BACHELOR OF ENGINEERING IN CHEMICAL AND PETROCHEMICAL ENGINEERING

Main Language of Instruction:
French ☑ English ○ Arabic ○

Campus Where the Program Is Offered: CST

OBJECTIVES

The Bachelor of Engineering in Chemical and Petrochemical Engineering aims to equip students to:

- Pursue successful professional careers by skillfully solving emerging engineering problems.
- Contribute to the sustainable growth and development of society.
- Sustain intellectual curiosity and further expand their knowledge and skills allowing them to assimilate the advances in the profession in a changing world.
- Assume leadership roles while respecting diversity and ethical practices.

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to effectively communicate with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to effectively function on a team whose members provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

PROGRAM REQUIREMENTS

180 credits: Required courses (152 credits), Institution's elective courses (26 credits), Open elective course (2 credits)
USJ General Education Program (26 credits – part of the above categories).

USJ General Education Program (26 Cr.)
At least 10 additional credits are earned at the Department of Preparatory Classes
English (4 Cr.)
English Level A (4 Cr.)
Arabic (4 Cr.)
Open elective: Arabic Culture and Language (2 Cr.)
Business Law (2 Cr.)
Humanities (4 Cr.)
Engineering Ethics (4 Cr.)
4 credits are earned at the Preparatory Classes Department
Social Sciences (6 Cr.)
One institution's elective: Entrepreneurship (2 Cr.) or Work Ready Now (2 Cr.)
Production Management (2 Cr.)
Project Management (2 Cr.)
Communication Techniques (8 Cr.)
Communication Skills (2 Cr.)

Process Design Project (2 out of the 6 credits of the course)
Final Year Project (4 out of the 16 credits of the course)

Quantitative Techniques

6 credits are earned at the Preparatory Classes Department

Fundamental courses

Required Courses (152 Cr.)

Bioreactors and Fermentation Lab (2 Cr.)
Business Law (2 Cr.)
Chemical kinetics/heterogeneous catalysis (2 Cr.)
Chemical Thermodynamics (4 Cr.)
Chemistry of Polymers (4 Cr.)
Communication Skills (2 Cr.)
Contactors: systems G-L, F-S, L-L (4 Cr.)
Dynamics and Process Control (4 Cr.)
Energy Management Applied to Processes and Utilities (2 Cr.)
Engineering Ethics (4 Cr.)
English (4 Cr.)
Final Year Project (16 Cr.)
Fluid Mechanics (4 Cr.)
Formulation Processes (4 Cr.)
Ideal and Non-ideal Reactors (2 Cr.)
Industrial Chemistry (4 Cr.)
Internship (2 Cr.)
Internship II (2 Cr.)
Introduction to Continuous and Discontinuous Processes (4 Cr.)
Mass and Energy Balances (6 Cr.)
Mass Transfer (4 Cr.)
Mathematical Techniques in Chemical Engineering (6 Cr.)
Mechanical Agitation and Transfer (2 Cr.)
Modeling and Simulation (2 Cr.)
Numerical analysis (4 Cr.)
Petrochemical Processes (4 Cr.)
Process Design Project (6 Cr.)
Process Engineering Lab (2 Cr.)
Process Equipment Design (4 Cr.)
Production Management (2 Cr.)
Programming and Databases (4 Cr.)
Project Management (2 Cr.)
Quality Health Safety (2 Cr.)
Refining Processes (6 Cr.)
Separation Techniques (6 Cr.)
Statistics (4 Cr.)
Theoretical Chemistry (4 Cr.)
Thermal Engineering (2 Cr.)
Total Synthesis and Activation Methods (4 Cr.)
Unit Operations: Adsorption, Drying, Crystallization (4 Cr.)

Institution's Elective Courses (24 Cr.)

Six courses to choose from the list below
Biochemical Techniques and Instrumentation (4 Cr.)
Composite Materials (4 Cr.)
Design and Construction of Wells (4 Cr.)
Drilling Technology (4 Cr.)
Food Manufacturing and Packaging (4 Cr.)

Microbiology-Enzymatic Catalysis (4 Cr.)
Pharmaceutical Process Design (4 Cr.)
Reservoir Engineering (4 Cr.)
Solid and Hazardous Waste Management (4 Cr.)
Statistical Analysis and Design of Pharmaceutical Operations (4 Cr.)
Tribology and Lubricants (4 Cr.)
Wastewater Treatment (4 Cr.)

One restricted elective to choose either
Entrepreneurship (2 Cr.) or Work Ready Now (2 Cr.)

Open Elective Course
Arabic Culture and Language (2 Cr.)

SUGGESTED STUDY PLAN

Semester1

Code	Course Name	Credits
020CCHCS1	Chemical Kinetics/Heterogeneous Catalysis	2
020THCCS1	Chemical Thermodynamics	4
020CHPCS1	Chemistry of Polymers	4
020ETHCS1	Engineering Ethics	4
020BMECS1	Mass and Energy Balances	6
020ANNCS1	Numerical Analysis	4
020IBDCS1	Programming and Databases	4
020CHTCS1	Theoretical Chemistry	4
	Total	**32**

Semester 2

Code	Course Name	Credits
	Arabic Open Elective	2
020DROCS2	Business Law	2
020COMCS2	Communication Skills	2
020MEFCS2	Fluid Mechanics	4
020RNICS2	Ideal and Non-ideal Reactors	2
020CHICS2	Industrial Chemistry	4
020PROCS2	Introduction to Continuous and Discontinuous Processes	4
020PDTCS2	Mass Transfer	4
020QHSCS2	Quality Health Safety	2
020STACS2	Statistics	4
020STMCS2	Total Synthesis and Activation Methods	4
	Total	**34**

Semester 3

Code	Course Name	Credits
020CONCS3	Contactors: systems G-L, F-S, L-L	4
020DCPCS3	Dynamics and Process Control	4
020ST1CS3	Internship (S2-S3)	2
020MOSCS3	Modeling and Simulation	2
020PRPCS3	Refining Processes	6
020TESCS3	Separation Techniques	6
020GTHCS3	Thermal Engineering	2
020OPUCS3	Unit Operations: Adsorption, Drying, Crystallization	4
	Institution's Elective	4
	Total	**34**

Semester 4

Code	Course Name	Credits
020BRFCS4	Bioreactors and Fermentation Lab	4
020ANGCS4	English	2
020TMCCS4	Mathematical Techniques in Chemical Engineering	6
020AMTCS4	Mechanical Agitation and Transfer	2
020PPCCS4	Petrochemical Processes	4
020PDPCS4	Process Design Project	6
020CEPCS4	Process Equipment Design	4
020GEPCS4	Production Management	2
	Institution's Elective: General Education	2
	Total	**32**

Semester 5

Code	Course Name	Credits
020GEACS5	Energy Management Applied to Processes and Utilities	2
020PFOCS5	Formulation Processes	4
020ST2CS5	Internship II	2
020GEPCS5	Process Engineering Lab	2
020GPRCS5	Project Management	2
	Institution's Electives	20
	Total	**32**

Semester 6

Code	Course Name	Credits
020PFECS6	Final Year Project	16
	Total	**16**

COURSE DESCRIPTION

020TBICS5 Biochemical Techniques and Instrumentation 4 Cr.

General principle of chemical and physical quantification. Comparison of different methods for identification and quantification of biomolecules. Electrochemical principle of biomolecule quantification and separation. Electrochemical instruments. Spectrophotometric methods and instruments in quantitative analysis. Chromatographic principles of separation, identification, and quantitative analysis. Chromatographic instruments.

020BRFCS4 Bioreactors and Fermentation Lab 2 Cr.

Methods of microbiology. Microbial growth: analysis. Microbial growth: kinetic analysis. Growth and production reactions. Microbial growth: methods for biomass measurement. Microbial cell: structure and function (schema). Kinetic analysis of fermentation. Overview of metabolism (nutrition; substrates and products). Major metabolic pathways. Microbial processes: kinetic laws, kinetics of industrial processes. Modeling of fermentation processes: physiological models, industrial fermentations. Fermentation practical work.

020DROCS2 Business Law 2 Cr.

Introduction to law, rules, and sanctions. Subjective rights. The trial, first instance, avenues of appeal (in civil and commercial matters). Commercial law: commercial acts, traders, goodwill. Commercial companies. Legal framework of the company's legal environment. Main payment and credit tools. Guarantees given and received by the company.

020CCHCS1 Chemical Kinetics/Heterogeneous Catalysis 4 Cr.

Reactions in open and closed sequences. Basic concepts of catalysis and heterogeneous kinetics. Different stages of catalytic action (diffusion, adsorption, and surface reaction). Properties of solid catalysts and their main industrial and environmental applications.
Prerequisite: Kinetics of Chemical Reactions (020CIHNI4)

020THCCS1 Chemical Thermodynamics 4 Cr.

Chapter I - Reminders of the concepts; Chapter II - Perfect systems; Chapter III - Principle of the study of balances - The variance; Chapter IV - Binary solutions – Raoult and Henry; Chapter V – Thermodynamics stability- Liquid binary system - stability with respect to diffusion - Liquid-liquid transition or demixing; Chapter VI- The model of MSR regular solutions; Chapter VII Fractional distillation; Chapter VIII - Azeotropic mixtures and their mode of separation; Chapter IX – Completely or partially immiscible solid liquid mixtures Eutectics
Prerequisite: Thermodynamics II (020TH2NI3)

020CHPCS2 Chemistry of Polymers 4 Cr.

Chapter I – Introduction – Definition of polymers, nomenclature, and classifications. Chapter II - Concepts of macromolecules: linkage of units, tacticity, and macromolecular masses. Chapter III - Reactions and polymerization techniques: step polymerizations - chain polymerizations. Chapter IV – Polymers and cohesion of macromolecular systems. Chapter V - Morphology in the condensed state. Chapter VI - Phase transitions. Chapter VII - Special structures. Chapter VIII - Thermomechanical properties of polymers. Chapter IX - Additives and adjuvants in polymers. Chapter X - Polymer transformation processes.
Prerequisite: Organic Chemistry (020CORNI3)

020COMCS2 Communication Skills 2 Cr.

Communication is of high importance for an engineering student. Indeed, whether in academic or professional activities, transmitting information is a powerful tool for convincing and even influencing. Communication is unavoidable, but it includes many errors and risks to be avoided. Otherwise, the reception of the information may be disturbed and misunderstood. This course offers students the knowledge of essential basic rules of main ways of communication (written, verbal and non-verbal) and making them aware of the errors to be avoided.

020MACCS4 Composite Materials 4 Cr.

This course explores the fundamental principles of composite materials, covering their classification, fabrication, characterization, micromechanics, and macromechanics. Non-conventional composites are also addressed.
Prerequisite: Inorganic Chemistry and Laboratory (020CITNI4) - Polymer Chemistry (020CHPCS1)

020CONCS3 Contactors: Systems G-L, F-S, L-L 4 Cr.

Gas-liquid contactor technology: case of tray and packed columns. Sizing of technologies to implement them in gas-liquid separation columns in countercurrent. Description of industrial contactors (individualized stage contactors, differential contactors). Criteria for selecting devices. Overview: classification of fluid-solid contactors, applications, advantages, and disadvantages. Characterization of divided solids (grain scale, particle bed): porosities, densities, compressibility of a powder, specific surfaces, equivalent diameters and shape factor, particle size distribution and mean diameter, cohesiveness and flowability of a powder. Flow through fixed beds: radius and hydraulic diameter, Darcy's law, Kozemy-Carman relation, Ergun relation. Fluidized bed contactor: general presentation, different hydrodynamic regimes, powder classification, fluidization limits, expansion of fluidized beds, bubbling phenomena, technology (distributor calculation, cyclone calculation, TDH calculation), heat transfer, application examples.
Prerequisite: Mass Transfer (020PDTCS2)

020CPRCS5 Design and Construction of Wells 4 Cr.

This course is the second course in oil and gas well drilling that students take. A basic knowledge about drilling rigs, onshore and offshore, and the drilling rig components is needed. This course focuses on the construction of a well from the beginning where the cellar is prepared, the rig is located, drilling the consecutive holes, running casing and cementing it, buildup of the wellheads, and all the processes involved within these major steps. Process such as bottom hole equipment, drilling fluids, tubular goods, directional and horizontal drilling, processes that ensure successful reaching of TD (Total Depth), and getting an idea of drilling challenges that may be encountered during the well construction process.
Prerequisite: Drilling Technology (020TDFCS3)

020TDFCS3 Drilling Technology 4 Cr.

A course on theoretical and practical methods of calculation and operation of drilling equipment and their systems: electrical systems, fluid systems, lifting and rotation systems, control systems, drill string and drill bits, casing and cementing systems.
Prerequisite: Geology (020GELNI4)

020DCPCS3 Dynamics and Process Control 4 Cr.

Introduction to process control: characteristics and associated problems. Dynamic modeling of chemical processes. Laplace transform and solutions of differential equations. Transfer function and dynamic behavior of first and second-order systems. Closed-loop control. Basic principles and new techniques related to the dynamics of continuous, batch, and hybrid processes. Development of a methodology in modeling (development and structuring of models) and dynamic process simulation based on algebraic-differential processing with extensions for parameter identification, constraint-based simulation, and optimization.
Prerequisite: Introduction to Continuous and discontinuous Processes (020PROCS2)

020GEACS5 Energy Management Applied to Processes and Utilities 2 Cr.

Global energy balances. Energy balances on an industrial site. Different uses of energy. General presentation of utilities and typical processes. Energy efficiency. Energy saving potentials. Reminders on heat exchange laws. Heat exchanger design method (thermal calculations and pressure loss calculations). Air-cooled and condenser technology. Cold production in industry, components (theoretical and real cycle, COP and Carnot efficiency). Industrial combustion. Boiler technology and operation (calculation of energy efficiency, economical steam production, flue gas recovery, air heater, economizer). Waste heat recovery (valorization by heat pump, by local electricity production via an ORC). Techno-economic aspect (case study).

020ANGCS4 English 4 Cr.

This course is designed to develop critical thinking, reading, oral and writing skills. It focuses on synthesizing sources producing a research paper and defending it in front of an audience. Emphasis is on the analytical reading of different text types required in the disciplines as well as on synthesis from a variety of sources to produce a written text and present it orally.

020ENPCS2 Entrepreneurship 2 Cr.

Should you become an entrepreneur? What skills do entrepreneurs need? Entrepreneurs in a market economy. Selecting a type of ownership. Developing a business plan. Identifying and addressing a market need. Financing, protecting, and insuring your business. Choosing your location and starting a business. Marketing your business. Hiring and managing personnel. Record keeping and accounting. Financial management. Using technology. Fulfilling your legal, ethical, and social obligations.

020ETHCS1 Engineering Ethics 4 Cr.

The course is aimed at students destined to work in public or private companies and in all fields. The objective of the course is to raise awareness of the necessity of ethics, which has become essential today, given current trends in sustainable development, dissemination of information to stakeholders, and transparent competition. The course offers future engineers the opportunity to analytically understand business issues and to distinguish themselves through their professionalism and enlightened attitude towards ethics. Finally, students will be more attentive to entrepreneurial approaches and the ethical reflection that accompanies them.

020MEFCS2 Fluid Mechanics 4 Cr.

Fluid statics. Conservation of mass, momentum, and energy. Dynamics of ideal fluids. Potential flow theory. Dimensional analysis and similarity. Viscous fluid flow.
Prerequisite: Introduction to Fluid Mechanics (020IMFNI4)

020FEACS5 Food Manufacturing and Packaging 4 Cr.

This course provides a comprehensive understanding of food packaging materials and processes. Students will explore the role of ingredients, learn about advanced techniques such as microencapsulation and texturization, and gain insights into various packaging materials and their manufacturing processes. Topics include lamination, coating, aseptic packaging, and considerations of permeability. By the end of the course, students will have a solid foundation in food packaging, preparing them to make informed decisions in the industry.

020PFOCS5 Formulation Processes 4 Cr.

Basic concepts and principles governing various colloidal environments. Physicochemical factors that can be manipulated (pH, temperature, salinity, addition of additives, etc.) to modulate the properties and behavior of these systems for desired applications. Applications in cosmetics and galenic formulations. Surfactants: 1) definition, 2) classification of surfactants, examples of industrial applications, 3) various surfactant structures, 4) surfactant character, 5) HLB concept. Aqueous surfactant solutions: 1) micelles, formation, definition of CMC and Nag (experimental determination, factors influencing CMC), direct micelle shapes and sizes, other aggregates. Microemulsions: 1) definition, phase diagram, parameters influencing formation and stability, Winsor regions. Emulsions, multiple emulsions: 1) formation, stability.

020PFECS6 Final Year Project 16 Cr.

The final year project is carried out in groups of 2 to 3 students aiming to design an industrial unit, following a feasibility study and a selection among process alternatives. Students must develop the process scheme, calculate mass and energy balances, choose and size major equipment components, determine process startup, shutdown, and control conditions, conduct environmental and safety assessments, and an economic evaluation of the design. A final report and two oral presentations are the main project deliverables.
Prerequisite: Process Design Project (020PDPCS4)

020RNICS2 Ideal and Non-Ideal Reactors 2 Cr.

Material balances on ideal reactors: closed reactor, open stirred reactor, piston reactor. Energy balances in ideal reactors: closed reactor, open reactor in steady state. Real flows in reactors. Residence time distribution. Measurement of RTD: tracer method. Diagnosis of reactor malfunction. Modeling of non-ideal reactors: cascade of perfectly mixed tanks model. Axial dispersion model. Models with adjustable zero parameters.
Prerequisite: Kinetics of Chemical Reactions (020CIHNI4); Mass and Energy Balances (020BMECS1)

020CHICS2 Industrial Chemistry 4 Cr.

Introduction to industrial engineering, through a comparative study of processes in inorganic chemistry and organic chemistry: This course allows students to analyze a process diagram and, conversely, to design a block diagram based on the description of the process. This course teaches students the design of the first flow sheet of a process based on its description, the choice of technology (reactor, separations), the positioning of recycling, purges, the production chain, the industry economy interaction etc. The course ultimately provides some elements on the safety aspects and the environmental impact of the processes.

020PROCS2 Introduction to Continuous and Discontinuous Processes 4 Cr.

Introduction: difference between continuous, batch, multi-product, multifunctional processes. Transient regime balances. Dynamics of continuous and batch processes. Application to reactors. Gantt chart. Description of design, planning, and scheduling problems of batch workshops: presentation of different criteria. Short-term planning: concept of recipe, representation of recipes (SSN STN), associated mathematical model, and optimization. Simulation of batch processes.

020BMECS1 Mass and Energy Balances 6 Cr.

Unit operations and degree of freedom analysis. Material balances on unit processes. Calculations on multi-unit processes. Material balances in processes with reaction. Multiple systems with reaction, recycling, and purging. Energy balances in the absence of reaction. Energy balances with reaction; Material and energy balances under transient conditions.
Prerequisite: Thermodynamics II (020TH2NI3)

020PDTCS2 Mass Transfer 4 Cr.

Identification of mass transfer mechanisms. Formulation of rate equations. Estimation of diffusion coefficients for binary gas and liquid phase systems. Determination of molar fluxes for steady-state diffusion of A through stagnant B and for equimolar counter-diffusion. Listing fluxes through porous solids for both types of diffusion: molecular and Knudsen. Explanation of mass transfer coefficient concept for turbulent diffusion by analogy with molecular diffusion. Calculation of interfacial mass transfer rates as a function of local mass. Definition and use of overall mass transfer coefficients. Definition and generation of minimum and actual operating curves for co-current and counter-current processes in steady state.

020TMCCS4 Mathematical Techniques in Chemical Engineering 6 Cr.

Review of fundamental properties used in optimization. Optimization problem (mathematical programming). Derivation. Notion of topology. Convexity. Convexity analysis. Eigenvalues. One-dimensional search. Definitions and general assumptions. Method of direct search for the golden ratio. Quadratic interpolation method (quasi-Newton). Examples. Conclusion. Theoretical aspects of unconstrained optimization. Problem formulation. Fundamental theorem. Conclusion. Numerical methods for unconstrained problems. Fundamental principle of descent methods. Descent direction. Step length. Termination test(s). First-order methods. Second-order Newton method. Quasi-Newton methods. Generalized reduced gradient, SQP.
Prerequisite: Dynamics and Process Control (020DCPCS3)

020AMTCS4 Mechanical Agitation and Transfer 2 Cr.

Types of bioreactors - Stirred aerated reactor: hydrodynamic constraints. Modeling and extrapolation of fermentation.
Prerequisite: Mass Transfer (020PDTCS2)

020MCECS3 Microbiology - Enzymatic Catalysis 4 Cr.

Introduction and history. Ultrastructure and morphology. Bacterial systematics. Growth and physiology. Bacteria/host relationship. Bacterial genetics. Antibiotics/antiseptics. Introduction: nucleic acid structure, restriction enzymes. Different types of RNA. Transcription in eukaryotes and prokaryotes. Post-transcriptional modifications in eukaryotes and prokaryotes. Transcriptional regulation. Ribozymes. Genetic code and translation in eukaryotes and prokaryotes. Post-translational modifications. Replication. Sequencing. Different molecular biology tools. Introduction to biotechnology. Enzymatic processes: kinetic laws, trends in industrial enzymology, models of starch hydrolysis processes. Processes with immobilized enzymes and cells: immobilized enzyme technology, fixed cell technology.

020MOSCS3 Modeling and Simulation 2 Cr.

This course is designed for chemical engineering students who have already been exposed to Aspen HYSYS®. It aims to deepen their understanding of process simulation while introducing them to some new features of HYSYS®. Throughout the sessions, students will enhance their ability to simulate more complex chemical processes, building on the knowledge gained in a previous course.
Prerequisite: Computer-Aided Design (020COANI4)

020ANNCS1 Numerical Analysis 4 Cr.

General introduction to numerical methods. Approximation and interpolation. Numerical integration. Numerical differentiation. Numerical solution of differential equations. Systems of linear equations. Nonlinear equations and systems of nonlinear equations. Methods for computing eigenvalues. Partial differential equations.
Prerequisite: Analysis II (020AN2NI4), Bilinear Algebra and Geometry (020ALBNI3)

020PPCCS4 Petrochemical Processes 4 Cr.

Introduction to chemical process industries. Raw materials for organic chemical industries. Profile of the petrochemical industry and its structure. Raw materials: existing and emerging. Overview of unit processes with applications, Nitration-nitrobenzene, nitrotoluenes, Halogenation-DCM, MCA, VCM, chlorobenzene. Esterification - Alcohols C1 to C4. Production of olefins and derivatives, naphtha and gas cracking for olefins production. Recovery of chemicals from FCC and steam cracking. Ethylene derivatives: ethylene oxide, ethylene glycol, vinyl chloride, propylene, and propylene oxide. Aromatic production, separation of aromatics. Aromatic product profile - Benzene, toluene, xylene, ethylbenzene and styrene, cumene and phenol, bisphenol, aniline unit - Polymers V and elastomers. Polymers: polyethylene, polypropylene, polystyrene, polyvinyl chloride, polycarbonate, thermosetting resin: phenol-formaldehyde, urea-formaldehyde, and melamine-formaldehyde. Elastomers: styrene butadiene (SBR), polybutadiene, nitrile rubber unit - VI fibers. Polyamides or nylons (PA), DMT and terephthalic acid, polyester, acrylic fiber, modified acrylic fiber, acrylonitrile, acrolein, viscose and acetate fiber.
Prerequisite: Refining Processes (020PRPCS3)

020CPPCS4 Pharmaceutical Process Design 4 Cr.

Introduction to synthesis, separation, and sterile processing and their applications to the design and optimization of pharmaceutical processes. Fundamental principles of drug synthesis. Industrial pharmaceutical examples. Introduction to essential operations used in the manufacture of pharmaceutical products. Separation process, distillation, crystallization, filtration, lyophilization, and drying. Lifecycle of pharmaceutical products, variability, testing, and specifications of pharmaceutical ingredients. Unit operations, including mixing, granulation, fluid bed operations, milling, capsule filling, compression, tablet coating, scaling up, troubleshooting, and optimization.

020CEPCS3 Process Equipment Design 4 Cr.

General design procedure. Design methodology. Stages of the design activity. Process design and mechanical design. Mechanical properties of materials. Safety factor. Construction material. Selection. Economic considerations in the design process. Design of basic machine elements (shafts, keys, and belts). Design of mechanical components such as protected and unprotected flange couplings. A brief overview of process design aspects of pressure vessels (such as a reactor for example), head design (flat, hemispherical, torispherical, elliptical, and conical). Design of storage tanks. Study of different types of storage tanks and applications. Atmospheric vessels, vessels for storing volatile and non-volatile liquids. Gas storage. Losses in storage vessels. Various types of roofs. Types

of heat exchangers. Codes and standards for heat exchangers. Design of heat exchanger (U-tube and fixed-tube), i.e., shell, head, tubes. Fouling in heat exchangers. Types of fouling. Safety measures and overprotection devices in equipment design. Risk analysis in equipment design, overpressure protection devices such as blowdown, relief valves, rupture disk, steam purger, etc.

020PDPCS4 Process Design Project 6 Cr.

The objective of the Process Design Project is to give students the opportunity to place their knowledge in a process context. Teams of 2 to 4 students work on creating or modifying a flowsheet for the manufacture of a desired chemical product.
Prerequisite: Modeling and Simulation (020MOSCS3)- Pre or Co-requisite: Process Equipment Design (020CEPCS4)

020GEPCS4 Production Management 2 Cr.

Introduction to the main methods of managing production systems. Design system (study office, methods, industrialization) and management system. Push/pull flow approach, business process (workflow), and production-related functions. Project/production differences. Technical data (bill of materials, routing, work center, lead times) and production data. Production planning (MRP, load/capacity adjustment, inventory management). Operational production management (scheduling, procurement). Production management (control/command, monitoring, launch, follow-up). Software solutions for production (APS, ERP, MES, supervisor, PLC).

020GEPCS5 Process Engineering Lab 2 Cr.

The "Process Engineering Lab" course offers an exploration of three fundamental methods used in industry for the efficient separation of dissolved or suspended substances within complex mixtures. These techniques include liquid-liquid extraction, absorption, and reverse osmosis. Through this laboratory course, students will have the opportunity to gain a concrete understanding of these processes and their applications, while enhancing their problem-solving skills through practical experiments and data collection.
Prerequisite: Separation Techniques (020TESCS3)

020IBDCS1 Programming and Databases 4 Cr.

This course presents the basics of object-oriented programming to develop applications including databases. It will provide skills in the field of object-oriented programming and databases and their implementation. This course will be divided into three phases. In the first phase: Present the C# language and the fundamental concept of object-oriented programming. In the second phase: Present the fundamental concept of relational databases. Specify the fundamental concepts of setting up and using databases in the relational context. Query optimization, SQL, PL/SQL language, triggers, stored procedures, and views under Oracle, MySQL, or PHPMYSQL.
Prerequisite: Programming II (020IF2NI3)

020GPRCS5 Project Management 2 Cr.

Definition of a project. Phasing. Milestone organization. Definition of roles of different actors (sponsor, contractor, implementation). Clarification of objectives. Project breakdown (products, activities, costs, responsibilities). Planning approach. Planning methods. Resource allocation. Joint cost allocation-control. Costs, deadlines, quality, task evaluation, before, during, after, lessons learned.

020QHSCS2 Quality, Health, Safety 2 Cr.

Risk classification. Chemical risks. CLP regulation. Hazard classes. Risks related to chemical product storage. Evaluation and prevention of chemical risks in the company. Fire risk. Emergency intervention planning. Engineer's contributions to risk management. Risk analysis methods.

020PRPCS3 Refining Processes 6 Cr.

Physicochemical properties and standardized tests. Relationship between product specifications and their use (fuels and other products). Implementation of crude oils. Petroleum logistics. Strategic stocks. Petroleum distribution. Industrial catalysts. Catalytic reforming. Isomerization. HD. Catalytic cracking. VGO and residues, VGO and residue hydrocracking. Sulfur chain. Refinery internship. FCC gasoline treatment. Oligomerization, etherification, alkylation. Residue valorization. Visbreaking. Coking. Softening. Base oils, waxes, paraffins,

bitumens. Gas: desulfurization, dehydration, liquid extraction from gases, and practical exercises. Natural gas liquefaction. Gas pipeline transportation. LNG transport terminals, Flow assurance. Synthetic gas: H2 production and Fischer Tropsch process, SMDS. Steam cracking. Aromatic loop. Selective hydrogenations. Ethylbenzene – Styrene, PEHP. Petroleum analysis lab.
Prerequisite: Organic Chemistry (020CORNI3)

020IDRCS5 Reservoir Engineering 4 Cr.

Darcy's law and applications. Permeability concepts. Relative permeability. Capillary pressure. Wettability. Material balance equations for different types of reservoirs and drives. Aquifer behavior and water influx. Immiscible displacement. Buckley-Leverett theory. Stable displacement by gravity. Coning and cresting. Decline curve analysis. Reservoir and well deliverability.
Prerequisite: Geology (020GELNI4)

020TESCS3 Separation Techniques 6 Cr.

Physical aspects of phenomena (definition, application). Equilibria, solutions, and solubility, solvent selection. Analysis by macroscopic balances: variance, balance, operating curve, and function diagram. Countercurrent absorption of a component: cut. Scope of the problem and assumptions. Algebraic resolution. Graphical treatment. Distillation of a binary mixture. McCabe and Thiele Method - Ponchon-Savarit Method - Incidence of operating conditions. Multicomponent distillation. Problem analysis - Short Cut Method (Fensk, Underwood, Gilliland, Kirkbridge Relation). Solvent selection, characteristics, and properties of solvents. Equilibria between liquid phases. Study of simple, multiple-contact, and countercurrent contactors with and without reflux. Understanding the mechanisms of liquid-solid separation and the fundamental equations for sizing industrial equipment for this separation. Decantation: theoretical study - limiting settling velocity. Experimental study. Modeling of continuous decanters with vertical walls. Sizing of continuous decanters with vertical walls. Filtration: definitions and ancillary techniques. Theory of filtration on support. Application examples. Membrane filtration: membrane separation techniques. Osmotic pressure. Polarization phenomenon. Mechanisms of fouling. Electrodialysis compartments. Centrifugation: centrifugal effect and centrifugal pressure of filtration. Centrifugal squeezing and flow rates.
Prerequisite: Chemical Thermodynamics (020THCCS1)

020GDSCS5 Solid and Hazardous Waste Management 4 Cr.

This waste management course offers students a thorough understanding of core principles, waste generation methods, environmental and health impacts, and a range of management options including sanitary landfills, material recovery, energy recovery, waste minimization, thermal treatment, chemical/physical/biological treatment, site remediation, and waste sorting/recycling facilities. By examining current and future trends, students will be equipped to develop and implement effective strategies for reducing environmental effects, advancing circular economy practices, and contributing to global sustainability.

020ASCCS5 Statistical Analysis and Design of Pharmaceutical Operations 4 Cr.

The course introduces statistical analysis and experimental design methods and their applications in the design and optimization of pharmaceutical processes. Classical statistical concepts and methods will be examined using pharmaceutical examples, including product/process development scenarios, routine testing during manufacturing, finished products, and failure investigations. Regulatory requirements for sample testing, sampling plans, tablet and capsule dosage, content uniformity, hardness, friability, dissolution, and bioavailability testing will be discussed in detail.
Prerequisite: Statistics (020STACS2)

020STACS2 Statistics 4 Cr.

This course is a standard applied statistics course that applies to the field of Engineering Sciences. It presents the statistical analyses necessary for a researcher in the field of chemical and petrochemical engineering. Topics to be covered include descriptive statistics, parametric tests (t-test for independent samples, paired samples t-test, one-sample t-test, ANOVA), non-parametric tests (Mann-Whitney test, Wilcoxon signed-rank test, Wilcoxon rank-sum test, Kruskal-Wallis test), chi-square test as well as correlation and linear regression. The course focuses on verifying the assumptions required by each statistical test used (normality, equality of variances, etc.). It uses the

flipped classroom approach to expose students to a basic statistical method as well as the use of statistics in the real world. Finally, the course uses IBM-SPSS software for analyses.
Prerequisite: Probability (020PRBNI4)

020ST1CS3 Summer Internship I 2 Cr.

This internship lasts between 2 and 4 weeks in a university or industrial laboratory.

020ST2CS5 Summer Internship II 2 Cr.

This internship lasts between 6 and 8 weeks in the chemical industry.

020CHTCS1 Theoretical Chemistry 4 Cr.

Introduction to quantum phenomena, postulates of quantum mechanics: angular momentum, hydrogen atom. Major approximation methods: variational principle, perturbation theory. Multi-electron atom. Approximation of atomic orbitals. Approximation of molecular orbitals and quantum chemistry methods: Hartree-Fock, Hückel method. Application to diatomic and polyatomic molecules. Role of spatial symmetry. Introduction to reactivity. Approximation of frontier orbitals.
Prerequisite: Atomic Structure and Chemical Bonding (020ATONI2)

020GTHCS3 Thermal Engineering 2 Cr.

Study of convection (natural convection: empirical relationships, forced convection in pipes, laminar regime - theoretical and empirical relationships, turbulent regime - empirical relationships, Extension to non-cylindrical pipes and film flows, forced convection around solid obstacles, case of cylinder and sphere, case of tube bundles, case of the shell of a multitubular exchanger). Heat exchanger theory (co-current, counter-current, and multi-pass approaches, definition and expression of overall heat transfer coefficient, DTML method, Efficiency method, practical sizing method: this part is essentially treated using the example of multitubular exchangers). Other heat transfer technologies (plate and spiral exchangers, transfer in agitated tanks). Phase change heat transfer (condensation of pure vapor, condensation of a vapor mixture).
Prerequisite: Thermodynamics II (020TH2NI3)

020STMCS2 Total Synthesis and Activation Methods 4 Cr.

Total synthesis. Industrial alternatives. Synthesis planning. Retro synthesis techniques. Solutions to chemoselectivity problems. Protection of functional groups and applications. Enantiomer splitting techniques. Asymmetric induction. Prediction of the stereochemistry of products from diastereoselective reactions. Asymmetric synthesis strategies. Enzymatic engineering and industrial asymmetric synthesis. Fields of synthetic chemistry. Profile of synthetic chemistry companies. Accessibility of starting substrates. Sources of organic compounds, SynGas. Production of basic compounds. REACH regulation and procedures to follow. Green chemistry and engineering. Parameters for evaluating the “green” character of a chemical process. Bioprocesses and biotechnologies. Green alternatives to conventional solvents. Principle of electrosynthesis. Advantages and disadvantages of electrosynthesis. Different types of electrosynthesis. Electro-catalytic reactions. Principle of sonochemistry. Constraints and limitations of sonochemistry. Transducers and industrial-scale sonochemistry. Principle of microwave activation. Microwave activation and dielectric properties of materials. Microwave heating and conventional thermal heating. Microwave effects.
Multi-step synthesis practical work.
Prerequisite: Organic Chemistry (020CORNI3)

020MLTCS3 Tribology and Lubricants 4 Cr.

This course explores the study of tribology and lubricants, covering fundamental principles related to friction, wear, and lubrication. Additionally, the course explores topics such as lubricating base oils and their importance in technical applications.
Prerequisite: Refining Processes (020PRPCS3) - Fluid Mechanics (020MEFCS2)

020OPUCS3 Unit Operations: Adsorption, Drying, Crystallization 4 Cr.

Designing adsorption columns. Mass transfer zone and breakthrough curve in a fixed-bed column. Empirical methods: unused bed length. Scaling approach. Mathematical models (Thomas model, Bohart-Adams model (bed depth service time, BDST), Yoon Nelson model). Drying. Dryer efficiency. Mass transfer in drying. Psychrometry. Equilibrium relative humidity. Drying rates. Calculation of drying times. Material and energy balance on a continuous dryer. Different types of dryers. Crystallization. Fundamentals of crystal growth. Measurement of growth rate. Crystal yield. Crystallization technologies. Equipment for solution crystallization. Crystallization in the molten state. Modeling and design of crystallizers. Lab work: 1-Drying 2-Crystallization 3-Polyvalent reactor
Prerequisite: Chemical Thermodynamics (020THCCS1)

020TEUCS5 Wastewater Treatment 4 Cr.

Classification of wastewater from different perspectives. Assessment of wastewater pollution. Equipment of wastewater treatment plants. Technological lines for wastewater treatment and sludge disposal. Mechanical, chemical, and biological stages of wastewater treatment. Pretreatment and primary stage of wastewater treatment - mechanical separators, sedimentation and flotation, settler. Secondary stage of wastewater treatment - activation and secondary settler, basic parameters of activation, types of aerobic bioreactors, nitrification and denitrification, phosphorus removal. Tertiary stage of wastewater treatment - post-treatment of wastewater. Anaerobic processes - types of anaerobic bioreactors. Treatment of sewage sludge. Industrial wastewater treatment. Physico-chemical and chemical treatment processes. Modeling, design, and optimization of activated sludge process. An introduction to automatic control of wastewater treatment plants.

020WORCS4 Work Ready Now 2 Cr.

This course is designed to provide students with general skills, communication skills, and workplace learning experiences to prepare them for success in the workplace. It is designed to facilitate participatory and practical teaching and learning. Students will be actively engaged in the learning process and will have the opportunity to practice and enhance new skills and gain the self-confidence needed to obtain and maintain employment related to their career goals. Workplace learning activities are integrated into the course and will require students to visit real workplaces in the profession outside of class hours. Students will be guided to use free online digital tools to demonstrate their learning. Throughout the course, students will create a career portfolio that will assist them in their Work Ready Now experimental journey from student to employee.