German Jordanian University

School of Applied Medical Sciences

Department of Pharmaceutical & Chemical Engineering

Master of Science in Pharmaceutical and Chemical Engineering

Non-Thesis Track

2022 Study Plan

Program Vision

Leadership in the field of pharmaceutical and chemical engineering in terms of teaching, scientific research, and social impact.

Program Mission

Providing students with distinctive education in pharmaceutical and chemical engineering based on hybrid integration of Pharmacy and Chemical Engineering to meet the needs of the pharmaceutical and chemical industries and provide novel and sustainable solutions to national and global challenges.

Program General Description

The Department of Pharmaceutical and Chemical Engineering (PCE) at the German Jordanian University (GJU) offers a two-year master's degree program. The 33 credit hours (Cr Hr) are divided as follows: 24 Cr Hr represent compulsory, and 9 Cr Hr represent technical elective courses. This MSc program at GJU is unique at the local and regional level, as it combines the disciplines of pharmacy and chemical engineering to prepare graduates to meet the needs of both the pharmaceutical and chemical industries. The PCE department is distinguished by its emphasis on practical and applied aspects of engineering and pharmaceutical sciences, with 12 laboratories equipped with the state-of-the-art equipment allowing for practical implementation of engineering principles that satisfies the needs of the pharmaceutical and chemical industries. Moreover, in the vicinity of the university, there are numerous pharmaceutical plants where our students can train, and our graduates can find suitable job opportunities.

Program Objectives

The educational objectives of the Pharmaceutical and Chemical Engineering Program at the German Jordanian University are to produce graduates who possess the following qualities:

1. A solid foundation of scientific knowledge and required skills in the labor market.
2. Efficiency in working in various pharmaceutical and chemical industries.
3. High ethical and professional principles.
4. The ability to reach leadership roles in various fields of specialization.
5. Continuous learning.
6. Ability to provide new and sustainable solutions to national and global challenges.

Learning Outcomes

Upon completion of this program, the student will have the following outcomes:

1. An ability to apply the principles of chemistry, physics, mathematics, and engineering in the development of various processes in the pharmaceutical and chemical industries.
2. An ability to communicate effectively through proficiency in three languages (Arabic, English, and German) and applying various communication skills.
3. An ability to work in various labor markets, such as the Jordanian, German and international markets.
4. An ability to apply ethical and professional principles in the presented technical solutions.
5. An ability to work in teams and cooperate to achieve plans and tasks.
6. An ability to analyze data, draw conclusions and use present new solutions.
7. An ability to learn continuously.

Framework

All graduate students will take a minimum of 33 credit hours in order to receive their MSc degree in Pharmaceutical and Chemical Engineering. Students pursuing the MSc in PCE will start with the non-thesis (comprehensive exam) track. After the first year, students will be able to transfer to the thesis track based on the cumulative average for the first year and the capacity of the thesis track determined by the department. Non-thesis option will be suitable for students who wish to have a professional communication career in industries, whereby the thesis option best fits the students who wish to reflect theory and work in research. The student is required to successfully complete the following credit hours in each track of their choice (non-thesis or thesis option) over two years:

Program requirements	**Cr Hr**
Compulsory Courses	24
Technical Elective Courses	9
Total	**33**

PCE Course Grouping

The core of the program covers four principal areas or disciplines as indicated in the course code. Every course has a 6-digit code such as PCE711, which identifies the following sequence:

- An abbreviation for the department offering the course (PCE): Pharmaceutical and chemical engineering department
- Level digit (7): Graduate-level of master's program
- The middle digit represents the specialized field of knowledge:
  - 1 = Chemical Engineering
  - 2 = Pharmaceutical Sciences
  - 3 = Research
  - 4 = Linguistic
- The right digit represents the sequence of the course within the field.

Program Requirements (33 Credit Hours)

1. Compulsory Courses: (24 Credit Hours)

Course ID	Course Title	Cr Hr	Theoretical Hours	Practical Hours
PCE711	Thermodynamics in chemical and pharmaceutical processes	3	3	0
PCE731	Pharmaceutical instrumental analysis	3	3	0
PCE712	Transport phenomena in chemical and pharmaceutical processes	3	3	0
PCE713	Kinetics, catalysis, and reactor design	3	3	0
PCE721	Pre-formulation in pharmaceutical manufacturing	3	3	0
PCE732	Research methodology and statistical quality control	3	3	0
PCE722	Pharmaceutical process design and quality assurance	3	3	0
PCE733	Industrial research project	3	3	0

2.Technical Elective Courses: (9 Credit Hours) selected from the following courses:

Course ID	Course Title	Cr Hr	Theoretical Hours	Practical Hours
PCE714	Biochemical engineering	3	3	0
PCE715	Polymeric materials	3	3	0
PCE716	Pharmaceutical water and wastewater treatment	3	3	0
PCE717	Operations and supply chain management	3	3	0
PCE718	Computational methods in pharmaceutical and chemical engineering	3	3	0
PCE741	German language	3	3	0
PCE723	Seminars in pharmaceutical and chemical industries	3	3	0
PCE724	Pharmaceutical industry and new technologies	3	3	0
PCE725	Nanotechnology in pharmaceutical and chemical applications	3	3	0
PCE726	Biomaterials in in pharmaceutical and chemical applications	3	3	0
PCE727	Special topic in pharmaceutical and chemical engineering	3	3	0

Guide Study Plan

1st Semester		2nd Semester		3rd Semester		4th Semester	
PCE711	Thermodynamics in chemical and pharmaceutical processes	PCE713	Kinetics, catalysis, and reactor design	PCE721	Pre-formulation in pharmaceutical manufacturing	PCE722	Pharmaceutical process design and quality assurance
PCE731	Pharmaceutical instrumental analysis	PCE712	Transport phenomena in chemical and pharmaceutical processes	PCE732	Research methodology and statistical quality control	PCE733	Industrial research project
Technical Elective course from A List				Two Technical Elective courses from B List			

List A of technical elective courses

Course ID	Course Title	Cr Hr
PCE714	Biochemical engineering	3
PCE715	Polymeric materials	3
PCE716	Pharmaceutical water and wastewater treatment	3
PCE717	Operations and supply chain management	3
PCE718	Computational methods in pharmaceutical and chemical engineering	3
PCE741	German language	3

List B of technical elective courses

Course ID	Course Title	Cr Hr
PCE723	Seminars in pharmaceutical and chemical industries	3
PCE724	Pharmaceutical industry and new technologies	3
PCE725	Nanotechnology in pharmaceutical and chemical applications	3
PCE726	Biomaterials in pharmaceutical and chemical applications	3
PCE727	Special topics in pharmaceutical and chemical engineering	3

Courses Description

PCE711: Thermodynamics in chemical and pharmaceutical processes 3 Cr Hr (0,3)

Basic principles of classical chemical thermodynamics. Chemical and physical equilibria and their relationships in simple and reactive systems. Estimation and correlation of thermodynamic functions, applications of thermodynamic principles to transport and rate processes. Irreversible and statistical thermodynamic topics also introduced.

PCE731: Pharmaceutical instrumental analysis 3 Cr Hr (0,3)

Undertaking this course is essential for a master's degree student to be able to gain additional laboratory skills relying on fundamentals and application of pharmaceutical analytical techniques including advanced spectroscopic techniques such as atomic and molecular absorption and emission spectroscopy, Imaging techniques such as scanning Electron, and Scanning tunneling microscopy, and electrochemical clean techniques of potentiometry, Colorometry and voltammetry. In addition to basic techniques in separation as well as thermoanalytical techniques, which are likely to be used by students through their practical commencement of this degree. The emphasis will be placed onto research training and thesis writing throughout learning scientific methodology of communicating the obtained results from these techniques and validating them with all relevant statistical tools and references in a proper reporting mechanism.

PCE712: Transport phenomena in chemical and pharmaceutical processes 3 Cr Hr (0,3)

Momentum transport processes in laminar- and turbulent-flow systems. Development and application of steady and unsteady boundary-layer processes, including growth, similitude principles, and separation. Potential flow theory coupled with viscous dissipation at boundaries. Momentum transport in fixed- and fluid-bed exchangers and reactors. Energy balances derived from first and second law approaches to open systems, with reaction. Conduction in fluids and solids, both steady and unsteady examples. Convection in laminar- and turbulent-flow systems. Diffusion and its treatment in stagnant and flowing media. Two-phase systems, coupled reaction, mass transfer and interphase transport.

PCE713: Kinetics, catalysis, and reactor design 3 Cr Hr (0,3)

Kinetics and Reactor Design: Review of fundaments of reaction engineering, reaction kinetics and ideal reactors; transport processes in heterogeneous reactions catalyzed by solids; gas-liquid and gas-solid reactions without catalysts; reaction and reactor modelling; non-ideal reactors; reactor scale-up and optimization. Catalysis: Catalyst function; catalyst structure and surface chemistry; catalyst development, materials and preparation methods; catalyst testing, characterization and kinetics; catalyst deactivation and regeneration.

PCE721: Pre-formulation in pharmaceutical manufacturing 3 Cr Hr (0,3)

The course will give an introduction of the concepts and methods with the underlying theory of a key stage required in product development and identified as preformulation inputs. Basics of converting ideas into candidate drugs for development will be reviewed with an emphasis on approaches of converting drugs into products that establish sustainable value in the pharmaceutical market. Key concepts that address safety, selectivity and efficacy will be recognized relying on harmonized pharmacopoeias and standardized tests across the major globe. The concepts of using modern preformulation techniques to evaluate physicochemical properties of compounds, salts and

polymorphs will be gleaned based on preferred pharmaceutical properties of the drug, such as good aqueous solubility and stability, to ensure reduction of development costs in clinical phases or bioequivalence studies, and to inform formulation strategy to launch products with improved life span of market exclusivity with proper planning for a balanced 'CoG' targets.

PCE732: Research methodology and statistical quality control 3 Cr Hr (0,3)

Undertaking this course is essential for a master's degree student to be able to gain additional laboratory skills relying on fundamentals and application of pharmaceutical analytical techniques including advanced spectroscopic techniques such as atomic and molecular absorption and emission spectroscopy, Imaging techniques such as scanning Electron, and Scanning tunneling microscopy, and electrochemical clean techniques of potentiometry, Colorometry and voltammetry. In addition to basic techniques in separation as well as thermoanalytical techniques, which are likely to be used by students through their practical commencement of this degree. The emphasis will be placed onto research training and thesis writing throughout learning scientific methodology of communicating the obtained results from these techniques and validating them with all relevant statistical tools and references in a proper reporting mechanism.

PCE722: Pharmaceutical process design and quality assurance 3 Cr Hr (0,3)

The course will explore the aspects of project design and management, including site selection, process flow, pharmaceutical process utility systems, cleanroom design and requirements. The focus of this course will be on acquisition necessary data on high-quality yet affordable products using conventional infrastructure of tablet production systems, coating Systems, capsule filling systems, in addition to the design requirements of sterile and aseptic manufacturing facility for specialized products including parenterals. The students will develop understanding of approaches to ensure the quality of data in process monitoring and control systems and build data quality-in to generate specifications that speaks to living documents continuously revised and updated with decision points for demands of FDA or regulatory bodies while providing flexibility for developers through understanding of basic principles of process and facility design. This course will cover topics of validation, total quality management (TQM), GMPs, SOPs, and Six Sigma.

PCE733: Industrial research project 3 Cr Hr (0,3)

Theoretical and/or experimental investigation of a problem in the chemical/pharmaceutical industries. The project aims to improve the student's research skills and give him/her experience in systematically dealing with problems in the chemical/pharmaceutical industries.

PCE714: Biochemical engineering 3 Cr Hr (0,3)

Biochemical reaction engineering combines traditional chemical reaction engineering, which is a combination of kinetics and the design and analysis of reactors, with cellular processes to effect bioproduction or biodegradation reactions. These desired reactions may serve to produce a specific product or raw material in the pharmaceutical, agricultural, or food industries, or may serve as pathways for the biodegradation of specific compounds in the environmental remediation industries, often referred to as 'clean' technologies for waste remediation. Biochemical engineering, biochemical processes, thermodynamics and kinetics are used in the application of engineering principles to analyze, design, and develop processes using biocatalysts. It plays an important key role in manufacturing pharmaceuticals, biomaterials and agents for gene and cell therapies. The course is suitable to equip its graduates to meet challenges in biotech industries, while at the same time preparing them for research in frontier areas of Biotechnology.

PCE715: Polymeric materials 3 Cr Hr (0,3)

This course is designed to introduce the basic principle of polymers and polymeric materials in terms of synthesis, polymer molecular weight and its influence on polymer chemical and physical properties. The course will also cover topics on polymers classification, amorphous and crystalline polymers, chain conformation, kinetics of addition and step growth polymerizations. Polymers characterizations: quantitative and qualitative, polymer coating and the role of different additives used in common formulation. The course introduces common pharmaceutical polymers and their applications in pharmaceutical industry.

PCE716: Pharmaceutical water and wastewater treatment 3 Cr Hr (0,3)

Water chemistry. Water Treatment for drinking and pharmaceutical/industrial uses. Characterization of domestic and pharmaceutical/industrial wastewater. Physical, chemical and biological treatments. Applications. Government and municipal regulations.

PCE717: Operations and supply chain management 3 Cr Hr (0,3)

Operations and supply chain management. Quality management. Process capability and statistical control. Designing products. Process design technology. Capacity and facilities planning. Human Resources in Operations Management. Managing projects. Strategic supply chain management and design. Forecasting.

PCE718: Computational methods in pharmaceutical and chemical engineering 3 Cr Hr (0,3)

This course introduces advanced computational methods used in chemical engineering for various types of pharmaceutical chemical engineering related processes. The course covers topics on computational errors, stability of algorithms, modelling of chemical engineering single and integrated processes. High level programming software such as MATLAB and ASPEN PLUS will be utilized for solving different linear and nonlinear models.
MATLAB: this module covers topics include solving systems of linear and nonlinear algebraic equations, ordinary differential equations (initial and boundary value problem) and curve fitting. Basic principles of optimization of linear constrained and nonlinear unconstrained problems are also introduced.
Aspen: getting started with process simulation, thermodynamic models and physical properties, pressure changer, heat exchangers, flowsheet analysis, reactors, and equilibrium separation column.

PCE741: German language 3 Cr Hr (0,3)

This course aims to teach the basics of the German language.

PCE723: Seminars in pharmaceutical and chemical industries 3 Cr Hr (0,3)

Seminars given by students and invited experts on topics related to ‘state of the art’ pharmaceutical and chemical engineering applications. The student must attend more than 80% of the seminars and submit a report with the presented seminar.

PCE724: Pharmaceutical industry and new technologies 3 Cr Hr (0,3)

This module introduces an overview of the pipeline of drug manufacturing process and explores some themes that cover specific examples of advanced techniques to develop or evaluate delivery

systems, such as electrospinning, microfluidics, 3D printing, and extrusion technologies. This involves integration of the structure of the industry responsible for these processes and how to build a strategic mapping for more reliable and less costly final products. Therefore, challenges faced by the pharmaceutical industry, and the opportunity for business development, pharma funding based on new therapeutic technology will be covered and explored.

PCE725: Nanotechnology in pharmaceutical and chemical applications 3 Cr Hr (0,3)

This course aims to provide a broad overview of fundamental principles and current research directions in nanoscience and nanotechnology. Specifically, the course covers: Introduction to nanomaterials, identification of nanomaterials both natural and synthetic, fundamental scaling laws (physical and chemical) that affect the materials' properties at the nanometre scale, fabrication methods (physical and chemical) applied to different types of nanomaterials including nanoparticles, nanofibers, thin films and nanocomposites, characterization techniques including electron microscopy (SEM, TEM, AFM, etc) and spectroscopy (XRD, EDX, Raman, etc), applications of nanotechnology in energy, environment, medicine, etc,. The course also covers the new trends and recent research directions in nanoscience and nanotechnology

PCE726: Biomaterials in pharmaceutical and chemical applications 3 Cr Hr (0,3)

This course introduces the chemistry and engineering skills needed to solve challenges in the biomaterials and tissue engineering area. It covers fundamental principles in biomedical engineering, material science and chemistry, and how they contribute to biomaterial development and performance, macromolecular chemistry, physical characterization, and properties. The course introduces an overview on components in the human body used to construct tissue. Implantable materials: temporary or permanent implants, biodegradable materials, cell substrates, tailored tissue. Interactions between human tissue and biomaterials: properties at natural tissue and transplantation techniques.

PCE727: Special topics in pharmaceutical and chemical engineering 3 Cr Hr (0,3)

Title and course contents of the topic must be approved by the Department's Council and preannounced by the Department.