CMC-601 Mass Transfer-II

Unit-I

Absorption: Absorption. Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and Extraction in continuous contact columns, co-current, counter current and cross current contacting fluids, calculations of NTU and HTU, concept of HETP, Absorption and desorption factors**.**

Unit-II

Distillation: Introduction. Vapour liquid equilibria, Boiling point diagram, Relative volatility. Prediction of VLE from vapour pressure data using Raoult‟s law. VLE for multicomponent systems. Non-ideal systems. Azeotropes. Steam distillation. Flash and simple distillation extractive distillation.

Unit-III

Multistage distillation: Multi-stage rectification column, McCabe Thiele, and Ponchon-Savarit methods for multistage operations, tray efficiencies, concept of reflux, minimum reflux ratio, optimum reflux, total reflux, Murphree plate efficiencies. Multicomponent distillation. Vacuum, molecular, extractive and azeotropic distillations. Fensky and underwood equation for minimum numbers of plate calculation.

Unit-IV

Liquid-liquid extraction: Ternary equilibrium. Solvent selection. Single stage. Multistage-cross-current, counter-current extraction. Equipment for liquid-liquid extraction, continuous contact extraction in packed towers.

Unit-V

Solid-Liquid Extraction (Leaching): Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams, ideal stage equilibrium, stage efficiencies, Calculation of single stage and multi-stage leaching operation.

References:

1. Treybal, R.E., Mass Transfer Operations, 3rd Edition, McGraw Hill, 1981
2. Richardson J. F. and Coulson J.M. “Chemical Engineering”, Vol. I , II
3. McCabe and Smith, „Unit Operations in Chemical Engineering”
4. Henley E. J. and Seader H.K. “Stage wise Process Design” , McGraw Hill
5. A.L. Lyderson, “Mass Transfer in Engineering Practices”, John Wiley
6. Coulson, J.M., Richardson, J.F. and Sinnott, R.K. , Chemical Engineering Vol I, II, IV and V,
1. 4th Edition, Pergmen Press, 1998.
7. Wankat P.C., Rate Controlled Separations, Elsevier, 1990.
8. Foust, A., Principals of Unit Operation, 2nd Edition, John Wiley, 1994.
9. Geankoplis, C. J, Transport Processes and Unit Operation, Prentice Hall(I, 2000.

List of Experiment:

1. To study steam distillation
2. Vapour liquid equilibrium
3. Liquid-liquid equilibrium for ternary system
4. Liquid – Liquid Extraction (single stage and multistage)
5. Characterization of Spray Extraction Column
6. Batch/ Continuous Leaching
7. To verify Rayleigh equation for differential distillation of binary system.
8. To study batch distillation.
9. To study continuous distillation.
10. Studies on packed tower distillation unit.
11. Studies on the sieve plate distillation unit.
12. Studies on bubble cap distillation column.
13. To study the absorption of a gas in a packed column and calculation of NTU and HTU.

CMC-602 Chemical Reaction Engineering-I

Unit-I

Introduction: Scope of Chemical Reaction Engineering, Classification of reactions, Rate equation and rate of reaction, Factors affecting rate of reaction. Chemical kinetics and Thermodynamics/Equilibrium, Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories, activated complex theory, Mechanism of reaction series, Parallel and consecutive reaction, autocatalytic reactions, chain reaction, polymerization reaction.

Unit-II

Kinetics of Homogeneous Reactions: Defining a rate equation and its representation, single and multiple reactions, Autocatalytic reactions, molecularity and order of reactions, Integral method of Analysis of data, Irreversible, zero, first, second, and nth order reactions (Uni-molecular and bimolecular type), Overall orders from half-life method. **Non-elementary reactions:** Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions, kinetic models for non-elementary reactions,

Unit-III

Design of ideal reactors: Concept of ideality. Development of design expressions for batch, tubular, and stirred tank reactors for both constant and variable-volume reactions, Design of Isothermal and non-isothermal batch, CSTR, PFR, reactors. **Comparison of ideal reactors:** General graphical comparison. Multiple Reactor Systems: Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series.

Unit-IV

Design of reactors for multiple reactions: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions, **Thermal characteristics of reactors:** Review of Calculations of heats of reactions and equilibrium constant with temperature dependency. General graphical design procedure for non-isothermal reactors. Optimum temperature Progression.

Unit-V

Basics of Non Ideal flow: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. RTD Dispersion model, evaluation of RTD characteristics, Tanks in series model, Conversion in non- ideal flow reactors for simple systems.

References:

1. Levenspeil, O., Chemical Reaction Engineering, 3rd Edition, John Wiley & Sons, 2001.
2. Fogler, H. S., Elements of Chemical Reaction Engineering, 3rd Edition, Prentice Hall, 2001.
3. Smith J.M; Chemical Engineering Kinetics; Mc Graw Hill.
4. Denbigh & Turner K.G; Chemical Reaction Theory An Introduction; United Press.
5. Copper & Jeffery‟s GVJ; Chemical Kinetics And Reactor Engineering; Prentice Hall
6. Levenspiel O; Chemical Reaction Engg; Willey Eastern, Singapore.

7. Houghen Watson & Ragatz; Chemical Process Principles Part Iii; Asian Pub-House Mumbai
8. Laidler, K.J., Chemical Kinetics, Tata McGraw Hill, 1997.
9. Sharma M.M & L.K Doraiswamy, Heterogeneous Reactions, Vol 1
10. Fogler, H.S., Elements of Chemical Reaction Engineering, 4 ed.,PHI, 2008.

List of Experiment:

1. To determine velocity rate constant of the hydrolysis of ethyl acetate by sodium hydroxide.
2. To study the rate constant of hydrolysis of an ester-catalyzed by acid.
3. Determine the rate constant and order of reaction between Potassium per sulphate and
1. Potassium iodide.
4. To study temperature dependency of rate constant, evaluation of activation energy and
2. Verification of Arrhenius law.
5. To study a consecutive reaction system(hydraulic model)
6. To study a parallel reaction system (hydraulic model)
7. To study a homogeneous reaction in a semi-batch reactor under isothermal conditions.
8. Study of non catalytic homogeneous saponification reaction in CSTR.
9. To study a non-catalytic homogeneous reaction in a plug flow reactor.
10. To study the residence time distribution behavior of a back mix reactor.
11. To study the RTD behavior of a tubular reactor.
12. To study the RTD behavior of a packed bed reactor.
13. To study the behavior of a continuous flow reactor system-three reactor in series.
14. To study the kinetics of thermal decomposition of calcium carbonate.
15. To study a homogeneous catalytic reaction in a batch reactor under adiabatic conditions.
16. Study of non catalytic saponification reaction in a tubular flow reactor.

CMC-603 Chemical Engineering Thermodynamics – II

Unit-I

Non-Ideal behavior: Thermodynamic properties of homogeneous mixtures; property relationship for systems of variable compositions, partial molar properties their evaluation, Fugacity and fugacity coefficient of pure substances and components in solution, Generalized correlations for the fugacity coefficient, Lewis Randall rule, excess properties

Unit-II

Fundamentals of Phase Equilibria: Concept of equilibrium in phases, The theory of ideal and non-ideal solutions, Thermodynamic equations of Vapor Liquid Equilibrium for ideal and non-ideal solutions, Liquid-liquid and Solid-liquid equilibria. **Reaction Equilibria:** Concept of reaction equilibria, single and multiple reactions, Degrees of freedom for single and multiple reactions.

Unit-III

Refrigeration and Liquefaction: Principles of refrigeration, Theory of refrigeration, Vapor Absorption Refrigeration, Vapor Absorption Refrigeration, Carnot refrigerator, vapor compression cycle, absorption refrigeration. Liquefaction processes: Linde liquefaction process, Claude liquefaction process.

Unit-IV

Duct flow of compressible fluids: pipe flow, nozzles, throttling process, Turbines. Compression processes: compressors, pumps, introduction to ejectors. Chemical potential & its physical significance, effect of pressure & temperature on heat of reaction, concept of free energy Vant-Hoffs equation, Clausius-Clapeyron equation, Gibbs- Duhem relationship of free energy with equilibrium constant, equilibrium & its applications.

Unit-V

Methods for estimation of Thermodynamics properties: Estimation methods for critical parameters, Estimation method for Mixture Enthalpy and Entropy. Elements of statistical thermodynamics, counting the number of microstates for a given macro-state, the most probable macrostate, Boltzman distribution, evaluation of Lagrangian constants alpha, statistical interpretation of work & heat.

References:

1. Rao .Y.V.C, "Chemical Engineering Thermodynamics", University Press (I) Ltd., Hyderabad, 1997.
2. Kyle,B.G"Chemical and Process Thermodynamics", 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 20000.
3. Smith J.M and Van Ness- Introuction to Chemical Engg Thermodynamics – 6th edition
4. Daubert; chemical engg thermodynamic; TMH
5. Rathakrishnan E; Fundamentals of Engg Thermodynamics; PHI
6. Dodge B.F. Chemcail Engineering –Thermodynamics –McGraw Hill
7. Balzhiser Samules and Eliassen-Chemical Engg- Thermodynaics Prentic Hall
8. Sandler S.I Chemical Engg-Thermodynamics-John Wiley and son
9. Rastogi and Mishra-Chemical Engg Thermodynaics.

List of experiments:

1. To determine Steam Turbine Module.
2. To determine cycle-Pad is the first open source simulation software allowing the simulation of complex thermodynamic cycles.
3. To determine Brayton cycle depicts the air-standard model of a gas turbine power cycle.
4. To find large cooling towers that is connected to the air conditioning system.
5. The principle that makes Stirling engines possible is quite simple.
6. To Spark-Ignition Engine Performance Test.

CMC-604 (A) Bio Chemical Engineering

Unit-I

Introduction to Bioscience: Types of Microorganisms: Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture. Isolation and purification of Enzymes from cells. Assay of Enzymes. Functioning of cells and Fundamental Molecular.

Unit-II

Biology: Metabolism and bio-energetics, Photosynthesis, carbon metabolism, EMP pathway, tricarbocyclic cycle and electron transport chain, aerobic and anaerobic metabolic pathways. Synthesis and regulation of bimolecular, fundamentals of microbial genetics, role of RNA and DNA.

Unit-III

Enzyme Technology and Kinetics: Applications of enzymes in industry and medicine. Immobilization of enzymes, Kinetics of enzyme catalytic reactions involving isolated enzymes, Reversible inhibition. Reactions Catalysed By Enzymes.

Unit-IV

Reactors Analysis: Reactor Design and Analysis for soluble enzyme systems. Cofactor regeneration, Membrane reactor . Effect of mass transfer in immobilised enzyme particle systems. Reactors for immobilised enzyme systems. Bio Reactors, Effect of Transport Processes.

Unit-V

Introduction to Bioreactor design: Continuously Stirred aerated tank bioreactors. Mixing power correlation .Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption. Multiphase bioreactors and their applications. Downstream processing and product recovery in bioprocesses.

References:

1. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals.
2. Trevan, Boffey, Goulding and Stanbury, Biotechnology.
3. M. L. Shuler and F. Kargi, Bio Process Engineering: Basic concepts.
4. Inamdar S.T.A, Biochemical Engineering – Principles and Concepts.

CMC-604 (B) Fertilizer Technology

Unit-I

Introduction: Plant nutrients, different types of fertilizers and their production in India.

Unit-II

Nitrogenous Fertilizers: Different feed stocks. Synthesis gas production by steam-naptha reforming and gas purefication. Ammonia synthesis. Urea manufacturing processes. Manufacture of sulphuric acid and ammonium sulphate. Nitric acid and ammonium nitrate manufacture.

Unit-III

Phosphatic Fertilizers: Availability and grinding of rock phosphate, manufacturing processes for single and triple super- phosphate and phosphoric acid. Mixed Fertilizers: Availability and manufacture of muriate of potash.

Unit-IV

Mixed Fertilizers: Mono and di-ammonium phosphate, urea ammonium phosphates, NPK complex fertilizers, granulation techniques.

Unit-V

Engineering Problems: Fertilizers storage and handling. Corrosion problems in fertilizers industries. Fertilizer plant effluent treatment and disposal.

References:

1. Slack A.V, Chemistry and Technology of Fertilizers.
2. Austin G.T., and Shreve‘s, Chemical Processes Industries.
3. Waggaman W.H., Phosphoric Acid, Phosphates and Phosphatic Ferilizers.
4 Rao M.G. and Sittig M Dryden‘s, Outlines of Chemical Technology.

CMC – 604 (C) Petroleum Refinery Engineering

Unit-I

Primary Processing of Crude Oil, Classification of crude oil, Atmospheric distillation, Vacuum distillation of residue-Products and distillation practice.

Unit-II

Secondary Processing of Crude Oil: FCCU, Hydro cracking, Visbreaking, Thermal cracking, Coking, Reforming, Alkylation, Polymerisation and Isomerisation process.

Unit-III

Treatment Techniques: Treatment techniques for removal of objectionable gases, Odours, to improve performance, Storage stability.

Unit-IV

Extraction of aromatics, Olefins and recovery operations from petroleum products.

References:

1. W.L. Nelson, Petroleum Refinery Engineering.
2 B. K. Bhaskara Rao, Modern Petroleum Refining Processes.
4. G. D. Hobson and W. Pohl, Modern Petroleum Technology.
5. R. A. Meyers, Hand book of Petroleum Refining Processes.

CMC-605 (A) Pharmaceutical Technology

Unit-I

Practice of the following unit operation in pharmaceutical industries: Heat transfer, evaporation, distillation, dry, mixing size reduction, crystallization, filtration, size separation, conveying, humidification, air conditioning and refrigeration, Formulation, development of sterile dosage forms.

Unit-II

Production facilities, environmental control and personnel in the production of sterile dosage form, compounding, processing, filtration, sealing, sterilization, packing and labeling of sterile dosage forms. Quality control tests like sterility, pyrogen, clarify, safety and leakage testing, types of tablets. Manufacturing of tablets by wet granulation, dry granulation and direct compression. Tablet processing problems and defects, tablet standardization: hardness, friability, weights variation, disintegration, dissolution and content uniformity tests.

Unit-III

Capsules: Hard gelatin capsule, capsule size, formulation and preparation of filled hard gelatin capsules, soft gelatin capsule, soft gel – manufacturing procedures. Quality control of capsule.

Unit-IV

Cosmetics and Toiletries: Introduction, factors to be considered in the formulation of facial cosmetics, dentifrice‘s, deodorant, antiperspirants, shampoos, hairdressing and hair removers.

Unit-V

Pharmaceutical packing: Packing components, types of packing containers and closures, materials used for and their pharmaceutical specification, method of evaluation, stability aspects of packaging materials.

References:

1. Leon Lachman, H.A. Lieberman, J.L.K, The Theory and Practice of Industrial Pharmacy.
2 Ganderton, Unit Process in Pharmacy.
3 D. Hershey, Chemical Engineering in Medicine And Bodogy.
4. Chern. Engg. Prpgrer Syrnp Series, Chemical Engineering in Medicine.

CMC-605 (B) Corrosion Engineering

Unit-I

Basic concepts: Definition and importance; Electrochemical nature and forms of corrosion; Corrosion rate and its determination. Electrochemical thermodynamics and kinetics: Electrode potentials; Potential-pH (Pourbiax) diagrams; Reference electrodes and experimental measurements; Faraday‘s laws; Electrochemical polarization; Mixed potential theory; Experimental polarization curves; Instrumentation and experimental procedure.

Unit-II

Galvanic and concentration cell corrosion: Basic concepts; Experimental measurements, and determination of rates of galvanic corrosion; Concentration cells, Corrosion measurement through polarization techniques: Tafel extrapolation plots; Polarization resistance method; Instrumental methods and Errors in measurement of polarization resistance; Commercial corrosion probes; other methods of determining polarization curves.

Unit-III

Passivity: Basic concepts of passivity; Properties of passive films; Experimental measurement; Applications of Potentiostatic Anodic Polarization; Anodic protection. Pitting and crevice corrosion: Basic concepts; Mechanisms of pitting and crevice corrosion; Secondary forms of crevice corrosion; Localized pitting, Metallurgical features and corrosion: Inter-granular corrosion; Weldment corrosion; De-alloying and dezincification.

Unit-IV

Environmental induced cracking: Stress corrosion cracking; Corrosion fatigue cracking; Hydrogen induced cracking; Some case studies; Methods of prevention and testing; Erosion, fretting and Wear, Environmental factors and corrosion: Corrosion in water and Aaqueous Ssolutions; Corrosion in sulphur bearing solutions; Microbiologically induced corrosion; Corrosion in soil; Corrosion of concrete; Corrosion in acidic and alkaline process streams.

Unit-V

Atmospheric and elevated temperature corrosion: Atmospheric corrosion and its prevention; Oxidation at elevated temperatures; Alloying; Oxidising environments, Prevention and control of corrosion: Cathodic protection; Coatings and inhibitors; Material selection and design**.**

References:

1. An Introduction to Corrosion and Corrosion Inhibition S.N. Banerjee,
2. An Introduction to Metallic Corrosion and its Prevention Raj Narayan**.**

CMC-605 (C) Numerical Methods in Chemical Engineering

Unit-I

Systems of Linear Algebraic Equations**:** Overview of course Introduction to systems of linear equations Application: Mass balance on a simple separator, Matrix properties and algebra; Gaussian Elimination, Eigenvalue problems.

Unit-II

System of Non-Linear Algebraic Equations**:** Generalized Newton-Raphson Method Application: Multiple reactions in a CSTR, Numerical Integration,

Unit-III

MATLAB**:** Case Study: Multicomponent material balance for separation process with recycle, Tridiagonal Matrices Application: Liquid-liquid extractor. Solve generalized eigenvalue problems.

Unit-IV

Use Matlab to perform both symbolic and numeric integration of mathematical functions, Apply these numerical methods to the solution of Chemical Engineering problems, including batch reaction kinetics, heat transfer, mass transfer, and vapor-liquid equilibria calculations.

Unit-V

Use and understand the key differences between different function optimization methods, Solve basic problems in statistics and data regression for model parameter estimation, Prepare Matlab programs using user-defined functions and scripting files.

References:

1. Al-Malah, Kamal I. M.., Matlab Numerical Methods with Chemical Engineering Applications.
2. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers.
3. Beers, Kenneth J. Numerical Methods for Chemical Engineering: Applications in MATLAB.
4. Press, William H. Numerical Recipes in C: The Art of Scientific Computing. New York.
5. Recktenwald, Gerald W. Introduction to Numerical Methods with MATLAB.
6. Heath, Michael T. Scientific Computing: An Introductory Survey.

CMC-606 (A) Petrochemical Technology

Unit-I

Chemicals from methane and synthetic gas: Ammonia, Methanol and Hydrogen Cyanide.

Unit-II

Chemicals from olefins: Ethylene derivatives, Propylene derivatives and Butylenes derivatives, Chemical from Aromatics**,** synthetic fibres, Plastics and rubber.

Unit-III

Conversion of - Ethylene to ethylene oxide, ethylene glycol, ethanol amine Propylene to acrylic acid ,methyl ethyl ketone acrylonitrile**.**

Unit-IV

Conversions of – Butenes to iso and n butanols, MIBK, MTBE Aromatics to maleic and phathalicanhydride, DMT, phenols and acetones Cyclohexane to caprolactum, adipic acid.

Unt-V

Hydration: Technologies for production of alcohols such as ethanol, isobutyl alcohol and higher alcohols, Esterification: Process for production of few esters such as acrylates, terephthalates, ester for flavoring industries.

References:

1. Mall, I D, Petrochemical Process Technology.
2. Bhaskar Rao, Modern Petroleum Refining Processes.
3. Speight J, Chemistry & Technology of Petroleum.
4. Robert Mayer, Handbook of Petroleum Refining Processing.
5. N.N. Lebdev, Chemistry and technology of basic organic and petrochemical synthesis.
6. B.K. Bhaskarrao, A text on Petrochemicals, 2nd Ed, Khanna publishers, New Delhi.
7. G.N. Sarkar, Advanced Petrochemicals, 1st Ed, Khanna Publishers, New Delhi.

CMC-606 (B) Food Technology

Unit-I

Introduction: Current status of the Indian a) agriculture b) Food Industry c) Food processing industry.

Unit-II

Basic Food Biochemistry and Microbiology: Food Constituents, Water activity enzymes, Ambient Temperature Processing: Raw material preparation, Size reduction of solid fibrous foods and in liquid foods, Emulsification and Homogenization, Theory and equipment, Mixing and Forming, Extraction and expression,

Unit-III

Membrane concentration Fermentation: Theory, Types, Equipment Effect on foods.

Unit-IV

Heat Processing using Heat or water: Theory, Equipment, Effect on foods, blanching, extrusion, pasteurization, Heat Sterilization, In-container Ultra high temperature (UHT)/aseptic processes. Heat processing using Hot air: Theory, Equipment, Effect on foods, Dehydration, Baking and Roasting; Heat Processing using hot oils: Theory, Equipment, Effect on foods Frying.

Unit-V

Heat Processing by direct & radiated energy: Theory, Equipment, Effect on foods Dielectric heating microwave. Processing by removal of heat, Food Preservation & Storage Food contamination Modified Atmosphere Storage (MAS) Hurdle Technology; Post Processing Applications Packaging**.**

References:

1. Vijaya khader, Preservation of Fruits and Vegetables.
2. Viyaya khader, Food Processing and Preservation.
3. Srilakshmi. B, Food science, (2nd edition) & Food science & Nutrition.
4. Swaminathan. M, Essentials of Food and Nutrition , Vol. I & II.

CMC – 606 (C) Environmental Impact Assessments and Environmental Audit

Unit-I

Environmental acts - Their need, historical background, national and international acts; Genesis of environmental acts - General procedure followed in changing a bill into an act; implementation of an act using judiciary, executive and legislative powers and their limitations.

Unit-II

Main national acts - Environmental protection agency, air act, water act, water and sewerage Board's Factory act, Municipal acts, acts dealing with hazardous and infections wastes.

Unit-III

Environmental impact assessment, environmental audit, general procedures followed in preparing reports incorporating EIA ES and EA.

Unit-IV

Definitions and concepts, partial audit, compliance audit, methodologies and regulations, Introduction to ISO and ISO 14000. EMAS regulations.

Unit-V

Environmental and occupational health, industrial hygiene, risk assessment disaster management plan, epidemiology. Assessment of existing effluent treatment plants, trouble shooting, remedial measures.

References:

1. L. W. Canter, Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.
2. P. Judith and G. Eduljee, Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1994.
3. G. Burke, B. R. Singh and L. Theodore, Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons, 2000.
4. C. H. Eccleston, Environment Impact Statements: A Comprehensive Guide to Project and Strategic Planning, John Wiley & Sons, 2000.
5. R. Welford, Corporate Environmental Management - Systems and Strategies, Universities Press, 1996.
6. K. Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997.
7. The Economist Intelligence Unit, Best Practices - Environment, Universities Press, 1993.
8. R. Therivel, John Glasson, Andrew Chadwick, Introduction to Environmental Impact Assessment (Natural and Built Environment), Routledge, 2005.