University of Tripoli
Faculty of Engineering

CHEMICAL ENGINEERING DEPARTMENT
Graduate programs

General Information

Chemical Engineers apply scientific and engineering principles to develop processes or systems for the economic production and distribution of useful and value-added materials through the physical, chemical or biochemical transformation of matter. Furthermore, this must be accomplished with attention paid to economics, health and safety, and environmental impact. Chemical engineering courses in multi component thermodynamics, transport phenomena, kinetics, process control and process design are further emphasized in the graduate program to provide more training for engineers to enter production, research and process development, process design, technical sales and engineering management positions. Training in chemical engineering equips the graduate to solve many problems facing the society today such as, human health, energy shortages, synthetic fuels production, water and air pollution, toxic chemical control, and food production.

Vision

Our vision is to be distinct and internationally recognized graduate chemical engineering program and reach top rankings.

Mission

Graduate students are provided with a high quality education and academic training to assume leadership positions within chemical and other associated industries. The unit operation laboratory at the department is equipped with many types of equipment covering fluid flow, heat and mass transfer, Kinetics and thermodynamics.
In addition, the department has a state of the art PVT and slim tube laboratories. Moreover, enough space is available at the unit operation laboratory for any specific experimental facilities to be built by students.

Programs

The graduate programs in the Chemical Engineering Department offers M.Sc. degrees in the Chemical Engineering fields.

Chemical Engineering (1) ***with course and thesis***
Chemical Engineering (2) ***with courses only***

Program-I

Chemical Engineering (1) 8 courses, seminar and Thesis

PROGRAM-I	*Chemical Engineering (1)* ***8 courses, seminar and Thesis***
DEGREE	*M.Sc.*
OBJECTIVES	The Chemical Engineering Graduate is designed to produce graduates who have: ➢ The ability to identify, formulate and solve **chemical engineering** problems. ➢ The ability to design a process that meets desired specifications with consideration of environmental, safety, economic and ethical criteria. ➢ The ability to have life-long learning skills and are able to apply their engineering knowledge to critically evaluate relevant literature and new technologies or systems. The M.S. graduates of the UOT Chemical Engineering Department ➢ Actively participate in the execution and realization of R&D projects. ➢ Function as team leaders in chemical engineering applications and processes.

Code	Title	Credits	Hours	ECTS
Faculty Requirements (3 credits)				
GE604	Advanced Engineering Mathematics	3	4	8
GE606	Applied Statistics and Computer Application	3	4	8
Department Requirements (15 credits)				
CHE610	Advanced Fluid Mechanics	3	4	8
CHE615	Advanced Heat Transfer	3	4	8
CHE620	Advanced Thermodynamics	3	4	8
CHE625	Advanced Reaction Engineering	3	4	8
CHE630	Advanced Mass Transfer	3	4	8
Elective courses (7 credits)				
GE609	Numerical Methods in Engineering	3	4	8
CHE 621	Phase Equilibrium Thermodynamics	3	4	8
CHE 627	Membrane Processes	3	4	8
CHE 628	Bioseparation Engineering	3	4	8
CHE 629	Metabolic Engineering	3	4	8
CHE635	Transport Phenomena	3	4	8
CHE640	Heterogeneous Catalysis	3	4	8
CHE642	Biochemical Engineering	3	4	8

CHE644	Polymeric Materials	3	4	8
CHE646	Process Optimization	3	4	8
CHE648	Water Pollution Control	3	4	8
CHE650	Air Pollution Control	3	4	8
CHE652	Process Modeling And Simulation	3	4	8
CHE654	Process Integration	3	4	8
CHE656	Advanced Separation Processes	3	4	8
CHE658	Advanced Mathematics for Chem. Engineering	3	4	8
CHE660	Transport Phenomena in Multiphase Systems	3	4	8
CHE662	Fuel Cells Theory and Applications	3	4	8
CHE664	Adsorption and Ion Exchange Technology	3	4	8
CHE697	Special Topics	3	4	8
CHE698	Graduate Seminar **	1	2	10
Thesis (6 Credits)				
CHE699	M. Sc. Thesis	6	*0*	*50*
Total		**31**	**0**	**124**

*** Mandatory Courses.* *ECTS: European Credit Transfer and Accumulation System*

Program-II

Chemical Engineering (2) ***with courses only***

PROGRA-II	*Chemical Engineering (2)* ***with courses only***
DEGREE	*M.Sc.*
OBJECTIVE	*The M.Sc. graduates of the UOT Chemical Engineering Department* ➢ *are preferred in businesses that provide chemical and engineering products and services.* ➢ *are accepted into Ph.D. programs of prestigious national and international colleges and universities.* ➢ *are distinguished by their entrepreneurship.* *Chemical Engineering Graduate Programs is designed to produce graduates who have:* ➢ *The ability to be effective leaders, capable of working in diverse environments.* ➢ *The ability to apply their engineering education to a variety of career paths.* ➢ *The ability to evaluate the impact of their work on society, including ethical, economic, global and environmental aspects*

Code	**Title**	**Credits**	**Hours**	**ECTS**
Faculty Requirements (4 credits)				
GE601	Seminar in Research Methodology **	1	2	10
GE604	Advanced Engineering Mathematics	3	4	8
GE606	Applied Statistics and Computer Application	3	4	8
Department Requirements (15 credits)				
CHE610	Advanced Fluid Mechanics	3	4	8
CHE615	Advanced Heat Transfer	3	4	8
CHE620	Advanced Thermodynamics	3	4	8
CHE625	Advanced Reaction Engineering	3	4	8
CHE630	Advanced Mass Transfer	3	4	8
Elective courses (22 credits)				
GE609	Numerical Methods in Engineering	3	4	8
CHE621	Phase Equilibrium Thermodynamics	3	4	8
CHE627	Membrane Processes	3	4	8

CHE628	Bioseparation Engineering	3	4	8
CHE 629	Metabolic Engineering	3	4	8
CHE635	Transport Phenomena	3	4	8
CHE640	Heterogeneous Catalysis	3	4	8
CHE642	Biochemical Engineering	3	4	8
CHE644	Polymeric Materials	3	4	8
CHE646	Process Optimization	3	4	8
CHE648	Water Pollution Control	3	4	8
CHE650	Air Pollution Control	3	4	8
CHE652	Process Modeling And Simulation	3	4	8
CHE654	Process Integration	3	4	8
CHE656	Advanced Separation Processes	3	4	8
CHE658	Advanced Mathematics for Chem. Engineering	3	4	8
CHE660	Transport Phenomena in Multiphase Systems	3	4	8
CHE662	Fuel Cells Theory and Applications	3	4	8
CHE664	Adsorption and Ion Exchange Technology	3	4	8
CHE697	Special Topics	3	4	8
CHE698	Graduate Seminar **	1	2	10
Total		**41**	**0**	**124**

*** Mandatory Courses.* *ECTS: European Credit Transfer and Accumulation System*

Description of the Graduate Courses:

- *Faculty General Courses*

GE 6091 Seminar in Research Methodology (1 Credits – 2 Hours)

This graduate course introduces research methodology in Science and their specific application in Engineering. Definition and development of science, scientific research approach, literature survey, research design, quantitative and qualitative research methodologies, data gathering, writing techniques for thesis, project, and scientific article, ethical principles to be followed when conducting research, ethical principles to be followed when publishing, citation ethics, tips for a successful presentation, students' presentations within the scope of some topics in engineering fields.

GE604 Advanced Engineering Mathematics (3 *Credits* – 4 Hours)

Review of ordinary differential equations; linear differential equation of the first order; linear differential equations with constant coefficients; particular solutions by variations of parameters. Power series solutions; method of Frobenius; Legendre's equation; Fourier-Legendre Series; Bessel's equation; modified Bessel equation. Fourier methods; Fourier series; Sturm-Liouville theory; Fourier integral; Fourier transformation. Partial differential equations; heat conduction equation; separation of variables; waves and vibrations in strings; wave equation; D'Alembert's solution; longitudinal vibrations in an elastic rod; two dimensional stress systems; solution of Navier's equations by the application of Fourier transforms; Laplace equation.

GE606 Applied Statistics and Computer Application *(3 Credits – 4 Hours)*

Random variables; common discrete, continuous expectations and their applications; Sampling of the mean, hypothesis testing of the mean and variance, confidence intervals and Chi-Square procedures; Simple linear regression and correlation; precision and straight line fits; Matrix approach; multiple; Linear regression; polynomial and extra sum of squares in linear regression analysis; Transformation, weighted dummy variables and special topics in multiple regression analysis; Selecting the best regression model; Design of experiments; Single-factor and Multi-factor analysis of variance. Application of Statistical software packages such as: MINITAB, SPSS, etc.…

GE609 Numerical Methods in Engineering (3 *Credits* – 4 Hours)

Interpolation; Linear interpolation, Lagrange and Aitkin's interpolating polynomials, Difference calculus, Newton forward and backward difference formula, curve fittings, least square approximations, Fitting nonlinear curves, Cubic spline, Chebyshev polynomials, Approximation with rational function ordinary differential equations, Analytical and computer-aided solutions, Boundary conditions, Taylor series method.

- *Department Courses*

CHE610 Advanced Fluid Mechanics (3 *Credits* – 4 Hours)
Laminar boundary layers and their solutions. Laminar stability and transition to turbulence. Basic equations of turbulent flow. Turbulent boundary layers. Non-Newtonian fluids. Constitutive equations for viscoelastic fluids. Flow through porous media, compressible flows. Multi-phase flow.

CHE615 Advanced Heat Transfer (3 *Credits* – 4 Hours)
Solution of steady and transient conduction and convection problems analytically and numerically. Fundamentals of convection boundary layer in laminar and turbulent flow Free and forced convection in pipe, Combined mechanisms of conduction and convection Free and forced convection in porous media. As examples, conduction, composite regions, non-linear boundary-value problem of heat conduction; convection, heat transfer in packed or fluidized beds, techniques to augment heat transfer; combined phase change problems such as condensation, heat pipes, cooling towers and ponds; radiation, such as furnaces, radiant interchange between surfaces separated by non-absorbing and non-emitting media.

CHE620 Advanced Thermodynamics (3 *Credits* – 4 Hours)
Classical thermodynamics of phase equilibrium and stability. The phase rule. Ideal and non- ideal systems. Fugacity and activity coefficient. Phase equilibrium at moderate and high pressure. Activity coefficient models of local composition and group contribution. Equation of states and phase equilibrium. Liquid-Liquid equilibrium. Vapor-Liquid equilibrium Solid-Liquid equilibrium. Solid-Vapor equilibrium. Phase equilibrium by simulation. Phase and chemical equilibrium. Multi component system computations. Characterization of petroleum fractions. Applications to industrial process design. Physical and chemical equilibria in multi component systems, including chemically reacting and heterogeneous systems.

CHE625 Advanced Reaction Engineering (3 *Credits* – 4 Hours)
A study of the effect of temperature on conversion, stability, and product distribution in complex homogeneous reactions. Analysis of flow and mixing patterns and residence time distributions in chemical reactors. Kinetics of catalytic gas-solid reactions, mass and heat transport effects in catalysis. Design of catalytic fixed-bed reactors. Macro- and micro-mixing effects in homogenous reactors. Steady-state multiplicity & stability in homogeneous reactors. Transport/reaction interactions in gas-liquid, liquid-liquid reactions, and design of two-phase reactors. Theory of gas-solid fluidization and fluidized-bed reactors. Three-phase slurry and trickle-bed reactors. Advanced study of the factors involved in the design and operation of chemical reactors for both homogeneous and heterogeneous systems; batch reactors; continuous flow stirred tank reactors; tubular reactors; multi bed adiabatic reactors; cold shot cooling in reactors; determination of optimal temperature gradients and yields; catalyst effectiveness factors, optimal control with decaying catalysts.

CHE630 Advanced Mass Transfer (3 *Credits* – 4 Hours)
Advanced coverage of laminar and turbulent mass transfer theory for binary and multi component systems. The coupling between and mass, heat and momentum transfer and chemical reactions. Inter phase mass transfer. Applications in various fields shall be discussed. Study of traditional as well as contemporary rate controlled separation processes such as crystallization, chromatography, sorption, membranes, etc. Rate based models for distillation. Review of fundamentals and advanced treatment of mass transfer in multiphase systems.

- *Elective Courses*

CHE 621 Phase Equilibrium Thermodynamics (3 *Credits* – 4 Hours)
Calculation of fugacities in gaseous and liquid mixtures. Theory of liquid solutions. Fluid phase equilibria at high pressures. Phase equilibria in condensed systems. Case studies.

CHE 627 Membrane Processes (3 Credits – 4 Hours)
Membrane concept. Principles of membrane separations and applications in biotechnology. Membrane preparation techniques, applications of membranes in stream purification in product recovery and in industrial wastewater treatment.

CHE 628 Bioseparation Engineering (3 Credits – 4 Hours)
Separation processes in biological systems. Enzyme/cell isolation, product enrichment by methods of ion-exchange, filtration, centrifugation, chromatography, reverse-osmosis, precipitation, salting-out, electrophoresis, membrane separations.

CHE 629 Metabolic Engineering (3 Credits – 4 Hours)
Microorganism as a microbioreactors; Industrially important microorganisms. Influence of bioreactor operation conditions on the bioreaction networks and regulation of metabolic pathways: fermentation physiology. Principles of metabolic engineering: Determination of the metabolic bottlenecks. Metabolic control analysis. Thermodynamic analysis of cellular pathways. Pathway design.

CHE635 Transport Phenomena (3 *Credits* – 4 Hours)
Analytical and approximate solutions of equations of mass, momentum and energy transport. Introduction to creeping, potential and laminar boundary layer flows. Description of heat and mass transfer in multicomponent systems. Interface momentum, heat and mass transfer.

CHE640 Heterogeneous Catalysis (3 *Credits* – 4 Hours)
Molecular theories of adsorption and catalysis. Solid-state and surface chemistry of catalysts. Diffusion and reaction in porous catalysts. Design, preparation and characterization of catalysts. Catalyst deactivation and regeneration. Catalytic process engineering: examples and case studies. Theoretical and experimental aspects of heterogeneous catalysis and surface science. Design, preparation, and characterization of catalysts. Kinetics of heterogeneous catalytic reactions, thermal and diffusional effects in catalytic reactors. Case studies of important industrial catalytic processes. Theoretical and experimental aspects of heterogeneous catalysis and surface science. Design, preparation, and characterization, of catalysts.

CHE642 Biochemical Engineering (3 *Credits* – 4 Hours)
Enzyme kinetics and immobilized enzymes systems. Cellular growth, bio reactions, transport processes. Stoichiometry of microbial reactions. Analysis of bio reaction rates. Bioreactors modeling and design. Immobilization and immobilized cell bioreactors. Inhibitory effects in bio reactors. Optimization and control of bioreactors. Applications of microbiology and biochemistry to biochemical engineering. Kinetics and thermodynamics of biochemical reactors. Transport phenomena in biological systems. Bioreactor design and scale-up. Applies chemical engineering principles to the analysis and design of biological processes widely used in the pharmaceutical, food and environmental remediation industries. Topics include kinetics of enzyme-catalyzed reactions, cellular growth and metabolism, bioreactor design and mass transfer considerations.

CHE644 Polymeric Materials (3 *Credits* – 4 Hours)

The structure, morphology, and properties of polymers. Polymerization reactions, molecular weight characterization, and polymer processing and rheology. Viscoelasticity, Rubber Elasticity, and mechanical properties. Thermodynamics of polymer solutions. Application of chemical engineering principles to polymer and materials systems. Structures and properties of metals, ceramics and polymers. Thermodynamics, synthesis, rubber elasticity, Viscoelasticity, kinetics, rheology, and processing of polymers systems. Applications of statistics and problem-solving skills to materials systems.

CHE646 Process Optimization (3 *Credits* – 4 Hours)
Review 0f computerized material and energy balances, modeling of chemical and biochemical processes. Formulation of optimization problems, nature and organization of optimization problems in the process industry, optimization theory and techniques (basic concepts, optimization of unconstrained functions, unconstrained multivariable optimization, constrained optimization, linear programming and nonlinear programming). Real Time Optimization (RTO) Calculus of variation and Pontryagin maximum principle. Energy Integration (IE), Mass Integration (MI and Pinch Technology.

CHE648 Water Pollution Control (3 *Credits* – 4 Hours)
Wastewater treatment objectives and methods. Design of facilities for physical and chemical treatment of waste water. Ecology of biochemical reactors, kinetics of biochemical systems, modeling of ideal biochemical reactors, design of facilities for the biological treatment of waste water. Topics include: Fresh Water Resources, Waste water sources, Water and wastewater treatment processes, Waste water Characteristics, Treatment objectives and regulations. Unit Operation and Design (Pre and Primary Treatment, Secondary Treatment and Tertiary Treatment processes), Disinfections.

CHE650 Air Pollution Control (3 *Credits* – 4 Hours)
Production, emission and transfer of contaminants through the atmosphere from stationary sources. Mathematical models of air pollution. Control concepts. Theory and design of control devices. Integration of pollution control in chemical engineering processes. Current research and development in air pollution control. Sources of air pollution. Risk assessment and the effects of pollutants. Air quality standards. Global warming, ozone layer. Meteorology. Regulation philosophies. Air pollution concentration models (1-3D, dispersion models). Control of particulate matter (gravity settlers, cyclones, electrostatic devices, scrubbers and filtration). Control of VOCs, SOx, and NOx Focuses on strategies and technologies for complying with air pollution control regulations. Introduces atmospheric mixing and dispersion modeling to describe impact of process air emissions on the environment. Examines chemistries of pollutant production and atmospheric fate of air pollutants.

CHE652 Process Modeling and Simulation. (3 *Credits* – 4 Hours)
This course gives students basic knowledge on process simulation, process synthesis principles, cost analysis and flow sheet optimization. Program: Basics on process simulation. Flow sheet simulation. Algorithms for process synthesis. Cost analysis (capital costs, profitability analysis) using process evaluator software. Flow sheet optimization. Process flexibility analysis. Chemical plant controllability. Flow sheet dynamical behavior. Teaching method: Lectures, practical work, project. Assessment pattern: Written assignments, test, project, examination**.**

CHE654 Process Integration. (3 *Credits* – 4 Hours)

This course will give to students the basic knowledge about process integration, design and optimization of heat exchanger networks , mass transfer networks and waste minimization in process industries. Program: The hierarchy of chemical process design, composite curves, design and optimization of heat exchange network, mass transfer network, heat integration of distillation columns, heat integration of evaporators, heat integration of chemical reactor, waste minimization.

CHE656 Advanced Separation Processes (3 *Credits* – 4 Hours)
Forces for adsorption, equilibrium adsorption isotherms, sorbent materials, pore size distribution, heterogeneity, predicting mixture adsorption, rate processes in adsorption/adsorbers, adsorber dynamics, cyclic adsorption processes, temperature and pressure swing adsorption, membrane separation processes, polymer membranes, dialysis, electrolysis, evaporation, reverse osmosis, research projects.

CHE658 Advanced Mathematics for Chemical Engineers (3 *Credits* – 4 Hours)
Introduction to modeling; formulation of momentum, heat and mass transfer models; macro and micro modeling; solution techniques for models yielding ordinary differential equations; solution techniques for models yielding partial differential equations (separation of variables and Laplace transformation). For ordinary differential equations, both analytical and numerical solution methods are taught, including series solution methods (power series and Frobenius method). For partial differential equations, different solution methods will be discussed, including numerical methods such as finite elements and finite difference methods, analytical methods such as separation of variables method, Laplace transformation methods. Visualization and analysis of the solutions will be emphasized through computer projects.

CHE658 Special Topics (3 *Credits* – 4 Hours)
The topics are not listed in department programs and may vary from year to year according to interests of students and instructors. M.S. students choose and study a topic under the guidance of the department coordinator. Typical contents include advanced fields of study according to recent scientific and technological developments in the related areas. Also, it could be studied from other related departments after getting the permission.

CHE660 Transport Phenomena in Multiphase Systems (3 *Credits* – 4 Hours)
Transport equations for mass, momentum and energy in multicomponent systems; jump conditions at phase interfaces; the spatial averaging theorem and the method of volume averaging; flow in porous media. Darcy's law for one and two phase flows; dispersion of heat and mass in bundles of capillary tubes; the general problem of dispersion in porous media.

CHE 662 Fuel Cells Theory and Applications (3 *Credits* – 4 Hours)
Hydrogen energy systems: hydrogen production, storage, safety and economy. Introduction to fuel cells: Fuel cell types, fundamentals of alkaline, proton exchange membrane, phosphoric acid and direct methanol fuel cells. Fuel cell electrochemistry, fuel cell components: membranes, catalysts and membrane electrode assemblies. Fuel cell modeling and system design, fuel cell applications.

CHE 664 Adsorption and Ion Exchange Technology (3 Credits – 4 Hours)
Sorption and sorbent materials. Physical properties of sorbent materials. Typical sorption processes. Fundamental factors in performance of adsorption and ion exchange. Design

principles of adsorption and ion exchange equipment. Industrial applications of adsorption and ion exchange processes.

CHE 666 Applied Data Analysis Techniques (3 Credits – 4 Hours)
Basic concepts about probability. Statistical inferences. Data fitting by linear and non-linear regression methods. Design of experiments. Factorial and fractional factorial designs. Special experimental designs for parameter estimation and model discrimination. Applications in chemical engineering; process modeling with computer programming.

CHE698 Graduate Seminar (1 *Credits* – 2 Hours)
This course help students to develop their research proposals, establishing and expanding their research skills and implementing their work through scholarly writing, which can be achieved through the seminar. The seminar course must to be taken in the second semester of the registration and managed by an instructor who is responsible to prepare the final grade list of all the registered students. Students must prepare and present their chosen topics through a scientific term paper, which can be shared and discussed with other students and department staff to gain their feedback.

CHE699 M.Sc. Thesis (6 Credits)
Involves individual studies by students in the field of chemical engineering. The work must be original and the concept, data and the conclusions must contribute new knowledge to the field of engineering. The quality of the work must reflect the student's proficiency in research and creative thinking. Following preliminary studies and a literature survey on the thesis subject, each student will present his proposed thesis subject orally, and also submit a written proposal to the Graduate Studies for approval. On satisfactory completion of his thesis work, the student is required to make a formal defense of his research thesis.

Learning Outcomes of Program-I

The M.Sc. graduates of the UOT Chemical Engineering Department

- Acquire knowledge in depth and breadth via scientific research in their field; evaluate, interpret and apply this knowledge.
- Design and apply theoretical, experimental and model-based research; analyze and resolve complex problems that arise during this process.
- Acquire knowledge in depth and breadth via scientific research in their field; evaluate, interpret and apply this knowledge.
- Are thoroughly informed about current techniques and methods of engineering, and their limitations.
- Complement and apply uncertain, limited or incomplete knowledge using scientific methods; are capable of integrating knowledge from different disciplines.
- Are thoroughly developed the ability to design and conduct experiments safely, as well as to analyze and interpret data.
- Design and apply theoretical, experimental and model-based research; analyze and resolve complex problems that arise during this process.

Learning Outcomes of Program-II

Upon completion of the Master of Science Program in the Chemical Engineering, graduates are expected to attain the following outcomes:

.

- The ability to design a process that meets desired specifications with consideration of environmental, safety, economic and ethical criteria.
- The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- Develop new and/or original ideas and methods; design complex processes and develop innovative/alternative solutions in design.
- The 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.
- The ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- The ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

الاعتماد			
البيان	منسق الدراسات العليا بالقسم	رئيس القسم	مدير مكتب الدراسات العليا بالكلية
الاسم			
التاريخ	2022 / 09 /	2022 / 09 /	2022 / 09 /
التوقيع			
الختم			

اعداد / لجنة دليل الدراسات العليا 2022