Department of Chemical Engineering

UNDERGRADUATE COURSE DESCRIPTIONS
for Chemical Engineering

Basic courses

Physics I
Fundamentals of mechanical physics
51 hours, 3 cr.
References:
1. D, Halliday and R. Resnick, “Fundamentals of Physics”, John Wiley and Sons lnc., 1986.

Physics II
Fundamentals of electrical physics
51 hours, 3 cr.
References:
1. D, Halliday and R. Resnick, “Fundamentals of Physics”, John Wiley and Sons lnc., 1986.

Physics LAB I
Implementing theoretical principles of mechanical physics
34 hours LAB, 1 cr.

Physics LAB II
Implementing theoretical principles of electrical physics
34 hours LAB, 1 cr.

General Mathematics I
Fundamentals of mathematics
68 hours, 4 cr.
References:
1. L. Leithold, “The Calculus with Analytic Geometry”, Vol. I, II, 5th Ed., Harper and Row Publisher, 1986.
2. R. A. Silverman, “Calculus with Analytic Geometry”, 4th Ed., Prentice Hall, 1984.
3. G. B. Thomas, “Elements of Calculus and Analytic Geometry”, Addisan Wesley, 1981.
4. R. Larson, “Calculus with Analytic Geometry”, 7th Ed, 2002.

General Mathematics II
Fundamentals of mathematics
68 hours, 4 cr.
References:
1. L. Leithold, “The Calculus with Analytic Geometry”, Vol. I, II, 5th Ed, Harper and Row Publisher, 1986.

2. .R. A. Silverman, “Calculus with Analytic Geometry”, 4th Ed, Prentice Hall, 1984.
3. .R. Larson, “Calculus with Analytic Geometry”, Heath publication, 7th Ed 2002.

General Chemistry I

Fundamentals of chemistry

51 hours, 3 cr.

References:

1. D. Ebbing and S. D. Gammon, “General Chemistry”, 9th Ed., Amazon, 2007.
2. C. E. Mortimer, “Introduction to Chemistry”, Van Nost, Reinhold, 1977.

General Chemistry II

Fundamentals of chemistry

51 hours, 3 cr

1. D. Ebbing and S. D. Gammon, “General Chemistry”, 9th Ed., Amazon, 2007.
2. C. E. Mortimer, “Introduction to Chemistry”, Van Nost, Reinhold, 1977.

General Chemistry LAB

Independent laboratory work

34 hours LAB, 1 cr.

Organic Chemistry (For Chemical Engineering Students)

Structure and bonding, alkanes, alkenes, reactions and mechanism, alkyls, stereochemistry, alkynes, aldehydes, ketones, alcohols, ethers, carboxylic acids, nitrogen compounds, Benzene derivatives.

51 hours, 3 cr.

References:

1. Organic Chemistry: A Short Course, H. Hart, L. E. Craine, D. J. Hart, 12th Ed., 2002, Designed specifically for the one-semester short course in organic chemistry. Houghton Mifflin (2007).
2. A Short Course in Organic Chemistry, E. E. Burgoyne, McGraw Hill Book Company, New York.
3. Organic Chemistry, the Basis of life.

Organic Chemistry LAB (For Chemical Engineering Students)

Independent laboratory work in synthesis, separation and identification of organic compounds.

34 hours LAB, 1 cr.

Analytical Chemistry (For Chemical Engineering Students)

Statistics, Acid – Base precipitation, volumetric titration, complexometry, Electrochemistry, Oxidation - Reduction titration, Instrumentation.

51 hours, 3 cr.

References:

1. D.A. SkooG, Fundamentals of Analytical Chemistry.

Analytical Chemistry LAB (For Chemical Engineering Students)

Experiments in precipitation, complexometry, electrochemistry, volumetric and gravimetric.

34 hours LAB, 1 cr.

Differential Equations

Principles of differential equations, different ways of solving equations: First-order ordinary differential equations, second-order ordinary differential equations; series solutions of ordinary differential equations, homogeneous ordinary differential equations, variation of parameters, method of undetermined coefficients, Bessel functions, gamma function, Legendre polynomials, systems of differential equations, Laplace transform, and its applications.

51 hours, 3 cr.

References:

1. F. Simmons, "Differential Equations with Applications and Historical Notes", McGraw Hill, 8th Ed., 2005.

General workshop 1

Carpentry & ironwork operations such as welding, filings, shearing.

Practical,

1 cr.

Principles of electrical engineering

Fundamentals of electrical engineering

51 hours, 3 cr.

References:

1. H. William, “Electric Circuits”, McGraw Hill, 1971.

Fundamentals of Programming Language (PHYTHON)

The way of the program, Variables, expressions and statements, Functions, Conditionals, Fruitful functions, Strings, Tuples, Event-Driven Programming, Lists, Modules, Files, List Algorithms, Classes and Objects — the Basics, Classes and Objects — Digging a little deeper, Exceptions, Dictionaries, Debugging.

51 hours, 3 cr.

References:

1. Deitel and Deitel, “C++ How to Program”, Prntice Hall Inc., 2006.

Principal courses

Material and Energy Balance

Principles of engineering calculations, The mass balance equation, systems of simultaneous equations, recycle, bypass, purge, properties of gases; liquids; and Solids, saturation and equilibrium, 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, analysis of humidity charts.

51 hours, 3 cr.

References:

1. D. M. Himmelblau and J. B. Riggs, "Basic Principles and Calculations in Chemical Engineering", 7th Ed. , Prentice Hall Inc., 2004.

Fluid Mechanics I

Foundations of fluid mechanics:

Fluid and flow properties, fluids statics, basic equation of fluid flow (continuity and momentum equations), macroscopic balances, dimensional analysis, boundary layers (laminar- and turbulent flow), fully developed laminar flow. Shear stress in laminar and turbulent flow, viscous flow. Turbulent flow in pipes and ducts, flow of incompressible non-Newtonian fluids in pipes.

51 hours, 3 cr.

References:

1. R.B. Bird, W.E. Stewart and E.W. Lightfoot, "Transport Phenomena", John Wiley and Sons Inc., 2002.
2. V.L. Streeter, E.B. Wylie and K.W. Bedford, "Fluid Mechanics", 9th Ed., McGraw Hill,1996.
3. W. L. McCabe, J. C. Smith, P. Harriott. Unit Operations of Chemical Engineering, 7th Ed., McGraw Hill Inc., 2005

Fluid Mechanics II

Steady one-dimensional compressible flow, momentum and energy equations, equations of state, speed of sound in fluids, Mach number, isothermal & non-isothermal flow of an ideal gas in pipes, adiabatic flow, and compressor. Introduction to two-phase flow, flow & pressure measurement, flow measuring devices. Liquid-solid flow, flow in open
channels, fluid flow about immersed bodies (motion of particles through fluids, motion of fluid through beds, fluidized beds).

34 hours, 2 cr.

References:

1. W. L. McCabe; J. C. Smith; P. Harriot. Unit Operations of Chemical Engineering, McGraw Hill Inc., 7Ed, 2005.

Fluid Mechanics LAB

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 fluidized beds, hydrostatic pressure, drag force, gas viscosity determination, development of velocity profiles in pipes.
34 hours LAB, 1 cr.

Thermodynamics I

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. 51 hours, 3 cr.
References:

1. J. M. Smith, H. C. Van Ness, M. M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th Ed, McGraw Hill, 2005.

Thermodynamics II

Properties of systems of variable composition, Partial properties, Excess properties, the calculation of phase equilibrium for ideal gas and ideal solution, Raoult's law, VLE calculations at low to moderate pressures, VLE calculations based on generalized equations of state, solution thermodynamics, Chemical reaction equilibrium.
51 hours, 3 cr.
References:

1. J. M. Smith, H. C. Van Ness, M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 9th Ed, McGraw Hill, 2007.

Heat Transfer I

Physical origins and rate equations of conduction, convection, 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.
51 hours, 3 cr.
Refrences:

1. Holman, J.P., Heat Transfer, McGraw Hill, 8th Ed., 1997.
2. Incropera. F.P.& Dewitt O.P., Fundamentals of Heat & Mass Transfer, Wiley, 1997.

Applied Heat Transfer

Fundamental concepts of radiation, radiation exchange between surfaces, introduction to heat exchangers, 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 furnaces, calculation of heat transfer in agitated vessels.

51 hours, 3 cr.

References:

1. Holman, J.P., Heat Transfer, McGraw Hill, 8th Ed., 1997.
2. Incropera. F.P.& Dewitt O.P., Fundamentals of Heat & Mass Transfer, Wiley, 1997.
3. Bejan. A., Heat Transfer, Wiley, 1993.
4. Ganapathy, V., Applied Heat Transfer, Pennwell, 1985.

Heat Transfer LAB

Steam to water heat exchanger for studying film condensation, water turbulent flow heat transfer unit, boiling heat transfer unit, heat conduction unit, thermal radiation unit, temperature measurement unit, refrigeration cycle demonstration unit, vapor compression refrigeration unit, convective heat transfer unit.

34 hours LAB, 1 cr.

Statics and Strength of materials

Force systems, equilibrium, structures, distributed forces, friction, moments and products of inertia, Tension, compression, strain, torsion, bending, shear, combined stresses in beams and frames, Mohr circle.

51 hours, 3 cr.

References:

1. J. L. Meriam, L. G. Kraige, “Engineering Mechanics, Statics”, Vol. 1, John Wiley and Sons Inc., 28th Ed., 2001.

Technical Drawing

Drawing instruments and accessories, geometrical constructions, scales, three-dimensional graphics, descriptive geometry, orthographic projection, isometric projection, welding, fasteners, AutoCAD.

51 hours practical + 17 hours theoretical, 2 cr.

Physical Chemistry (For Chemical Engineering Students)

Chemical kinetics, gas kinetics, quantum chemistry, statistical thermodynamics.

51 hours, 3 cr.

References:

1. P. W. Atkins. Physical Chemistry
2. I. N. Levine. Physical Chemistry
3. G. M. Barrow. Physical Chemistry

Physical Chemistry LAB (For Chemical Engineering Students)

Experiments in chemical kinetics, adsorption, equilibrium constants, phase diagrams. Conductometry, MW determination of macromolecules.
34 hours LAB, 1 cr.

Kinetics & Reactor Design

Chemical reaction equilibrium, interpretation 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, CSTR and Plug-flow Reactors.
51 hours, 3 cr.
References:

1. Levenspiel, O. , "Chmical Reaction Engineering. Butterworth, 2002.
2. Fogler, S., "Elememts of Chemical Reaction Engineering". Prentice Hall,

Applied Mathematics in Chemical Engineering

Mathematical modeling of processing systems, review of analytical solution of algebraic and ordinary differential equations, numerical integration and differentiation, interpolation, extrapolation, numerical solution of algebraic and ordinary differential equations (ODE). Solution of partial differential equations (PDE) implementing combination and separation of variables, utilization of these methods to solve chemical engineering problems.
51 hours, 3 cr.
References:

1. R. G. Rice and D. D. DO. Applied Mathematics and Modeling for Chemical Engineers, John Wiley and Sons Inc.1995.
2. V. G. Jenson and G. V. Jeffreys. Mathematical Methods in Chemical Engineering, 1997.

Mass Transfer

Molecular diffusion in fluids, mass transfer coefficients, interphase mass transfer, equipment for gas-liquid operations and gas absorption, mass transfer through packed columns.
51 hours, 3 cr
References:

1. R.E.Treybal. Mass Transfer Operations. McGraw-Hill, 1980.

Process Control

Introduction to process control, Laplace transformation, linear system responses control and final control element systems, block diagram and closed loop transfer functions, stability, root-locus, frequency response, design of control systems implementing frequency response, stability analysis, control valve,

Actual controllers versus Ideals, pneumatic controller mechanism, electronics simulation of controllers, electronics simulation of processes, introduction to control systems, how to design controllers,

51 hours, 3 cr.

References:

1. D.R. Coughanover " Process System Anslysis and Control, 2009.
2. G. Stephannopolous " Chemical Process Control", 1984.
3. T.E. Marlin, " Process Control Designing Processes and Control System for Dynamics Performance" , 2000
4. D.E. Seborg, " Process Dynamics and Control " , 1989.
5. C.A. Smith, " Principles and Practice of Automatic Process Control, "1997.

Process control LAB

Processes control lab is comprised of the following set of experimental rigs: First Order Systems, second order systems, air systems, feedback control of various process operations, dynamics of process components such as temperature sensors and pneumatic valves.

34 hours LAB, 1 cr.

Unit Operation I

DISTILLATION: vapor-liquid equilibrium, flash evaporation, differential (batch) distillation, distillation columns, number of distillation trays, minimum reflux ratio, Ponchon-Savarit method, McCabe-Thiele method.

LIQUID-LIQUID EXTRACTION: singular stage unit, multi stages unit (cross flow, current flow, and counter-current flow).

51 hours, 3 cr.

References:

1. R. E. Treybal. Mass Transfer Operations, 3rd Edition, McGraw Hill Inc., 1980.

Unit Operation II

Evaporation & crystallization, humidification, adsorption, filtration & deposition, drying and mechanical separations, dryers.

51 hours, 3 cr.

References:

1. Robert E. Treybal. Mass Transfer Operations, 3rd Edition, 1980.
2. W. L. McCabe, J. C. Smith, P. Harriott. Unit Operations of Chemical Engineering, 7th Ed., McGraw Hill Inc., 2005

Unit Operation LAB

Boiler, tray and packed distillation columns, falling film and circulation evaporators, solid-liquid and liquid-liquid extraction plants, drum and spray dryer.

16 hours LAB, 1 cr.

Plant Design & Economics

PFD & BFD diagrams, Flow-sheeting ,general design considerations, cost estimation, depreciation cost, Total capital investment, Fixed capital investment, Working capital , optimization, materials of construction, minimum acceptable rate of return, rate of investment, payback period, fluid transfer equipment design & cost, heat transfer equipment design & cost, mass transfer equipment design & cost.

51 hours, 3 cr.

References:

1. Peters, Max Stone, Kaus D. Timmerhaus, and R.E.West. Plant Design and Economics for Chemical Engineers, McGrew Hill, 2003

Engineering mathematics

Fourier series and integrals, Fourier transform, Partial differential equations, Analytic Functions, conformal mapping, and different integrals.

51 hours, 3 cr.

References:

1. E. Kreyszig, “Advanced Engineering Mathematics”, 8th Ed. John Wiley and Sons Inc., 8th Ed. 2005.

Numerical Calculations

Numerical methods for solving system of linear equations.

34 hours, 2 cr.

References:

1. S. C. Chapra and R. Canale,"Numerical Methods for Engineers", Prentice Hall Inc., 1999.
2. C. F. Gerald and P. O. Wheatly, "Applied Numerical Analysis", Addison Wesley Publishing Company, 6th Ed., 1998.
3. A. Constantindes and N. Mostoufi, "Numerical Methods for Chemical Engineering With MATLAB Applications", Prentice Hall Inc., 1999.

BSc Project

BSc thesis: "Removal of heavy metals in industrial wastewater by electrospun nanofibers"

3 cr.

Specialized courses

Industrial Catalysts

Chemical Catalyzers' definition and application, structure and classification of chemical catalyzers, catalyzed reactions, mass transfer on the surface of catalyzers, adsorption and absorption principles , alkalization, sulfurization, hydrocracking, manufacturing of catalyzers, calculation of required mass of catalyzers for specific reactions, catalytic reactors.

51 hours, 3 cr.

References:

1. Applied Heterogeneous Catalysis,design, Manufacture. Use of Solid Catalysis. By: J. F. LEPage, 1987.
2. Introduction to the Principles of Heterogeneous Catalysis, J. W. Thomas
3. Chemical Reaction Engineering,Third Edition,Octave Levenspiel,1999.

Water and Waste Water Treatment

Theory and description of methods of waste water treatment, Theoretical and Chemical oxygen demand, Biological oxygen demand (BOD), Bacteriology, Activated sludge process, Aeration, Wet land & Lagoon. Biological Treatment: bioreactors, bio-filters, biological towers, aerobic/anaerobic/facultative systems, N.R.C formula.

34 hours, 2 cr.

References:

1. R. Sanks,"Water Treatment Plant Design", John Wiley and Sons Inc., 1995.

Corrosion in petrochemical industry

Thermodynamics and kinetics of corrosion, various types of corrosion, methods of corrosion prevention, corrosion in boiler, cooling towers and petroleum industry.

51 hours, 3 cr.

References:

1. H. H. Uhlig and R. W. Revie, "Corrosion and Corrosion Control", 3rd Ed., John Wiley and Sons Inc., New York, 1985.
2. A. Zaki, "Principles of Corrosion Engineering and Corrosion Control", Elsevier, 2003.
3. P. Roberge, "Handbook of Corrosion Engineering", McGraw Hill,2000.

Construction and Application of Polymer

An introduction to polymer science, Principal of determination of molecular weight, physical and mechanical properties of polymers, Polymerization, copolymerization, Processing technology of polymers, Development of rate expressions for polymerization reactions, Development of characterization factors for polymerization reactions, Design of polymerization reactors. 34 hours, 2 cr.

References:

1. F. Rodriguez, "Principles of Polymer Systems", NY, 1996.
2. Kumar, R. K. Gupta, "Fundamentals of Polymer Engineering", 2003.

Food Biochemistry

General Chemistry of Microorganisms and Biochemicals, Biochemistry Definition and Division
The composition of foods including sugars, fats, amino acids, proteins and enzymes, as well as acids
Nucleic
Bio-energy: photosynthesis and energy generation, sugar metabolism without air, glycolysis pathogens, pentosulfate, Crevice Period or Citric Acid
Fat metabolism - electron transport and protein metabolism - nitrogen and phosphorus periods - biochemistry of food
Milk, meat and cereals include biochemical changes during storage and conversion operations.
34 hours, 2 cr.
References:

1. Shahbazi and Maleknia N. Vol I and II. General biochemistry ,Tehran University .
2. Conn, E.E. and Stumpe, P.K. Outline of Biochemistry, John Wiley and Sons Inc. New York .

Introduction to Biochemistry Engineering

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.
51 hours, 3 cr.
References:

1. Biochemical Engineering by: Hamphery and Aiba.
2. Fundamental of Biochemical Engineering by: Bailey and Olis.

Microbiology Lab Foundations of Inorganic Chemistry

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.
34 hours LAB, 1 cr.