UNDERGRADUATE COURSE DESCRIPTIONS for Chemical Engineering

14202 Material and Energy Balances 4 Cr. Principles of engineering calcula- tions. The mass balance equation, systems of simultaneous equations, recycle, bypass, purge, properties of gases; liquids; and Solids, saturation and equilibria, partial saturation, The energy balance equation for closed and open systems, calculation of sensible heat, enthalpy change of phase transition and chemical reactions, simultaneous solution of mass and energy balance equations, psychometric chart.

Prerequisite: 24 Credits standing

14231 Fluid Mechanics 4 Cr. Fluid properties, fluids statics, basic equation of fluid flow (continuity and momentum equations), dimensional analysis, fully developed laminar flow, boundary layers (laminar- and turbulent flow) turbulent flow in pipes and ducts, flow in open channels, fluid flow about immersed bodies (motion of particles through fluids, motion of fluid through beds, fluidized beds), steady one-dimensional compressible flow, flow measurement, turbomachinery

Prerequisite: Material & Energy Balances 14202, Differential Equations 19201

14221 Thermodynamics I 3 Cr. Heat and work, the first law of thermodynamics for closed and open systems, the phase behavior of pure fluids, equations of state, viral and cubic equations of state, generalized equations of state, heat effects, engines and refrigerators, the second law of thermodynamics for closed and open systems, properties of pure fluids.

Prerequisite: Material & Energy Balances 14202, Computer Programming 18150

14322 Thermodynamics II 3 Cr. Properties of systems of variable composition, Partial properties, Excess properties, property changes of mixing, calculation of phase equilibrium for ideal gas and ideal solution, the Raoult , s law, VLE calculations at low to moderate pressures, VLE calculations based on generalized equations of state, solution thermodynamics, chemical reaction equilibria.

Prerequisite: Thermodynamics for Chemical Engineering I 14221

14325 Heat Transfer I 3 Cr. Physical origins and rate equations of conduction, convection and radiation, Conservation energy for a control volume. The heat diffusion equation, boundary and initial conditions, one and two dimensional steady-state conduction, introduction to transient conduction, the velocity and thermal boundary layers, laminar and turbulent flow, internal flow and heat transfer in circular and non-circular channels, physical considerations of free convection (The governing equations, empirical correlations), combined free and forced convection, introduction to boiling and condensation, physical mechanisms, boiling and condensation modes.

Prerequisite: Fluid Mechanics for Chemical Engineering 14231, Engineering Mathematics 19202

14232 Fluid Mechanics Lab 1 Cr. The fluid mechanics lab is comprised of the following set of experimental rigs: pressure drop in pipes and fittings, fluid flow measurement devices, pumps and cavitation phenomena, fixed and fluidised beds, hydrostatic pressure, drag force, gas viscosity determination, development of velocity profiles in pipes.

Prerequisite: Fluid Mechanics for Chemical Engineering 14231

14401 Kinetics & Reactor Design 4 Cr. Chemical reaction equilibria, inter- pretation of experimental kinetic data, reaction rate expression, molecular interpretation of kinetic phenomena, multiple reactions, ideal flow reactor models, Optimization of multiple reaction systems, non-isothermal reactors and energy considerations, deviations from ideal flow.

Prerequisite: Thermodynamics II 14322

14341 Mass Transfer 3 Cr. Molecular diffusion in fluids, mass transfer coefficients, interphase mass transfer, equipment for gas-liquid operations and gas absorption.

Prerequisite: Heat Transfer 14325, Thermodynamics II 14322

14409 Process Control 3 Cr. Laplace transformation, Linear system responses control and final control element systems, block diagram and closed loop transfer functions, stability, rootlocus, frequency response, design of control systems implementing frequency response, Nyquist stability analysis.

Prerequisite: Heat Transfer 14325, Kinetics & Reactor Design 14401

14331 Heat Transfer Lab 1 Cr. The following set of experimental units comprise the heat transfer Lab: steam to water heat exchanger for studying film and dropwise condensation, water/water turbulent flow heat transfer unit, boiling heat transfer unit, heat conduction unit, thermal radiation unit, temperature measurement

unit, refrigeration cycle demonstration unit, bench top cooling tower, vapor compression refrigeration unit, convective heat transfer unit, calibration wind tunnel.

Prerequisite: Heat Transfer 14325

14335 Heat Transfer II 3 Cr. Fundamental concepts of radiation, radiation exchange between surfaces, introduction to heat exchanger, the overall heat transfer coefficient, heat exchanger analysis: the effectiveness-NTU method, methodology of a heat exchanger calculation, compact heat exchangers, general description and classification of furnaces, the heating capacity of batch-type and continuous furnaces, heat saving methods.

Prerequisite: Heat Transfer 14325

14455 Applied Mathematics in Chemical Engieering 3 Cr. Mathematical modeling of processing systems. Review of analytical solution of algebraic and ordinary differential equations sets, numerical integration and differentiation. Inter- polation, extrapolation, curve fitting. Numerical solution of algebraic and ordinary differential equations. Solution of partial differential equations implementing combination and separation of variables.

Prerequisite: Mass Transfer 14341, Computer Programming 18150

14410 Process Control Lab 1 Cr. Pneumatic control equipment for pressure, flow, level and temperature control of simple processes, analog simulation of conventional control schemes and a battery of stirred tank reactors for dynamic behavior studies comprise the process control lab.

Prerequisite: Process Control 14409

14410 Process Control II 3 Cr. Tuning of feedback controllers using open-loop process characterization, cascade control, override and selective control, ratio and feed forward control, multivariable process control.

Prerequisite: Process Control 14409

14345 Unit Operations I 3 Cr. Distillation, liquid-liquid extraction and leaching.

Prerequisite: Mass Transfer 14341

14400 Plant Design & Economics 3 Cr. Flow diagrams, general design considerations, cost estimation, depreciation, alternative investments, optimization , materials of construction, report writing, fluid transfer equipment design & cost, heat transfer equipment design & cost, mass transfer equipment design & cost.

Prerequisite: Kinetics & Reactor Design 14401, Unit Operations I 14345

14344 Unit Operations Lab 2 Cr. A diverse set of pilot plants comprise the unit operations lab. Those plants include: tray and packed distillation columns, falling film and circulation evaporators, solid-liquid and liquid-liquid extraction plants, tubular reactor, battery of stirred tank reactors, drum dryer and spray dryer, jig saw crusher, ball mill, rod mill, jaw crusher, flotation cells, thickener and classifiers.

Prerequisite: Unit Operations 14345

14350 Unit Operations II 3 Cr. Evaporation, humidification, adsorption, drying and mechanical separations.

Prerequisite: Mass Transfer 14341

14527 Principles of Polymerization Engineering 3 Cr. Engineering aspects of polymerization of thermoplastics and thermosetting polymers including: PE, PS, PVC, PVA, PU, Nylons, Phenoplasts, Aminoplasts and Epoxy resins. Preparation of monomer, polymerization methods. Principles of polymerization and fibre formation of Nylons, Linearsaturated polyesters and poly acrylonitriles.

Prerequisite: Chemistry and Kinetics of Polymerization 14521, Kinetics & Reactor Design 14401

14422 Rubber & Plastic Technolgoy 4 Cr. Processing techniques including: extrusion, injection, calendaring, compression moulding, transfer moulding, thermoforming, hand lay up forming, screw, types of screw in single screw extruder machine, screw design and equations involved, die and die design, moulds in injection moulding machines and design of a mould, engineering plastics and their properties, elastomers and their properties, mastication techniques, vulcanization techniques, additives and reinforcing materials for rubbers.

Prerequisite: Mechano-Physical Properties of Polymers 14525

14525 Mechano-Physical Properties of Polymers 3 Cr. Mechanical tests such as tensile, creep, stress-relaxation, dynamic mechanic, and strength phenomena. linear viscoelasticity, mechanical models, real viscoelasticity concept, rubber elasticity. Thermophysical properties such as specific and molar

volume, heat capacity, of anisotropic materials such as composites and oriented polymers, electrical properties such as dielectric constant and resistivity.

Prerequisite: Statics and Strength of Materials 16205, Physical Chemistry of Polymers 14522

14521 Chemistry and Kinetics of Polymerization 3 Cr. Molecular weight characteristics: Average molecular weights, (or degree of polymerization), molecular weight distribution. Step growth polymerization: chemistry and kinetics formation of linear and nonlinear polymers, Gelation theory, chain reaction polymerization, chemistry and kinetics of free radical and ionic polymerization processes. Bulk, solution, suspension and emulsion. Polymer reactions: chemical modifications and degradation.

Prerequisite: Organic Chemistry 21116

14528 Composites & Additives Technology 3 Cr. Fibre types used in polymer reinforcement, Reinforcement theories: elastic modules and strength of longitudinal uniaxial composites, transverse directions, biaxial directions. FRP (e.g GRP), SMC and BMC technology. Use of coupling agents, composite processings: injection moulding, filament winding, pulltrusion. Coating technolgoy: various techniques used in coatings polymers on metals glasses, polymers, coating characteristics. Foams and adhesives technolgoy: theories and applications.

Prerequisite: Mechanophysical Properties of Polymers 14525

14540 Modelling & Design of Polymerization Reactors 3 Cr. Introduction to polymers. Complex reactions and interpretation of experimental results. Thermodynamic of polymerization reactions. Development of rate expressions for polymerization reactions. Development of characterization factors for polymerization reactions. Design of polymerization reactors.

Prerequisite: Computer programming 18150, Engineering Mathematics 19202, Process Control 14409

14526 Polymer Physical and Mechanical Properties Lab 1 Cr. Impact test- ing, hardness, tensile testing, abrasion, vicat test, bending test, plastometer, fatigue test, creep, three point bending.

Prerequisite: Mechanophysical Properties of Polymers 14525

14523 Polymer Chemistry Lab 1 Cr. The polymer chemistry lab is equipped for the following typical experiments in preparation and characterization of polymers: molecular weight determination, determination of density, identification of polymers, preparation of resins, synthesis of elastomers, co-polymerization reactions, slurry, bulk and emulsion polymerization reactions, application of re-enforcement techniques, gelation of unsaturated polymers.

Prerequisite: Chemistry and Kinetics of Polymerization 14521, Physical Chemistry of Polymers 14522

14253 Industrial Water Treatment 3 Cr. Theory and description of various methods of industrial water treatment, lime-soda processes, floclation & coagulation, filtration, ion-exchange, reverse osmosis. Design of various ion-exchange systems using various types of resins. Quality of water for boilers & heating/cooling systems and various methods of internal water treatment.

Prerequisite: 95 Credits Standing

14465 Transport Phenomena 3 Cr. Viscosity and the mechanism of momentum transport, thermal conductivity and the mechanism of energy transport, diffusivity and the mechanism of mass transport. Velocity, temperature and concentration distributions in laminar and turbulent flow and with more than one independent variable. Temperature and concentration distributions in solids. The equations of change for isothermal, nonisothermal and multicomponent systems. Macroscopic balances for isothermal, nonisothermal and multicomponent systems.

Prerequisite: Mass Transfer 14341

14512 Corrosion in Petroleum Industry 2 Cr. Thermodynamics and kinetics of corrosion, various types of corrosion, methods of corrosion prevention, corrosion in boiler, cooling towers and petroleum industry.

Prerequisite: Analytical Chemistry 21131

14351 Petroleum Refinery Engineering 3 Cr. Composition of petroleum, refinery products and test methods, physical properties of petroleum oil and refinery products, introduction to processing, refinery and distillation processes, auxiliary processes and operations, chemical treatments, extraction processes, catalytic cracking and decomposition processes, reforming, natural and refinery gases.

Prerequisite: Unit Operations I 14345

14353 Petroleum Products Characterization Lab 1 Cr. The following charac- terization experiments are performed in the petroleum lab: distillation of petroleum products, kinematic viscosity of transparent and opaque liquids, detection of copper corrosion by copper strip tarnish test, penetration of bituminous materials, conradson

carbon residue of petroleum products, flash and fire point, sulfur content of petroleum products, vapor pressure, smoke point and thin film aniline point.

Prerequisite: Unit Operations I 14345

14405 Reactor Design for Heterogenous Systems 3 Cr. Equipment design for carrying out chemical reactions of heterogeneous nature, that is, reactions involving at least two different phases.

Prerequisite: Kinetics & Reactor Design 14401

14255 Water Analysis Lab 1 Cr. The following quantitative analyses are performed on various water samples: total dissolved solids, calcium and magnesium determination, pH., chlorides, sulphate ions, ammonia based nitrogen and related compounds, iron, torpidity, electrical conductivity, phosphates, chemical oxygen demand and biological oxygen demand.

Prerequisite: Industrial Water Treatment 14253

14414 Polymer Chemistry & Technology 3 Cr. An introduction to polymer science, Principal of determination of molecular weight, analysis and tests of polymers (IR, X-ray and Thermal Analysis), physical and mechanical properties of polymers, polymerization, copolymerization, processing technology of polymers (Extrusion, Injection Moulding, ...), thermosetting resins.

Prerequisite: Organic Chemistry 21116

14524 Polymer Rheology 3 Cr. Classification of non-Newtonian fluids, time independent non-Newtonian fluids, time dependent non-Newtonian fluids, viscoelastic fluids, flow of non-Newtonian fluids in pipes and channels, heat transfer and mixing characteristics of non-Newtonian fluids, viscometric measurements and apparatus.

Prerequisite: Heat Transfer I 14325

14450 Petrochemical Processes 3 Cr. Petrochemical Processes in the industrial production of organic raw materials such as: synthetic gas, olefines, aromates, solvents, monomers, surficant and fertilizers.

Prerequisite: Unit Operations I 14345

14450 Unit Operations Design 3 cr.

Course is dealing with, choice of separation processes, column hydrodynamic design, efficiency and capacity and reduction of energy consumption.

14-12-452 Principles of Environmental Engineering 3 cr.

Mass and energy balance in environmental processes and regimes; environmental chemistry, evaporation, precipitation-dissolution, acid-base, acid rain, pollution movement and transport; air terminology, greenhouse effect, inversion, ozone layer; air pollution, sources, standards, treatment techniques; water pollution, standards, water and wastewater characteristics, water treatment, wastewater treatment; solid waste management, sources, recovery, recycle, reuse, composting, hazardous waste.

Prerequisite: 90 Credits standing

14-10-260 Microbiology 2 cr.

microbial taxonomy, principles, diversity, prokaryotes, eukaryotes, bacteria, fungi, algae, yeast, protozoa; microbial cell structure, structure-function relation; microscope, cell staining; growth and culture media, solid and liquid culture; microbial growth, mechanism, growth curve, affecting parameters, growth measurement, growth kinetics; sterilization; inoculum development; industrial applications in agriculture, environment, and food industries.

Prerequisite: 3rd semester

14-10-261 Microbiology Lab 1 cr.

Laboratory equipments; microscope; morphology of yeast, fungi, and bacteria; sterilization; preparation of culture and growth media; microbial culture on liquid and solid media; different methods for bacteria enumeration and concentration measurement; gram staining, spore staining.

Prerequisite: Microbiology 14-10-260

14-10-262 Biochemistry 3 cr.

Biochemistry as a discipline and an interdisciplinary science; Interaction in aqueous environment; Molecular structure of living matter; Proteins, amino acids classification, structure and functional diversity, Fibrous & globular proteins, Hemoglobin, Enzymes, kinetics, inhibitors, classification, vitamins; Carbohydrates, monosaccharides and Polysaccharides, starch, glycogen, cellulose; Lipids, fatty acids, triglycerides, phospholipids, steroids, lipoproteins, structural and membrane lipids; Nucleic acids, structure and biological

function; Dynamics of life, metabolism, catabolism, anabolism, glycolysis, citric acid cycle, oxidative phosphorylation, aerobic and anaerobic biosynthesis.
Prerequisite: Organic Chemistry 21116.

14-10-360 Biotechnology & Fermentation 3 cr.
Kinetics of growth and production, growth curve, models of microbial growth, unstructured growth kinetics, simple structured models, mechanistic models, morphologically structured models, growth of filamentous microorganism, models and kinetics of product formation, yield; bioreactors, classification and design of different types of bioreactors, batch, fed-batch, continuous stirred tank and plug flow bioreactors; transfer phenomena in bioreactors, mass transfer and oxygen and substrate transfer, heat transfer; solid state fermentation, comparison with submerged fermentation and modeling.
Prerequisite: Microbiology 14-10-260; Biochemistry 14-10-262; Kinetics & Reactor Design 14401

14-10-361 biotechnology Lab 1 cr.
Buffer preparation; measurement of sugars and glucose; measurement of proteins; measurement of enzyme activity; study of the enzyme kinetics; familiarity to the molecular laboratory including DNA extraction, PCR, gel electrophoresis; enzymatic hydrolysis of starch and cellulose; fermentation of sugars using yeast in lab-scale fermentor.
Prerequisite: Biotechnology & Fermentation 14-10-360

14-10-356 Principles of Biotechnology 3 cr.
A brief microbiology, microbial classification and diversity, cell structure, structure-function relation, microbial nutrition, culture and growth media, macromolecules including sugars, protein, nucleic acids; enzymes, kinetics, classification, applications; microbial metabolism and energetic of life, fermentation, respiration; inoculum preparation; microbial growth and kinetics, growth curve, affecting parameters; bioreactor, batch and continuous bioprocesses, modeling; mass and energy transfer in biological processes; industrial applications.