PHARMACEUTICAL ENGINEERING AND SCIENCE (PESC)

PESC 505. Pharmaceutical Engineering Fundamentals I. 3 Hours.
Semester course; 3 lecture hours (delivered face-to-face or hybrid). 3 credits. Enrollment is restricted to students in the Ph.D. in Pharmaceutical Engineering program or with permission of the instructor. This is an introductory course designed to expose students to basic concepts in drug discovery as well as principles in pharmaceutics, biopharmaceutics and pharmacokinetics that are fundamental to the development of various dosage forms. Topics to be covered include a general survey from drug discovery to clinical trials; omics-guided drug target identification and strategies for the design of new drugs; the physicochemical characteristics of drugs and excipients; formulation, manufacturing and packaging of pharmaceutical dosage forms; drug and dosage form stability and degradation; physicochemical mechanisms of drug absorption, distribution, metabolism and elimination; and mathematical models and physiological principles used to describe ADME. Prior basic knowledge (B.S.-level) in physical-chemistry, calculus and statistics is required. The course content is delivered through lectures, group discussions, in-class calculations, homework and online tools.

PESC 507. Pharmaceutical Engineering Fundamentals II. 3 Hours.
Semester course; 3 lecture hours (delivered face-to-face or hybrid). 3 credits. Enrollment is restricted to students in the Ph.D. in Pharmaceutical Engineering program or with permission of the instructor. This is an introductory course designed to expose the students to basic concepts in materials balance, thermodynamics, reaction kinetics and transport processes applied to pharmaceutical processes. Students will be exposed to common problem-solving strategies common to pharmaceutical engineering problems and various tools (software) used to enhance their ability to solve these problems. These introductory steps will provide students with the required tools to address phase equilibrium problems based on a thermodynamic framework; tools to design reaction systems for the production of active pharmaceutical ingredients; and fundamental transport properties for the design systems for the purification and separation of active pharmaceutical ingredients.

PESC 515. Nanomedicine. 1 Hour.
Semester course; 1 lecture hour. 1 credit. Enrollment is restricted to students in pharmaceutical engineering or with permission of the instructor. This is an introductory course designed to expose students to basic concepts in nanomedicine. Topics to be covered include: introduction to nanocarrier-based drug delivery applications; design of nanocarriers for drug delivery applications; characterization of nanocarriers, including their spatial/temporal controlled-release properties and critical quality attributes; interaction of nanocarriers and the physiological environment; nanocarriers and their dosage forms; nanocarriers for pulmonary drug delivery; nanocarriers for ocular drug delivery; nanocarriers for systemic and lymphatic drug delivery; liposomal drug products; FDA guidance to industry.

PESC 605. Advanced Topics in Pharmaceutical Engineering I. 3 Hours.
Semester course; 3 lecture hours (delivered face-to-face or hybrid). 3 credits. Enrollment is restricted to students in the Ph.D. in Pharmaceutical Engineering program or with permission of the instructor. This is an advanced course in pharmaceutical engineering covering relevant multidisciplinary topics that straddle the boundaries between pharmaceutics and engineering. Topics include process analytical technology (PAT, situ analytical tools) with a focus on analytical techniques, including particle size analysis, and IR and other in situ spectroscopic techniques; particle solid state characterization, with a focus on methods for characterization/quantification of polymorphs, crystallinity/amorphous ratio, size and size distribution, flowability; modeling, with a focus on modeling of pharmacokinetics, aerosol properties and omics; separations, with a focus on hardware and regulatory, including LC-MS, quality control; and advanced formulations, with a focus on nanomedicine, physiological barriers and sustained release.

PESC 607. Advanced Topics in Pharmaceutical Engineering II. 3 Hours.
Semester course; 3 lecture hours (delivered face-to-face or hybrid). 3 credits. Enrollment is restricted to students in the Ph.D. in Pharmaceutical Engineering program or with permission of the instructor. This is an advanced course in pharmaceutical engineering covering relevant multidisciplinary topics that straddle the boundaries between pharmaceutics and engineering. Topics include process analytical technology (PAT, situ analytical tools) with a focus on data processing, including data analysis, data visualization and big data; particle formation and size control, with a focus on fundamentals of crystallization, size control operations and control of particle morphology; modeling, with a focus on fundamentals of chemical kinetics, crystallization and formulation processing; separations, with a focus on theory, including analytical, membrane separation and large-scale biosynthesis; advanced formulations, with a focus on engineering materials for the pharmaceutical industry, processing dosage forms for sustained release and transport properties across physiological barriers.

PESC 609. Pharmaceutical Engineering Laboratory I. 1 Hour.
Semester course; 3 laboratory hours. 1 credit. Didactic laboratory in pharmaceutical engineering. Laboratory experiments will be focused on three major themes based on the following routes of administration: pulmonary drug delivery (metered-dose and dry powder inhalers); oral drug delivery (tablets and capsules); parenteral drug delivery (sterile parenteral formulations). Experiments performed will focus on drug discovery, active pharmaceutical ingredient characterization and API pre-formulation; they will provide the platform for product formulation manufacturing in more open-ended experiments to be carried out on the same themes in subsequent courses. In situ analytical tools (process analytical technology) will be used in the laboratory experiments as appropriate.

PESC 690. Pharmaceutical Engineering Seminar. 0.5 Hours.
Semester course; .5 seminar hours (delivered face-to-face or hybrid). .5 credits. May be repeated for credit. Enrollment is restricted to students in the pharmaceutical engineering Ph.D. program or with permission of the instructor. This course will provide students an opportunity to develop their scientific seminar preparation and oral presentation skills, a forum for discussion of student research, and a mechanism to expose faculty and students to cutting-edge research in pharmaceutical engineering. Feedback from the seminar audience will be provided through discussions, question-and-answer sessions and an evaluation form so the student may benefit from the ideas and experience of the audience.

PESC 691. Special Topics in Pharmaceutical Engineering. 1-5 Hours.
Semester course; 1-5 lecture hours (delivered face-to-face or hybrid). 1-5 credits. Presentation of subject matter is by lectures, tutorial studies and/or library assignments in selected areas of advanced study not available in other courses or as part of the training in research. Graded as Pass/Fail.

PESC 697. Directed Research in Pharmaceutical Engineering. 1-15 Hours.
Semester course; 1-15 laboratory hours. 1-15 credits. May be repeated for credit. Enrollment is restricted to students in the Ph.D. in Pharmaceutical Engineering program. Research leading to the Ph.D. in Pharmaceutical Engineering. Graded as Satisfactory/Unsatisfactory.

PESC 701. Post-candidacy Doctoral Research. 9 Hours.
Semester course; 9 research hours. 9 credits. May be repeated for credit. Enrollment is restricted to students who have been admitted to doctoral candidacy in the pharmaceutical engineering program and are graduate teaching assistants or graduate research assistants; registration requires approval from the student's current degree program coordinator. Students will participate in supervised discipline-specific research related to their dissertation topic. This course can be approved as a substitution for any post-candidacy degree requirement. Graded as Satisfactory/Unsatisfactory.

PESC 707. Process Analytical Technology. 3 Hours.
Semester course; 3 lecture hours. 3 credits. Prerequisite: Basic chemistry/instrumentation lab skills, basic statistics/programming. Enrollment is restricted to students in Ph.D. in Pharmaceutical Engineering. Students should have basic chemistry/instrumentation lab skills and be familiar with basic statistics/programming. Familiarizes students with process analytical instrumentation commonly used in industrial R&D and manufacturing for process monitoring and development and product quality control. Students will gain practical lab experience of important process analytical technology and develop a better understanding of technology principles and new perspectives on data collection, data comprehension and data analysis.

PESC 709. Pharmaceutical Engineering Laboratory II. 1 Hour.
Semester course; 1 laboratory hour. 1 credit. Prerequisite: PESC 609. Corequisites: PESC 605 and PESC 607. Enrollment is restricted to students in the Ph.D. in Pharmaceutical Engineering program or with permission of the instructor. This course is the second in a sequence. Didactic laboratory in pharmaceutical engineering. Laboratory experiments will be focused on formulation development and characterization/testing in the three major themes based on the following routes of administration: pulmonary drug delivery (metered-dose and dry powder inhalers); oral drug delivery (tablets and capsules); parenteral drug delivery (sterile parenteral formulations).