Annexure B

SYLLABUS OF

UNDERGRADUATE DEGREE COURSE

Chemical Engineering

BIKANER TECHNICAL UNIVERSITY, BIKANER

Effective from session: 2021-22

Office: Bikaner Technical University, Bikaner
Karni Industrial Area, Pugal Road, Bikaner-334004
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Syllabus

B. Tech. Chemical Engineering

2nd Year – III Semester

3CH2-01: Advanced Mathematics

Credit:3		Max Marks:150(IA:30,ETE:120)
3L+0T+ 0P		End Term Exams: 3 hr
Unit No.	Contents	**Hours**
1.	**Complex Variables:** Analytic functions, Cauchy-Riemann equations, Elementary conformal mapping with simple applications, Line integral in complex domain, Cauchy's theorem, Cauchy's integral formula, Taylor's series, Laurent's series, Poles, Residues, evaluation of simple definite real integrals using the theorem of residues. Simple contour integration.	14
2.	**Introduction to Statistics:** Probability distribution: Bimodal, Poisson, Uniform, Normal, Correlation and Regression, Linear regression, Confidence limits, types of errors, testing of hypothesis based on normal, Chi-square test, F-test, Z-test, Student's T-test. Comparison of means and variances.	12
3.	**Finite differences-** Forward, Backward, and Central differences, Newton's forward and backward difference interpolation formulae, Stirling's formula.Numerical differentiation, Numerical Integration – Trapezoidal rule, Simpson's one-third and three-eighth rule. Introduction to numerical solution of ordinary differential equation	14
	Total Hrs	40

3CH1-02/3CH1-03 : TECHNICAL COMMUNICATION

Credit:2	Max Marks:100 (IA:20, ETE:80)
2L+0T+ 0P	EndTermExams:2hr

Unit No.	Contents	Hours
1.	**Introduction to Technical Communication-** Definition of technical communication, Aspects of technical communication, forms of technical communication, importance of technical communication, technical communication skills (Listening, speaking, writing, reading writing), linguistic ability, style in technical communication.	4
2.	**Comprehension of Technical Materials/Texts and Information Design & development-** Reading of technical texts, Reading and comprehending instructions and technical manuals, Interpreting and summarizing technical texts, Note-making. Introduction of different kinds of technical documents, Information collection, factors affecting information and document design, Strategies for organization, Information design and writing for print and online media.	6
3.	**Technical Writing, Grammar and Editing-** Technical writing process, forms of technical discourse, Writing, drafts and revising, Basics of grammar, common error in writing and speaking, Study of advanced grammar, Editing strategies to achieve appropriate technical style, Introduction to advanced technical communication. Planning, drafting and writing Official Notes, Letters, E-mail, Resume, Job Application, Minutes of Meetings.	8
4.	**Advanced Technical Writing-** Technical Reports, types of technical reports, Characteristics and formats and structure of technical reports. Technical Project Proposals, types of technical proposals, Characteristics and formats and structure of technical proposals. Technical Articles, types of technical articles, Writing strategies, structure and formats of technical articles.	8
	Total Hrs	**26**

3CH1-02/3CH1-03 : MANAGERIAL ECONOMICS AND FINANCIAL ACCOUNTING

Credit:2	Max Marks:100 (IA:20, ETE:80)
2L+0T+ 0P	End Term Exams: 2hr

Unit No.	Contents	Hours
1.	**Basic economic concepts-** Meaning, nature and scope of economics, deductive vs inductive methods, static and dynamics, Economic problems: scarcity and choice, circular flow of economic activity, national income-concepts and measurement.	4
2.	**Demand and Supply analysis-** Demand-types of demand, determinants of demand, demand function, elasticity of demand, demand forecasting –purpose, determinants and methods, Supply-determinants of supply, supply function, elasticity of supply.	5
3.	**Production and Cost analysis-** Theory of production- production function, law of variable proportions, laws of returns to scale, production optimization, least cost combination of inputs, isoquants. Cost concepts-explicit and implicit cost, fixed and variable cost, opportunity cost, sunk costs, cost function, cost curves, cost and output decisions, cost estimation.	5
4.	**Market structure and pricing theory-** Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	4
5.	**Financial statement analysis-** Balance sheet and related concepts, profit and loss statement and related concepts, financial ratio analysis, cash-flow analysis, funds flow analysis, comparative financial statement, analysis and interpretation of financial statements, capital budgeting techniques.	8
	Total Hrs	**26**

3CH4-04: Chemical Engineering Thermodynamics-1

Credit:3		**Max Marks:150 (IA:30, ETE:120)**
3L+0T+ 0P		**End Term Exams: 3hr**
Unit No.	**Contents**	**Contact Hours**
1.	**Introduction:** Definitions and Concepts: System, Surroundings, Property, Energy, Work, Thermodynamic equilibrium, stability of equilibrium states. **Zeroth Law of Thermodynamics**: Perfect gas scale. **First Law of Thermodynamics:** First law of Thermodynamics and Its Applications, First law analysis of processes, Control mass and control volume analysis, Steady state and Transient state flow processes	8
2.	**Volumetric Properties of Pure Fluids:** PVT behavior of pure substances, virial equation and its applications, cubic equations of state, generalized correlations for gases and liquids.	8
3.	**Heat Effects:** Sensible heat effects, heat effects accompanying phase changes of pure substances, standard heats of reaction, formation and combustion, effect of temperature on the standard heat of reaction.	8
4.	**Second law of Thermodynamics:** Limitation of First Law, Kelvin-Planck and Clausius Statements, Reversible and Irreversible Processes, Carnot cycle, Entropy, Second Law analysis of a control volume. Exergy.	8
5.	**Thermodynamic Properties of Fluids:** Fundamental property relations, Maxwell's equations, Residual properties, Clapeyron's Equation, Generalized correlations for thermodynamic properties of gases.	8
	Total Hrs	40

3CH4-05: Fluid Mechanics

Credit:3	Max Marks:150(IA:30,ETE:120)
3L+0T+ 0P	End Term Exams: 3 hr

Unit No.	Contents	Hours
1	**Properties of fluids;** Classification; Ideal fluid, Newtonian and Non-Newtonian fluids; Newton's law of viscosity. Pascal's and Hydrostatic law, manometers. Types of manometer	5
2	**Fluid Statics:** fluid pressure and its measurement.	3
3	**Fluid Kinetics:** Continuity equation; types of flow.	3
4	**Fluid dynamics:** One dimensional equation of motion; Bernoulli's equation; application; application of Bernoulli's equation. Friction losses in pipe flow, valves and fittings, k-values, sudden expansion and contraction, pipe flow problems Nozzle. Introduction to laminar & turbulent flow. Velocity Distribution for turbulent flow, concept of Reynolds number & friction factor.	8
5	**Flow through Pipes** – Darcy – Weisbach's equation. Head loss in pipes. Pipes in series/ Parallel. Classification, basic construction and application of different types of pumps.	6
6	**Pump:** Centrifugal pump, Principles and application in Bernoulli's theorem Types of Pump: Axial pumps, Gear pump, Plunger Pumps Vane pump, Reciprocation pump and Screw pump. Characteristic Curves of Pumps. Valves, types of valves.	5
7	**Flow Metering:** Metering of fluids; orifice meter, Venturimeter, Pitot tube, Rota meter, Notches, Gas flow meters, coefficient of discharge.	6
	Total Hrs	**36**

3CH4-06: Chemical Process Calculation

Credit:3	Max Marks:150 (IA:30, ETE:120)
3L+0T+ 0P	End Term Exams: 3hr

Unit No.	Contents	Hours
1	Introduction to chemical Engineering calculations: Units and dimensions, mole unit, 6 conventions in methods and analysis and measurements, basis, temperature, pressure, the chemical equations and stoichiometry.	6
2	Material Balances: Material balance of physical and chemical processes with and without chemical reactions, including recycle, purge and bypass.	7
3	Gases, Vapors, Liquids, and Solids: Ideal gas law calculations, real gas relationships, vapour pressure and liquids, saturation, partial saturation and humidity, introduction to vapor liquid equilibria for multi-component systems, material balance involving condensation and vaporization	8
4	Energy Balances: Concept and unit, calculation of enthalpy changes, general balance with and without chemical reactions, heat of solution and mixing	9
5	Unsteady state material and energy balance	4
6	Solids, liquids and gaseous fuels, some industrial examples of the above, simple estimation of physical properties (Transport, Thermodynamic) of fluids and mixtures	6
	Total Hrs	**40**

3CH4-07: Mechanical Operation

Credit:3	Max Marks:150 (IA:30, ETE:120)
3L+0T+ 0P	End Term Exams: 3hr

Unit No.	Contents	Hours
1.	Particles Size Analysis: Sieve analysis, size distribution, size averaging and equivalence, size estimation in sub-sieve range, effectiveness of screen.	4
2.	Size Reduction: Theory of crushing and grinding, laws of crushing and grinding, crushing and grinding equipment and their selection.	4
3.	Storage of Solids: Angle of slide and repose, design of bins, silos, and hoppers, Jansen's equation.	4
4.	Particle Mechanics: Motion of particle in fluid, effect of particle shape, Stoke's law, hindered settling, jigging and classification.	4
5.	Sedimentation and Flotation: Gravity and centrifugal sedimentation, design of sedimentation tank and continuous thickeners, mechanism of flotation, flotation agents and flotation equipment.	6
6.	Flow Through Packed Beds: Characteristics of packings, flow of a single fluid through a packed bed, problem of channeling and wetting, counter current gas-liquid flow through packed beds, loading and flooding characteristics, industrial applications.	4
7.	Fluidization: Fluidization characteristics, aggregative and particulate fluidization, voidage and minimum fluidization velocity, voidage correlation, liquid-solid and gas-solid fluidization characteristics, industrial applications of fluidization.	5
8.	Filtration: Flow through filter cake and medium, washing and drying of cake, filter aids, selection of filtration equipment, constant rate and constant pressure filtration	5
9.	Conveying of Solids: Pneumatic and hydraulic conveying of solids, general characteristics and flow relations, mechanical conveyers.	4
	Total Hrs	**40**

3CH4-21: Fluid Mechanics Lab

Credit:2		**Max Marks:100 (IA:60, ETE:40)**
0L+0T+ 4P		**End Term Exams: 2hr**
S. No.	**Title of experiment**	Hours
1.	Reynolds experiment for Laminar, transitional and turbulent flow identification, through Reynolds apparatus	4
2.	Verification of Bernoulli's Equation through Bernoulli's Theorem Apparatus.	4
3.	Determination of co efficient of Discharge for Orifice, Venturimeter through Venturimeter and orifice meter test rig.	4
4.	Estimation of losses through pipe fitting, sudden enlargement and contraction frictional Pressure drop in Circular pipes.	4
5.	Verification of Darcy's Law through Darcy apparatus.	4
6.	To Study Construction, Working of Centrifugal, Reciprocating, Gear and Plunger Pumps through test rig	4
7.	To Study pitot tube apparatus and cavitation apparatus in a pipe flow.	4
	Total	28

3CH4-22: Mechanical Operation Lab

Credit:2		**Max Marks:100 (IA:60,ETE:40)**
0L+0T+ 4P		**EndTermExams:2hr**
Experiment No.	**Objectives**	**Hours**
1.	To study the principle of a hydro-cyclone and find out the efficiency of separation.	4
2.	To determine the average particle size of a mixture of particles by sieve analysis.	4
3.	To determine and experimentally verify Ritinger"s constant of Jaw crusher.	4
4.	To determine reduction ratio, maximum feed size and theoretical capacity of crushing rolls.	4
5.	To determine the effect of no. of balls on grinding in a Ball mill and comparison of its critical speed with the operating speed.	4
6.	To find out enrichment of the coal sample using a froth flotation cell.	4
7.	To determine and experimentally verify reduction ratio using Pulverizer.	4
8.	To determine and experimentally verify the efficiency of separation of a cyclone separator.	4
	Total Hrs	**32**

3CH4-23: DBMS (Data Base Management System) Lab

Credit:2	**Max Marks:100 (IA:60,ETE:40)**
0L+0T+ 4P	**EndTermExams: 2hr**

Experiment No.	**Objectives**
1.	Objectives: At the end of the semester, the students should have clearly understood and implemented the following: 1. Stating a database design & application problem. 2. Preparing ER diagram 3. Finding the data fields to be used in the database. 4. Selecting fields for keys. 5. Normalizing the database including analysis of functional dependencies. 6. Installing and configuring the database server and the front end tools. 7. Designing database and writing applications for manipulation of data for a standalone and shared data base including concepts like concurrency control, transaction roll back, logging, report generation etc. 8. Get acquainted with SQL. In order to achieve the above objectives, it is expected that each students will chose one problem. The implementation shall being with the statement of the objectives to be achieved, preparing ER diagram, designing of database, normalization and finally manipulation of the database including generation of reports, views etc. The problem may first be implemented for a standalone system to be used by a single user. All the above steps may then be followed for development of a database application to be used by multiple users in a client server environment with access control. The application shall NOT use web techniques. One exercise may be assigned on creation of table, manipulation of data and report generation using SQL.
2.	**Suggested Tools:** For standalone environment, Visual FoxPro or any similar database having both the database and manipulation language may be used. For multi-user application, MYSql is suggested. However, any other database may also be used. For front end, VB.Net, Java, VB Script or any other convenient but currently used by industry may be chosen. Indicative List of exercises: 1. Student information system for your college. 2. Student grievance registration and redressal system. 3. A video library management system for a shop. 4. Inventory management system for a hardware/ sanitary item shop. 5. Inventory management system for your college. 6. Guarantee management system for the equipments in your college.

Syllabus

B. Tech. Chemical Engineering
2nd Year - IV Semester

SN	Category	Course		Contact hrs/week			Marks				Cr
		Code	Title	L	T	P	Exm Hrs	IA	ETE	Total	
THEORY											
1	BSC	4CH2-01	Numerical Methods in Chemical Engineering	3	0	0	3	30	120	**150**	**3**
2	HSMC	4CH1-03/ 4CH1-02	Managerial Economics & Financial Accounting /Technical Communications	2	0	0	2	20	80	**100**	**2**
3	ESC	4CH3-04	Material Science and Technology	3	0	0	3	30	120	**150**	**3**
4	PCC	4CH4-05	Heat Transfer	3	0	0	3	30	120	**150**	**3**
5		4CH4-06	Mass Transfer-I	3	0	0	3	30	120	**150**	**3**
6		4CH4-07	Thermodynamics-II	3	0	0	3	30	120	**150**	**3**
			Sub Total	17	0	0		170	680	**850**	**17**
PRACTICAL & SESSIONAL											
7	PCC	4CH4-21	Heat Transfer Lab	0	0	4		60	40	**100**	**2**
8		4CH4-22	Mass Transfer Lab-I	0	0	4		60	40	**100**	**2**
9		4CH4-23	Thermodynamics Lab	0	0	4		60	40	**100**	**2**
10	SODECA	4CR8-00	Social Outreach Discipline &Extra Curricular Activities	0	0	0		0	0	**25**	**0.5**
			Sub- Total	0	0	12		180	120	**325**	**6.5**
			TOTAL OF IV SEMEESTER	17	0	12		350	800	**1175**	**23.5**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*

ETE: *End Term Exam,* ***IA:*** *Internal Assessment*

4CH2-01: Numerical Methods in Chemical Engineering

Credit:3	Max Marks: 150(IA:30,ETE:120)
3L+0T+ 0P	End Term Exams: 3hr

S.No.	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Linear Algebraic Equations:** Introduction, Approximation and Concept of Error & Error Analysis Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linearalgebraic equations	8
3	**Root finding methods for solution on non-linear algebraic equations:** Bisection, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non- linearequations Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, splineinterpolation, linear regression, polynomial regression, least square regression	8
4	**Numerical integration:** Trapezoidal rule, Simpson's rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation andintegration	7
5	**Ordinary Differential Equations:** Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs	8
6	**Introduction to Partial Differential Equations:** Characterization of PDEs,Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method.	8
	Total	40

4CH1-03/4CH1-03: Managerial Economics And Financial Accounting

Credit:3		Max Marks:150 (IA:30, ETE:120)
3L+0T+ 0P		End Term Exams: 3hr
S.No.	**Contents**	**Hours**
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basic economic concepts-** Meaning, nature and scope of economics, deductive vs inductive methods, static and dynamics, Economic problems: scarcity and choice, circular flow of economic activity, national income-concepts and measurement.	4
3	**Demand and Supply analysis-** Demand-types of demand, determinants of demand, demand function, elasticity of demand, demand forecasting –purpose, determinants and methods, Supply-determinants of supply, supply function, elasticity of supply.	8
4	**Production and Cost analysis-** Theory of production- production function, law of variable proportions, laws of returns to scale, production optimization, least cost combination of inputs, isoquants. Cost concepts-explicit and implicit cost, fixed and variable cost, opportunity cost, sunk costs, cost function, cost curves, cost and output decisions, cost estimation.	8
5	**Market structure and pricing theory-** Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	5
6	**Financial statement analysis-** Balance sheet and related concepts, profit and loss statement and related concepts, financial ratio analysis, cash-flow analysis, funds- flow analysis, comparative financial statement, analysis and interpretation of financial statements, capital budgeting techniques.	10
	TOTAL	36

4CH1-02/4CH1-02: Technical Communication

Credit:2		Max Marks:100 (IA:20, ETE:80)
2L+0T+ 0P		End Term Exams: 2hr
S. No.	**Contents**	**Hours**
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to Technical Communication-** Definition of technical communication, Aspects of technical communication, forms of technical communication, importance of technical communication, technical communication skills (Listening, speaking, writing, reading writing), linguistic ability, style in technical communication.	3
3	**Comprehension of Technical Materials/Texts and Information Design & development-** Reading of technical texts, Readingand comprehending instructions and technical manuals, Interpreting and summarizing technical texts, Note-making. Introduction of different kinds of technical documents, Information collection, factors affecting information and document design, Strategies for organization, Information design and writing for print and online media.	6
4	**Technical Writing, Grammar and Editing-** Technical writing process, forms of technical discourse, Writing, drafts and revising, Basics of grammar, common error in writing and speaking, Study of advanced grammar, Editing strategies to achieve appropriate technical style, Introduction to advanced technical communication. Planning, drafting and writing Official Notes, Letters, E-mail, Resume, Job Application, Minutes of Meetings.	8
5	**Advanced Technical Writing-** Technical Reports, types of technical reports, Characteristics and formats and structure of technical reports. Technical Project Proposals, types of technical proposals, Characteristics and formats and structure of technical proposals. Technical Articles, types of technical articles, Writing strategies, structure and formats of technical articles.	8
	Total	26

4CH3-04: Material Science and Technology

Credit:3	Max Marks:150 (IA:30, ETE:120)	
3L+0T+ 0P	End Term Exams: 3hr	
S.No.	**Contents**	**Hours**
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to materials**: Atomic structure, bonding aggregates of atom. **Crystals Structure**: crystal structure, periodicity in crystal, types of structures: SC, BCC, FCC and HCP Crystals system, crystal lattice, unit cell, crystal direction, crystal planes, Miller indices, inter planar spacing, X-ray analysis, **Crystals Defects**: classifications and impact on the properties of engineering materials.	7
3	**Phase Equilibria** – phase rule phase changes in pure Iron, binary systems, solid solution, Eutectic, Eutectoid, Peritectic and Peritectoid reactions. General principles of heat treatment: Annealing, normalizing, hardening, tempering and age hardening	8
4	**Corrosion:** Types of Corrosion in Industries, corrosion of materials in construction, pipe line and in equipments and its control	6
5	**Materials and their properties: Mechanical properties:** Hardness, Strength, Toughness, Stiffness, Ductility, Malleability, Hardenability, Creep fatigue and Rheology. **Electrical properties:** Conductors, Semiconductors and insulators, dielectric materials. **Optical properties:** Absorption, Reflection, Transmission and Refraction, optical fibers and lasers. **Magnetic properties:** various types of magnetic materials, Diamagnetic, Paramagnetic, Ferromagnetic, Ant ferromagnetic and Ferromagnetic materials, Domain theory, Hard and soft magnetic materials. **Thermal Properties:** Thermal expansion, Heat capacity, Thermal Conduction, Thermal Stresses. Criteria for selection of materials for special applications in Industries such as smart materials. Smart materials.	10
6	**Characterization of Material:** Principle, Construction and Procedure for characterization of material using Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), EDS/EDX, Atomic force microscopy (AFM), Dielectric spectroscopy, Fluorescence spectroscopy.	8
	Total	40

4CH4-05: Heat Transfer-1

Credit:3	Max Marks:150 (IA:30, ETE:120)
3L+0T+ 0P	End Term Exams: 3hr

Unit No.	Contents	Hours
1.	**Introduction:** Modes of heat transfer: conduction, convection, radiation. **Steady-State Conduction in One Dimension:** Fourier's Law, thermal conductivity, steady-state conduction of heat through a composite solid, cylinder and sphere. Steady-state heat conduction in bodies with heat sources: plane wall, cylinder and sphere. **Unsteady-State Heat Conduction:** Mathematical formulations and initial and boundary conditions. Analytical solution, numerical solution.	8
2.	**Heat Transfer Coefficient:** Convective heat transfer and the concept of heat transfer coefficient, overall heat transfer coefficient, heat transfer from extended surfaces, thermal contact resistance, critical insulation thickness, optimum insulation thickness. **Forced Convection:** Flow over a flat plate, thermal boundary layer, flow across a cylinder. Dimensional analysis: Buckingham Pi theorem, Dimensional groups in heat transfer. Correlations for the heat transfer coefficient: Laminar flow through a circular pipe, turbulent flow through a circular pipe, flow through a non-circular duct, flow over flat plate, flow across a cylinder, flow past a sphere, flow across a bank of tubes, heat transfer coefficient in a packed and fluidized bed.Double-pipe heat exchanger in parallel and counter-current flow.	8
3.	**Free Convection:** Introduction, heat transfer correlations for free convection: flat surface, cylinder, sphere, enclosure. Combined free and forced convection. **Boiling and Condensation:** Boiling phenomenon, nucleate boiling, Correlations for pool boiling heat transfer: Nucleate boiling, critical heat flux, stable film boiling. Forced convection boiling, condensation phenomena, film condensation on a vertical surface, turbulent film condensation, condensation outside a horizontal tube and tube bank. Condensation inside a horizontal tube, effect of non-condensable gases. Dropwise condensation.	6
4.	**Radiation Heat Transfer:** Basic concepts of radiation from a surface: black body radiation, Planck's Law, Wien's Displacement Law, Stefan-Boltzmann Law, Kirchoff's Law, Gray body. Radiation intensity of a black body, spectral emissive power of a black body over a hemisphere. Radiation heat exchange between surfaces – the view factor. Radiation exchange between black bodies and between diffuse gray surfaces.	6
5.	**Evaporators:** Types of evaporators: Natural-circulation evaporators, forced--circulation evaporators, falling film evaporators, climbing-film evaporators, agitated thin-film evaporators and plate evaporators. Principles of evaporation and evaporators; Single and multiple effect evaporators, Capacity and economy, Boiling point rise, heat transfer coefficient enthalpy of a solution. Calculations of a single effect evaporator.	6

6.	**Heat Exchangers:** Construction of a shell-and-tube heat exchanger, fouling of a heat exchanger, LMTD, temperature distribution in multi-pass heat exchangers, individual heat transfer coefficients. Types of shell-and-tube heat exchanger. Design of different type of heat exchangers.	6
	Total Hrs	**40**

4CH4-06: Mass Transfer-I

Credit:3	Max Marks:150(IA:30,ETE:120)
3L+0T+ 0P	EndTermExams:3hr

S.No.	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Fundamentals of Mass Transfer:** Individual and film coefficients, overall mass transfer Coefficient and their inter relationships; Analogies in transfer processes, determination of mass transfer coefficient.	7
3	**Diffusion Phenomenon**: Molecular and eddy diffusion in gases, liquids and solids, Interface mass transfer. Mass transfer theories: film theory Penetration theory and surface renewal theory.	6
4	**Humidification and Dehumidification**: Humidification: General Theory, psychometric chart. Fundamental concepts in humidification & dehumidification, wet bulb temperature. Adiabatic saturation temperature, measurement of humidification calculation of humidification operation, cooling towers and related equipments.	6
5	**Drying:** Equilibrium mechanism theory of drying, drying rate curve. Batch and continuous drying for tray driers, Drum dryers, spray and tunnel dryers.	10
6	**Absorption**: Introduction to Adsorption, Absorption and Extraction in continuous contact columns; co-current, counter current and cross current contacting Absorption, calculations of NTU and HTU, Concept of HETP, Two phase flow in packed beds, co-current and counter current Processes Flooding loading, column internals: types of trays/plates and packing, point and plate efficiency.	10
	Total	40

4CH4-07: Thermodynamics – II
(Common with Petroleum Engineering & Petrochemical Engineering)

Credit: 3	Max Marks: 150 (IA:30,ETE:120)
3L+0T+ 0P	End Term Exams: 3 hr

S.No.	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Review of first and second law of thermodynamics.**	7
3	**Vapor-liquid equilibrium:** phase rule, simple models for VLE;VLE by modified Raoult'slaw; 1VLE from K-value correlations; Flash calculations.	10
4	**Solution Thermodynamics:** fundamental property relationships, free energy and chemical potential, partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, the ideal solution and excess properties. Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing. UNIFAC and UNIQUAC models. Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-GasEquilibria.	12
5	**Chemical reaction equilibria:** equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single reactions, multi-reaction equilibria Introduction to molecular/statistical thermodynamics.	10
	Total	40

4CH4-21: Heat Transfer Lab-1

Credit:2		Max Marks:100(IA:60,ETE:40)
0L+0T+ 4P		End Term Exams: 2hr
Experiment No.	**Objective**	**Contact Hours**
1.	Study of Heat transfer by conduction in a metal bar	2
2.	Study of Heat transfer by conduction in a Composite metal wall.	2
3.	Study of unsteady state heat transfer.	2
4.	Determination of Thermal conductivity of Insulated Powder.	2
5.	Study of Heat transfer by Natural convection.	2
6.	Study of Heat transfer by Forced convection.	2
7.	Study of Heat transfer in Agitated Vessel.	2
8.	Determination of Emissivity of given material.	2
	Total Hrs	16

4CH4-22: Mass Transfer – Lab I

Credit:2		Max Marks:100(IA:60,ETE:40)
0L+0T+ 4P		EndTermExams:2hr
Experiment No.	Objective	**Contact Hours**
1.	To determine diffusion coefficient of solid vapour in air	2
2.	To determine diffusion coefficient of Liquid vapour in air	2
3.	To study the rate dissolution of a rotating cylinder and then to calculate the mass transfer coefficient. (Mass Transfer with and without chemical Reaction)	2
4.	To investigate the mass transfer characteristic of a wetted surface column unit.	2
5.	To investigate the characteristics of cooling tower.	2
6.	To study the drying characteristics of a wet granular material using natural and forced circulation in tray dryer.	2
7.	To prepare the drying rate curve for force draft tray dryer.	2
8.	To study the characteristics of spray dryer.	2
	Total Hours	16

4CH4-23: Thermodynamics Lab

Credit:2	**Max Marks:75 (IA:45,ETE:30)**
0L+0T+ 4P	**EndTermExams:2hr**

Experiment No.	Objectives	Hrs
1.	Determination of specific heat.	2
2.	Determination of thermocouple voltage.	2
3.	Determination of Coefficient of Linear Expansion of Metals	2
4.	To study low pressure boilers and their accessories and mountings.	2
5.	To study high pressure boilers and their accessories and mountings.	2
6.	To study the working of impulse and reaction steam turbines.	2
7.	To prepare heat balance sheet for given boiler.	2
8.	To find power output & efficiency of a steam turbine.	2
	Total Hrs	**16**