

Semester II

Candidates will be examined in the subjects as indicated in the following tables :

Papers

| Sr. No. | Subject | No. of papers | Examination Hrs | Marks | Periodic Test Marks | Total Marks |
|---------|------------------------------------|---------------|-----------------|-------|---------------------|-------------|
| CHE 208 | Momentum transfer | 1 | 3 | 60 | 40 | 100 |
| CHE 209 | Process Calculations | 1 | 3 | 60 | 40 | 100 |
| CHE 210 | Material Technology | 1 | 3 | 60 | 40 | 100 |
| CHE 211 | Economics & Industrial Management. | 1 | 3 | 60 | 40 | 100 |
| CHE 212 | Heat Transfer | 1 | 3 | 60 | 40 | 100 |
| | | 5 | | 300 | 200 | 500 |

Practicals and Orals

| Sr. No. | Subjects | Examination Hrs | Marks | Marks for Class work | Total |
|-------------|------------------------------|-----------------|-------|----------------------|-------|
| CHE 213 | Heat Transfer Laboratory. | 6 | 60 | 40 | 100 |
| CHE-214 | Momentum Transfer Laboratory | 6 | 60 | 40 | 50 |
| | | 12 | 120 | 80 | 150 |
| Total Marks | | | | | 650 |

CHK 208 : Momentum Transfer :

fluid Properties : Definition of fluid, Types of fluids, Compressible and incompressible, Newtonian and Non-Newtonian, laminar turbulent, steady-unsteady, two and three dimensional flow.

Flow of Fluids : Nature and mechanism of fluid flow the continuity equation, Bernoulli's equation, Euler's equation of motion along stream line, Bernoulli's equation as integration of Euler's equation, Momentum changes in fluid, The energy of a fluid in motion, pressure and fluid head, pressure volume relationships for incompressible and compressible fluids, Reynold's number, laminar and turbulent flow in close conduit, velocity profile, friction factor for smooth and rough pipes, Hagen Poiseuille equation, velocity distribution in turbulent flow. The relation between maximum and average velocity, Friction factor chart, Drag reduction in turbulent flow, Effect of heat transfer on friction factor, friction factor in flow through channels of non-circular cross section, The friction loss from sudden expansion and contraction, Effect of fitting and valves, Distribution of flowing fluids through branched pipes, Measurement of viscosity, Darcy's Law (no derivation).

Boundary Layer Theory : Boundary Layer growth along flat plate, laminar and turbulent flow in boundary layer, The thickness of boundary layer (definition and formulae only), Boundary layer in straight tubes.

Two phase co current and counter current flow : Liquid-liquid and gas liquid systems, Flow patterns, (no mathematical treatment).

Flow & Pressure Measurements :- Principle and Types of manometers, The flow through nozzles, orificemeter, venturimeters, pitot tube, Rotameter, notch or weir, other flow measuring devices.

Dimensional Analysis : Dimensional Analysis, fundamental dimensions, units of various quantities used in fluid mechanics, Buckingham's Pi theorem, Dimensionless numbers, application to fluid flow problems.

Pumping of fluids : Pumping equipments for liquid, The reciprocating pump, positive displacement, Rotary pumps, Centrifugal pumps, design and operating Characteristics, NPSH calculations, Air lift pump.

Pumping Equipment for gases : Reciprocating piston compressors, rotary blowers and compressor, Centrifugal blowers and Compressor including turbo Compressor, Vacuum producing Equipments.

Power required for Compression of gasses : Clearance volume, multi stage Compressor efficiency, The power requirement for pumping through pipe line liquids and gases.

Reference Book

1. Fluid Dynamics and Heat Transfer : Kundsen J.G. & Katz D.L.
2. Momentum Transport Operations : Gupta

CHE-209 : Process Calculations :

Units and dimension :

basic and derived units, dimensional analysis, dimensional and empirical equations, Different ways of expressing units of quantities and physical constants.

Properties of gases, liquids and solids : Ideal and real gas laws, critical properties, properties of mixtures and solutions and equilibria.

basic concept : Humidity and saturation, Psychrometric chart, solubility diagrams.

Material balance : Concepts of limiting and excess reactants, tie element, recycle, purging, bypass etc., in batch, stagewise and continuous operations, in systems with and without chemical reaction, and in unit operations.

Thermodynamics : Concept of and calculations involving energy, heat, work and enthalpy of reversible and irreversible processes.

Thermochemistry : Heats of formation, combustion, solution, dilution, etc., and the effects of pressure and temperature on them. Temperature of reaction. Energy balance for systems with and without chemical reaction. Process efficiency.

Unsteady state material and energy balances. Energy balances for nuclear, electrochemical, photochemical and biochemical processes.

Less conventional separation processes.

Typical industrial applications.

Reference Book

1. Chemical Process Principles : G.A. Hougen, K.M. Watson, R.A. Regalis.
2. Industrial Stoichiometry : W.K. Lewis A.H. Radash, H.C. Lewis.
3. Process Calculations for Chemical Engineering : Durgaprasad Rao, D.V.S. Murthy

CHE 210 : Material Technology :

Classification of engineering materials, crystal structure, chemical bonding and structure of solids. Phase diagrams of important alloy systems such as steels, brasses, cupronickel etc. and the applications of phase diagrams. Heat treatment of steels. Crystal defects and mechanical properties of solids such as plastic deformation, creep, fracture, fatigue.

Thermosetting and thermoplastics, structure-property relationships in polymers, elastomers, Inorganic classes, wood, graphite and ceramics. Composite materials.

Corrosion : Electrochemical principles, forms, mechanisms, prevention and control, Protective coatings, Corrosion behaviour of important alloys, Criteria for selection of materials for chemical industries.

Reference Book

1. Material Science : G.B.S. Narang
2. Engineering Metallurgy and Material Science : S.P.Nayak

CHM-211 : Economics and Industrial Management :

1. Economics : Nature and significance of economics. Basic economic concepts, Demand and supply, elasticity of demand and supply.

Money, real and opportunity cost, Concepts of profit and losses, tax tariff and subsidies, wants and utilities.

Concepts of equilibrium and margin economic systems, Capitalism, socialism and mixed economy.

Factors of product.

Introduction to micro and macro economics and price theory.

Money banking and trade, Nature and functions of money.

Commercial and central banking, Problems of foreign exchange and implications of currency devaluation.

Economic development of India, Structure and features of India economy, Growth of public sector in India, Role of agriculture in Indian economy.

Meaning and tools of economic planning, Five year plans of India.

2. Industrial Management : Introduction: Management principles, Management and engineering studies, Meaning and type of management, Concept of scientific management.

Functional areas of business, Forms of business organization, theory and practice of management, planning, organizing, staffing, coordinating and control.

Production Management : Introduction to work study, Concept of productivity, wages and incentives, production planning and control, Scheduling of projects, Materials management, quality control and preventive maintenance.

Financial and Accounting Management : The sales organization in a firm, management of sales and advertisement, Market research.

Reference Book

1. Cost Manag. in Process Industries : Chilton C.H.

CHE-212 : Heat Transfer :

Modes of heat transfer, basic equations, dimensional analysis,

Conduction: Thermal conductivity of materials : Steady and unsteady state conditions, Steady state conditions, equation of planes, cylinders, hollow spheres and problems related to these cases. Lagging of pipes and other equipments; optimum lagging thickness. Heat transfer from extended surfaces (fins).

Convection : Individual and overall heat transfer coefficients, natural and forced convection, laminar and turbulent flow, Heat transfer inside and outside the tubes, Natural convection heat transfer to wall and cylinder. Filmwise and dropwise condensation. Heat transfer to boiling, correlations in boiling heat transfer.

Evaporation : Heat transfer to vaporisation processes. Single and multiple effect evaporations.

Radiation : Stefan-Boltzman's law, Black-body radiation, radiation from solid surfaces. Heat exchange by radiation between two finite black surfaces, between two infinite parallel surfaces, shape factor.

Heat Exchangers : Basic types, LMTD in single pass, parallel and counter flow arrangements, cross-flow arrangements. Use of correction factor. Design principles of heat exchangers.

Heat transfer through fluidised beds.

Reference Book

1. Engineering Heat Transfer : Gupta & Prakash
2. Problem on Heat Transfer : P.Chattopadhyaya
3. Heat Transfer : Chappan
4. A text book of Heat Transfer : Sukhatme S.P.

CHE-213 : Heat Transfer Laboratory:

1. To determine thermal conductivity of metal bar.
2. To determine thermal conductivity of an insulating material.
3. To determine heat transfer coefficient by natural and forced convection.
4. To determine heat transfer coefficient in shell and tube type heat exchanger.
5. To determine heat transfer coefficient in double pipe heat exchanger.
6. To determine efficiency of pin fin.
7. To determine the critical heat flux.
8. To determine Stefan Boltzaman's constant.
9. To determine the emissivity of aluminium plate.
10. To study dropwise and filmwise condensation.
11. Study of evaporators.
12. Study of different types of heat exchangers. (Minimum eight experiments)

CHE-214 : Momentum Transfer Laboratory :

- (1) Determination viscosity
- (2) Study of different types of manometers.
- (3) Verification of Bernoulli's Theorem
- (4) Venturimeter
- (5) Orificemeter
- (6) Notch or Weirs
- (7) Study of flow through pipe fittings
- (8) Verification of Darcy's law
- (9) Characteristics of Centrifugal pump
- (10) Flow of gases through pipes (Study of friction factor versus Reynold's number)
- (11) Reynold's Experiment
- (12) Study of different types of Compressors (Minimum eight experiments).

THIRD YEAR COURSE IN CHEMICAL ENGINEERING

Semester I

Candidates will be examined in the subjects as indicated in the following table.

Papers

| Sr. No. | Subjects | No. of papers | Examination Hrs | Marks | Periodic Test Marks | Total Marks |
|---------|-------------------------------------|---------------|-----------------|-------|---------------------|-------------|
| CHE 301 | Mass Transfer I | 1 | 3 | 60 | 40 | 100 |
| CHE 302 | Mechanical Operation | 1 | 3 | 60 | 40 | 100 |
| CHE 303 | Chemical Engineering Thermodynamics | 1 | 3 | 60 | 40 | 100 |
| CHE 304 | Chemical Reaction Engineering I | 1 | 3 | 60 | 40 | 100 |
| CHE 305 | Industrial & Engineering Chemistry | 1 | 3 | 60 | 40 | 100 |
| | | 5 | | 300 | 200 | 500 |

Practicals and Orals

| Sr. No. | Subjects | Examination Hrs | Marks | Marks for Total Class work | Total Marks |
|-------------|----------------------------|-----------------|-------|----------------------------|-------------|
| CHE 306 | Mass Transfer I Laboratory | 6 | 60 | 40 | 100 |
| CHE 307 | Mechanical Operations | 6 | 60 | 40 | 100 |
| | | 12 | 120 | 80 | 200 |
| Total Marks | | | | | 700 |

Third year
Semester I

CHE 301- Mass Transfer I

Principles of diffusion and mass transfer between phases, Equimolecular counter diffusion, diffusion through stationary gas, Maxwell's law of diffusion, Diffusion in vapours, diffusion in liquid, Diffusion in solids, unsteady state mass transfer.

Interphase mass transfer: Theories of mass transfer, mass transfer coefficients, counter current mass transfer, and transfer units, Concept of Mass transfer with chemical reaction.

Mass transfer Analogies: Heat, mass and momentum transfer.

Gas absorption: Mechanism of absorption and application of mass transfer theories, values of transfer coefficients in wetted wall columns, packed towers, spray towers, The absorption with chemical reaction.

Absorption in packed towers: height of columns, transfer units, equilibrium curves.

Plate towers: No. of plates by use of absorption factor, different equipments for absorption.

Humidification and Dehumidification: Principle and equipment, Definitions for Adiabatic saturation temperature, wet bulb temperature, humidity charts, Cooling tower, Height of packing, humidifying towers, Systems other than Air-water.

Drying: General principles, rate of drying, the mechanism of moisture movement during drying Diffusion and capillary theory classification and selection of dryers.

Drying equipments: Tray drier, rotary drier, drum drier, and vacuum drier.

Reference Book

1. Mass transfer operations, Treybal K.E.
2. Unit operations of Chemical Engineering: McCabe
3. Principles of Unit Operations : Foust A.S,
4. Chemical engineering Vol. II : Coulson J.M and Richardson, J.R.

CHE 302- Mechanical Operation

Solids: Properties of solids, screening, screening equipment effectiveness of screens, screen Analysis, Average diameters and average specific surface, shape factors etc. Size reduction of solids, types of equipment on the various stages of reduction, power requirement, Laws of crushing, Handling of solids, Design of belt conveyors, screw conveyors, flight conveyors, pneumatic conveyors.

Fluids: Flow of solids through fluids. maximum settling velocity, free and hindered settling conditions.

Classification: Equipments for classification, principles of Jigging, Tabling, Magnetic and electrostatic separations, sedimentation, laboratory batch sedimentation, Calculation of area and depth for continuous thickeners, Cyclone separators and their design.

Filtration: Equipments for filtration, constant pressure and constant rate filtration, filter calculations optimum cycle, handling of compressible cakes and use of filter aids, washing of cake, Centrifugation equipment and calculations.

Mixing & Agitation: Types of equipment, mixing characteristics, power consumption, Uniformity index calculations.

Fluid solid system: Fixed bed, spouted bed, Fluidized bed system and applications.

Reference Book

1. Mechanical Operations for Chemical Engineers : Naraynan & Bhattacharya
2. Unit Operations of Chemical Engineering, Vol. I & II. : P. Chatteropadhyay.

CHE 303- Chemical Engineering Thermodynamics

Brief revision of 1st and 2nd law of thermodynamics, Maxwell's relationships.

Partial molar quantities, Gibbs Duhem equation in multicomponent system, phase rule, single component phase equilibria.

Thermodynamics of solution, electrolytes, ideal and non ideal solution, Determination of activity coefficients, Regular solution theory, high pressure vapour equilibria, chemical reaction equilibria, Homogeneous and heterogeneous reaction system, Equilibrium constants and composition in multiple reaction phase rule.

Reference Book

1. Chemical Engineering Thermodynamics : Pandey & Chaudhari

CHE 304- Chemical Reaction Engineering I

Review of chemical reaction equilibrium, classification of chemical reaction, homogeneous systems, rates of reaction, order of reaction, and rate constant.

Collection and interpretation of kinetic data, rate of complex reactions, parallel series and other cases, heterogeneous reaction kinetics.

batch reactions: Concept of ideality. Development of design expression for batch, tubular and stirred tank reactors. Combined reactor system, comparison between mixed and plug flow reactor advantages and limitation in application.

Thermal characteristics of reactors : isothermal, adiabatic and non adiabatic conditions.

Principles of reactor stability and optimization:

Classified objective functions.

Residence time distribution : Residence time function and relation amongst there application to ideal reactors. The modelling of real systems, non-ideality parameters, prediction of reactor performance. Concept of micro and macro mixing.

Reference Book

1. Chemical Reaction Engineering : Levenspiel O.
2. Chemical Engineering Kinetics : Smith J.M.
3. Chemical Reactor Theory : Denbigh K.G. & Turner K.G.

CHE 305 - Industrial & Engineering Chemistry.

Salient features of manufacture of commodity chemicals; status of chemical industry in India.

Engineering aspects of the manufacture of basic inorganic chemicals such as sulphuric acid, caustic soda and chlorine, soda ash, ammonia, nitric acid and urea.

Principles of operations and processes in petroleum refining.

Engineering aspects of the manufacture, with consideration of alternative routes, of basic organic chemicals, such as benzene, toluene and other oils. Acetylene, butadiene, carbon and vinyl benzenes, vinyl chloride, styrene, phenols, alcohols, aldehydes, ketones, carboxylic acids, esters, ethylene oxide, phthalic anhydride and terephthalic acid.

Classification, sampling, analysis and selection of coal. Gasification and complete gasification of coal. Fuel oil specifications. Combustion of solid, liquid and gaseous fuels.

Utilities, treatment of water for industrial use.

Reference Book

1. Chemical Technology Vol. I to IV, Chem. Engg. Centre, I.I.T. Madras.
2. Unit Processes in Organic Synthesis : Greggins
3. Industrial Chemicals : Faith

CHE-306- Mass Transfer laboratory -I

Experiments based on diffusion in still air, diffusion coefficients, wetted wall column, absorption in packed tower, cooling tower, Tray drier, Rotary drier, Fluidized bed drier, solid dissolution, interphase mass transfer etc. (Minimum eight experiments)

CHE-307- Mechanical Operations

Experiments based on Grinding efficiency, Laws of crushing, sieve analysis, efficiency of screening, sedimentation, filtration, cyclone separators, Fluidization, Mixing etc. (Minimum 6 experiments)

Semester II

Papers

Candidates will be examined in the subjects as indicated in the following tables :

| Sl. No. | Subject | No. of papers | Examination Hrs | Marks | Periodic Test Marks | Total Marks |
|---------|---|---------------|-----------------|-------|---------------------|-------------|
| CHE 308 | Mathematics III | 1 | 3 | 60 | 40 | 100 |
| CHE 309 | Instrumentation & Instrumental analysis | 1 | 3 | 60 | 40 | 100 |
| CHE 310 | Mass transfer II | 1 | 3 | 60 | 40 | 100 |
| CHE 311 | Machine Design & Drawing. | 1 | 4 | 80 | 40 | 100 |
| CHE 312 | Elective I | 1 | 2 | 30 | 20 | 50 |
| | | 5 | | 270 | 180 | 450 |

Practicals and Orals

| Sl. No. | Subjects | Examination Hrs | Marks | Marks for Class work | Total |
|-------------|-------------------------------------|-----------------|-------|----------------------|-------|
| CHE 310 | Mass transfer Laboratory II | 4 | 60 | 40 | 100 |
| CHE 311 | Instrumentation Methods of analysis | 6 | 60 | 40 | 100 |
| CHE 312 | Machine Drawing | - | - | 50 | 50 |
| | | 12 | 120 | 130 | 250 |
| Total Marks | | | | | 700 |

CHE-308- Mathematics III

Statistics: Elementary treatment of probability and mathematical expectation. Measures of central tendencies, moments and moment generating function. Frequency distributions (Binomial, Poisson and Normal distributions).

Differentiation and integration of vectors. The vector operator, curl and divergence of a vector, Line and surface integrals. Gauss and Stokes's theorems. Complex Variables, Riemann Function, Cauchy-Riemann differential equations, Cauchy's theorem, Taylor's theorem. Contour integration, Simple conformal mapping, Fourier series and integrals.

Differential equations: Solution of differential equations by series method.

Transforms : Laplace transforms. Simple partial differential equations.

CHE 309- Instrumentation & Instrumental analysis

1. Measuring instruments :

Elements of measuring instruments

Static and dynamic characteristics of measuring instruments
Dynamic characteristics of 1st order and 2nd order-type measuring instruments.

2. Details of the instruments falling in the following categories:

(i) Temperature Measurement:

Temperature scales
Expansion thermometers
Thermocouples, Thermistors, R.T.D.
Radiation based temperature measuring instruments.

(ii) Pressure and Vacuum Measurement:

Manometers
Measuring elements for gauge pressure and vacuum
indicating elements for pressure and vacuum gauges
Measurement of absolute pressure etc.

(iii) Measurement of Head and Level

Direct and indirect methods

(iv) Flowmeasuring

Variable area meter, variable head meter.

(v) Measurement of Chemical Composition:

Spectroscopic analysis : Absorption spectroscopy,
emission spectroscopy, mass spectroscopy, X-ray
diffraction, colour measurement by spectrometers, details
of N.M.K.

Gas analysis by thermal conductivity
Moisture (humidity) analysis
pH measurement
Chromatography - G.L.C., H.P.L.C.
Other special methods of analysis including :
Heat of combustion method
Spectrochemical methods for analysis of hydrogen sulfide,
carbon dioxide etc
Magnetic susceptibility method
Polarising cell method
Spectrometer
Interferometer

3. Control Valves

4. Introduction to single loop feedback control:
Block diagram and a brief introduction to PID controllers

5. Introduction to Digital Control Systems :
Matter under this heading should be presented without going
into the details of constructional features and electronic
circuitry.

Digital control systems

Generalized data acquisition system consisting of transducers,
signal conditioners, multiplexer, analog to digital converters,
data processing and handling systems. Conversion of digital
signal to analog signals used in chemicals industries:

Digital to analog converters, current to pressure converters
etc.

6. Process Instrumentation :

Recording, indicating and signalling instruments,
transmission of instrument reading, instrumentation in modern
chemical plants, instrumentation diagrams etc.

CHE 310- Mass Transfer II

Distillation:

Vapor liquid equilibria ideal non ideal systems, relative
volatility. Methods of distillation, Differential, flash,
azeotropic and extractive distillation, low pressure distillation,
steam distillation.

Trays or No Trays Thiele, Ponchon - Savarit, Reflux ratio,
number of plates, plate efficiencies, Fenske equation. Plate and
packed columns for distillation. Types of trays, Bubble cap
tray, sieve trays, packed column for distillation. Continuous
contact equipment, concept of multicomponent system.

Liquid extraction : Calculation with and without reflux for
immiscible and partly miscible systems.

Leaching : Single and multistage operations based on lowest free coordinates.

Crystallisation - Principle, rate of crystal growth.

Thermal balances, equipment.

Absorption and ion exchange : Equilibria principles, stage wise and counter contact adsorption and ion - exchange.

New separation techniques.

Reference Book

1. Separation Process : King

CHE-311- Machine Design & Drawing.

Design : Mechanical properties of material, selection of material, theories of failure, factor of safety, stress concentration, fluctuating stresses.

Shafts and bearings, shaft design on the basis of rigidity, design of keys and coupling, Belt, chain and gear drives (in brief). Advantages and disadvantages.

Bolted, rivetted and welded joints, stresses, selection of ball and roller bearings.

CHE-312- Elective I

a) Fuel and Combustion

Fuels as source of Energy and Chemicals. Conventional (commercial and non-commercial) and renewable sources of energy, Reserves, production, origin properties and classification and gasification of coal and biomass, petroleum refining, Types and properties of gaseous fuels, Combustion calculations, Flame temperature, Types of combustion processes, Ignition temperature, Velocity of flame propagation.

Limits of inflammability, Combustion of coal on grates and in pulverised state, Oil and gas burners.

b) Particulate Technology : Particulate systems, characterization of particulate system through shape, size and surface, Generation of particulate system, Change of size distribution by size reduction, agglomeration and growth in suspension, Mixing characteristics, Separation of particulate matter from liquids and gases, Storage, flow and discharge of powders, Metering of particulate systems.

c) Polymer Chemistry : Natural and synthetic polymers, Principles of addition polymerization and polycondensation, Polymerization of monomers in bulk, solution, emulsion and suspension, Molecular weight of polymers, Testing and characterization of polymers, Degradation of polymers, Copolymerization, Inorganic polymers.

fillers and reinforcements for polymers, plasticizers, stabilizers, flame retardants. Introduction to polymer technology : fibres, elastomers, adhesives and foams.

d) Energy resources and Utilisation : Forms of energy and energy conversion. New coal conversion processes. Biochemical (renewable) sources of energy. Hydrogen energy. Nuclear energy. Solar energy collection and utilisation. Wind and wave energy. Geothermal energy. Energy storage systems. Energy auditing and economics. Concept of total energy system.

e) Catalysis: Basic principles of heterogeneous catalysis. Adsorption phenomena. Correlation between the structure and catalytic properties present status. Basic principles of homogeneous catalysis. acid-base catalysis. liquid phase oxidation. Walker process. hydroformylation-oxo process. Carbonylation reactions. polymeric catalysts, polymer bound catalysts and homogeneous catalysts.

CHE 313 - Mass Transfer Laboratory II

Experiments based on Distillation, solid liquid extraction, liquid liquid extraction, spray column, crystallization, adsorption, ionexchange, determination of H.T.U. and N.T.U., H.E.T.P. (any eight experiments).

CHE 314 Instrumentation Methods of Analysis

Valve characteristics, dynamic response of instruments such as, thermometers, thermocouples, manometers, control valves, pressure regulating valves etc.

Calibration of instruments such as, thermocouples, RTD sensors, rotameters, pressure gauges, orifice meter etc.

Composition measurements using refractometer and other methods for chemical analysis.

Chromatography (Any eight experiments based on above topics)

CHE 315- Machine Drawing

1. Types of valves globe, gate, needle, check relief valves and safety valves.

2. Mechanical drive Components - Stuffing box, coupling, gear assemblies, bearing, pulley (with design Calculations)

3. Process flow and Control diagrams.

4. Various types of pumps piston, plunger, duplex, gear, centrifugal & reciprocating.

Exam Work: Each candidate shall submit at least four Drawings from topic No. 1,3,4 and two Design Calculations and sketches from topic No. 2.

5. Duration of paper 4 hrs. 30 marks Theory, 30 Marks design and drawing.