DEPARTMENT OF CHEMICAL ENGINEERING

The chemical engineering department was established in 1982 at the Isfahan University of Technology (IUT). The department has constantly developed so that the total number of the graduated students has been ever-increasing. Full time faculty are teaching and investigating in the different fields of Chemical Engineering including Transport Phenomena, Process Control, Process Design, Reaction Engineering, Polymer Sciences, Biotechnology, and Nano as well as Bio-Materials in the equipped laboratories available in the department. At the present time, graduate and undergraduate students are studying in the three primary majors of Petrochemical Processes, Polymer Sciences, and Biotechnology.

UNDERGRADUATE PROGRAM

The B.Sc. Program includes one of the three majors:

Petrochemical Industries, Polymer Industries, and **Biotechnology**.

Undergraduate students must take 20 credits in general education courses, 50 credits in basic science courses, 60 credits of major-specific courses and 10 credits in elective courses (a total of 140 credits) to qualify for the B.Sc. degree.

UNDERGRADUATE COURSES

Curriculum for the Degree of Bachelor of Science in Chemical Engineering: Petrochemical Industries

Semester I (Fall)

COURSE CODE	COURSE TITLE	CREDITS
19101	Calculus I	4

21101	General Chemistry I	3
21102	General Chemistry Lab.	1
20101	Physics (Mechanics)	2
24101	General Workshop	1
-	General Courses	6

Semester II (Spring)

COURSE CODE	COURSE TITLE	CREDITS
19102	Calculus II	4
21103	General Chemistry II	3
20103	Physics of Heat	2
20111	Physics of Heat Lab.	1
21116	Organic Chemistry	4
21112	Organic Chemistry Lab I	1
28110	Engineering Graphics	2
-	General Courses	1

Semester III (Fall)

COURSE CODE	COURSE TITLE	CREDITS
19201	Differential Equations	3
20203	Physics of Electricity	2
20211	Physics of Electricity Lab	1
14202	Material & Energy Balance	4
18150	Computer Programming	3
21131	Analytical Chemistry	3
-	General Courses	2

Semester IV (Spring)

COURSE CODE	COURSE TITLE	CREDITS
19202	Engineering Mathematics	3
14231	Fluid Mechanics for Chemical Engineering	4
14221	Thermodynamics for Chemical Engineering I	3
21231	Analytical Chemistry Lab	1
17218	Fundamentals of Electrical Engineering	3
-	General Courses	3

Semester V (Fall)

COURSE CODE	COURSE TITLE	CREDITS
14322	Thermodynamics for Chemical Engineering II	3

14325	Heat Transfer I	3
14232	Fluid Mechanics Lab	1
21273	Physical Chemistry for Chemical Engineering	4
14401	Kinetics & Reactor Design	4
-	General Courses	2

Semester VI (Spring)

COURSE CODE	COURSE TITLE	CREDITS
14341	Mass Transfer	3
14409	Process Control	3
14331	Heat Transfer Lab	1
21274	Physical Chemistry for Chemical Engineering Lab	1
16205	Statics & Strength of Materials	3
-	Elective Course s	3
-	General Courses	4

Semester VII (Fall)

COURSE CODE	COURSE TITLE	CREDITS
14335	Heat Transfer II	3
14455	Applied Mathematics in Chemical Engineering	3
14410	Process Control Lab	1
14345	Unit Operations I	3
14450	Petrochemical Processes	3
-	Elective Courses	3
-	General Courses	2

Semester VIII (Spring)

COURSE CODE	COURSE TITLE	CREDITS
14344	Unit Operation Lab	2
14400	Plant Design & Economics	3
14350	Unit Operations II	3
14478	Project	3
14258	Industrial Training	2
-	Elective Courses	4

Elective Courses:

COURSE CODE	COURSE TITLE	CREDITS
14606	Industrial Water Treatment	3
14766	Transport Phenomena	3
14512	Corrosion in Petroleum Industry	2
14351	Introduction to Refinery Engineering	3
14353	Petroleum Lab	1
14414	Polymer Chemistry & Technology	3

14405	Reactor Design for Hetrogeneous Systems	3
14360	Unit Operation Design	3
14240	Principles of Environmental Engineering	3
14705	Multicomponent Distillation	3
14255	Water Analysis Lab	1

UNDERGRADUATE COURSES

Curriculum for the Degree of Bachelor of Science in Chemical Engineering: Polymer Industries

Semester I (Fall)

COURSE CODE	COURSE TITLE	CREDITS
19101	Calculus I	4
21101	General Chemistry I	3
21102	General Chemistry Lab.	1
20101	Physics (Mechanics)	2
24101	General Workshop	1
-	General Courses	6

Semester II (Spring)

COURSE CODE	COURSE TITLE	CREDITS
19102	Calculus II	4
21103	General Chemistry II	3
20103	Physics of Heat	2
20111	Physics of Heat Lab.	1
21116	Organic Chemistry	4
21112	Organic Chemistry Lab I	1
28110	Engineering Graphics	2
-	General Courses	1

Semester III (Fall)

COURSE CODE	COURSE TITLE	CREDITS
19201	Differential Equations	3
20203	Physics of Electricity	2
20211	Physics of Electricity Lab	1
14202	Material & Energy Balance	4
18150	Computer Programming	3
21131	Analytical Chemistry	3
-	General Courses	2

Semester IV (Spring)

COURSE CODE	COURSE TITLE	CREDITS
19202	Engineering Mathematics	3
14231	Fluid Mechanics for Chemical Engineering	4
14221	Thermodynamics for Chemical Engineering I	3
14521	Chemistry & Kinetics of Polymerization	
21231	Analytical Chemistry Lab	1
17218	Fundamentals of Electrical Engineering	3

Semester V (Fall)

COURSE CODE	COURSE TITLE	CREDITS
14322	Thermodynamics for Chemical Engineering II	3
14325	Heat Transfer I	3
14232	Fluid Mechanics Lab	1
21273	Physical Chemistry for Chemical Engineering	4
14522	Physical Chemistry of Polymers	2
14523	Polymer Chemistry Lab	1
14401	Kinetics & Reactor Design	4

Semester VI (Spring)

COURSE CODE	COURSE TITLE	CREDITS
14341	Mass Transfer	3
14409	Process Control	3
14331	Heat Transfer Lab	1
21274	Physical Chemistry for Chemical Engineering Lab	1
	Engineering Lab	
16205	Statics & Strength of Materials	3
14524	Rehology of Polymers	3
-	General Courses	4

Semester VII (Fall)

COURSE CODE	COURSE TITLE	CREDITS
14455	Applied Mathematics in	3
	Chemical Engineering	
14410	Process Control Lab	1
14345	Unit Operations I	3
14525	Mechanophysical Properties of Polymers	3
14526	Polymer Physical & Mechanical	1
14450	Properties Lab	
-	General Courses	5

Semester VIII (Spring)

COURSE CODE	COURSE TITLE	CREDITS
14344	Unit Operation Lab	2
14400	Plant Design & Economics	3
14478	Project	3
14258	Industrial Training	2
-	Elective Courses	6
-	General courses	2

Elective Courses:

COURSE CODE	COURSE TITLE	CREDITS
14422	Rubber & Plastic Technology	4
14527	Principles of Polymerization Engineering	3
14528	Composites & Additives Technology	2
14540	Modeling & Design of Polymerization Reactors	3

UNDERGRADUATE COURSES

Curriculum for the Degree of Bachelor of Science in Chemical Engineering: Biotechnology

Semester I (Fall)

COURSE CODE	COURSE TITLE	CREDITS
19101	Calculus I	4
21101	General Chemistry I	3
21102	General Chemistry Lab.	1
20101	Physics (Mechanics)	2
24101	General Workshop	1
-	General Courses	6

Semester II (Spring)

COURSE CODE	COURSE TITLE	CREDITS
19102	Calculus II	4
21103	General Chemistry II	3
20103	Physics of Heat	2
20111	Physics of Heat Lab.	1
21116	Organic Chemistry	4
21112	Organic Chemistry Lab I	1
28110	Engineering Graphics	2
-	General Courses	1

Semester III (Fall)

COURSE CODE	COURSE TITLE	CREDITS
19201	Differential Equations	3
20203	Physics of Electricity	2
20211	Physics of Electricity Lab	1
14202	Material & Energy Balance	4
18150	Computer Programming	3
21131	Analytical Chemistry	3
-	General Courses	2

Semester IV (Spring)

COURSE CODE	COURSE TITLE	CREDITS
19202	Engineering Mathematics	3
14231	Fluid Mechanics for Chemical Engineering	4
14221	Thermodynamics for Chemical Engineering I	3
21231	Analytical Chemistry Lab	1
1410260	Microbiology	3
1410261	Microbiology Lab.	1
-	General Courses	3

Semester V (Fall)

COURSE CODE	COURSE TITLE	CREDITS
14322	Thermodynamics for Chemical Engineering II	3
14325	Heat Transfer I	3
14232	Fluid Mechanics Lab	1
21273	Physical Chemistry for Chemical Engineering	4
14401	Kinetics & Reactor Design	4
1410262	Biochemistry	3
-	General Courses	2

Semester VI (Spring)

COURSE CODE	COURSE TITLE	CREDITS
14341	Mass Transfer	3
14409	Process Control	3
14331	Heat Transfer Lab	1
21274	Physical Chemistry for Chemical Engineering Lab	1
1410360	Biotechnology and Fermentation	3
-	General Courses	4

Semester VII (Fall)

COURSE CODE	COURSE TITLE	CREDITS
14335	Heat Transfer II	3
14455	Applied Mathematics in Chemical Engineering	3
14410	Process Control Lab	1
14345	Unit Operations I	3
14450	Properties Lab	3
1410361	Biotechnology Lab.	1
-	Elective Courses	3
-	General Courses	3
14478	Project	3

Semester VIII (Spring)

COURSE CODE	COURSE TITLE	CREDITS
14344	Unit Operation Lab	2
14400	Plant Design & Economics	3
14350	Unit Operations II	3
-	Elective Courses	3
14258	Industrial Training	2
-	Elective Courses	3

Elective Courses:

COURSE CODE	COURSE TITLE	CREDITS
-	Industrial Water Treatment	3
-	Bioseparation	3
-	Enzyme Kinetics and Technology	3
-	Experimental Design & data Analysis	3

UNDERGRADUATE COURSE DESCRIPTIONS

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.

GRADUATE PROGRAM
M.Sc. Program

The M.Sc. Program includes one of the four majors:
Advanced Chemical Engineering, Separation, Polymer Engineering and **Transport phenomena.**

Graduate students are required to take 15 credits from the core graduate courses, 6 from elective courses, and complete a research project (equivalent to 8 credits); thus, a total of 29 credits is required to obtain M.Sc. degree.

GRADUATE COURSES

Transport Phenomena Branch:

1- Two of these three courses: Advanced Fluid Mechanics – Advanced Heat Transfer – Advanced Mass Transfer

2- One of these two courses: Advanced Numerical Analysis – Advanced Mathematics

3- Advanced Thermodynamics

4- Advanced Reactor Design

5- Three special courses

Separation Processes Branch:

1- Advanced Fluid Mechanics

2- Advanced Mass Transfer

3- Advanced Numerical Analysis

4- Advanced Thermodynamics

5- Advanced Reactor Design

6- Three special courses

Advanced Chemical Engineering Branch:

1- Advanced Fluid Mechanics

2- Advanced Mass Transfer or Advanced Heat Transfer

3- Advanced Numerical Analysis

4- Advanced Thermodynamics

5- Advanced Reactor Design

6- Three special courses

Polymer Engineering Branch:

1- Advanced Rheology of Polymers

2- Advanced Heat Transfer

3- Advanced Mathematics

4- Advanced Polymerization Processes

5- Engineering Properties of Polymers

6- Shaping Processes of Polymers

7- Two other major-specific courses from polymer engineering courses

GRADUATE COURSE DESCRIPTIONS

Core courses

1410511 Advanced Heat Transfer 3 cr.

1410512 Advanced Mass Transfer 3 cr.
Formulation of mass transfer models, diffusion coefficient and mass transfer coefficient, models for prediction of M. T. coefficient, diffusional mass transfer, convective mass transfer, coupled processes in transport phenomena, multicomponent mass transfer.

1410513 Advanced Fluid Mechanics 3 cr.

1410514 Advanced Numerical Analysis 3 cr.
Approximation and errors, solution techniques of linear and non-linear algebraic equations sets. Interpolation, extrapolation, differentiation and integration. Numerical solution of ordinary differential equations, boundary and initial value problems. Numerical solution of partial differential equations, elliptic, parabolic and hyperbolic equations.

1410515 Advanced Reactor Design 3 cr.
Deviations from ideal flow, Residence time distribution, non-ideal flow models, mixed flow, segregated flow, axial dispersion model, laminar flow in tubular reactor, heterogeneous reactions, kinetics of solid-fluid catalytic reactions, characterization of solid catalysts, reactor design for heterogeneous reactions, fixed-bed reactor, fluidized-bed reactor, slurry reactor, trickle bed reactor, optimization of multiple-reaction systems, non-isothermal reactors.

1410516 Advanced Thermodynamics 3 cr.
Cubic equa- tions of state, virial equations of state, Maxwell equal area rule, Bridgeman tables, fugacity, fugacity coefficients, activity coefficients, Gibbs-Duhem equation, vapor -liquid equilibria, liquid-liquid equilibria, phase stability, chemical reaction equilibria.

1410517 Advanced Mathematics 3 cr.
Mathematical models representation, linear algebra, vectors and matrices, eigenvalue problem, optimization, special function (Gamma, Beta, Bessel, Legendre...), analytical solution techniques of differential equations, Approximate analytical methods of solution, statistical methods, numerical solution techniques of differential equation.

9010608 M.Sc. Project 8 cr.

Advanced Chemical Engineering: Elective courses

1410637 Electrochemical Engineering 3 cr.
This course deals with basic phenomena of electrochemistry such as thermodynamics, electrode kinetics, modeling and simulation, experimental method and applications.

1410532 Advanced Process Control 3 cr.
Process identification, design of feedback control loop, steady state and dynamic response performance. Compensation techniques, lead, lag, lead-lag compensators and control of systems with delay time. Cascade and

feedforward control systems. State-space representation and modern control theory. Digital computer control, discrete systems and Z transform, design of digital feedback controller.

1410537 Chemical Processes Design 3 cr.

1410538 Advanced Corrosion 3 cr.

1410572 Biological processes for wastewater treatment 3 cr.
Environmental Microbiology and Biochemistry, Stoichiometry and Energetics of Bacterial reactions; Kinetics of bacterial growth; Water and wastewater characteristics; Biological reactors design and operation, suspension, biofilm, CSTR, Plug, Recycled; Aerobic suspended bioprocesses, activated sludge design, lagoon and oxidation pond; Biofilm and its application, different biofilm reactors and mass transfer phenomena; Anaerobic treatment, suspended and biofilm processes; Nutrient removal, Nitrification, Denitrification, Anammox, Sharon, InNitri, Desulfurization; Biosorption kinetics of heavy metals, different biosorbent and kinetic models.

1410563 Fundamentals of Catalysis 3 cr.
Basic principles in preparation, characterization, testing and theory of heterogeneous and homogenous catalysts. Chemisorption, adsorption isotherms, diffusion, surface kinetics, promoters, poisons, catalyst theory and design, acid based catalysis and soluble transition, metal complexes. Examples of important industrial applications are given.

1410552 Wastewater treatment 3 cr.
Classification of wastewater, composition of wastewater, harmful effects of wastewater; types and amount of wastewater, domestic sewage water, municipal sewage water, commercial and industrial wastewater; technologies for industrial water reuse; methods of physical and physico-chemical wastewater treatment.

1410541 Industrial water treatment 3 cr.
Concepts of various treatment options for producing Industrial waters, Common water contaminants and their affect, Key water quality parameters, Outline of advanced Physico- Chemical treatment processes Options, Concepts in Coagulation and Flocculation processes, Ion Exchange based technologies, Membrane Based Technologies (MF, UF. Cartridge Filter, Reverse Osmosis Processes, Electrodialysis), Minimizing waste water.

1410556 Advanced Biochemical Engineering 3 cr.

1410631 Industrial Processes Design 3 cr.

1410632 Principles of Non-homogeneous Catalyst 3 cr.

14725 Fundamentals of Catalysis 3 cr.
Basic principles in preparation, characterization, testing and theory of heterogeneous and homogenous catalysts. Chemisorption, adsorption isotherms, diffusion, surface kinetics, promoters, poisons, catalyst theory and design, acid based catalysis and soluble transition, metal complexes. Examples of important industrial applications are given.

Separation: Elective courses

1410540 Surface Phenomena 3 cr.
Capillarity, thermodynamics description of interface, surface phenomena in fluid-fluid interfaces, adsorption in fluid-fluid interfaces, stability in suspensions, interfacial turbulency, foam, electro-kinetic phenomena: electrophoresis, electro-osmosis, streaming potential and sedimentation potential.

1410539 Advanced Methods in Separation 3 cr.
The course deals with some selected separation methods in chemical industries, includes ion exchange science & technology, membrane technology (electrodialysis and reverse osmosis), filtration and ultrafiltration, flotation (foam, froth, ion and aphron), adsorption.

1410531 Multicomponent Distillation 3 cr.

1410534 Advanced Unit Operations Design 3 cr.
Choice of separation processes, simplified flow sheet, conceptual design, column hydrodynamic design, reduction of energy consumption, separation factor and molecular properties, solvent extraction.

1410543 Membrane Processes 3 cr.

Introduction to membrane processes; definition of membrane ; introducing different membrane types and membrane modules; synthesis of polymeric membranes and their characterization; introducing driving forces for membrane process followed by detail discussion on different membrane processes such as: reverse-osmosis, micro- and ultra-filtration, membrane gas separation, pervaporation and vapor permeation, electrodialysis; introduction to ceramic and zeolite membranes.

1410542 Mechanical Separation 3 cr.

1410550 Advanced Mechanical Unit Operations 3 cr.

1410554 Advanced Extraction 3 cr.

1410638 Powder Technology 3 cr.

Polymer Engineering: Elective courses

1410536 Chemistry and Technology of Polymers 3 cr.
Step and chain polymerization kinetics, kinetic models Latex technology, polymer modifications, degradation and stabilization. polymer processings: mixing, vulcanization, formulation design: extrusion, injection, compression moulding of polymers. Advanced methods in polymer analyses(thermal, mechanical, etc).

1410535 Special Topics in Polymer Science 3 cr.
Polymerization and processing of medical grade polymers. Sterilization of medical grade polymers. Polymeric fibers in medicine (hollow fibers, structures). Polymeric adhesives.

1410553 Polymer Technology 3 cr.
Extruders, Single Screw Extruder, Die Design, Pipe Extrusion, Sheet Extrusion, Film Blowing, , Film Casting, Fiber spinning, Injection Molding, Blow Molding, Thermoforming, Compression Molding.

1410544 Polymer Formation Processes (Advanced Polymer Processing) 3 cr.
Extruders, Single Screw Extruder, Twin Screw Extruder, Devolatilization in Extruders, Reactive Extrusion, Mixing Zone in Extruders, Plasticating Extruders, Extrusion Dies, Coextrusion Dies, Die Design, Laminar Mixing, Residence Time Distribution, Strain Distribution, Dispersive Mixing, Distribution Mixing.

1410557 Advanced Rheology 3 cr.
Polymer Rheology, Classification of Non-Newtonian Fluids, Time Dependent Fluids, Time Independent Fluids, Viscoelastic Fluids, Linear Viscoelasticity, Flow of Non-Newtonian Fluids in channels, Mixing of polymeric melts, Capillary Viscometers, Rotational Viscometers, Elastic effects in polymer melt flow, The application of Rheological Studies to polymer Processing, Elongational Flow in Polymer Processing.

1410562 Polymer Modification and Alloys 3 cr.
Free Radical Grafting of Monomers onto Polymers by Reactive Extrusion, Modification of Polypropylene, Modification of polymer melts by reactive mixing, Moisture Cross-Linkable Polyolefins, polymer Blending, Reactive Polymer Blending.

1410545 Advanced Kinetics of Polymerization 3 cr.

1410546 Kinetics & Reactor Polymerization 3 cr.

1410549 Advanced Polymerization Processes 3 cr.

1410560 Polymer Engineering Properties 3 cr.

1410564 Biocompatible and Degradation of Polymers 3 cr.

1410565 Advanced physical chemistry of polymers 3 cr.

Transport Phenomena: Elective courses

1410555 Simulation of Transport Phenomena 3 cr.
A general processing system is composed of a numerous number of various elements that not only are connected to each other for transfer of momentum, various types of energies, and masses in a complex form, but also it is communicating with its environment. Modeling and simulation of such systems is complex and need a special treatment and management. In this course, besides of discussion on management of such complex systems, various topics such as types of models, dependency of models to their applications, various types of modeling, model simplification, and involved laws and constitute relationships are lectured. In this regards, by introduction of various types of boundary and initial conditions, and common approaches to simulation methods, various solution methods are discussed for simulating behaviors of systems.

1410547 Advanced Convection Heat Transfer 3 cr.

1410548 Boundary Layer Theory 3 cr.

1410551 Suspended Dynamic Fluids 3 cr.

1410644 Two Phase Fluid Mechanics

Research Areas:

Supercritical Fluid Technology: Principles and Applications

Over the past two decades supercritical fluid processing has shown great promise in addressing many of the technical challenges faced by scientists and engineers. Supercritical fluids have proved to be effective solvents and mediums for applications in chemical, petrochemical, nanotechnological, food, pharmaceutical and environmental processes. The principles and practice of supercritical fluid technology and their diverse applications in nanotechnology, separation, reaction, extraction, and purification are the research subjects of this group. As nanoparticle design is presently a major development in supercritical fluids applications, mainly in the pharmaceutical, nutraceutical, cosmetics and specialty chemistry industries, the following two techniques are currently used to manufacture nanoparticles (nanocatalysts), nanocapsules, liposomes or other dispersed materials like microfibers. Two important methods have been developed to form nanoparticles, namely, RESS (Rapid Expansion from Supercritical Solution) and SAS (Supercritical Anti-Solvent) process. Interconnecting the fundamentals of supercritical fluid technology to controlled drug delivery in medical applications is another important research activity of this group. In addition, Supercritical Fluid Extraction (SFE) is the process of separating one component from another (the matrix) using supercritical fluids as the extracting solvents. SFE can be used as a sample preparation step for analytical purposes, or on a larger scale to either strip unwanted material from a product or collect a desired product. In the field of extraction processes, using supercritical fluids such as CO2 overcomes many drawbacks linked to the use of liquid organic solvents such as liquid hexane. In this context, supercritical carbon

dioxide extraction, as an efficient extraction method, has attracted much attention during the last two decades due to its advantages including being non-explosive, non-toxic, and available in high purity with low cost and non-solvent residues. Besides, the extraction by supercritical CO2 omits the unit operations such as distillation in comparison with classical processes using hexane. Another field is focused on the studies associated with using supercritical carbon dioxide to extract a wide variety of contaminants from environmental matrices. This includes the remediation of soils contaminated with polyaromatic hydrocarbons, extraction of metals from water via chelation in supercritical carbon dioxide, supercritical regeneration of activated carbon adsorbents and extraction of trace contaminants from aqueous waste solutions.
The research subjects of this group include:
(1) Experimental Techniques in High-Pressure Studies
(2) Process Operations
(3) Industrial Applications
(4) Supercritical Fluid Process Development Studies
(5) Polymer and Monomer Processing
(6) Processing Pharmaceuticals, Natural Products, Specialty Chemicals, and Waste Streams (7) Chemical Reactions in Supercritical Fluids
(8) Nanoparticles (i.e., nanocatalysts) Size Design via RESS and GAS/SAS/ASES/SEDS/PGSS
(9) Reactions in Supercritical Media Leading to Nanoparticle Formation

Transport Phenomena & Rheology

Several Faculty members are engaged in experimental, computational and physical aspects of convective heat transfer and fluid dynamics relevant to a wide range of engineering applications of such phenomena. Examples of specific topics addressed by the group are: convective heat transfer, numerical methods in heat transfer and fluid flow, heat transfer in complex geometries, development of rheological equations of state for non-Newtonian liquids, problems involved in heat and mass transfer in Newtonian and non-Newtonian fluids, turbulent flow and heat transfer, two phase flow, membrane processes, and separation technologies.

Water Treatment and Pollution Control

Water is a valuable resource in the central plateau of Iran and the continuing industrial and agricultural developments in the region is an ever growing challenge for the researchers concerned with the conservation and protection of water resources. Increasing the efficiency and improvement of the industrial water producing facilities in the major process plants of the region, monitoring and modelling dispersion of hazardous chemical wastes in Zayandeh-Rood and the development of processes for manufacturing the major water treatment chemicals utilized by the region's industries are among the goals of this research group.

Corrosion and Electrochemical Engineering

Many aspects of corrosion and electrochemical engineering are addressed by this group. The development and characterization of organic and inorganic inhibitors, evaluation of corrosion behavior of coatings on metals, cathodic protection of steel in soils and concrete, corrosion in water and petroleum, corrosion of steel in polymer impregnated concrete and investigating the stability of passive films by DC and AC techniques are among the subjects being investigated.
The group is undertaking kinetic studies in corrosion by applying the AC-Impedance technique. Different electrochemical methods are to be applied in the production of organic and inorganic substances. Furthermore, electrochemical models are to be developed for enhancing the separation of impurities in solutions.

Distillation & Separation Processes

A diverse set of separation processes are under investigation by members of this group examples of which are: simulation as well as experimental studies in tray type and packed distillation columns, separations based on the use of surface active agents, novel techniques on the basis of fundamental surface studies e.g. the apron flotation, electrodialysis and other membrane based separation techniques.

Polymer Technology

The activities of this group are focused on polymerization, polymer processing, polymer degradation and radiation chemistry. The effect of different additives on polymer structures is investigated by applying different techniques. In the area of radiation chemistry**,** an x-ray source is used for chemical modification of polymers.

Investigating the degradability of polyolefins for producing life-controlled polymers is an integral part of the program pursued by this group.

In addition to research activities cited, the faculty members are involved in diverse research activities on fluid mechanics, coupled transport processes, chemical reaction engineering, process simulation and process control.

Biotechnolog

Industrial biotechnology is an interesting and growing branch in Chemical Engineering Department. Different research activities and projects are currently performed in this group including: Bioenergy, Bioethanol, Biogas, Sustainable Resources, Environmental Biotechnology, Enzyme purification, and Bioprocesses.

Biotechnology is one of three major fields of undergraduate study in this Department for students to gain the required and useful skills for advanced studies and investigations. These students take 10 credits of elective courses and 2 specialized Labs.

Nanofluid Research Group

Conventional heat transfer fluids play an important role in a number of industries such as power generation, chemical processes, etc, but these fluids are inadequate for high heat flux applications due to restrictions of their thermal properties. Development of high performance heat transfer fluids has been a subject of numerous investigations in the past few decades. One way of improving the thermal performance of fluids is to suspend small particles in them. Early studies used suspensions of milli- or micrometer sized particles which faced problems such as abrasion and channel clogging.

In recent years, modern technologies have permitted the manufacturing of particles of nanometer scale. Fluids with nanoparticles suspended are called nanofluids and have shown potential to resolve some disadvantages associated with the suspensions of large particles.

The aim of this research group is to identify and understand thermal behavior and flow features of nanofluids.

Educational and Research Facilities

The following laboratories are functional for both research and educational purposes. Each lab has pilot plants and/or equipment described below.

Unit Operations lab

Heat Transfer lab

Process Control lab

Fluid Mechanics lab

Petroleum Lab

Physical and chemical properties of polymers

Polymer Lab

Research Lab

Office of industrial collaborations:

The office is responsible for:

- Managing all aspects of student's mandatory training in various relevant industries such as refineries, petrochemical companies, steel production and manufacturing facilities, polymer production companies, etc. in Isfahan providence and all other areas in Iran. Usually, the main destinations of students are Isfahan Refinery and Isfahan Petrochemical Company.
- Arranging educational visits to major industries in Isfahan, such as Isfahan Refinery, Isfahan Petrochemical Company, Polyacryl Company, etc.
- Advising students on employment, informing senior and graduating students of possible employment opportunities

The Department of Chemical Engineering offers Bachelor of Science (B.Sc.), Master of Science (M.Sc.) and PhD degree Programs.

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