Faculty of Engineering and Technology

Radha Govind University

Chandausi, Sambhal (U.P.)

Evaluation Scheme & Syllabus for

Department of Chemical Engineering

Diploma in Chemical Engineering II Year

(III & IV Semester)

(Effective from session _____)

STUDY AND EVALUATION SCHEME FOR CHEMICAL ENGINEERING

2nd Year, 3th Semester

SUBJEC CODE	SUBJECT SNAME	STUDY SCHEM E Periods /Wee k			Credits	MARKSINEVALUATION SCHEME						Total Marks of Internal & External
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMEN T			
		L	T	P		Th.	Pr	Tot	Th.	Pr	Tot	
DCHE301	FLUID FLOW OPERATIONS	2	-	-	2	30	-	30	70	-	70	100
DCHE302	CHEMICAL PROCESS CALCULATIONS	3	-	-	3	30	-	30	70	-	70	100
DCHE303	CHEMICAL ENGINEERING THEMODYNAMICS	3	-	-	3	30	-	30	70	-	70	100
DCHE304	CHEMICAL TECHNOLOGY-I	2	-	4	4	30	-	30	70	-	70	100
DCHE305	MECHANICAL OPERATIONS & SOLID HANDING	2	-	-	2	30	-	30	70	-	70	100
DCHE306	FLUID FLOW OPERATIONS LAB	-	-	4	2	-	25	25	-	25	25	50
DCHE307	CHEMICAL TECHNOLOGY-I LAB	-	-	4	2	-	25	25	-	25	25	50
DCHE408	MECHANICAL OPERATIONS & SOLID HANDING LAB	-	-	4	2	-	25	25	-	25	25	50
Total					**20**	150	75	**225**	350	75	**425**	**650**

For pass the candidate is required to obtain 40% marks in each paper and 50% marks in aggregate.

STUDY AND EVALUATION SCHEME FOR CHEMICAL ENGINEERING

2nd Year, 4th Semester

SUBJEC CODE	SUBJECT SNAME	STUDY SCHEM E Periods /Wee k			Credits	MARKSINEVALUATION SCHEME						Total Marks of Internal & External
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMEN T			
		L	T	P		Th.	Pr	Tot	Th.	Pr	Tot	
DCHE401	Process Heat Transfer	2	-	-	2	30	-	30	70	-	70	100
DCHE402	Chemical Reaction Engineering	2	-	4	4	30	-	30	70	-	70	100
DCHE403	Chemical Technology-ii	2	-	-	2	30	-	30	70	-	70	100
DCHE404	Mass Transfer Operation-I	2	-	2	3	30	-	30	70	-	70	100
DCHE405	ELECTIVE -I	2	-	-	2	30	-	30	70	-	70	100
DCHE406	ELECTIVE-II	2	-	-	2	30	-	30	70	-	70	100
DCHE407	Process Heat Transfer Lab	-	-	4	2	-	25	25	-	25	25	50
DCHE408	Chemical Reaction Engineering Lab	-	-	4	2	-	25	25	-	25	25	50
DCHE409	Chemical Technology Lab	-	-	2	1	-	25	25	-	25	25	50
Total					20	180	75	255	420	75	495	750

For pass the candidate is required to obtain 40% marks in each paper and 50% marks in aggregate.

DCHE 405 ELECTIVE-I	DCHE 406 ELECTIVE-II
1. Material science & Technology 2. Food Technology	1. Plant Utilities 2. Modern Separation Techniques

Industrial training (Summer Internship) of 4-6 weeks duration to be organized after 4th semester exam.

DCHE 301

FLUID FLOW OPERATIONS

L	T	P
2	-	-

COURSE OBJECTIVES

This course provides knowledge of the measurement of fluid flow and various fluid transportation machinery. The knowledge gained in this subject is directly applied in different subjects of Chemical Engineering. This subject helps students understand the installation, working, and application of different fluid flow and transportation machinery used in industry.

COURSE OUTCOMES (CO):

After studying this course, the students will be able to:

CO1 : Distinguish between different types of fluids and explain their properties and flow characteristics.

CO2 : Explain pressure concepts and calculate pressure using manometers and pressure measuring devices.

CO3 : Analyze incompressible fluid flow and calculate flow rates using continuity equation, Bernoulli's theorem, and flow meters.

CO4 : Identify types of pipes, fittings, and valves and explain their construction and applications in fluid flow systems.

CO5 : Explain the principles, working, and performance of pumps used for transportation of fluids and calculate pumping requirements.

COURSE CONTENTS

Unit-1: Introduction to fluids (06 Periods)

1. Properties of fluids- Density and viscosity, Vapor pressure and surface tension, cohesion and adhesion, Hydrostatic Pressure.

2. Types of Fluids- Ideal and Real fluids, Compressible and Incompressible Fluids (liquid), Newtonian and Non-Newtonian fluids and Newton's Law of Viscosity.

3. Types of Fluid flow: Streamline flow, steady and unsteady state flow, uniform and non-uniform flow, rotational and irrotational flow, Laminar flow and turbulent flow.

Unit-2: Pressure Measurements (02 Periods)

1. Pressure: Types of Pressure, Atmospheric, Gauge & Absolute Pressure, Barometric Leg

2. List of Pressure measuring devices: U-Tube Manometer –computation of Pressure difference using U-Tube manometer - Inclined Manometer –Simple Problems in U Tube manometer.

Unit-3: Flow of Incompressible Fluids (08 Periods)

1. Equation of continuity, Mass flow rate, volumetric flow rate, average velocity and mass velocity.

2. Introduction to Bernoulli's Theorem and its applications (derivation excluded).

3. Concept of Boundary layer, Form friction and skin friction.

4. Hagen-Poiseuille equation (derivation excluded).

5. Construction and Comparative Application of Venturi meter, Orifice meter, Rota meter, Pitot tube.

Unit-4: Pipe, fitting and valves (04 Periods)

1. Type of Pipes, Standard sizes of pipes on the basis of Wall thickness, Schedule number, BWG Number, Difference between Tube and Pipe.

2. Joints and fittings, Gate valve, Globe valve, Ball valve, Needle valve, Nonreturn value, Butterfly valve, Diaphragm valve, Control Valves, Solenoid Operating Valves.

Unit-5: Transportation of Fluids (08 Periods)

1. Pumps- Classification of Pumps, Centrifugal Pump: Parts of centrifugal pump, working of Centrifugal pump, Installation of Centrifugal Pump (Strainer, valves, NRV's explanation), priming, Cavitation, Net Positive Suction Head (NPSH).

2. Positive displacement Pump: Reciprocating pumps based on Fluid Handling and based on action of piston/plunger, Construction & working of Gear pump, Rotary Pump, Diaphragm pump, Screw pump.

INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the student. Give industrial based practical problems for material and energy calculations.

RECOMMENDED BOOKS

1. Unit Operations of Chemical Engineering by McCabe, Smith; McGraw Hill

2. Introduction to Chemical Engineering by Badger &Banchero; McGraw Hill

3. Chemical Engineering Volume-1 by Richardson & Coulson; Pergamon Press.

WEBSITES FOR REFERENCE:

http://swayam.gov.in

FLUID FLOW OPERATIONS LAB

LIST OF PRACTICALS

Ex1. Determination of Density using Density Bottle and Hydrometer.

Ex2. To measure the viscosity of different liquids (Ostwald's Viscometer or Redwood Viscometer or latest Digital Viscometers).

Ex3. Study Sketch and Demonstration of U-Tube Manometer.

Ex4. Use of U-Tube Manometer to measure vacuum generated by vacuum pump.

Ex5. To perform experiment on Bernoulli's Theorem and prove that the summation of pressure head, kinetic head and potential head is constant.

Ex6. To perform Reynolds Experiment and determine Reynolds number at the end of laminar region and beginning of turbulent region

Ex7. Determination of coefficient of discharge of venturi meter

Ex8. Determination of coefficient of discharge of orifice meter

Ex9. Measurement of Flow using rotameter for different liquids

Ex.10. Study Sketch of Pressure Transducers (Mass Flow Meters)

Ex.11 Determination of equivalent length of pipe fittings

Ex.12 To measure the major and minor loses in pipes.

DCHE 302

CHEMICAL PROCESS CALCULATIONS

L	T	P
3	-	-

COURSE OBJECTIVES:

The objectives of this course are to:

1. Provide students with fundamental concepts of material and energy balance used in chemical industries.

2. Develop the ability to perform unit conversions and apply engineering units consistently in calculations.

3. Enable students to analyze gas mixtures and solution concentrations used in industrial processes.

4. Train students to perform material balance calculations for unit operations with and without chemical reactions.

5. Familiarize students with energy balance concepts, including heat of reaction, combustion calculations, and calorific values used in process industries.

COURSE OUTCOMES(CO):

After successful completion of this course, the students will be able to:

CO1 : Understand the scope and importance of material and energy balance in chemical industries and perform unit conversions using appropriate systems of units.

CO2 : Calculate properties and concentrations of solutions and gas mixtures used in chemical industries.

CO3 : Determine material input and output for unit operations without chemical reaction, including recycle, bypass, and purge systems.

CO4 : Perform material balance calculations involving chemical reactions, including excess and limiting reactants and combustion problems.

CO5 : Perform energy balance calculations involving heat of reaction, combustion, calorific value, and adiabatic processes.

COURSE CONTENTS

UNIT-1: INTRODUCTION (04 Periods)

1. Introduction to material and energy balance in chemical industries

2. Unit conversion, S.I. system, M.K.S. system, C.G.S. system.

UNIT-2: GASES AND GAS MIXTURE (08 Periods)

1. Boyle's law, Charle's law, Ideal Gas law, value of universal gas constant, Amagat's Law

2.

Average molecular weight, density and composition (by weight and by mole) of gas mixture.

3. Various units of concentration: PPM (parts per million), PPB (parts per billion) molarity, molality, normality.

UNIT-3: MATERIAL BALANCE WITHOUT CHEMICAL REACTION (08 Periods)

1. Steps for solving simple material balance problems.

2. Solving simple problems on various unit operations like drying, evaporation, crystallization, distillation, mixing and absorption.

3. Concept of: By-pass streams.

UNIT-4: MATERIAL BALANCE WITH CHEMICAL REACT (06 Periods)

1. Limiting component, excess component, percent excess, yield, conversion, and selectivity recycle, and purge related simple problems.

UNIT-5: ENERGY BALANCE & COMBUSTION (16 Periods)

1. Definitions of Specific heat (Cp & Cv)/sensible heat, latent heat.

2. Hess's law and associated basic problems.

3. Concept of Heat of reaction, heat of combustion & heat of formation.

4. Adiabatic reaction and adiabatic flame temperature

5. Calorific Value: Net and gross and its basic numerical problems.

6. Combustion: proximate and ultimate analysis, air fuel ratio in Boiler/Furnaces, Theoretical oxygen/air required.

7. Problems of fuel analysis.

8. Oxidation of sulphur and its compounds.

INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the student. Give industrial based practical problems for material and energy calculations.

RECOMMENDED BOOKS

1. Stoichiometry by B. I. Bhatt &S. M. Vora; McGraw Hill Publication

2. Chemical Process Principles Part-1 by O.A. Hougen and K.M. Watson.

3. Chemical Process Principles Part-1 by R.A. Rastogi

4. Solved Examples in Chemical Engineering by G.K. Ray

DCHE 303

CHEMICAL ENGINEERING THEMODYNAMICS

L	T	P
3	-	-

COURSE OBJECTIVES:

It is a core subject of Chemical Engineering and is essential for understanding basic concepts, thermodynamic properties of fluid and performance of thermal systems used in industry.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Explain thermodynamic systems, properties, state and path functions, and fundamental laws including zeroth law and gas laws.

CO2: Apply the first law of thermodynamics to open and closed systems and solve problems using property relations and steam tables.

CO3: Explain the second and third laws of thermodynamics, entropy concept, and performance of Carnot cycle, heat engines, heat pumps, and refrigerators.

CO4: Analyze thermodynamic cycles and equipment such as refrigeration systems and compressors based on second-law applications.

CO5: Explain phase and chemical reaction equilibrium, VLE behavior, and thermodynamic property relations used in industrial systems.

COURSE CONTENTS

Unit-1: Introduction and Basic Concepts (06 Periods)

Thermodynamic systems: closed, open, isolated, homogenous, heterogeneous and surroundings, Thermodynamic properties: intensive, and extensive properties, State and path functions. Concept of internal energy, enthalpy, entropy, free energy and equilibrium, Ideal gas law, Amagat's law, Dalton's law, Zeroth law of thermodynamics

Unit-2: First Law of Thermodynamics for Open and Closed System (10 Periods)

Statement of first law of thermodynamics, expression and application of first law of thermodynamics for isothermal, isobaric, isochoric, adiabatic and polytropic processes. Properties of pure substances, phase change process of pure substance, property diagram for phase change processes- T-V, P-V and P-T diagrams, property tables- use of steam tables.

Unit-3: Second Law of Thermodynamics (06 Periods)

Statement of second law of thermodynamics: Kelvin Plank and Clausius, Heat engine, Heat Pump and Refrigerators- coefficient of performance and efficiency, Reversible and irreversible process, Carnot cycle and its efficiency. Concept of entropy and Statement of third law of thermodynamics

Unit-4: Applications of Second law of Thermodynamics (10 Periods)

Concept of refrigeration, Thermodynamic cycles: vapor compression and absorption refrigeration and air refrigeration. Compressors- Piston, Rotary Screw, Centrifugal and Reciprocating. Liquefaction process, Properties and applications of refrigerants and their naming

Unit-5: Chemical Reaction Equilibrium and Vapor Liquid Equilibrium (10 Periods)

Composition of Gas Mixtures- Mass and Mole fraction, Concept of chemical potential, Henry's law, Raoult's law, Gibb's phase rule, vapor liquid equilibrium (VLE); P-v-T behavior. Dew point and bubble point, fugacity, fugacity coefficient, activity and activity coefficient.

Introduction to Applications of Thermodynamics in Industries: Power Generation-Steam Turbine & Gas Turbine, Refrigeration and Air Conditioning.

INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the students related to subject and transfer industrial knowledge to students.

RECOMMENDED BOOKS

1. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness; McGraw Hill.

2. Chemical Engineering Thermodynamics by K.V. Narayanan; Prentice Hall India.

3. Chemical Engineering Thermodynamics by Dodge; McGraw Hill.

4. Chemical Engineering Thermodynamics by YVC Rao

5. Engineering Thermodynamics by PK Nag

6. Thermal Engineering by Ballaney

7. Chemical Engineering Thermodynamics by K.A. Gavhane, Nirali Publication.

DCHE 304

CHEMICAL TECHNOLOGY –I

L	T	P
2	-	4

COURSE OBJECTIVES

The objectives of this course are to:

• Provide comprehensive knowledge of major chemical process industries and their role in the national economy.

• Enable students to understand raw materials, manufacturing processes, and production trends of important chemical industries.

• Develop the ability to prepare and interpret process flow sheets used in chemical industries.

• Familiarize students with engineering problems, material of construction, and pollution issues in process industries.

• Introduce the use and application of industrial equipment and instruments along with good manufacturing and laboratory practices.

COURSE OUTCOMES (CO):

After successful completion of this course, the students will be able to:

CO1 : State the basic principles, scope, and symbols used in major chemical process industries along with GMP and GLP practices.

CO2 : Explain the manufacturing process of sugar and identify engineering problems and pollution control methods in the sugar industry.

CO3 : Explain fermentation processes for production of chemicals and describe associated

engineering problems and pollution abatement methods.

CO4 : Explain manufacturing processes of soaps, detergents, disinfectants, and oils and identify engineering problems in these industries.

CO5 : Explain pulping and paper manufacturing processes, role of additives, engineering problems, and pollution control in pulp and paper industry.

CO6 : Explain polymerization processes and manufacturing of polymers, rubber, paints, varnishes, and dyes along with their applications.

COURSE CONTENTS

Units	Topics	No. of Lectures
1st	**Introduction:** 1.Introduction to Major chemical process industries (such as fertilizer industries, fermentation industries, Oil refineries etc.) with reference to Indian resources, trade and export potential.	(4 Periods)

	2. Process symbols used for various equipment and their uses. 3. Introduction to Good Manufacturing practices (GMP) and Good Laboratory Practices (GLP)	
2nd	**Sugar Industry** 1. Manufacturing of crystal sugar using cane sugar. 2. Various engineering problems encountered in sugar industry 3. Pollution abatement in sugar industry.	(4 Periods)
3rd	**Fermentation Industry** 1. Introduction of fermentation industry and classification of fermentation processes 2. Production of ethyl alcohol by fermentation 3. Various engineering problems encountered in fermentation industry 4. Pollution abatement in fermentation industry.	(5 Periods)
4th	**Soaps and Detergent Industry** 1. Manufacturing of soap and glycerin as by products from soap. 2. Manufacturing of detergents (including raw material and manufacturing process) 3. Hydrogenation of vegetable oils 4. Manufacturing of House disinfectants 5. Various engineering problems encountered in soaps and detergent industry	(6 Periods)
5th	**Pulp and Paper Industry** 1. Different pulping process 2. Manufacturing of paper 3. Role of additives 4. Various engineering problems encountered in paper industry. 5. Pollution abatement in pulp and paper industry.	(6 Periods)
6th	**Polymer and Paint Industry** 1. Types of polymer, polymerization process, manufacture of polyethylene, styrene, nylon 6, Nylon 66, rayon. Manufacture of rubber. 2. Introduction to Paint, Varnishes and dyes.	(3 Periods)
	INSTRUCTIONAL STRATEGY Teacher should explain each process industry and use of each and every equipment used. An industrial visit can be organized in various chemical and process industries. Audio-visuals should be used to teach.	
	MEANS OF ASSESSMENT • Demonstration of practical by using experimental set-up. • Viva-Voce.	
	RECOMMENDED BOOKS 1. Dryden's Outlines of Chemical Technology by M. Gopal Rao and Marshal Sitting; Affiliated Press Pvt. Ltd. 2. Shreve's Chemical Process Industries by Jorge Austin; Tata McGraw Hill 3. Unit Process in Organic Synthesis by P.H. Groggins; Tata McGraw Hill 4. Chemical Technology Vol I and II by G. N. Pandey	

CHEMICAL TECHNOLOGY –I LAB

LIST OF PRACTICALS

1. To measure the concentration of sugar solution by Refractometer.
2. Preparation of vinegar using sugarcane juice etc.
3. Preparation of Soap by Coconut Oil
4. Preparation of Soap by mustard oil
5. Preparation of Detergent/liquid detergent.
6. Recycling of Paper waste
7. Preparation of phenyl formaldehyde Resin.
8. Preparation of Urea formaldehyde Resin
9. To prepare natural dye from different Raw Materials-Hibiscus petals or leaves, Vinegar or Water.
10. To determine the Acid Value of Castor oil.

DCHE 305

MECHANICAL OPERATIONS & SOLID HANDING

L	T	P
2	-	-

COURSE OBJECTIVES

The subject gives the students the knowledge of working of individual mechanical operations and handling of solids and their significance in chemical industries. With this information, students will be able to control the operation of equipment and regulate production.

COURSE OUTCOMES:

After completing this course, students will be able to:

CO1 : Explain the concept and role of unit operations in process industries.

CO2 : Analyze characteristics of solid particles and methods of size analysis.

CO3 : Select and explain size-reduction equipment and crushing laws.

CO4 : Apply principles of screening and mechanical separation equipment.

CO5 : Explain filtration, sedimentation and associated separation equipment.

CO6 : Describe and select conveying equipment for solid particles.

COURSE CONTENTS

Unit-1: (02 periods)

Concepts and role of unit operation in process industries

Unit-2: Characterization of Solid Particles (04 periods)

Spherecity, Particle shape, particle size, mixed particle sizes and size analysis, expressions for specific surface of mixture, average particle size (expression and meaning of terms only, no derivation)

Unit-3: Size Reduction (08 periods)

1. Crushing laws: Rittinger's law, Bond's law and Kick's law, Crushing efficiency.

2. Size Reduction Equipment: Classification and types; study of machines including Gyratory Crusher, Jaw Crusher, Grinding Rolls, Single Roll Toothed Crusher, Impact or Attrition Mill, and Ball Mill, Ultra-fine grinders such as Fluid Energy Mills.

Unit-4: Mechanical Separation (05 periods)

1. Screening, Screen analysis, Tyler standard screen series, screen effectiveness, Types of screening equipment i.e. gyrating screens, stationary screens and vibrating screens, Screen efficiency, Screen capacity.

Unit-5: Filtrations: (05 periods)

1. Classification of filtrations, filter media, filter aids, mechanisms of filtrations, plate and frame filter press, Continuous: Vacuum filters, Rotary drum filters.

2. Separation based on the motion of particles through fluids, Gravity classifiers, clarifiers and thickeners, Batch sedimentation, centrifugal settling process, Cyclone Separators.

Unit-6: Conveying of Solid Particles: (04 periods)

1. Classification of conveying equipment, Belt conveyor, Screw conveyor, Chain conveyor and it's applications.

INSTRUCTIONAL STRATEGY

Mechanical operations have significant importance in the area of chemical engineering. Adequate competency needs to be developed by giving sufficient practical knowledge to mechanical operation (characterization of solid particles, size reduction, energy requirement and mechanical separation). A field visit may be conducted to expose the working of various conveyers and filtration equipment in industries.

RECOMMENDED BOOKS:

1. Unit Operations of Chemical Engineering - W.L.McCabe and J.C.Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.

2. Introduction to chemical Engineering - W.L.Badger and J.T.Banchero - Tata McGraw Hill Publishing Co.Ltd. New Delhi –1997.

3. Unit Operations –I - K A Gavhane - Nirali Publications - 2011.

4. Introduction to chemical Engineering - Ghoshal, Sanyal and Dutta - 1st Edition – TataMcGraw Hill Publishing Co.Ltd. New Delhi - 2004.

MECHANICAL OPERATIONS & SOLID HANDING LAB

LIST OF EXPERIMENTS

Ex. 1 To perform on experiment on Jaw crusher and find its crushing efficiency.

Ex. 2 To determine the crushing efficiency by a roll crusher using a sample of solid particles.

Ex. 3 To determine the crushing efficiency of ball-mill using a sample of solid particles.

Ex. 4 To find the sieve analysis of a given sample of solid particles by sieve shaker

Ex. 5 To find the rate of filtration with the help of filter press.

Ex. 6 To perform an experiment on rotary vacuum filter and find rate of filtration.

Ex. 7 To perform an experiment on cyclone separator.

Ex. 8 To perform an experiment on centrifuge.

Ex.9: To perform an experiment on ribbon mixer for solid-liquid mixing and find rate/time mixing.

Ex.10: To perform an experiment on industrial slurry mixer for solid-liquid mixing rate/time of mixing.

DCHE 401 PROCESS HEAT TARNSFER

L	T	P
2	-	-

COURSE OBJECTIVES

Most of the Chemical Engineering operations will involve either heat addition or heat removal in one way or the other. It is, therefore, extremely necessary to have good understanding about the heat transfer mechanisms. This subject enables the students to apply this knowledge for understanding the performances of various heat transfer equipment such as heat exchangers, condensers, evaporators etc. used in almost all chemical and related industries.

LEARNING OUTCOMES

After the completion of this course, the students will be able to:

- Understand basic laws of heat transfer
- Analyze problems involving steady heat conduction in simple geometries.
- Understand the concept of convective heat transfer and to analyze the problems involving heat
- transfer coefficients for natural and forced convection
- Analyze heat exchanger performance using LMTD and use it for parallel or counter flow
- Recognizer various type of heat exchanger working principle, and basic geometries of heat
- exchanger.
- Determine the overall heat transfer coefficient for a heat exchanger.
- Understand the concept of boiling and condenser
- Analyze the performance of evaporator

COURSE CONTENT

Units	Topics	No. of Lectures
1st	**Modes of Heat Transfer:** Conduction, Convection, Radiation. Concept of steady state and unsteady state heat transfer	**02 Periods**
2nd	**Conduction** 1. Fourier's law of heat conduction, thermal conductivity of materials – solids, liquids and gases and effect of temperature on thermal conductivity. One dimensional steady state heat conduction through a plane wall, composite wall and cylinder, multi-layer cylinder. 2. Insulation and insulating materials, critical thickness of insulation, physical properties of insulating materials	**04 Periods**
3rd	**Convection** 1. Natural and forced convection, Dimensionless numbers: Reynold, Prandtl, Nusselt and Grash off, empirical correlations for free and forced convection (Significance Only & Derivation Excluded). 2. Simple numerical problems using Fourier's law of heat conduction, Significance of DittusBoelter and Sieder-Tate Equation, Convective heat transfer coefficient (Derivation Excluded).	**10 Periods**
4th	**Radiation** Reflection, absorption and transmission of thermal radiation, Definitions of Transmissivity, reflectivity and absorptivity. Emissive power, Wein's displacement law, Stefan Boltzmann Law, Planck's law, Kirchhoff's law, Concept of black body, Grey body, solar radiation	**6 Periods**
5th	**Heat Exchanger** Introduction and classification: Local/individual and overall heat transfer coefficient, fouling factor, roughness of surfaces and their effect, LMTD for parallel and counter current heat	**6 Periods**

	exchangers. Construction and description of:- Concentric double pipe, Shell and tube (1-1heat exchanger and 1-2 heat exchanger), Compact heat exchanger-Plate type heat exchanger, Extended surface equipment-finned tube heat exchanger.	
6TH	**Boiling and condensation** Introduction to Boiling and Boiling Curves; Condensation – Drop wise and Film wise	**2 Periods**
7th	**Evaporators** Evaporation, Capacity &Economy of Evaporators, construction and description of open pan, long type vertical evaporator, falling film evaporator and agitated thin film evaporator, Multiple effect evaporator,	**4 Periods**
	INSTRUCTIONAL STRATEGY A field visit may be conducted to expose the students to various types of heat transfer equipment. Practical should be conducted to give an idea about modes of heat transfer, effect of insulation on heat transfer.	
	RECOMMENDED BOOKS 1. Heat Transfer by Chapman, MacMillan Publication. 2. Heat Transfer by KA Gavahane, NiraliPublications. 3. Process Heat Transfer by Kern DQ, McGraw Hill Book, New York 4. Heat Transfer 7th Ed. By Holman JP; McGraw Hill, New York 5. Heat Transfer Principles and Applications by K Dutta; Prentice Hall, India. 6. Unit Operation of Chemical Engineering by McCabe and Smith	

(DCHE402) CHEMICAL REACTION ENGINEERING

COURSE OBJECTIVES

L	T	P
2	-	4

The objectives of this course are to:

• Provide comprehensive knowledge of major chemical process industries and their role in the national economy.

• Enable students to understand raw materials, manufacturing processes, and production trends of important chemical industries.

• Develop the ability to prepare and interpret process flow sheets used in chemical industries.

• Familiarize students with engineering problems, material of construction, and pollution issues in process industries.

• Introduce the use and application of industrial equipment and instruments along with good manufacturing and laboratory practices.

LEARNING OUTCOMES

COURSE OUTCOMES (CO):

After successful completion of this course, the students will be able to:

CO1 : State the basic principles, scope, and symbols used in major chemical process industries along with GMP and GLP practices.

CO2 : Explain the manufacturing process of sugar and identify engineering problems and pollution control methods in the sugar industry.

CO3 : Explain fermentation processes for production of chemicals and describe associated engineering problems and pollution abatement methods.

CO4 : Explain manufacturing processes of soaps, detergents, disinfectants, and oils and identify engineering problems in these industries.

CO5 : Explain pulping and paper manufacturing processes, role of additives, engineering problems, and pollution control in pulp and paper industry.

CO6 : Explain polymerization processes and manufacturing of polymers, rubber, paints, varnishes, and dyes along with their applications.

COURSE CONTENT

Units	Topics	No. of Lectures
1st	**Introduction to Chemical Kinetics** 1. Concept of rate of reaction, rate equation, rate constant, order of reaction, Molecularity of reaction. 2. Elementary and non-elementary reaction. 3. Activation Energy, Theories of reaction rates constant- Arrhenius law, Collision theory &Transition state theory.	(6 Periods)
2nd	**Interpretation of batch reactor data** 1. Concept of batch reactor, semi batch reactor, constant and variable volume reactions. 2. Integral and Differential method of analysis of batch reactor data. 3. Integral method of analysis of irreversible unimolecular first order reaction, bimolecular second order reaction, nth order, zero order and auto catalytic reaction. 4. Half-life concept for the overall order of irreversible reactions.	(8 Periods)
3rd	**Introduction to Reactor Design** 1.Type of Reactors: Batch reactor & Continuous reactor (Plug flow reactor, Mixed flow reactor) 2. Concept of space-time, space velocity and holding time. 3. Performance equation for ideal batch reactor, mixed flow reactor and plug flow reactor for	(8 Periods)

	constant volume irreversible first order reaction. 4. Size comparison of the Reactor-PFR vs CSTR (For first order irreversible reactions).	
4th	**Introduction to Heterogeneous Reacting System (06 Periods)** 1. Rate Equation for Heterogeneous Reaction 2. Contacting pattern for two phase system 3. Factor affecting heterogeneous reaction 4. Basic of non-ideal flow 5. E , the age distribution of fluid	(6 Periods)
5th	**Catalysis** 1. Definition, types and classification of catalyst 2. Preparation of catalyst, ingredients (Promoter, inhibitor, accelerator) 3. Catalyst Poisoning & Regeneration. 4. Desired properties of catalyst.	**(06 Periods)**
	INSTRUCTIONAL STRATEGY Stress should be given on interpretation and designing of the different reactors. Industrial visit during the semester should be planned and audio-visual aids should be used for making student understand. This will make subject interesting and improve student's performance in the subject.	
	RECOMMENDED BOOKS 1. Chemical Reaction Engineering by Octave Levenspiel; Wiley Eastern Ltd. 2. Chemical Engineering Kinetics by J.M Smith; McGraw Hill Publication 3. Chemical Engineering Thermodynamics by J.M Smith, H.C. Vanness; McGraw Hill 4. Thermodynamics for Chemists by Samuel Glasstone; Krieger Publication Company.	

(DCHE403) Chemical Technology-II

COURSE OBJECTIVES

L	T	P
2	-	-

The objectives of this course are to:

• Provide students with essential knowledge of major inorganic chemical process industries and their manufacturing practices.

• Enable understanding of process parameters such as temperature, pressure, concentration, and catalyst affecting product yield.

• Develop the ability to prepare and interpret process flow sheets for industrial chemical processes.

• Familiarize students with engineering problems and pollution control measures in chemical industries.

• Introduce sources and properties of raw materials used in the manufacture of inorganic chemicals.

COURSE OUTCOME:

After successful completion of this course, the students will be able to:

CO1: Explain the manufacturing process, flow sheet, and pollution control measures of the sulphuric acid industry.

CO2: Explain manufacturing processes of fertilizers and analyze engineering problems and pollution abatement methods in fertilizer industries.

CO3: Explain chlor-alkali processes for production of caustic soda and soda ash and interpret related process flow sheets.

CO4: Explain manufacturing processes and classification of flue and industrial gases used in chemical industries.

CO5: Explain cement manufacturing processes, constituents, applications, and pollution control measures in cement industries.

COURSE CONTENT

Unit-1: Sulphuric Acid Industry (04 Periods)

1. Manufacturing process of Sulphuric Acid by Double Contact Double Absorption Method.

2. Manufacturing of oleum

3. Pollution abatement in Sulphuric Acid Industry

Unit-2: Fertilizer Industry (06 Periods)

1. N-P-K, Types of Fertilizers

2. Manufacturing of Ammonia

3. Manufacturing of Nitric acid

4. Manufacturing of Urea

5. Manufacturing of Single Super Phosphate

6. Manufacturing of Triple Super Phosphate

7. Engineering Problems and Pollution abatement in fertilizer industry

Unit-3: Chlor-alkali Industry (04 Periods)

1. Manufacturing process of Caustic Soda

2. Manufacturing process of Soda ash.

3. Engineering Problems in Chlor-alkali Industry

Unit-4: Flue and Industrial Gases (06 Periods)

1. Classification of Flue and Industrial Gases

2. Manufacturing process of Oxygen and Nitrogen from Air

3. Manufacturing process of Water Gas

4. Manufacturing process of Producer Gas

Unit-5: Cement Industry (08 Periods)

1. Classification of cement based on application

2. Constituents of cement and Gypsum

3. Manufacturing of Cement &Portland cement

4. Manufacturing of Plaster of Paris

5. Pollution abatement in cement industry

INSTRUCTIONAL STRATEGY

Teacher should explain each process industry and use of each and every equipment used. An industrial visit can be organized in various chemical and process industries. Audio-visuals should be used to teach.

RECOMMENDED BOOKS

1. Dryden's Outlines of Chemical Technology by M. Gopal Rao and Marshal Sitting; Affiliated Press Pvt. Ltd.

2. Shreve's Chemical Process Industries by Jorge Austin; Tata McGraw Hill

3. Unit Process in Organic Synthesis by P.H. Groggins; Tata McGraw Hill

4. Chemical Technology Vol I and II by G. N. Pandey

(DCHE404) Mass Transfer Operation-I

L	T	P
2	-	2

COURSE OBJECTIVES

The objectives of this course are to:

• Provide students with fundamental knowledge of mass transfer principles and mechanisms.

• Enable understanding of diffusion and interphase mass transfer occurring in process industries.

• Develop the ability to evaluate mass transfer coefficients for gas–liquid systems.

• Familiarize students with industrial mass transfer operations such as absorption, humidification, drying, and stripping.

• Train students to understand the working and application of mass transfer equipment used for product purification.

COURSE OUTCOMES:

After successful completion of this course, the students will be able to:

CO1: Explain the fundamentals and classification of mass transfer operations used in process industries.

CO2: Estimate diffusivity and determine mass transfer coefficients for molecular diffusion in gases and liquids.

CO3: Explain gas absorption and desorption processes and evaluate packed column performance parameters.

CO4: Analyze humidification and dehumidification processes using psychrometric concepts and humidity charts.

CO5: Explain drying mechanisms and analyze the working and applications of industrial drying equipment.

COURSE CONTENT

Units	Topics	No. of Lectures
1st	Introduction and Classification of Mass Transfer Operations	(1 Periods)
2nd	**Diffusion** 1. Definition of diffusion and its classification: Molecular &Eddy diffusion, Knudsen diffusion, Role of diffusion in mass transfer 2. Molar Flux, Fick's law of Diffusion, Diffusion in Gas phase: equimolecular counter diffusion, diffusion through stationary gas. 3. Mass transfer coefficient, Interface mass transfer, relation between film and overall mass transfer coefficient,	(07 Periods)
3rd	**Gas Absorption and Desorption** 1. Absorption and Desorption, absorption material balance and design equation of operating line (for Dilute system only), choice of solvent, Raoult's law and Henry's law, Absorption factor. 2. Concept of HTU and NTU, HETP for packed column of distillation (Derivation excluded) 3. Introduction to Packed Column and Tray Column (differences and applications), their internals, Random and Structured packings, properties of tower packings, flooding, channelling, weeping and loading.	(07 Periods)
4th	**Humidification and Dehumidification**	(07 Periods)

	1. Definition: Saturated and Unsaturated gas, Dry bulb and wet bulb Temperature, dew point, Adiabatic saturation temperature, Humidity, relative humidity, percentage humidity, humid heat, humid volume, use of humidity chart. 2. Gas liquid contact operation (Description, construction, Working, advantage and disadvantage): Cooling towers- natural, Induced and Forced draft, humidifier and dehumidifier, spray chambers, spray ponds.	
5th	**Drying** 1. Definition : moisture content (wet and dry basis), equilibrium moisture content, bound moisture ontent, unbound moisture content, free and critical moisture content, constant and falling rate periods , rate of drying curve, time of drying (Derivation excluded). 2. Dryingequipment (Description, construction, Working, advantage and disadvantage) – tray dryer, rotary dryer, spray dryer, fluidized bed dryer and application.	(06 Periods)
	INSTRUCTIONAL STRATEGY Field visit will make the students familiar with different types of column (packed/tray) and different types of packing's/trays used in the column. This will also make the students aware of auxiliary equipment/models/supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification.	
	RECOMMENDED BOOKS 1. Mass Transfer Operations by Treybal, Kogakusha Publication 2. Introduction to Chemical Engineering by Badger and Banchero, McGraw Hill Publication 3. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication 4. Mass Transfer by Sherwood Pigford and Wilke, McGraw Hill Publication 5. Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication 6. Mass Transfer Operations by Kiran D. Patil, Nirali Publication	

(DCHE 405) Elective -I

(E-I) MATERIAL SCIENCE & TECHNOLOGY

L	T	P
2	-	-

COURSE OBJECTIVES

The objectives of this course are to:

• Provide fundamental knowledge of structure, bonding, and classification of engineering materials.
• Enable understanding of mechanical, magnetic, electrical, and thermal properties of materials used in industries.
• Develop the ability to select suitable materials based on properties and application requirements.
• Familiarize students with testing methods and heat treatment processes for metals and alloys.
• Introduce advanced materials and their applications, especially relevant to the chemical process industry

COURSE OUTCOMES

After successful completion of this course, the students will be able to:
CO1: Explain the importance of engineering materials, types of bonding, crystal structures, and defects in solids.
CO2: Describe mechanical, magnetic, and electrical properties of materials along with standard testing methods.
CO3: Explain phase diagrams, phase rules, and equilibrium behavior of materials including the iron–carbon system.
CO4: Describe properties, heat treatment processes, and applications of ferrous and non-ferrous materials and alloys.
CO5: Identify ceramics, glass, refractories, and advanced materials suitable for applications in the chemical process industry.

COURSE CONTENT

Units	Topics	No. of Lectures
1ST	**Introduction** 1. Introduction: Importance of materials, Periodic table, Chemical bonding. 2. Crystallography and imperfections: Concept of unit cell, space lattice, Bravais lattices, common crystal structures. X-ray crystallography techniques, Imperfections, Defects &Dislocations in solids	**(04 Periods)**
2ND	**Properties of Materials** 1. Mechanical Properties and Testing: Stress strain diagram, Ductile and brittle materials, stress vs strength, toughness, hardness, fracture, fatigue and creep. Testing, such as Strength testing, Hardness testing, Impact testing, Fatigue testing Creep testing, Non-destructive testing (NDT) 2. Magnetic Properties: Concept of magnetism-Dia, para, ferro magnetic materials, Soft and hard magnetic materials. 3. Electric Properties: Concept of conductor, insulator and semiconductor. Intrinsic and extrinsic semi-conductors, Diffusion of Solid, Super conductivity, Type I & II superconductors. High temperature superconductors.	**(08 Periods)**
3RD	**Phase Diagram and Equilibrium Diagram**	**(04 Periods)**

	Unitary and Binary diagrams, Phase rules, Types of equilibrium diagrams: solid solution type, Iron-carbon equilibrium diagram.	
4TH	**Ferrous and Non-ferrous Materials and Alloys** 1. Ferrous materials: Types of iron and steel, Manufacture of steel, its properties and uses. 2. Heat Treatment: Annealing, Normalizing, Quenching, Tempering and Case hardening, Time Temperature Transformation (TTT) diagrams 3. Non-Ferrous Materials and Alloys: Non-ferrous metals- Cu, Al, Zn, Cr, Ni and its applications. Various types of brass, bronze, their properties and uses. Aluminium alloys such as Duralumin.	**(06 Periods)**
5TH	**Ceramics and Other Advanced Materials** 1. Ceramics: Structure, types, properties and applications of ceramics. 2. Introduction to glass and refractories. 3. Introduction to advanced material (Biomaterials, Nano Materials, Green Building Materials and composites)	**(06 Periods)**
	INSTRUCTIONAL STRATEGY Audio-visuals can be used as teaching aid. Processes of Heat-treatment can be shown to students in workshop.	
	MEANS OF ASSESSMENT • Assignments and quiz/class tests • Mid-term and end-term written tests	
	RECOMMENDED BOOKS 1. Material Science & Engineering by William D. Callisster Jr.; John Wiley and Sons Inc 2. Elements of Material Science & Engineering by Van Vlack; John Wiley &Sons. 3. Material Science by V. Raghvan; Prentice Hall of India. 4. Material Science by Narula; Tata Mc GrawHill. 5. Science of Materials Engineering by Srivastava, Srinivasan; New Age International	

(E-I) FOOD TECHNOLOGY

COURSE OBJECTIVE

The objectives of this course are to:

• Impart knowledge of advanced food science and technology used in modern food industries.

- Develop the ability to understand unit operations and process calculations applied in food processing.

• Familiarize students with equipment and processing techniques used in food industries.

• Introduce food preservation methods and microbiological aspects affecting food safety and quality.

COURSE OUTCOMES (CO):

After successful completion of this course, the students will be able to:

CO1: Explain food constituents, quality, nutritive aspects, adulteration, and deterioration factors using principles of food process engineering.

CO2: Apply fluid flow, heat transfer, refrigeration, evaporation, and dehydration concepts in food processing operations.

CO3: Describe food canning technology, heat sterilization methods, containers, and canning procedures for various food products.

CO4: Explain food preservation techniques including heating, cooling, drying, fermentation, irradiation, and packaging methods.

CO5: Describe processing and characteristics of major food products such as cereals, dairy, meat, beverages, bakery, and confectionery items.

COURSE CONTENT

Unit 1: (05 Periods)

Fundamentals of Food Process Engineering, Application of Quantitative methods of Material & Energy balances in Food Engineering Practices. Constituents of Food, Quality and Nutritive aspects, Food Adulterations, Deteriorative factors and Control

Unit 2: (05 Periods)

Fluid Flow, Thermal Process Calculations, Refrigeration, Evaporation and Dehydration operations in Food Processing

Unit 3: (06 Periods)

Fundamentals of Food Canning Technology, Heat Sterilization of Canned food, Containers – metal, Glass and Flexible packaging, Canning Procedures for Fruits, Vegetables, Meat, Poultry and Marine Products

Unit 4: (06 Periods)

Preservation by Heat and Cold, Dehydration, Concentration, Drying, Irradiation, Microwave heating, Sterilization and Pasteurization, Fermentation and Pickling, Packaging Methods

Unit 5: (06 Periods)

Cereal, Grains, Pulses, Vegetables, Fruits, Spices, Fats and Oils, Bakery, Confectionary and Chocolate Products, Soft and Alcoholic Beverages, Dairy Products, Meat, Poultry and Fish Products

INSTRUCTIONAL STRATEGY

Audio-visuals can be used as teaching aid. Processes of various food productions can be shown to students in workshop.

MEANS OF ASSESSMENT

• Assignments and quiz/class tests

Mid-term and end-term written tests

RECOMMENDED BOOKS:

1. B Sivasankar, 'Food Processing and Preservation, 'PHI Learning Pvt. Ltd.,

2. Rao DG, ' Fundamentals of Food Engineering', PHI Learning Private Ltd.,.

3. R Paul Singh, Dennis R Heldman, 'Introduction to Food Engineering,'4/e, Elsevier.

4. Da-Wen Sun, 'Emerging Technologies for Food Processing, Elsevier.

DCHE 406 Elective-II

(E-II) PLANT UTILITIES

L	T	P
2	-	-

COURSE OBJECTIVES

The objectives of this course are to:

• Provide knowledge of selection, requirement, and effective utilization of utilities in process plants.

• Enable understanding of water, steam, air, refrigeration, and fuels used in chemical industries.

• Develop the ability to perform basic calculations related to steam generation, psychrometrics, and refrigeration.

• Familiarize students with equipment used for utilities such as boilers, compressors, refrigeration systems, and cooling towers.

• Introduce water treatment methods, fuels, and waste disposal practices used in process plants.

COURSE OUTCOMES

After successful completion of this course, the students will be able to:

CO1: Explain types of industrial water, their uses, and methods of water treatment for process plants.

CO2: Describe steam properties, steam generation methods, boiler accessories, and related calculations.

CO3: Explain refrigeration principles, refrigeration cycles, refrigerants, and industrial refrigeration applications.

CO4: Describe compressed air systems, compressors, humidification–dehumidification equipment, and cooling towers used in process plants.

CO5: Identify fuels used in chemical industries and explain waste disposal methods and environmental considerations

COURSE CONTENT

Units	Topics	No. of Lectures
1ST	**Importance and Classification of utilities:** 1. Hard and soft water, requisites of industrial water and its uses. 2. Methods of water treatment such as chemical softening and demineralization, resins used for water 3. Softening and reverse osmosis. Effects of impure boiler feed water.	(04 Periods)
2ND	**Steam and steam generation:** 1. Properties of steam, problems based on steam, types of steam generator such as solid fuel fired boiler, waste gas fired boiler and fluidized bed boiler. 2. Scaling and trouble shooting. Steam traps and accessories	(06 Periods)
3RD	**Refrigeration:** Refrigeration cycles, methods of refrigeration used in industry and different types of refrigerants such as monochloro-difluro methane, chlorofluro carbons and brins. Refrigerating effects and liquefaction processes.	(06 Periods)
4TH	**Compressed air:** 1. Classification of compressor, reciprocating compressor, single stage and two stage compressor, velocity diagram for centrifugal compressor, silp factor, impeller blade Shape. Properties of air – water vapors and use of humidity chart. 2. Equipments used for humidification, Dehumidification and cooling	(08 Periods)

	towers	
5TH	**Fuel and waste disposal:** 1. Types of fuel used in chemical process industries for power generation such as natural gas, liquid petroleum fuels, coal and coke. Internal combustion engine, petrol and diesel engine. 2. Waste disposal.	(04 Periods)
	INSTRUCTIONAL STRATEGY • Teacher should focus on conceptual clarity. • An industrial visit can be organized in relevant industries. Audio-visuals aids should be used to teach.	
	MEANS OF ASSESSMENT • Assignments and quiz/class tests • Mid-term and end-term written tests	
	RECOMMENDED BOOKS 1. Thermal Engineering by P.L. Ballaney; Khanna Publisher New Delhi 2. Industrial water treatment by S.T. Powel; McGraw Hill New York 3. Boiler Operations by Chattopadhyay; Tata McGraw Hill, New Delhi 4. Perry's chemical Engineer's Handbook by Perry R.H. Green D.W; McGraw Hill, New York 5. Elements of Heat Engines Vol. II,III by R.C. Patel C.J.Karmchandani; Acharya Book Depot Vadodara 6. Refrigeration & Air conditioning by P.N. Ananthanarayan; Tata McGraw Hill 7. Industrial chemistry by Jain & Jain; Tata McGraw Hill	

(E-II) MODERN SEPERATION TECHNIQUES

COURSE OBJECTIVE

The objectives of this course are to:

- Introduce students to modern and novel separation techniques used in chemical process industries.

• Enable understanding of principles and mechanisms governing advanced separation processes.

• Develop awareness of industrial applications of modern separation technologies.

• Familiarize students with economic considerations involved in selection and application of separation processes.

• Compare conventional separation techniques with modern separation methods.

COURSE OUTCOMES (CO):

After successful completion of this course, the students will be able to:

CO1: Explain the principles, equipment, and applications of thermal diffusion and zone melting processes.

CO2: Describe chromatographic techniques, molecular sieves, and their industrial applications.

CO3: Explain cryogenic separation, supercritical fluid extraction, and azeotropic separation processes.

CO4: Explain principles, classification, and applications of membrane-based separation techniques.

CO5: Describe foam, bubble, and adsorption-based separation techniques and their industrial relevance.

COURSE CONTENT

Unit-1: (06 Periods)

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipment's design and Applications. Zone Melting

Unit-2: (06 Periods)

Chroma to graphic techniques, Equipment and Commercial processes, Molecular Sieves.

Unit-3: (04 Periods)

Cryogenic, Supercritical fluid extraction and Azeotropic separation.

Unit-4: (06 Periods)

Principle of membrane separations process; Classification: Reverse osmosis, Ultra-filtration, Micro-filtration, Nano-filtration and Dialysis; Membrane modules and application; Electro-dialysis. Per-evaporation and gas separation using membranes; Electrophoresis; Liquid membranes.

Unit-5: (06 Periods)

Foam and bubble separation: Principle; Classification; Separation techniques; Column operations.

Surface Adsorption, Nature of foams.

INSTRUCTIONAL STRATEGY

• Teacher should focus on conceptual clarity.

• An industrial visit can be organized in relevant industries. Audio-visuals aids should be used to teach.

MEANS OF ASSESSMENT

• Assignments and quiz/class tests

• Mid-term and end-term written tests

RECOMMENDED BOOKS:

1. Schoen H. M., New Chemical Engineering Separation Techniques, 2nd Edition, Inter Science Publications, New York.

2. Seader, J.D, and Henley E.J.,Separation 'Process Principles,' John Wiley & Sons, Inc.

3. Perry R.H. and. Green D.W.,Perry's Chemical Engineers Handbook, 6th Edition. McGraw Hill, New York.

4. King C.J. 'Separation Processes', 4th Edition, Tata McGraw Hill, New Delhi.

(DCHE 407) PROCESS HEAT TRANSFER (Lab)

L	T	P
-	-	4

LIST OF PRACTICALS

Ex.1 To find the thermal conductivity of (material at different temperature) metal rod.

Ex.2 To calculate the rate of heat loss through composite wall.

Ex.3 To determine experimentally the k value of insulating powder

Ex.4 To calculate the heat transfer co-efficient for natural convection.

Ex.5 To calculate the heat transfer co-efficient for forced convection.

Ex.6 To determine the heat transfer coefficient with the help of double pipe heat exchanger using parallel and counter flow.

Ex.7 To determine heat transfer coefficient in shell and tube heat exchanger using parallel and counter flow.

Ex.8 To determine heat transfer rate in finned tube heat exchanger.

Ex.9 To determine overall heat transfer co-efficient for an open pan evaporator.

Ex.10 To determine the rate of evaporation in a jacketed bottle (open pan evaporation).

(DCHE 408) CHEMICAL REACTION ENGINEERING LAB

L	T	P
-	-	4

LIST OF PRACTICALS

Experiments:

Ex.1 Study, Sketch and Demonstration of Batch Reactor

Ex.2 Study, Sketch and Demonstration of CSTR

Ex.3 Study, Sketch and Demonstration of PFR

Ex. 4 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through a batch reactor.

Ex. 5 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through a CSTR.

Ex. 6 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through a PFR

Ex.7 To determine the rate constant for Saponification reaction of Sodium Hydroxide and Ethyl Acetate through CSTR's in Series.

Ex.8 Demonstration of heterogeneous Catalytic reaction

DCHE 409 CHEMICAL TECHNOLOGY-II LAB

L	T	P
-	-	2

NAME OF EXPERIMENT

1. To determine the Density and NTU of Sulphuric Acid.
2. To draw the Process Flow Sheet of Sulphuric Acid manufacturing by the DCDA Process and
determine its percentage purity.
3. To determine the NPK value of Urea and the phosphorus content of SSP and TSP.
4. To perform the proximate analysis of Urea, SSP, and TSP and determine the percentage purity of commercial Nitric Acid.
5. To draw the Process Flow Sheet of Ammonia and Urea manufacturing and study the major process operations involved.
6. To find the percentage purity of commercial Hydrochloric Acid.
7. To draw the Process Flow Sheet of Caustic Soda manufacturing and determine the density of Caustic Soda.
8. To study the electrolysis of brine solution for the production of Chlorine, Hydrogen, and Sodium Hydroxide.
9.To draw the Process Flow Sheet of Cement manufacturing and perform the analysis of Cement.
10. Preparation of Soap using Coconut Oil and Mustard Oil.
11. Preparation of Detergent/Liquid Detergent
12. Determination of sugar concentration using a Refractometer.
13. Recycling of Paper Waste and evaluation of recycled paper quality.