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**German Jordanian University**

**School of Applied Medical Sciences**

**Department of Pharmaceutical & Chemical Engineering**

**Master of Science in Pharmaceutical and Chemical Engineering**

**Non-Thesis Track**

**Study Plan 2022**

# Program Objectives

Program 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:

# An ability to apply the principles of chemistry, physics, mathematics, and engineering in the development of various processes in the pharmaceutical and chemical industries.

# An ability to communicate effectively through proficiency in three languages (Arabic, English, and German) and applying various communication skills.

# An ability to work in various labor markets, such as the Jordanian, German and international markets.

# An ability to apply ethical and professional principles in the presented technical solutions.

# An ability to work in teams and cooperate to achieve plans and tasks.

# An ability to analyze data, draw conclusions and use present new solutions.

# An ability to learn continuously

# Course Delivery Methods

Courses are in one of the following three methods:

* **Face-to-Face (F2F) Method**

Courses using this method are delivered by faculty in person in regularly scheduled class sessions physically on campus.

* **Blended (BLD) Method**

Courses are delivered in a hybrid mode of physical face-to-face class sessions and asynchronous material including online instructional videos, presentations, projects, and similar learning activities.

* **Online (OL) Method**

Courses are delivered exclusively online. This method consists of a hybrid of synchronous regularly scheduled class sessions delivered via the Internet, and asynchronous material including online instructional videos, presentations, projects, and similar learning activities. Virtual classrooms utilizing different online platforms are used. No physical face-to-face meetings are required.

# Admission Requirements

To apply for admission, the following minimum requirements must be met:

1. Holding a BSc in Chemical engineering or Pharmaceutical Chemical Engineering
2. Or /Holding a BSc in Pharmacy
3. Or / Holding A BSc in Chemistry

# Holders of BSc in Chemical engineering should take PCE502 (3 CH, Basic principles of Pharmaceutical Systems) as a remedial course in their 1st year

# Holders of BSc in Pharmacy should take PCE501 (3 CH, Chemical engineering fundamentals for non-chemical engineering students) as a remedial course in their 1st year

# Holders of BSc in Chemistry should take both PCE501 (3 CH) and PCE502 (3 CH) as remedial courses in their 1st year

# Degree Requirements (33 Credit hours)

Degree requirements \_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| **Classification** | **Credit Hours** |
| Compulsory courses | 24 |
| Technical Elective courses | 9 |
| **Total** | **33** |

# Curriculum (33 Credit hours)

### Compulsory Requirements: (24 credit hours)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course ID** | **Course Name** | **Credit Hours** | **ECTS** | **Contact Hours** | | **Type** | **Prerequisites / Corequisites** |
| **Lect** | **Lab** |
| PCE711 | Thermodynamics in chemical and pharmaceutical processes | 3 | 8 | 3 | 0 | F2F | PCE501 |
| PCE731 | Pharmaceutical instrumental analysis | 3 | 8 | 3 | 0 | F2F |  |
| PCE712 | Transport phenomena in chemical and pharmaceutical processes | 3 | 8 | 3 | 0 | F2F | PCE501 |
| PCE713 | Kinetics, catalysis, and reactor design | 3 | 8 | 3 | 0 | F2F | PCE501 |
| PCE721 | Pre-formulation in pharmaceutical manufacturing | 3 | 8 | 3 | 0 | OL | PCE502 |
| PCE732 | Research methodology and statistical quality control | 3 | 8 | 3 | 0 | BLD |  |
| PCE722 | Pharmaceutical process design and quality assurance | 3 | 8 | 3 | 0 | BLD | PCE501 |
| PCE733 | Industrial research project | 3 | 8 | 3 | 0 | BLD | PCE501 |
|  | **Total** | **24** | **72** | **24** | **0** |  |  |

### Elective Courses: (9 credit hours out of the following)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course ID** | **Course Name** | **Credit Hours** | **ECTS** | **Contact Hours** | | **Type** | **Prerequisites / Corequisites** |
| **Lect** | **Lab** |
| PCE714 | Biochemical engineering | 3 | 6 | 3 | 0 | BLD |  |
| PCE715 | Polymeric materials | 3 | 6 | 3 | 0 | BLD |  |
| PCE716 | Pharmaceutical water and wastewater treatment | 3 | 6 | 3 | 0 | BLD |  |
| PCE717 | Operations and supply chain management | 3 | 6 | 3 | 0 | BLD | PCE501 |
| PCE718 | Computational methods in pharmaceutical and chemical engineering | 3 | 6 | 3 | 0 | BLD | PCE501 |
| PCE741 | German language | 3 | 6 | 3 | 0 | BLD |  |
| PCE723 | Seminars in pharmaceutical and chemical industries | 3 | 6 | 3 | 0 | BLD |  |
| PCE724 | Pharmaceutical industry and new technologies | 3 | 6 | 3 | 0 | BLD | PCE502 |
| PCE725 | Nanotechnology in pharmaceutical and chemical applications | 3 | 6 | 3 | 0 | BLD |  |
| PCE726 | Biomaterials in in pharmaceutical and chemical applications | 3 | 6 | 3 | 0 | BLD |  |
| PCE727 | Special topic in pharmaceutical and chemical engineering | 3 | 6 | 3 | 0 | BLD |  |
|  | **Minimum required** | **9** | **18** | **9** | **0** |  |  |

List A of technical elective courses

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PCE714 | Biochemical engineering | 3 | 6 | 3 | 0 | BLD |  |
| PCE715 | Polymeric materials | 3 | 6 | 3 | 0 | BLD |  |
| PCE716 | Pharmaceutical water and wastewater treatment | 3 | 6 | 3 | 0 | BLD |  |
| PCE717 | Operations and supply chain management | 3 | 6 | 3 | 0 | BLD | PCE501 |
| PCE718 | Computational methods in pharmaceutical and chemical engineering | 3 | 6 | 3 | 0 | BLD | PCE501 |
| PCE741 | German language | 3 | 6 | 3 | 0 | BLD |  |

List B of technical elective courses

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PCE723 | Seminars in pharmaceutical and chemical industries | 3 | 6 | 3 | 0 | BLD |  |
| PCE724 | Pharmaceutical industry and new technologies | 3 | 6 | 3 | 0 | BLD | PCE502 |
| PCE725 | Nanotechnology in pharmaceutical and chemical applications | 3 | 6 | 3 | 0 | BLD |  |
| PCE726 | Biomaterials in in pharmaceutical and chemical applications | 3 | 6 | 3 | 0 | BLD |  |
| PCE727 | Special topic in pharmaceutical and chemical engineering | 3 | 6 | 3 | 0 | BLD |  |

### Thesis/Comprehensive Exam/Other: (00 credit hours)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Course ID** | **Course Name** | **Credit Hours** | **ECTS** | **Contact Hours** | | **Type** | **Prerequisites / Corequisites** |
| **Lect** | **Lab** |
|  | Comprehensive Exam | 0 | 0 |  |  |  |  |
|  | **Minimum required** | **00** |  | **00** | **00** |  |  |

1. **Study Plan Guide**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **First Year** | | | | | | | |
| **First Semester** | | | | | | | |
| **Course ID** | **Course Name** | **Credit Hours** | **ECTS** | **Contact Hours** | | **Type** | **Prerequisites / Corequisites** |
| **Lect** | **Lab** |
| PCE711 | Thermodynamics in chemical and pharmaceutical processes | 3 | 8 | 3 |  | F2F | PCE501 |
| PCE731 | Pharmaceutical instrumental analysis | 3 | 8 | 3 |  | F2F |  |
|  | **Total** | **6** | **16** | **6** | **0** |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **First Year** | | | | | | | |
| **Second Semester** | | | | | | | |
| **Course ID** | **Course Name** | **Credit Hours** | **ECTS** | **Contact Hours** | | **Type** | **Prerequisites / Corequisites** |
| **Lect** | **Lab** |
| PCE713 | Kinetics, catalysis, and reactor design | 3 | 8 | 3 |  | F2F | PCE501 |
| PCE712 | Transport phenomena in chemical and pharmaceutical processes | 3 | 8 | 3 |  | F2F | PCE501 |
| Technical Elective course from A List | | 3 | 6 | 3 |  | BLD |  |
|  | **Total** | **9** | **22** | **9** | **0** |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Second Year** | | | | | | | |
| **First Semester** | | | | | | | |
| **Course ID** | **Course Name** | **Credit Hours** | **ECTS** | **Contact Hours** | | **Type** | **Prerequisites / Corequisites** |
| **Lect** | **Lab** |
| PCE721 | Pre-formulation in pharmaceutical manufacturing | 3 | 8 | 3 | 0 | OL | PCE502 |
| PCE732 | Research methodology and statistical quality control | 3 | 8 | 3 | 0 | BLD |  |
| One Technical Elective courses from B List | | 3 | 6 | 3 | 0 | BLD |  |
|  | **Total** | **9** | **22** | **9** | **0** |  |  |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Second Year** | | | | | | | |
| **Second Semester** | | | | | | | |
| **Course ID** | **Course Name** | **Credit Hours** | **ECTS** | **Contact Hours** | | **Type** | **Prerequisites / Corequisites** |
| **Lect** | **Lab** |
| PCE722 | Pharmaceutical process design and quality assurance | 3 | 8 | 3 | 0 | BLD | PCE501 |
| PCE733 | Industrial research project | 3 | 8 | 3 | 0 | BLD |  |
| One Technical Elective courses from B List | | 3 | 6 | 3 | 0 | BLD |  |
|  | **Total** | **9** | **0** | **0** | **0** |  |  |

# Course Descriptions

# Compulsory Courses

|  |  |  |
| --- | --- | --- |
| **PCE711: Thermodynamics in chemical and pharmaceutical processes** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites:* PCE501 | | |
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| **PCE731: Pharmaceutical instrumental analysis** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE712: Transport phenomena in chemical and pharmaceutical processes** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites:* PCE501 | | |
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| --- | --- | --- |
| **PCE713: Kinetics, catalysis, and reactor design** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites:* PCE501 | | |
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| **PCE721: Pre-formulation in pharmaceutical manufacturing** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites:* PCE502 | | |
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| **PCE732: Research methodology and statistical quality control** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE722: Pharmaceutical process design and quality assurance** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE733: Industrial research project** | **3 Cr Hr** | **8 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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# Elective Courses

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| **PCE714: Biochemical engineering** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE715: Polymeric materials** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE716: Pharmaceutical water and wastewater treatment** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE717: Operations and supply chain management** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE718: Computational methods in pharmaceutical and chemical engineering** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE741: German language** | **3 Cr Hr** | **6 ECTS** |
| This course aims to teach the basics of the German language. | | |
| *Prerequisites: -* | | |
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| **PCE723: Seminars in pharmaceutical and chemical industries** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE724: Pharmaceutical industry and new technologies** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| **PCE725: Nanotechnology in pharmaceutical and chemical applications** | **3 Cr Hr** | **6 ECTS** |
| 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 | | |
| *Prerequisites: -* | | |
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| **PCE726: Biomaterials in pharmaceutical and chemical applications** | **3 Cr Hr** | **6 ECTS** |
| 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. | | |
| *Prerequisites: -* | | |
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| --- | --- | --- |
| **PCE727: Special topics in pharmaceutical and chemical engineering** | **3 Cr Hr** | **6 ECTS** |
| Title and course contents of the topic must be approved by the Department’s Council and preannounced by the Department. | | |
| *Prerequisites: -* | | |
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# Thesis/Comprehensive Exam/Other

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| --- | --- | --- |
| **Comprehensive Exam** | **00 Cr Hr** | **00 ECTS** |
| Course description course description course description course description course description course description course description course description course description course description. | | |
| *Prerequisites: -* | | |
|  | | |

1. **Remedial Courses**

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| **PCE501: Chemical engineering fundamentals for non-chemical engineering students** | **3 Cr Hr** |  |

This course is designed to provide an overview of the basic principles and concepts of chemical engineering for students with no background in engineering. It aims at bridging the knowledge gap and familiarize the non-engineering students with the core principles and applications of chemical engineering. Students will explore key topics that form the foundation of chemical engineering, such as mass and energy balances, thermodynamics, chemical reactions, separation process and fluid mechanics. Also, the course introduces the role of chemical engineers and their contributions to pharmaceutical, energy, and environmental engineering.

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| **PCE502: Basic principles of Pharmaceutical Systems** | **3 Cr Hr** |  |

This course is designed to Provide students with the basic understanding of Pharmaceutical Dosage forms and doses of drugs. In the area of solid dosage form as tablet technology, capsules and pellets etc…also semi-solid dosage form, liquid dosage form, Aerosol; Drug administration, Drugs in Pregnancy /Causing Disabilities in Newborn; classification of drug dosage forms, machinery used for manufacturing dosage forms; Introduction to Biopharmaceutics; Pharmaceutical and Technological design. Quality Control terminology.