PESC 505. Pharmaceutical Engineering Fundamentals I. 3 Hours. Semester course; 3 lecture hours. 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 506. Pharmaceutical Engineering Fundamentals II. 3 Hours. Semester course; 3 lecture hours. 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 508. Advanced Topics in Pharmaceutical Engineering I. 3 Hours. Semester course; 3 lecture hours. 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 crystalization, size control operations and control of particle morphology; modeling, with a focus on fundamentals of chemical kinetics, crystalization 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 509. 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 605. Advanced Topics in Pharmaceutical Engineering II. 3 Hours. Semester course; 3 lecture hours. 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.