Bachelor of Technology (Chemical Engineering)
KURUKSHETRA UNIVERSITY, KURUKSHETRA
SCHEME OF EXAMINATIONS w.e.f: 2025-2026
(Semester III)

S. No.	Course Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs.)
						End Semester exam	Internal Assessment	Practical Exam.	Total	
1.	B24-CHE-201	Chemical Engineering Thermodynamics-I	3:1:0	4	4	70	30	0	100	3
2.	B24-BSC-203	Industrial Chemistry	3:0:0	3	4	70	30	0	100	3
3.	B24-CHE-203	Chemical Engineering Process Calculations	3:1:0	4	4	70	30	0	100	3
4.	B24-CHE-205	Fluid Flow	3:1:0	4	4	70	30	0	100	3
5.	B24-BSC-209	Advance Mathematics	3:1:0	4	4	70	30	0	100	3
6.	B24-CHE-207	Unit Processes	3:0:0	3	3	70	30	0	100	3
7.	B24-CHE-209	Industrial Chemistry Lab	0:0:2	2	1	0	40	60	100	3
8.	B24-CHE-211	Fluid Flow Lab	0:0:2	2	1	0	40	60	100	3
9.	B-24-MAC-201	Environmental Studies	3:0:0	3	1	70	30	0	100	3
Total				**29**	**26**	**490**	**290**	**120**	**900**	

Note:

- NCC/NSS/SPORTS/YOGA/TECHNICAL OR CULTURAL CLUB/SOCIETY ACTIVITES may also be joined by students in 2nd year and will be evaluated in 7th semester by the institute based upon continuous evaluation model as per guidelines.

Bachelor of Technology (Chemical Engineering)
KURUKSHETRA UNIVERSITY, KURUKSHETRA
SCHEME OF EXAMINATIONS w.e.f: 2025-2026
(Semester IV)

S. No.	Course Code	Subject	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						End Semester Exam	Internal Assessment	Practical Exam	Total	
1	B24-HSM-902	Fundamentals of Management	3:1:0	4	4	70	30	0	100	3
2	B24-CHE-204	Heat Transfer	3:1:0	4	4	70	30	0	100	3
3	B24-CHE-206	Mechanical Operations	3:1:0	4	4	70	30	0	100	3
4	B24-CHE-208	Numerical Methods in Chemical Engineering	3:1:0	4	4	70	30	0	100	3
5	B24-CHE-212	Material Technology	3:0:0	3	3	70	30	0	100	3
6	B24-CHE-214	Heat Transfer Lab	0:0:2	2	1	0	40	60	100	3
7	B24-CHE-216	Mechanical Operations Lab	0:0:2	2	1	0	40	60	100	3
8	B24-MAC-202	Essence of Indian Traditional Knowledge	2:0:0	2	1	0	100	0	100	3
Total				**25**	**22**	**350**	**330**	**120**	**800**	

Note:

1. All students have to undertake the industrial training for 4 to 6 weeks after 4th semester which will be evaluated in 5th semester.

B24-CHE-201	CHEMICAL ENGINEERING THERMODYNAMICS-I						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	To understand the basics of thermodynamics and P-V-T behavior, Laws of Thermodynamics, Thermodynamics relations, concept of Power and Refrigeration cycle.						
Course Outcomes							
CO1	To Introduce with the basics of thermodynamics and P-V-T behavior.						
CO2	To familiarize with the Laws of Thermodynamics.						
CO3	To familiarize with the concept of Thermodynamics relations.						
CO4	To familiarize with the concept of Power and Refrigeration cycle.						

Unit I

Introduction and P-V-T behavior: Concept of Work and heat, Cp, C_V, open system and closed system, extensive and intensive properties, Internal Energy, enthalpy, entropy, P-V-T behavior of Pure Fluids- Virial equations, cubic equations, generalized correlations, Throttling process, Joules Thompson coefficient.

Unit II

Laws of thermodynamics: Laws of thermodynamics Energy equations for close system and steady flow processes, Limitations of first law, carnot cycles, concept of available energy and dead state availability and irreversibility.

Unit III

Thermodynamics relations: Maxwell relations, Helmholtz and Gibbs function, Tds equations, clausius clapeyron equation.

Unit IV

Power and Refrigeration cycle: Rankine cycle, Air standard cycles, vapour compression cycle, otto cycle, Brayton cycle, refrigerant and their properties, Liquifaction of gases, generation of power from heat.

Books Recommended:

1. Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press.
2. Smith & van Ness, Introduction to Chemical Engineering Thermodynamics, McGraw Hill.
3. B. Bhattacharyya and S. C. Bera, Engineering Thermodynamics and Fluid Mechanics, New Age International Publishers.
4. Radha Krishnan, Fundamentals of Engineering Thermodynamics, PHI Publishers.
5. P.K. Nag, Engineering Thermodynamics, Tata McGrew Hill.

Note: The Examiner will be given the question paper template to set the question paper.

B24-BSC-203	INDUSTRIAL CHEMISTRY						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	To familiarize with the basic knowledge of Organic reactions and mechanism Chemistry of Hydrocarbons, Chromatographic analysis methods, Kinetic of a chemical reaction and chemical Equilibrium of the processes.						
Course Outcomes							
CO1	To understand the basic knowledge of organic reactions and mechanism, substitution and addition of electrophilic, nucleophillic, free radical and chemistry of hydrocarbons.						
CO2	To familiarize with the various Chromatographic analysis methods.						
CO3	To introduce the Kinetic of a chemical reaction.						
CO4	To give in-depth knowledge of chemical Equilibrium of the processes.						

UNIT I

Classification of Organic Reactions: Types of mechanism, types of reactions, Reaction intermediates, the mechanism ofthe following type of reactions. substitution - Electrophiilic, nucleophiilic, fee radical, Addition- Electrophilic, nucleophillic, free radical Elimination-Elimination (E_1 and E_2 type) Rearrangement, Migration with electron (electrophillic).

Chemistry of Hydrocarbons: Sources, preparation and uses of alkanes, alkenes, alkynes, cracking & reforming aromatic hydrocarbons, concept of aromaticity (Huckel rule, 4n+2) rule) and directive effect.

UNIT II

Chromatography: Introduction, classification, solid, Liquid chromatography (LSC, TLC, Liquid - Liquid Chromatography(LLC), Column, GPC, HPLC, Gas-Liquid Chromatography (GLC).

UNIT III

Chemical Kinetics: Rate expression of reactions of various orders, rate mechanism, kinetics of complex reactions,molecularity, order of reaction, concept of energy barrier and activation energy theories of reaction rates, Arhenius equation.

UNIT IV

Chemical Equilibrium: Equilibrium constant, Factors affecting, Ka, Kp, Standard free energy and equilibrium constant, homogeneous and heterogeneous chemical equilibria, Le Chtelier's principle and its applications' Relation between Kp and Kc.

Books Recommended:

1. Advanced organic chemistry (Reaction Mechanism and structure) by JerryMarch (Willey Eastern 3rd edition)
2. Text Book of Organic Chemistry by R'K' Bansal' (T'M'H')
3. Organic Chemistry by Morrison, Bayd (P'H'L')
4. Chromatography by B'K' Sharma (Goel Publishing' Merrut')
5. Organic Chemistry Vol' I By l'L' Finar (ELBS)'
6. Schaum's solved Problems series,Organic Chemistry(T'M'H')
7. Organic Reaction Mechanism, 3rd edition(T.M.H')by R.K.Bansal.

Note: The Examiner will be given the question paper template to set the question paper.

B24-CHE-203	CHEMICAL ENGINEERING PROCESS CALCULATIONS						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	To familiarize with the concept of units, their dimensions and conversions, stoichiometric and composition relations, various Gas laws, Material balance and Energy balance.						
Course Outcomes							
CO1	To introduce the basic concept of units, their dimensions and conversions, stoichiometric and composition relations.						
CO2	To understand the various Gas laws and Henry"s Law, Humidity and use of humidity charts for engineering calculations.						
CO3	To familiarize with the concept of Material balances for systems with and without chemical reactions, species and elemental balance.						
CO4	To familiarize with the concept of Steady state energy balance for systems with and without chemical reactions, Enthalpy-concentration charts; Degrees of freedom in steady state processes, Unsteady state material and energy balance.						

Unit I

Units and Dimensions: Introduction-Units, their dimensions and conversions, Dimensional consistency of equations, Dimensional and dimensionless constants, Mass and volume relations, Stoichiometric and composition relations, Excess reactants, Degree of completion, Conversion, Selectivity and Yield.

Unit II

Gas Law and Humidity: Gas laws-Ideal gas law, Dalton"s Law, Amagat"s Law, and Average molecular weight of gaseous mixtures. Vapour pressure-Effect of temperature on vapour pressure, Vapour pressure plot (Cox chart), Vapour pressures of miscible and immiscible liquids and solutions, Raoult"s Law and Henry"s Law. Relative Humidity and percent saturation; Dew point, Dry and Wet bulb temperatures; Use of humidity charts for engineering calculations

Unit III

Material Balance: Material balances for systems with and without chemical reactions, species and elemental balance. Analysis of systems with by-pass, recycle and purge. Heat capacity of gases, liquids and solutions, Heat of fusion and vaporization.

Unit IV

Energy Balance: Steady state energy balance for systems with and without chemical reactions; Calculations and application of heat of reaction, combustion, formation, neutralisation and solution; Enthalpy-concentration charts; Degrees of freedom in steady state processes, solution of simultaneous material and energy balance problems using flow sheeting codes; Unsteady state material and energy balance.

Books Recommended:

1. D.M. Himmelblau, Basic Principles and calculations in Chemical Engineering, Printice-Hall.
2. O.A. Hougen, K.M.Watson & R.A.Ragatz, Chemical process principles, John Willey & sons.
3. D. P. Tiwari, Chemical Calculation,Vrinda Publications (Zalgaon).
4. S. N. Saha, Chemical Engineering process calculation, Dhanpat Rai publication.
5. Bhatt and Vora, Stoichiometry, Nirali Publications.

Note: The Examiner will be given the question paper template to set the question paper.

B24-CHE-205	FLUID FLOW						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	Application of fluid, fluid forces, pressure measurement in fluid, energy.To understand the concept and losses, friction factor and various flow measuring devices.						
Course Outcomes							
CO1	To understand the fundamental concepts of fluids, Classification of fluid-forces, Pressure measurement by manometers, Types of flow, velocity distribution for laminar flow in conduits, Reynold's number and its significance.						
CO2	To understand the concept of Conservation of mass, momentum and energy, Euler's equation. Energy losses.						
CO3	To familiarize with the basic equations of fluid flow and flow measuring devices.						
CO4	To familiarize with the flow of incompressible fluids in conduits.						
CO5	To familiarize the concept of hydrodynamic boundary layer and dimensional analysis by Rayleigh"s and Buckingham"s method.						
CO6	To familiarize with the flow past immersed bodies and transportation of fluids.						

UNIT I

Introduction: Fluid, Properties of fluid, Classification of fluids, Newton"s law of viscosity, Rheological classification of fluids, Pressure and temperature dependence, Types of flow, Lines to describe the flow, Application of fluid flow in Chemical Engineering.

Fluid Statistics and Its Applications: Hydrostatic equilibrium, parametric equation, Hydrostatic equilibrium in centrifugal field; Concept of atmospheric, gauge and absolute pressure, manometers, pressure measurement by simple and differential manometer.

UNIT II

Basic Equations of Fluid Flow and Flow Measuring Devices: Basic equations of fluid flow: Continuity equation, equation of motion, Flow measurement using Venturimeter, Orificemeter, Rotameter & Pitot Tube.

Flow of Incompressible Fluids in Conduits: Shear stress distribution, Relation between skin friction and wall shear, The friction factor; Laminar flow through circular pipe, on inclined plane, through annular space; Relation between average and maximum velocity, Major and Minor Loses, Darcy Weisbach equation, Friction factor chart.

UNIT III

Boundary Layer and Dimensional Analysis: Concept of hydrodynamic boundary layer, Growth over a flat plate, Different thickness of boundary layer, Fundamental dimensions of quantities, Dimensional homogeneity, Dimensional analysis by Rayleigh"s method and Buckingham"s method, Dimensionless numbers.

UNIT IV

Flow Past Immersed Bodies And Transportation Of Fluids: Drag and drag coefficient, Flow through beds of solids, Motion of particles through fluids, Introduction to fluidization, Pipes and tubing"s, Joints and fitting Major and minor losses, Different types of valves, Pumps: Centrifugal pump, Performance of centrifugal pumps.

Books Recommended:

1. J.M. Coulson and J.F. Richardson, Chemical Engineering, Vol-1, Pergamon.
2. W.L. McCabe and J.C. Smith, Unit Operations of Chemical Engineering, McGraw Hill.
3. A.K. Jain, Fluid Mechanics, Khanna publishers, New Delhi.
4. Jagdish Lal, Hydraulics & Fluid Mechanics, Metro-polliton Books Co. Pvt. Ltd. Delhi
5. D. S. Kumar, Fluid Mechanics, S. K. Kataria& Sons.

Note: The Examiner will be given the question paper template to set the question paper.

B24-BSC-209	Advance Mathematics						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	**To provide the conceptual knowledge of Engineering mathematics**						
Course Outcomes							
CO1	To study various fundamental concepts of Fourier series and Fourier Transformation.						
CO2	To study and understand the functions of a complex variables.						
CO3	To study the Probability Distributions.						
CO4	To study the linear programming problem formulation.						

UNIT – I

Fourier Series: Euler"s Formulae, Conditions for Fourier expansions, Fourier expansion of functions having points of discontinuity, change of interval, Odd & even functions, Half-range series.

Fourier Transforms: Fourier integrals, Fourier transforms, Fourier cosine and sine transforms.
Properties of Fourier transforms, Convolution theorem, Perseval"s identity, Relation between Fourier and Laplace transforms, Fourier transforms of the derivatives of a function, Application to boundary value problems.

UNIT-II

Functions of a Complex Variables: Functions of a complex variable, Exponential function, Trigonometric, Hyperbolic and Logarithmic functions, limit and continuity of a function, Differentiability and analyticity. Cauchy-Riemann equations, Necessary and sufficient conditions for a function to be analytic, Polar form of the Cauchy-Riemann equations, Harmonic functions, Application to flow problems, Conformal transformation, Standard transformations (Translation, Magnification &rotation, inversion & reflection, Bilinear).

UNIT-III

Probability Distributions: Probability, Baye"s theorem, Discrete & Continuous probability distributions, Moment generating function, Probability generating function, Properties and applications of Binomial, Poisson and normal distributions.

UNIT-IV

Linear Programming: Linear programming problems formulation, Solution of Linear Programming Problem using Graphical method, Simplex Method, Dual-Simplex Method.

Text Book

1. Higher Engg. Mathematics : B.S. Grewal
2. Advanced Engg. Mathematics : E. Kreyzig

Reference Book

1. Complex variables and Applications : R.V. Churchil; Mc. Graw Hill
2. Engg. Mathematics Vol. II: S.S. Sastry; Prentice Hall of India.
3. Operation Research : H.A. Taha.
4. Probability and Statistics for Engineer : Johnson. PHI.

Note: The Examiner will be given the question paper template to set the question paper.

B24-CHE-207	UNIT PROCESS						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**0**	**-**	**70**	**30**	**100**	**3**	**3**
Purpose	To make student able to understand about various unit operations.						
Course Outcomes							
CO1	To familiarize with the Alkylation process.						
CO2	To understand the concept of hydrogenation.						
CO3	To familiarize with the Sulfonation.						
CO4	To familiarize with the halogenations and nitration.						

UNIT-I

ALKYLATION: Products derived from alkylation, types of alkylation, factors controlling alkylation, flow street for alkylaryl sulfonates, sulfuric acid alkylation for petroleum industry equipment for alkylation-kellogg cascade alkylater.

UNIT - II

HYDROGENATION: Products derived from hydrogenation, types of hydrogenation, factors controlling hydrogenation, equipment for hydrogenation, apparatus and rnaterial of construction, high pressure autoclave, shaking autoclave, flow sheet for synthesis of methanol from carbon rnonoxide and hydrogen, Hydrogenation of oil.

UNIT - III

SULFONATION: Sulfonation and sulfonating agents, physical and chemical factors in sulfonation, mechanism of desulfonation, Industrial equipment and techniques, batch surfonation kettle, ball mill sulfonator, flowsheet for manufacture of anthraquinone sulphonate ethanol from methylene.

UNIT-IV

HALOGENATION: Products derived by halogenation, types of halogenation, mechanism of dehalogenation, Design and construction of equipment for halogenations, flow sheets for manufacture of chroroacetic acid, monochroroacetic acid & chloral.

NITRATION: Products derived from nitration, types of nitration, process equipment for nitration, batch nitration, continuous nitration, schmidt nitration of propane.

BOOKS RECOMMENDED:

1. Unit Processes in Organic synthesis by P.H. Groggins (MGH)
2. Chemical Technology by Merk and Hahn (MGH)
3. Chemical Egg. Dev., NT, Madras (Organic)-ll Centre.

Note: The Examiner will be given the question paper template to set the question paper.

B24-BSC-209	INDUSTRIAL CHEMISTRY LAB						
Lecture	**Tutorial**	**Practical**	**Practical Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
-	**-**	**2**	**60**	**40**	**100**	**1**	**3**
Purpose	To make student able to identify and quantify organic compounds.						
Course Outcomes							
CO1	Students will be able to perform preliminary tests to identify organic compounds.						
CO2	Students will be able to analyze functional groups of organic compounds and prepare derivatives.						
CO3	Students will be able to determine kinetics of reaction by method of half- life period.						
CO4	Students will be able to determine the activation energy for reaction by integral and differential method.						

Identification of organic compounds :

Preliminary tests (elemental analysis, Ignition, colour, odour and determination of physical constants)
Functional group analysis.

Preparation of derivatives, Organic Acids, Aldehydes, Ketones, Amides, .Phenols, amines, Carbohydrates, Hydrocarbons.
Preparation of aspirin, 2,4, 6- tribromo aniline, picric acid from phenol, iodoform, S benzyl isothiourounim chloride.

Quantitative organic analysis:

Estimation of phenol, aniline, formaldehyde.

To determine kinetics of reaction between ethyl acetate and sodium hydroxide at room temp. by method of half-life period.

To determine the activation energy for reaction between ethyl acetate and sodium hydroxide by integral and differential method.

Books Recommended:

A. I. Vogel, Qualitative Organic analysis (ELBS) Longman.
Satish Aggarwal& R.C. Aggarwal, Advanced organic analysis, Pargati Prakashan.
G. Mann, Practical Organic Chemistry, Longman

B24-CHE-211	FLUID FLOW LAB						
Lecture	**Tutorial**	**Practical**	**Practical Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
-	**-**	**2**	**60**	**40**	**100**	**1**	**3**
Purpose	To provide practical knowledge for the application of flow measurement devices, calibration of flow measurement device, pressure drop in pipe flow, determination of equivalent length of various fittings in pipe line.						
Course Outcomes							
CO1	Students will be able to use various flow measurement devices to measure flow rates.						
CO2	Students will be able to calibrate flow measurement device.						
CO3	Students will be able to determine pressure drops in pipe flow.						
CO4	Students will be able to determine equivalent length of various fittings in pipe line.						

List of Experiments:

1. Flow measurement by Venturimeter.
2. Flow measurement by Orifice meter.
3. Calibration of Rotameter.
4. Flow measurement by V-notch.
5. Pressure drop in pipe flow.
6. Verification of Bernoulli's Theorem.
7. Determine friction factor in pipes of different material.
8. Flow measurement by Pitot tube.
9. To obtain the equivalent length of various fittings.

B24-MAC-201	ENVIROMENTAL STUDIES						
Lecture	**Tutorial**	**Practical Exam.**	**End Semester Exam**	**Internal Assessment**	**Total**	**Duration of Exam (Hrs)**	**Credits**
3	**0**	**0**	**70**	**30**	**100**	**3 Hrs.**	**1**
Purpose	The students will familiarize themselves with natural resources, ecosystems, factors affecting environments and human relationship with nature						
Course Outcomes							
CO1	Students will be able to understand the importance of natural resources.						
CO2	Students will understand the concept of an ecosystem, its structure, and its functions						
CO3	The students will be able to understand the causes and impacts of various environmental pollution.						
CO4	Students will be able to understand the relationship between the human population and the environment.						

UNIT-1

Introduction to Environmental studies: The Multidisciplinary nature of environmental studies Definition; Scope and importance, Need for public awareness. Natural Resources: Forest resources: Use and Over-exploitation, deforestation. Timber extraction, mining, dams, and their effects, Water resources: Use and over-utilization of surface and groundwater, conflicts over water, dams benefits and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, Energy resources: renewable and non-renewable energy sources, Land resources: land degradation, soil erosion, and desertification.

UNIT-II

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Energy flow in the ecosystem, Ecological succession, Food chains, food webs, and ecological pyramids. Major types of ecosystem-Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystem. Biodiversity and its Conservation: Introduction-Definition: genetic, species, and ecosystem diversity. Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, manwildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-III

Environmental pollution: Causes, effects, and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Nuclear hazards, and Solid waste Management: Causes, effects, and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides. Social Issues and the Environment: Sustainable development, Water conservation, rainwater harvesting, Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, and wasteland reclamation. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act., and Forest Conservation Act.

UNIT-IV

Human population and the Environment: Population growth, Population Explosion-Family welfare Programme, Environment and human health. Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Drugs and their effects; Useful and harmful drugs; Use and abuse of drugs; Stimulant and depressant drugs. Concept of drug de-addiction. Legal position on drugs and laws related to drugs. Field Work (Practical)- - Visit to a local area to document environmental assets -river/forest/grassland/ hill/mountain. - Visit to a local polluted site- Urban/Rural/Industrial/Agricultural. - Study of common plants, insects, and birds. - Study of simple ecosystems- pond, river, hill slopes, etc.

Field Work (Practical)-

- Visit to a local area to document environmental assets -river/forest/grassland/ hill/mountain.
- Visit to a local polluted site- Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, and birds. - Study of simple ecosystems- pond, river, hill slopes, etc

B24-HSM – 902	Fundamentals of Management						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	**To enhance the knowledge about the basic management concepts so that engineers can apply their managerial skills.**						
	Course outcomes						
CO1	An overview about Business Environment and its Components.						
CO2	Understand the concept of Financial Management and its importance.						
CO3	Enabling the students to know about the hiring and guiding the work force by the understanding of Human Resource Management.						
CO4	To understand the concept of economical production aspects of Management.						

UNIT 1

Business Environment: Concept, nature and objectives of business, social responsibility of business, Constituent of Business Environment; Economic, Social, Political, Legal and technological. Definition, Nature and Significance of Management, Henry Fayol"s Principles of Management, Functions of Management.

UNIT 2

Financial Management: Introduction of Financial Management, Objectives of Financial Decisions, Financial Planning-Tools of financial planning, Management of working capital, factors affecting requirements of working capital. Capital Structure decisions. Features of appropriate capital structure. Sources of finance.

UNIT 3

Personnel Management: Personnel Management-Meaning, Nature and importance, Functions of Personnel Management (a) Managerial Functions and (b) Operative functions. Job Analysis; Meaning and importance; Process of Job Analysis, Job Description and Job Specification. Human Resource Development-Meaning and Concept.

UNIT 4

Production Management: Production Management: Definition and objectives. Plant Location: Ideal plant location, Factors affecting plant location. Plant Layout: Ideal plant layout, Factors affecting Plant layout. Work Measurement: Meaning Objectives and Essentials of work measurement. Production Control: meaning and Importance of production control and steps involved in production control, Nature, scope and importance of Marketing Management, Modern Marketing concepts. Role of marketing in economics development. Marketing Mix. Marketing Information System. Meaning, nature and scope of International Marketing.

Suggested Books:

- Charunilam , “Business Environment” , Himalaya Publishing House
- Harold, Koontz & Cyriol ,”Mangement” , MGH
- Principles of Personnel Management-Edwin B.PhilpoMGH
- Cundiff &Stiff , “Basic Marketing” PHI

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

B24-CHE-204	HEAT TRANSFER						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	To understand the basic concept and applications of various modes of heat transfer, boiling & condensation, Evaporation and types of Heat exchangers.						
Course Outcomes							
CO1	To understand the concept of basic equations of steady state condition in slab, cylinder and sphere, Critical thickness of insulation, Use of transient temperature charts and lumped system analysis.						
CO2	To understand the basic concept of convection, boiling & condensation						
CO3	To familiarize with the concept of various types of Heat exchangers.						
CO4	To familiarize with the concept of Radiation and Evaporations.						

UNIT I

Introduction: Basis equation - one dimensional, two dimensional and three dimensional, Steady state condition in slab, cylinder and sphere, Critical thickness of insulation. Finned surfaces, Transient conduction Analytical solution for slabes, Use of transient temperature charts for slabs, cylinders and sphere and lumped system analysis.

UNIT II

Convection: Concept of free and forced convection. Dimensional Analysis. Empirical correlations for free and forced convection for various shapes.

Boiling & Condensation: Film wise and drop wise condensation, Laminar film condensation on a vertical plate, Film condensation on tubes, Boiling regimes, Bubble growth and nucleate boiling.

UNIT III

Heat Exchangers: Basic types of heat exchanges, Overall heat transfer coefficient, log mean temperature difference, Effectiveness and NTU methods for heat exchanger analysis.

UNIT IV

Radiation: Black body radiation, radiation properties, concept of shape factor, Radiation exchange in enclosure with black surface.

Evaporators: Types of evaporators, Single & Multiple effect evaporators, calculations for surface area requirement. Methods of feeding.

Books Recommended:

1. W. L. McCabe & J. C. Smith, Unit operations of chemical engineering, McGraw Hill Book Company, New Delhi
2. J. P. Holman, Heat Transfer, McGraw Hill Book Company, New Delhi.
3. M. L. Oziski, Heat Transfer, McGraw Hill lnternational Editions.
4. A. J. Chapman, Heat, Macmillan lndian, Delhi.
5. D. S. Kumar, Heat and Mass Transfer, S.K. Kataria and Sons, Delhi. .
6. Kirk, D. Hegen, Heat Transfer with Applications, Prentice Hall lnternational. Inc., New Jercy.

Note: The Examiner will be given the question paper template to set the question paper.

B24-CHE-206	MECHANICAL OPERATIONS						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	To understand the concept of unit operation and their role in chemical engineering industries, Types of mechanical operations, various size reduction techniques.						
Course Outcomes							
CO1	To Introduce the concept of unit operation and their role in chemical engineering industries, Types of mechanical operations, Particle size and shape, Measurement and analysis, various size reduction techniques.						
CO2	To familiarize with the concept of various methods of mixing of solids, Size enlargement: scope and applications and techniques, Filtration.						
CO3	To understand the concept of Drag force, Settling velocity of a particle in a fluid, Stoke's law, Elutriation, Classifiers, Thickeners, Gravity separation, concept of relative velocity.						
CO4	To familiarize with the concept of Storage of Solids, Flow of solids by gravity, Transport of solids, particle collection systems.						

UNIT I

Introduction to Unit operations: Introduction to unit operation and their role in chemical engineering industries, Types of mechanical operation, Particle size and shape, Particulate mass, Size and shape distributions, Measurement and analysis, Concept of average diameter, Screening, types of screens, effectiveness of screens, particle separation efficiency. Mixing of solids, blending, kneading, etc., Filtration: classification of filters, theory of filtration, cake resistance.

UNITII

Size Reduction and Size Enlargement of Solids: Size reduction, Crushing, Grinding and ultrafine grinding and selection of equipment, Laws of grinding. Construction and working principle of mostly used equipments, viz., Jaw crushers, gyratory crushers, hammer mill, crushing rolls, ball mills, and fluid energy mills. Size enlargement: scope and applications, size enlargement techniques, Agglomeration and compaction.

UNITIII

Drag force and Separation of solid particles: Flow around' single particle, Drag force & drag coefficient, Settling velocity of a particle in a fluid, Stoke's law, Elutriation, Classifiers, Hindered & free settling of particles, Thickeners, Gravity separation, concept of relative velocity.

UNIT IV

Storage, Handling & Transport of Solids: Storage of Solids, Flow of solids by gravity, Transport of solids by screw/ belt conveyors, pneumatic conveyors, cyclones, Bag filters, Electrostatic precipitators; particle collection systems.

Books Recommended:

1. J. M. Coulson & J. F. Richardson, Chemical Engineering, Vol. II, Pergamon press.
2. G. G. Brown, Unit Operations, Asia publishing House.
3. A. S. Foustetal, Principle of Unit Operations, John Wiley.
4. W. L. McCabe & J. C. Smith, Unit Operations of Chemical Engineering, McGraw Hill.
5. B. C. Bhattacharya & C. M. Narayanan, Mechanical Operations for Chemical Engineers, Khanna publishers.

Note: The Examiner will be given the question paper template to set the question paper.

B24-CHE-208	Numerical Methods in Chemical Engineering						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**1**	**-**	**70**	**30**	**100**	**4**	**3**
Purpose	To understand the concept of types of errors, Eigen values and Eigen vectors of matrices, Non-linear algebraic equations, Function evaluation, Ordinary differential equations						
Course Outcomes							
CO1	To Introduce the concept of error, linear algebraic equations						
CO2	To familiarize with the Eigen values and Eigen vectors of matrices, non-linear algebraic equations						
CO3	To understand the Linear Regression, Interpolation and Extrapolation Technique						
CO4	To familiarize with the Ordinary Differential Equations						

UNIT-I

Errors: Classification, significant digits and numerical stability.

Linear algebraic equations: Cramer's rule, Gauss Elimination and LU Decomposition Gauss-Jordan elimination,

Gauss-Seidel and Relaxation Methods.

UNIT-II

Eigen values and eigenvectors of matrices: Faddeev Leverrier's Method, Power Method

Non linear algebraic equations: Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

UNIT-III

Function evaluation: Least squares curve-fit (Linear Regression), Newton's interpolation formulae (equal intervals), Newton's Divided Difference Interpolation Polynomial, Lagrangian Interpolation Unequal intervals), differentiation formulae, Integration formulae or Quadratures (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt

UNIT-IV

Ordinary differential equations: Initial value problems; ode-ivps The Finite difference Technique

TEXT BOOKS

1. Numerical methods with programming in „C", T. Veerarajan, and T. Ramachandran, TMGH(2007).
2. Numerical Methods for Scientists and Engineers, SankaraRao K, 3rd edition PHI, New Delhi, (2007).

REFERENCE BOOKS:

1. Numerical Methods for Engineers, S.C. Chapra and R.P. Canale, 5th Edition, TMGH, New Delhi, 2007.
2. Numerical Methods in Engineering and Science, B.S. Grewal, and,J.S. Grewal, 6th Ed,Khanna Pub.2004.

Note: The Examiner will be given the question paper template to set the question paper.

B24-CHE-212	MATERIAL TECHNOLOGY						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
3	**0**	**-**	**70**	**30**	**100**	**3**	**3**
Purpose	To understand the concept and applications of material science, Crystal Geometry, Isothermal transformations, Heat Treatment, Corrosion and its Prevention, various polymers						
Course Outcomes							
CO1	To Introduce the material science, classification of engineering materials.						
CO2	To understand the concept of Isothermal transformations (TTT Curves); Heat Treatment methods.						
CO3	To familiarize with the Corrosion and its Prevention.						
CO4	To familiarize with the typical engineering materials.						

Unit I

Introduction: Introduction to material science, classification of engineering materials, Crystal Geometry And StructureDetermination, Crystal Imperfections: Point imperfections, Line imperfections-edge and screw dislocations, Surface imperfections.

Unit II

Isothermal transformations (TTT Curves); Heat Treatment methods: Isothermal transformations (TTT Curves); Heat Treatment: Annealing Normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering, Carburising, Cyaniding, Nitriding, Flame hardening.

Unit III

Corrosion and its Prevention: Corrosion and its Prevention: Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, Factor influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors, Cathodic protection, Protective coatings, glass lining, lead lining, FRP lining.

Unit IV

Engineering Materials: Typical Engineering Materials: Ferrous metals, Non ferrous metals and alloys – Aluminum and its alloys, Copper and its alloys, Alloy steels Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Speciality glasses and refractories, properties and applications. Polymers: Classifications, comparison and properties, of various polymers and their relationship with chain structure. Grey and white cast iron- properties, applications, Uses.

Books Recommended:

1. V. Raghawan, Material Science & Engineering, Prentice Hall.
2. O.P. Khanna, Material Science, Dhanpat Rai Publications, New Delhi.
3. S. K. Hajra Choudhury, Material Science and Processes**,** 2nd Edition, Indian Book Distributing Co.,1982.
4. R. L. Timings, Kemal Ahmet, Engineering Material,Vol. I&II., Longman Publisher.
5. V.L. Van Vlack, Material of Engineering: Concepts and Application, Addison Wesley.

Note: The Examiner will be given the question paper template to set the question paper.

B24-CHE-214	HEAT TRANSFER LAB						
Lecture	**Tutorial**	**Practical**	**Practical Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
-	**-**	**2**	**60**	**40**	**100**	**1**	**3**
Purpose	To provide practical knowledge of the application of different modes of heat transfer theory, heat transfer through composite walls, pipe and rod						
Course Outcomes							
CO1	Student will be able to determine heat transfer coefficient.						
CO2	Student will be able to determine Filmwise and Dropwise condensation.						
CO3	Student will be able to determine LMTD, Thermal conductivity, Emissivity.						
CO4	Student will be able to determine Stefan Boltzman constant.						

LIST OF EXPERIMENTS:

1. To determine total thermal resistance and total thermal conductivity of composite wall.
2. To determine the thermal conductivity of insulating powder.
3. To find out heat transfer coefficient of vertical cylinder in natural convection.
4. (a) To study the unsteady state heat transfer and compare theoretical vs. practical value of response
   (b) To determine the convective heat transfer coefficient.
5. (a) To determine the heat flow rate through the lagged pipe for known value of thermal conductivity of lagging material.
   (b) To plot the temperature distribution across the lagging material.
6. To calculate LMTD for parallel and counter flow in double pipe heat exchanger.
7. To find average heat transfer coefficient for drop wise and film wise condensation and find the overall heat transfer.
8. To study the temperature distribution along the length of a pin fin under natural convection heat transfer.
9. To study the temperature distribution along the length of a pin fin under forced convection heat transfer.
10. To find the emissivity of the test plate surface at various temperature and compare with the actual reported value.
11. To determine the thermal conductivity of metal rod.
12. (i) To demonstrate super thermal conductivity heat pipe and to compare its working with that of best conductor
13. (ii) To plot temperature vs. time response of three pipes
    (iii) Temperature distribution along length of three members at different time intervals can be plotted and nearly isothermal temperature distribution in case of heat pipe.
14. To find out the Stefan Boltzmann constant.
15. To find heat transfer coefficient for heated pipe and air is forced to flow through it for different air flow.

B24-CHE-216	MECHANICAL OPERATIONS LAB						
Lecture	**Tutorial**	**Practical**	**Practical Exam**	**Internal Assessment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
-	**-**	**2**	**60**	**40**	**100**	**1**	**3**
Purpose	To provide the practical knowledge for the application of theories of Drag coefficient, Sedimentation, size reduction, grinding, screen analysis, separation of particles from air, filtration of slurry, Elutriation and the pressure drop in packed bed.						
Course Outcomes							
CO1	Students will be able to know the concept of Drag coefficient, Sedimentation, Size reduction.						
CO2	Students will be able to know the principle and working of grinding in a ball mill, separation of dust particles from air and filtration of slurry.						
CO3	Students will be able to know the solid separation techniques and size distribution of particles						
CO4	Students will be able to determine the pressure drop in a packed bed.						

LIST OF EXPERIMENTS:

1. Drag coefficient: Determination of drag coefficient from the plot of drag coefficient Vs modified Reynolds No. and verify Stroke"s law.
2. To carry out Batch Sedimentation.
3. Size reduction: To determine the efficiency of the roll crusher for crushing a material of known working index.
4. Grinding in a Ball Mill:

   (a) To determine the critical speed, work index, Bond"s law,Rittenger"s law, Kick"s law.

   (b) To determine the surface area generation for the given amount of feed.
5. Screen Analysis: To analyze sample for size distribution using sieve shaker.
6. Separation of dust particles from air:

   (a) To study the performance of given cylinder (efficiency vs. dp).

   (b) To study the effect of inlet gas velocity on overall efficiency.

   (c) To study the effect of solid concentration or dp or Drop.
7. Packed bed: Determination of pressure drop packed bed
8. Filtration of slurry: To calculation specific cake resistance and medium resistance in plate and frame filter press.
9. Elutriation: To analyze given sample of sand using Elutriator.

B24-MAC-202	Essence of Indian Traditional Knowledge						
Lecture	**Tutorial**	**Practical Exam**	**End Semester Exam**	**Internal Assesment**	**Total**	**Credits**	**Duration of Exam (Hrs)**
2	**0**	**-**	**0**	**100**	**100**	**1**	**3**
Purpose	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the importance of the roots of the knowledge system, analyze and apply to their day-to-day life.						
Course Outcomes (CO)							
CO1	The students will be able to understand, connect and explain the basics of Indian traditional knowledge from a modern scientific perspective.						
CO2	The students will be able to understand Holistic Health using the Indian Knowledge System.						
CO3	The students will be able to Manage their thoughts and Emotions and will learn positivity, self-regulation, and control.						
CO4	The students will be able to Achieve Consciousness through Indian Knowledge System.						

UNIT 1

Introduction to Indian Traditional knowledge: Define traditional knowledge, importance, kinds of traditional knowledge. Philosophical systems, Basics of Rajyoga and Karam yoga, Benefits of Rajyoga and Karamyoga.

UNIT 2

Holistic Health using Indian Knowledge System: Basic principles of natural life style, Benefits through five elements. Healing through food, Chakras and Mudras. Physical, Mental, Emotional and Spiritual health using traditional knowledge.

UNIT 3

Positivity: Traditional approaches. Happiness: objective and subjective measures of wellbeing, life satisfaction. Resilience, Self-regulation and self-control, optimism, self-esteem. Managing thoughts and Emotions with the help of Rajyoga. Achieving Powers for Self-Mastery.

UNIT 4

Achieving Consciousness through Indian Knowledge System: Emotional intelligence, Indian approach to Psychology. Consciousness; levels, body-mind relationship, self-motivation, Self and Identity in modern Psychology and Indian thought., Spirituality and well-being.

Reference and Text Books:

Mahadevan, M., Bhat, V.R. & Pavana N. (2022). Introduction to Indian Knowledge System: Concepts and Applications. PHI Learning Baumgardner, SR & Crothers, MK (2009). Positive Psychology. Prentice Hall/Pearson Education. Cornelissen, R.M., Misra G. & Varma S. (2014). Foundations & Applications of Indian Psychology. Pearson Education. Rajyoga Education and Consciousness Improvement Programme for Educators, Rajyoga Education and Research Foundation. Rajyoga Meditation Course, Thoughkart, Jaipur(Rajasthan), India. Prakartik Swasthya Shastra, Publisher Natural Lifestyle Note: The paper setter will set the paper as per the question paper templates provided.

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Kaushik, Anubha and Kaushik, C.P. (2004 Perspectives in Environmental Studies, New age International Publishers.
3. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad -380013, India, Email: mapin@icenet. net (R).
4. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p.
5. Clerk B.S., Marine Pollution, Clanderson Pross Oxford (TB).
6. Cunningham, W.P.Cooper, T.H. Gorhani, E & Hepworth, M.T.2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p.
7. De A.K., Environmental Chemistry, Wiley Eastern Ltd. 8. Down to Earth, Centre for Science and Environment (R).