.

UNIT IV THE COLLOIDAL STATE 9

Introduction to colloids – Classification of colloids – Preparation of colloids – Purification of colloidal solutions – Properties of colloids – Coagulation of solutions – Origin of charge on colloidal Particles – Electrical double layer – Electrokinetic properties: Electrophoresis – Electro-osmosis – Emulsions – Gels – Applications of colloids.

UNIT V THE DISTRIBUTION LAW 9

Nernst distribution law, Conditions for the validity of the distribution law, Thermodynamic derivation, Association of the solute in one of the solvents, Dissociation of the solute in one of the solvents, Solute enters into chemical combination with one of the solvents, Applications of the distribution law – Solvent extraction.

TOTAL PERIODS 45

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	predict reaction behavior based on temperature and pressure changes.	Understanding (K3)
CO2	examine the suitable catalysts to modify the rate of chemical reactions.	Applying (K2)
CO3	apply the principles of adsorption to remove impurities from a mixture.	Applying (K3)
CO4	determine suitable methods to prepare various colloidal materials.	Applying (K3)
CO5	analyze solutes in a mixture and separate the desired compounds.	Analyzing (K4)

TEXT BOOKS

1. Puri B.H., Sharma L.R. and Pathania M.S., "Principles of Physical Chemisry", Vishal Publishing Company, Jalandhar, 2018-2019.
2. Arun B., Bahl B.S., and Tuli G.D., "Essentials of Physical Chemistry" S.Chand and Company, New Delhi, 2012.

REFERENCES

1. Kund.N and Jain S.K., "Physical Chemistry", S.Chand and Company, New Delhi, 2011.
2. Gurudeep Raj, "Advanced Physical chemistry", 34th edition, Goel Publishing House, Krishna Prakashan Media (P) Ltd., 2011.
3. Gordon M. Barrow, "Physical Chemistry", Eight Edition, Tata McGraw-Hill, 2013.
4. Peter Atkins & Julio de Paula, Atkins "Physical Chemistry", 9th Edition, Oxford university press 2012.

CO-PO MAPPING :

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

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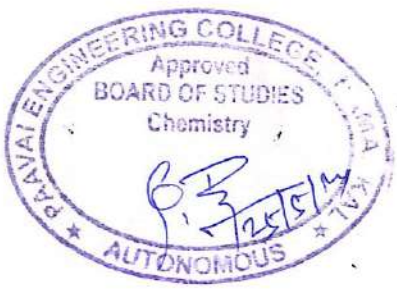
CO's	PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2	2	-	-	-	1	1	-	-	1	2	-	1
CO2	2	1	2	2	-	-	2	2	-	-	1	2	1	1
CO3	2	1	2	1	-	-	2	2	-	-	1	2	1	1
CO4	2	2	2	2	-	-	2	2	-	-	1	2	2	2
CO5	2	2	3	-	-	-	2	2	-	-	2	2	2	2



CM23301	FLUID MECHANICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the basic concepts of fluid statics and dimensional analysis
2	learn the fluid flow operations in pipes and basic equations associated with flow through pipes.
3	execute the packed and fluidized beds used in process industries
4	prepare the types of flow measuring devices and to determine coefficient of discharge.
5	acquire knowledge over classification of fluid moving machinery and their performance analysis.

UNIT I FLUID PROPERTIES AND STATICS 9

Physical properties of fluids -Classification of fluids; Pressure measurement – Manometers – Simple and Differential; Dimensional Analysis-Dimensionless Group-The Rayleigh Method -Application of Dimensional Analysis to Fluid Flow -Buckingham's π Theorem - Use of Buckingham's π Theorem for Dimensional Analysis; Dimensionless numbers.

UNIT II FLOW THROUGH CONDUITS 9

Types of flow– Shear stress distribution-Laminar and turbulent flow in pipes; Equation of Continuity; Bernoulli Equation- Pump Work in Bernoulli Equation; Reynold's Experiment; Flow of Incompressible Fluids in Pipes- Fanning Friction Factor; Laminar Flow in Circular Pipe-Hagen-Poiseuille equation.

UNIT III FLOW AROUND SOLIDS 9

Drag and its types-Drag coefficient; Pressure drop across packed bed- Ergun's equation; Fluidization and its classification- Pressure drop across the fluidized bed – Minimum fluidization velocity- Motion of particles through fluids–Terminal settling velocity; motion of spherical particle -stokes law.

UNIT IV FLOW METERING 9

Classification and Selection of flow meters; Principle, working and applications of Venturimeter, Orifice meter, Rotameter and Pitot tube; Determination of discharge coefficient; Other meters – Anemometer, Mass flow meter, Magnetic Flow Meter; Measurement of Flow in Open Channels - Rectangular Notch and Triangular notch.

UNIT V FLUID MOVING MACHINERY 9

Classification and selection of fluid moving machinery; Principle, working and applications of Centrifugal pump and Reciprocating Pump-Characteristics curves of centrifugal pump; Elementary principles of gear, air lift, diaphragm and submersible pumps.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	analyze fluid properties and dimensional analysis problems.	Analyzing (K4)

CO2	apply continuity and Bernoulli's equation to solve pipe flow problems, identifying laminar vs. turbulent regimes.	Applying (K3)
CO3	analyze drag forces and calculate terminal settling velocity of particles.	Analyzing (K4)
CO4	distinguish the principles of various flow meters.	Understanding (K2)
CO5	investigate different types of fluid moving machinery.	Applying (K3)

TEXT BOOKS

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 3rd Edition, McGraw-Hill, 2011.
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2006.

REFERENCES

1. A.P. Kulkarni, "Fluid Mechanics for Chemical Engineers" Nirali Prakshan Publication, 2015.
2. J.M.Coulson and J.F.Richardson, "Chemical Engineering Vol - I &II", 6th Edition Butterworth – New Delhi, 2000.
3. R.K. Bansal, "Fluid Mechanics and Hydraulic Machines", Revised Ninth Edition, Laxmi Publications (p) limited, 2014.
4. Yunus A. Cengel and John M. Cimbala, "Fluid mechanics: Fundamentals and application", 4th Edition, New York, 2018.

CO-PO MAPPING :

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

CM23302	CHEMICAL PROCESS CALCULATIONS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	understand the basic principles involved in Chemical Process Calculations.
2	solve the problems in Energy balance and law of conservation of energy.
3	get knowledge about the calculation of pressure, volume and temperature using ideal gas law.
4	learn mass and energy balance in unit operation and process involved in chemical industries.
5	know about the composition of mixture and solutions.

UNIT I	BASIC CHEMICAL CALCULATIONS	10

Base and derived Units – Basis of calculations – Normality, Molality, weight, mole & volume percent - Composition of Mixture and solutions – specific gravity, density, average molecular weight, Laws for Ideal gas and solutions. Calculations of density and average molecular weight of gas mixture, applications of real gas relationship in gas calculation.

UNIT II	MATERIAL BALANCE IN UNIT OPERATIONS	10

Material balance principles – law of conservation of mass, Application of material balance to unit operations like distillation, evaporation, extraction and drying - Unit operations with recycle - bypass and purge – introduction to material balance with chemical reaction – Yield and selectivity.

UNIT III	HUMIDITY	7

Humidity, Percent humidity, Relative humidity, Dew point, humid heat, humid volume, Wet bulb temperature, dry bulb temperature, adiabatic saturation temperature, Enthalpy, Humidity chart, Application of humidity-humidification and dehumidification.

UNIT IV	ENERGY BALANCE	9

Energy and thermochemistry - Energy balance for systems with and without chemical reaction - Heat capacity, heat capacity of liquid mixtures, Sensible heat changes in gases at constant pressure, sensible changes in liquids and solids, and mixtures. - Enthalpy, enthalpy changes for pure substances and their ideal states, Standard heat of reaction, heats of formation, solution and mixing.

UNIT V	COMBUSTION	9

Fuels, calorific values of fuels, Heat of combustion- solid, liquid and gaseous fuels, Calorific value of fuels – GCV, NCV, air requirement, Determination of Composition by Orsat analysis- Calculation of Theoretical air and excess air requirement by orsat technique.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	apply unit conversion methods in process calculations.	Applying (K3)
CO2	compute the yield and product of various unit operations.	Applying (K3)
CO3	analyze the pschrometric properties using pschrometric chart.	Analyzing (K4)

CO4	explain the concept of heat capacity and its variations.	Analyzing (K4)
CO5	identify the enthalpy application in thermodynamic systems.	Analyzing (K4)

TEXT BOOKS

1. Narayanan K.V. and Lakshmikutty B., "Stoichiometry and Process Calculations", 5th Edition, Prentice Hall of India, New Delhi, 2013.
2. Bhatt, B.L., Vora, S.M., "Stoichiometry", 4th Edition, Tata McGraw-Hill, 2004.

REFERENCES

1. Himmelblau D.M., "Basic Principles and calculation in Chemical Engineering", 6th Edition, Prentice Hall of India, New Delhi, 2003.
2. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers, 2nd Edition, 2004.
3. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 5th Edition, John Wiley & Sons, New York, 2005.
4. Venkataramani V., Anantharaman N. and Meera Sheriffa Begum K.M., "Process Calculations", 2nd Edition, Prentice Hall of India, New Delhi, 2011.

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CO's	PO's												PSO's	
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CO1	3	2	2	-	-	-	-	-	-	-	1	2	3	1
CO2	2	1	1	-	-	-	1	-	-	-	1	2	3	-
CO3	2	3	2	-	-	-	1	-	-	-	1	2	2	1
CO4	2	3	3	-	-	-	2	-	-	-	1	2	1	1
CO5	2	2	2	-	-	-	2	-	-	-	2	2	1	1

MC23301	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY	2	0	0	0

COURSE OBJECTIVES

To enable the students to

1	establish the knowledge of precious resources of the environment and their various impacts.
2	create awareness on ecosystem and biodiversity preserve.
3	learn scientific and technological solutions to current day pollution issues.
4	analyze climate changes, concept of carbon credit and the challenges of environmental management.
5	understand green materials, energy cycles and the role of sustainable urbanization.

UNIT I	ENVIRONMENT AND NATURAL RESOURCES	6

Definition, scope and importance of Environment. Forest resources: Use and over-exploitation, deforestation, - mining, dams and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, dams-benefits and problems. Food resources: effects of modern agriculture, fertilizer-pesticide problems. Role of an individual in conservation of natural resources.

UNIT II	ECOSYSTEMS AND BIODIVERSITY	6

Concept of an ecosystem: Structure and function of an ecosystem - ecological succession - food chains and food webs. Ecosystems- Types of ecosystem: Introduction - forest ecosystem and lake ecosystems. Biodiversity: Introduction - definition (genetic - species - ecosystem). Diversity - Value of biodiversity - Hotspots of biodiversity - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III	ENVIRONMENTAL POLLUTION	6

Pollution: Définition - air pollution - water pollution - marine pollution - noise pollution. Solid waste management: Causes - effects - control measures of urban and industrial wastes. Role of an individual in prevention of pollution - Electronic waste -Sources-Causes and its effects- Pollution case studies-Field study of local polluted site – Industrial/Agricultural

UNIT IV	SUSTAINABILITY AND ENVIRONMENT	6

Sustainability - from unsustainability to sustainability-millennium development goals, and protocols. Sustainable development goals-targets, indicators and intervention areas. Climate change— acid rain - ozone layer depletion. Regional and local environmental issues and possible solutions-case studies. Concept of carbon credit, carbon footprint. Environmental management in industry-A case study.

UNIT V	SUSTAINABILITY PRACTICES	6

Zero waste and R concept, Circular economy, ISO 14000 Series, Environmental Impact Assessment - Sustainable energy: Non-conventional Sources, Green materials, Energy Cycles - carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio economical and technological change.

	TOTAL PERIODS	30

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	find the method of conservation of natural resources	Understanding (K2)
CO2	understand ecosystem and the conservation of biodiversity.	Understanding (K2)
CO3	aware of environmental pollution and interpret its effects.	Understanding (K2)
CO4	apply sustainable development for technological advancement and societal development.	Applying (K3)
CO5	measure the sustainability practices for green energy cycles.	Analyzing (K4)

TEXT BOOKS

1. Benny Joseph, "Environmental Science and Engineering", Tata McGraw Hill, 1st edition, 2017.
2. Gilbert M. Masters, Wendell P. Ela " Introduction to Environmental Engineering and Science", 3rd edition, Pearson, 2022.

REFERENCES

1. William P. Cunningham and Mary Ann Cunningham, "Environmental Science: A Global Concern", McGraw Hill, 16th edition, 2023.
2. C. S. Rao, Environmental Pollution and Control engineering, New Age International (P) ltd Publication, New Delhi, 4th edition, 2021.
3. Erach Bharucha, "Textbook of Environmental Studies", Universities Press Pvt. Ltd., edition, 2020.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 4th Edition, 2015.

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

CM23303	THERMAL ENGINEERING	3	0	2	4

COURSE OBJECTIVES

To enable the students to

1	understand the fundamentals and laws of thermodynamics
2	gain knowledge of thermo dynamic cycles and its efficiency
3	learn the properties of steam and energy conservation opportunities in steam systems
4	study different types of boilers, mounting and accessories
5	acquire knowledge of turbines and vacuum systems

UNIT I THERMODYNAMIC LAWS AND CYCLES 9

Property, State, path and process and quasi-static process, work, Energy, Thermodynamic Systems - open, closed and isolated; zeroth, First and Second Laws (basic concept only), Air standard Cycles: Otto, Diesel and Combined cycle; Carnot, Brayton and Rankine cycles – cycle efficiencies.

UNIT II INTERNAL COMBUSTION ENGINES 9

Classification-components and their function-Valve timing and Port timing diagram, Working of S.I and C.I engines-Simple carburetor-Battery and Magneto ignition system-Knocking in S.I and C.I engines-Lubrication and cooling systems, Hybrid electric vehicles.

UNIT III BOILERS AND STEAM PROPERTIES 9

Types and classification of boilers: water tube, fire tube, coal, oil and gas fired boilers, Concept of Steam distribution systems. Steam traps- types; Mountings and accessories. Performance and Efficiency of boilers.-Properties of steam, Mollier chart, dryness fraction of steam.

UNIT IV AIR COMPRESSORS 9

Classification of compressors – work of compression with and without clearance; volumetric efficiency; Isothermal efficiency and isometric efficiency of reciprocating air compressors: Multi stage air compressor and inter cooling- Work of multi stage air compressor.

UNIT V TURBINES AND VACUUM SYSTEMS 9

Steam turbines- types and working principles: Reaction and impulse turbines; Application of co-generation principles in process industries. Gas turbines- principle and working. Production of Vacuum: Systems and Equipment- Vacuum Pumps.

LIST OF EXPERIMENTS

1. Valve Timing and Port Timing Diagrams
2. Performance Test on 4-stroke Diesel Engine/Petrol Engine
3. Heat Balance Test on 4-stroke Diesel Engine
4. Retardation Test to find Frictional Power of a Diesel Engine
5. Performance and Energy balance Test on Boilers.

6. Efficiency of Air compressor.		
7. Conduct experiments and draw the characteristic curve of turbine.		
	TOTAL PERIODS	**75**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	compare different thermodynamic cycles and their thermal efficiencies.	Understanding (K2)
CO2	demonstrate the functions and working of I.C engine components.	Applying (K3)
CO3	classify the boilers and perform simple calculations of boiler efficiencies.	Understanding (K2)
CO4	acquire knowledge on working and performance of air compressors.	Applying (K3)
CO5	classify the principles of steam turbines and calculation of turbine efficiencies.	Applying (K3)

TEXT BOOKS

1. Rajput R.K., "Thermal Engineering", 9th Edition, Laxmi Publications, 2010.
2. Rudramoorthy R., "Thermal Engineering", 4thEdition, Tata McGraw Hill Publishing Company, New Delhi, 2006.

REFERENCES

1. Kothandaraman, C.P., Domkundwar.S and Domkundwar.A.V, "Course in Thermodynamics and Heat Engines", 3rd Edition, DhanpatRai& Sons, New Delhi, 2011
2. Ballaney P.L., "Thermal Engineering", Khanna Publishers, New Delhi, 2005.
3. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2017.
4. Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, PHI Learning, Pvt. Ltd., 2005.

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CO2	3	2	1	2	-	-	-	-	1	-	-	2	1	1
CO3	3	2	1	2	-	-	-	-	1	-	-	2	2	2
CO4	3	2	2	2	-	-	-	-	1	-	-	2	2	2
CO5	3	2	2	2	-	-	-	-	1	-	-	2	2	2

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Chemical Engineering
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CH23302	PHYSICAL CHEMISTRY LABORATORY	0	0	4	2

COURSE OBJECTIVES

To enable the students to

1	learn conductivity properties of different electrolytes.
2	understand the rate of reactions and their mechanisms.
3	gain knowledge on adsorption and surface chemistry
4	understand solubility properties and characteristics of solvents and mixtures.

LIST OF EXPERIMENTS

1. Titration of Strong Acid versus Strong Base - Conductometric experiments.
2. Titration of mixture of Strong Acid and Weak Acid versus Strong Base - Conductometric experiments.
3. Titration of Weak Acid versus Weak Base - Conductometric experiments.
4. Conductometric experiments - Verification of Ostwald's Dilution Law.
5. Determination of ferrous ion concentration by potentiometric titration.
6. Determination of pH metric titration of strong acid versus strong base.
7. Determination of Rate Constant (K)-Ester Hydrolysis.
8. Determination of adsorption of acetic acid on charcoal.
9. Determination of adsorption of oxalic acid by activated charcoal – Freundlich's Adsorption isotherm.
10. Determination of partition co-efficient of iodine between two immiscible solvents.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	classify the relationship between conductivity and concentration using Oswald's Dilution Law for ionic solutions.	understanding (K3)
CO2	explore potentiometric titration to determine the concentration of ferrous ions.	analyzing (K4)
CO3	investigate adsorption phenomena by quantifying the adsorption of organic acids on charcoal.	analyzing (K4)
CO4	explain the partition coefficient of a solute and solvents.	analyzing (K4)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

CM23304	FLUID MECHANICS LABORATORY	0	0	4	2

COURSE OBJECTIVES

To enable the students to

1	calibrate and study the working of flow meters.
2	acquire knowledge in different pumps in pressure loss for flowing fluid.
3	determine characteristics of different pump.
4	determine the efficiency of pumps.

LIST OF EXPERIMENTS

1. Determination of co-efficient of discharge of given orifice meter.
2. Determination of co-efficient of discharge of given venturimeter
3. Calculation of percentage error in rotameter.
4. Friction factor for flow through straight pipe.
5. Flow through helical coil and spiral coil.
6. Losses in pipe fittings and valves.
7. Characteristic curves of Centrifugal pumps .
8. Performance study on Reciprocating pump.
9. Pressure drop studies in packed column.
10. Pressure drop studies in Fluidized bed.

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	compute the flow rate measurements by calibrating instruments used in open channel and closed conduit flow.	Understanding (K2)
CO2	analyze the properties of fluid behaviour.	Applying (K3)
CO3	estimate and predict pressure losses in packed equipment used for separation, mixing, and reaction processes.	Evaluating (K4)
CO4	measure flow rate, head, efficiency of different pumps.	Understanding (K2)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

GE23301	PROFESSIONAL DEVELOPMENT I	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1	enhance and evaluate the student's professional skills and introduce the function of corporate world.
2	enhance and develop the students behavioral, speaking and listening skills to face the interview.
3	solve advance level verbal aptitude tests to get placed in Tier I companies.
4	improve their reasoning skills to get placed in reputed companies.

UNIT I	SELF - UNDERSTANDING AND PERSONALITY ENHANCEMENT SKILLS	7

Introduction self-exploration; SWOT analysis - Types and barriers; Effective communication in workplace; Leadership skills; Decision making - Problem solving; Goal setting - Critical, strategic and lateral thinking; JAM level- I; Basic resume building level- I.

UNIT II	BEHAVIOURAL SKILLS, LISTENING AND SPEAKING SKILLS	7

Behaviouralskills; Time management; Emotional intelligence; Analytical thinking- Listening; Listening and hearing; Self-introduction; Group discussion - Types and importance, evaluation criteria, do's and don'ts of GD; GD Level-1.

UNIT III	QUANTITATIVE APTITUDE	8

Number System; LCM and HCF; Simple interest and compound interest; Average; Pipes and cisterns; Area; Profit and loss.

UNIT IV	LOGICAL REASONING	8

Logical sequence; Analogy; Classification; Causes and effect; Making judgment; Directions.

	TOTAL PERIODS	30

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	define and analyze soft skills to improve the leadership skills.	Analyzing (K4)
CO2	demonstrate the behavioral skills through various activities.	Applying (K3)
CO3	develop the problem solving skills through quantitative aptitude.	Applying (K3)
CO4	illustrate the logical reasoning Skills to solve real world problems.	Analyzing (K4)

TEXT BOOKS

1. Agarwal, R.S. "Objective General English", S.Chand & Co.2021.
2. Agarwal, R.S. "Quantitative Aptitude", S.Chand & Co.2021.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill, 2023.
2. Agarwal, R.S." a modern approach to Verbal & Non Verbal Reasoning", S.Chand & Co Ltd,

New Delhi.2021.

3. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications, 2021.

CO-PO MAPPING :

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

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

MA23401	STATISTICS AND NUMERICAL METHODS	3	1	0	4

(Common to Civil, Chemical, Mech, MCT, R&A)

COURSE OBJECTIVES

To enable the students to

1	determine the concepts of hypotheses testing, its need and applications.
2	equip with statistical techniques for designing experiments, analyzing, interpreting and presenting research data.
3	apply various numerical techniques for solving algebraic/transcendental equations and system of linear equations.
4	develop the knowledge of numerical differentiation and numerical integration techniques.
5	acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I	TESTING OF HYPOTHESIS	12

Sampling theory; Large sample - Tests for single mean, proportion and difference of means; Small sample- Test for single mean and difference of means; Test equality of variances; Chi square test- Goodness of fit, Independence of attributes.

UNIT II	DESIGN OF EXPERIMENTS	12

Completely randomized design; Randomized block design; One way and two way classifications- Latin square design - 2^2 factorial design.

UNIT III	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	12

Solution of algebraic and transcendental equations; Fixed point iteration method; Newton Raphson method; Solution of linear system of equations; Gauss elimination method – Pivoting; Gauss Jordan method; Iterative methods of Gauss Jacobi and Gauss Seidel; Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT IV	INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION	12

Interpolations - Newton's forward and backward difference interpolation; Approximation of interpolation polynomials; Divided differences; Lagrangian methods for equal and unequal intervals; Numerical differentiation and integration by trapezoidal and Simpson's 1/3 rules.

UNIT V	NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	12

Single step methods: Taylor's series method; Euler's method, Modified Euler's method; Fourth order Runge-Kutta method for solving first order differential equations; Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

	TOTAL PERIODS	60

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	apply the concept of testing of hypothesis for small and large samples in real life problems	Applying (K3)
CO2	analyse the principles to be adopted for designing the experiments.	Analysing (K4)
CO3	apply various numerical techniques to solve algebraic and transcendental equations.	Applying(K3)
CO4	derive the concepts of numerical differentiation and integration.	Applying (K3)
CO5	compute the solution of first order ordinary differential equations by numerical techniques..	Applying (K3)

TEXT BOOKS

1. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
2. Sankar Rao K " Numerical Methods for Scientists and Engineers –3rd Edition Princtice Hall of India Private, New Delhi, 2007.

REFERENCES

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
3. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

CO-PO MAPPING :

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

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

CM23401	CHEMICAL PROCESS INDUSTRIES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	impart knowledge on various aspects of production Engineering of sulfur and cement materials.
2	acquire knowledge on raw materials, types of Chemical fertilizers.
3	understand the industrial manufacturing processes of carbohydrate compounds.
4	make the student to understand the production of petrochemical products.
5	understand the industrial production processes of fuel and industrial gases.

UNIT I	SULFUR, SULFURIC ACID AND CEMENT	9

Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II	FERTILIZER INDUSTRY	9

Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries, Phosphoric acid, Single Super Phosphate, DAP, MAP and NPK – Potassium chloride, Potassium Sulphate – Liquid Fertilizers – Bio Fertilizers.

UNIT III	PULP, PAPER, SUGAR AND STARCH INDUSTRIES	9

Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.

UNIT IV	PETROLEUM AND PETRO CHEMICAL INDUSTRIES	9

Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Butadiane – Chemicals from Aromatics - Benzene, Toluene and Xylene.

UNIT V	FUEL AND INDUSTRIAL GASES	9

Fuel Gases – Natural gas, Liquefied natural gas, Synthesis Gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen – Argon.

	TOTAL PERIODS	45

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	explain the process flow diagram for manufacture of chemical products.	Understanding (K2)
CO2	illustrate the manufacturing process of chemical fertilizers using flow diagram.	Analyzing (K4)

CO3	explain the process flow diagram for productions of pulp, paper and starch.	Understanding (K2)
CO4	explore the refining and manufacturing processes of petrochemicals.	Analyzing (K4)
CO5	explain the process flow diagram for the production of fuel and industrial gases.	Understanding (K2)

TEXT BOOKS

1. Dryden, C.E, Outlines of Chemical technology, II Ed., Affiljate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley, Second edition 2013.

REFERENCES

1. Austin, G.T., Shreve's "Chemical Process Industries", 5th Edition, McGraw-Hill, 2017.
2. Mark W.V. and Bhatia S.C., "Chemical Process Industries", Volume-I and II, 2nd Edition, CBS Publishers and Distributors, New Delhi, 2007.
3. Srikumar Koyikkal, "Chemical Process Technology and Simulation", PHI Learning Ltd.
4. Gopala Rao M. and Marshall Sittig, "DRYDEN'S Outlines of Chemical Technology ", 3rd Edition, East-West Press, New Delhi, 2008.

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CO1	2	2	3	-	-	-	1	-	-	-	-	2	3	2
CO2	2	1	2	-	-	-	2	-	-	-	-	2	2	1
CO3	2	1	2	-	-	-	2	-	-	-	-	2	2	1
CO4	2	2	3	-	-	-	3	-	-	-	-	2	1	1
CO5	2	2	3	-	-	-	3	-	-	-	-	2	2	1

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CM23402	MECHANICAL OPERATIONS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	study the Characteristics of particulate solids, and storage of solids.
2	describe size reduction equipment and its application.
3	acquire knowledge in separating solids from solids, solids from liquids.
4	familiarize mechanism of filtration and equipment's involved in process.
5	gain knowledge on mixing of solid-solid, liquid – liquid components.

UNIT I PARTICLE CHARACTERIZATION AND MEASUREMENT **9**

General characteristics of solids, different techniques of size analysis- Static - Image analysis and Dynamic analysis - Light scattering techniques, shape factor, surface area determination, estimation of particle size. Advanced particle size analysis techniques. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT **9**

Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Advanced size reduction techniques - Nano particle fabrication - Top-down approach - Bottom-up approach. Size enlargement - Importance of size enlargement, principle of granulation, briquetting, pelletization, and flocculation. Fundamentals of particle generation.

UNIT III PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM) **9**

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging.

UNIT IV FILTRATION AND FILTRATION EQUIPMENTS **9**

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V MIXING AND PARTICLE HANDLING **9**

Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, Powder hazards, conveyer selection, different types of conveyers and their performance characteristics.

TOTAL PERIODS **45**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	understand and determine various properties of particulates.	Understanding (K2)
CO2	gain Preliminary understanding on Size Reduction and Size Enlargement.	Applying (K2)
CO3	understand various separation and purification techniques employed in solid particles.	Understanding (K2)
CO4	enhance their knowledge on Filtration Process.	Applying (K3)
CO5	understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications.	Understanding (K2)

TEXT BOOKS

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill, 2005.
2. Badger Walter L. and Banchero Julius T, "Introduction to Chemical Engineering", 1st Edition, Tata McGraw Hill Publishing, Company Ltd, New Delhi, 2008.

REFERENCES

1. Anup K Swain, HemlataPatra, G K Roy, "Mechanical Operations", Tata McGraw Hill Education Private Limited, 2011.
2. Coulson, J.M. and Richardson, J.F.,"Chemical Engineering" Vol. I, 4th Edition, Asian Books Pvt. Ltd. India, 1998.
3. Julian Smith, Warren McCabe, Peter Harriott, emeritus, "Unit Operations of Chemical Engineering", 7th Edition, McGraw-Hill, Education, New York, 2017.
4. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edition, John Wiley & Sons, 1994.

CO-PO MAPPING:

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

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

CM23403	PROCESS ORGANIC SYNTHESIS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1	learn the principle of nitration and manufacture of amino compounds.
2	understand the significance of amination and ammonolysis.
3	have insight industrial manufactures of hydrogen gas and catalytic hydrogenations.
4	develop knowledge about oxidation.
5	acquire knowledge of industrial chlorination.

UNIT I NITRATION — **9**

Types of nitration, Nitrating agents, Aromatic nitration: Orientation of groups – Benzene series, Nitration of isopentane in gas-phase, Nitration of acetylene in liquid-phase, Industrial continuous nitration processes of benzene and propane, Nitrate esters, N-nitro compounds, Equipments: Schmid nitrator – Biazzi nitrator, Advantages of batch and continuous processes.

UNIT II AMINATION — **9**

Amines: Classification and Preparation methods, Amination, Methods of reduction for preparation of amines, Reduction of nitrobenzene, Industrial continuous fluid-bed vapor-phase reduction of nitrobenzene, Ammonolysis: Classification – Aminating agents – conversions of halogen and alcohol compounds to amines – Manufacture processes of Methylamine and Aniline by ammonolysis.

UNIT III HYDROGENATION — **9**

Hydrogen productions by steam reforming and from water gas, Catalytic hydrogenation reactions of acetylene – Olefins – Diolefins and Carbonyl compounds, Hydrogenation of oils (hardening of oils), Industrial continuous hydrogenation processes of Cotton seed oil and Heavy oil, synthesis of Methanol – methanation and Fischer-Tropsch reaction.

UNIT IV OXIDATION — **9**

Types of oxidation reaction, oxidizing agents: Permanganate in alkaline solution – in neutral solution– in acid solution, Industrial oxidation processes: Acetaldehyde to acetic acid – Ethanol to acetic acid (The quick-vinegar process) in liquid-phase and methanol to formalin in vapour-phase, Oxidations of aliphatic hydrocarbons and liquid petroleum hydrocarbons.

UNIT V CHLORINATION — **9**

Introduction, Chlorination methods, Chlorination Rules, chlorination of Methane – Ethane – Propane – Ethanol, Preparation of ethylene dichloride, Sandmeyer reaction, Industrial manufacturing processes of Chloral and DDT.

TOTAL PERIODS	**45**

COURSE OUTCOMES		
At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	apply nitration principles and equipment for batch/continuous production of nitro-compounds.	Applying (K3)
CO2	illustrate classification of amines and preparation methods.	Analyzing (K4)
CO3	design and optimize hydrogenation processes for various organic compounds.	Analyzing (K4)
CO4	illustrate industrial oxidation processes for converting aldehydes/alcohols to acids and for vapor-phase methanol oxidation.	Analyzing (K4)
CO5	apply chlorination methods and principles for manufacture of chlorides.	Applying (K2)

TEXT BOOKS

1. Groggins P.H., "Unit Processes in Organic Synthesis", 5th edition (reprint), McGraw-Hill International Co., 2001.

REFERENCES

1. Austin G.T., "Shreve's Chemical Process Industries ", 5th edition (Special Reprint edition), McGraw Hill International co., 2005
2. K.S.Tewari and N.K.Vishnoi, "A Textbook of Organic Chemistry", 4th Edition, Vikas Publishing House, New Delhi, 2017.

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(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

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MC23402	HUMAN VALUES AND GENDER EQUALITY	2	0	0	0

COURSE OBJECTIVES

To enable the students to

1	define different types of human values and their impact on individual behaviour and societal norms.
2	apply principles of personal development such as self-confidence, self-discipline, and resilience to navigate modern challenges effectively.
3	evaluate the role of values in shaping professional ethics, civic sense and global citizenship.
4	examine the socio-economic factors influencing gender inequality and explore avenues for empowerment and advocacy.
5	critically analyze prevalent issues and challenges faced by women, including gender-based violence, discrimination, and cultural biases, and propose measures for their eradication.

UNIT I	HUMAN VALUES	6

Value Education - Definition, Types of values; Human values - Acceptance, Consideration. Appreciation, Listening. Empathy, Sympathy, Honesty, Integrity, Wisdom, Decision making, Self-actualization, Character formation towards positive personality, Contentment; - Religious Values - Humility, Compassion, Gratitude, Peace, Justice, Freedom, Equality.

UNIT II	PERSONALITY DEVELOPMENT	6

Personal Development - Introspection, Self-confidence, Self-discipline; Flexibility -Peer pressure - Sensitization towards Gender Equality; Reliability; Unity; Modern Challenges of Adolescent Emotions and behavior - Comparison and Competition, Positive and Negative attitudes; Family values; Self- improvement - Physical exercises, Meditation ,Yoga.

UNIT III	VALUE EDUCATION TOWARDS NATIONAL AND GLOBAL DEVELOPMENT	6

Professional Values -. Integrity, Responsibility, Punctuality, Dedication - Perseverance - Competence; Civic sense and Responsibility; Global Values - Computer Ethics, Moral Leadership, Code of Conduct; Corporate Social Responsibility; Aesthetic values; National Integration and International understanding of Religious Values – Spirituality, thought process.

UNIT IV	GENDER EQUALITY	6

Gender Equality - Definition, Empowerment, Economic Equality; Condition of Women in India-Education, Healthcare, Political Representation, Gender-based Violence; Challenging Stereotypes: Parental and Caregiving Responsibilities; Legal and Policy Reform; Cultural Shifts; Global Perspective; Male Chauvinism; Sustainable Development..

UNIT V	WOMEN ISSUES AND CHALLENGES	6

Women Issues and Challenges - female feticide, violence against women; Domestic violence- dowry

related abuse and deaths, Physical violence, Emotional abuse; Sexual assault; Honour killing; Eve-teasing- Stalking, e-stalking (cyber-crime).	
TOTAL PERIODS	**30**

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	discuss the concept of human values and their significance in personal and societal development.	Understanding (K2)
CO2	demonstrate introspective skills to enhance personal growth and self-awareness.	Applying (K3)
CO3	recognize the importance of gender equality in promoting a just and equitable society.	Understanding (K2)
CO4	cultivate a sense of social responsibility and ethical conduct towards achieving national and global development.	Analyzing(K4)
CO5	analyse the challenges faced by women in various spheres and identify strategies for addressing them.	Analyzing(K4)

TEXT BOOKS

1. A Foundation Course in Human Values and Professional Ethics: Presenting a Universal Approach to Value Education - Through Self-exploration. New Delhi, 2016.
2. Aurther, John. Personality Development. Lotus Press, 2018.

REFERENCES

1. Joshi, Dhananjay. Value Education in Global Perspective. Lotus Press, 2014.
2. Mahrotra, Mamta. Gender Inequality in India: Challenging Social Norms. Prabhat Books, 2015.

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

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

CM23404	HEAT TRANSFER	3	0	2	4

COURSE OBJECTIVES

To enable the students to

1	understand the modes of heat transfer.
2	acquire knowledge on the correlations for calculation of heat transfer coefficients.
3	learn the concept of evaporation and radiation.
4	understand the heat transfer regions.
5	learn various types of heat exchangers and condensers.

UNIT I CONDUCTION 9

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction – one dimensional steady state heat conduction equation for flat plate - hollow cylinder - Heat conduction through a series of resistances - effect of temperature on thermal conductivity - Thermal insulation - Optimum thickness of insulation - Critical radius of insulation - Heat transfer in extended surfaces.

UNIT II CONVECTION 9

Concepts of heat transfer by convection - Natural and forced convection, Dimensional analysis in heat transfer, Velocity Boundary layer - Concepts of thermal boundary layer -Relationship between Individual and overall heat transfer coefficients; Equations for forced convection under laminar and turbulent flow conditions in pipes, - Natural convection.

UNIT III RADIATION 9

Introduction to thermal radiations –Concept of Black and grey bodies; Emissivity, Stefan Boltzmann, Kirchhoff's, Planck's and Wien laws; Radiation between surfaces – configuration factor; radiation shield.

UNIT IV HEAT TRANSFER WITH PHASE CHANGE 9

Boiling heat transfer-General aspects, boiling regimes, factors affecting boiling, boiling correlations, condensation heat transfer—film and drop wise condensation, Evaporator-Types and method of feed – capacity and steam economy, surface area calculations for single effect evaporator and multiple effect evaporator.

UNIT V HEAT EXCHANGERS 9

Types of heat exchangers - Single pass and multipass heat exchangers LMTD; use of correction factor charts; Fouling factors; Heat transfer area calculations for double pipe and shell and tube heat exchangers; effectiveness and number of transfer units Heat exchangers for low temperature applications.

LIST OF EXPERIMENTS

1. Determination of thermal resistance of Composite wall.
2. Determination of heat transfer coefficient of Natural and Forced Convection.

3. Estimation of Stefan Boltzmann constant for Radiation.	
4. Determination of Emissivity of black and grey body.	
5. Determination of LMTD and heat transfer coefficient of Double pipe Heat Exchanger.	
6. Determination of thermal conductivity of surface for two slab guarded hot plates.	
7. Estimation of rate of evaporation using Open Pan Evaporator.	
	TOTAL PERIODS 75

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	explain the modes of heat transfer and its application.	understanding (K2)
CO2	differentiate natural and forced convection.	analyzing (K4)
CO3	measure thermal radiation using Stefan-Boltzmann, Kirchhoff's, etc.	analyzing (K4)
CO4	analyze boiling heat transfer regimes, and condensation behavior.	analyzing (K4)
CO5	examine the transfer units of heat exchanger.	analyzing (K4)

TEXT BOOKS

1. Dutta B.K., "Heat Transfer Principles and Application" 5th Edition, Prentice Hall of India Private Limited, 2006.
2. Holman J.P., "Heat Transfer" 8th Edition, McGraw Hill, 1997.

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1. McCabe W.L., Smith J.C., Harriott. P., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill International Student Edition, 2005.
2. Kern, D.Q., "Process Heat Transfer", McGraw-Hill, 1999.
3. Rajput R.K, "Heat and Mass Transfer", 7th Edition, S.Chand, New Delhi, 2019.
4. Coulson, J.M. and Richardson, J.F., "Chemical Engineering " Vol. I, 4th Edition, Asian Books , Pvt. Ltd., India, 1998.

CO-PO MAPPING:

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

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

CM23405	MECHANICAL OPERATIONS LABORATORY	0	0	4	2

COURSE OBJECTIVES

To enable the students to

1	acquire knowledge on different types of crushing equipments.
2	study the characteristics of filtration.
3	characterize different mechanical operation separators based on the size and efficiency.
4	determine the experimental values and conclude the best fit model.

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Reduction ratio of Roll Crusher
8. Separation characteristics of cyclone separator
9. Reduction ratio of Drop weight crusher
10. Determination of Mixing index

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	estimate the particle size distribution.	Understanding (K3)
CO2	explore the knowledge on filtration characteristics.	analyzing (K4)
CO3	predict settling behaviour of particles in suspensions for solid-liquid separation.	analyzing (K4)
CO4	estimate the crushing efficiency.	evaluating (K5)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

CM23406	ORGANIC CHEMISTRY LABORATORY	0	0	4	2

COURSE OBJECTIVES

To enable the students to

1	gain knowledge on qualitative analysis of organic compounds.
2	learn skill to perform functional group tests for unknown compounds.
3	understand the elemental analysis of organic compounds.
4	acquire basic principles involved synthesis of different organic compounds.

LIST OF EXPERIMENTS

1. Qualitative analysis of organic compounds – Carbohydrates.
2. Qualitative analysis of organic compounds – Esters.
3. Qualitative analysis of organic compounds – Acids.
4. Qualitative analysis of organic compounds – phenols.
5. Qualitative analysis of organic compounds – nitro compounds.
6. Qualitative analysis of organic compounds – urea.
7. Qualitative analysis of organic compounds – amines.
8. Preparation of meta di-nitro benzene from nitro benzoate.
9. Preparation of benzoic acid from ethyl benzoate.
10. Preparation of benzoic acid from benzaldehyde.

TOTAL PERIODS	**60**

COURSE OUTCOMES

At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	learn to test for sugars and related compounds using Molisch's, Fehling's, or Benedict's tests.	Understanding (K3)
CO2	perform hydrolysis and solubility tests to confirm the presence of ester functional groups.	analyzing (K4)
CO3	utilize litmus, solubility, and ferric chloride tests to identify acidic and phenolic compounds.	analyzing (K4)
CO4	explore lab preparations involving conversion of nitrobenzoate to di-nitrobenzene, ester to acid, and aldehyde to acid.	analyzing (K4)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes (PSO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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

GE23401	PROFESSIONAL DEVELOPMENT II	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1	enhance their own behavioural skills to survive in corporate world.
2	evaluate their listening and speaking skills to face the interviews in a successful way.
3	solve advance level verbal aptitude tests to get placed in Tier I companies.
4	improve their reasoning skills to get placed in reputed companies.

UNIT I	WRITING SKILLS	7

Email writing; Fixing and cancelling appointments; Paper submission for seminars and conferences; Business communication; Stress management; Body language; Dress code; Self-introduction II; Update resume building II; JAM level -3.

UNIT II	PRESENTATION SKILLS	7

Presentation skills - Types and methods of delivering presentation, ways and methods to improve presentation skills; Mini presentation in smaller groups; Situational role play; Face to face interview; Group discussion level IL; JAM Level-4.

UNIT III	QUANTITATIVE APTITUDE - I	8

Simplification; Time, speed and distance; Trains; Boats and streams; Ratio and proportion; Partnership; Percentage.

UNIT IV	LOGICAL REASONING	8

Seating arrangement; Arithmetic reasoning; Character puzzle; Syllogisms; Matching definitions; Statements and arguments.

	TOTAL PERIODS	30

COURSE OUTCOMES

At the end of this course, students will be able to		BT Mapped (Highest Level)
CO1	interpret the personality development through various activities.	Understanding (K2)
CO2	examine speaking and listening skills to excel in their jobs.	Analyzing (K4)
CO3	develop the quantitative skills and analytical skills to face the interview.	Applying (K3)
CO4	extend the reasoning abilities by scoring exceeded percentage to get placed in reputed companies.	Understanding (K2)

TEXT BOOKS

1. Agarwal, R.S. "Objective General English", S.Chand & Co., 2021.
2. Agarwal, R.S. "Quantitative Aptitude", S.Chand & Co., 2021.

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1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill, 2023.

2. Agarwal, R.S." a modern approach to Verbal & Non Verbal Reasoning", S.Chand & Co Ltd, New Delhi., 2021.

3. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications, 2021.

CO-PO MAPPING :

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

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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