

Undergraduate Course Listing

BME – Biomedical Engineering

BME 3009. Introduction to Biomedical Engineering (3). Prerequisites: BSC 2010, MAC 2312, and PHY 2048C, all with a grade of "C" or higher. Corequisites: ECH 3024, ECH 3301, MAC 2313, and PHY 2049C. This course presents an introduction to the field of biomedical engineering, building on previous basic coursework in biological science, physics, and calculus. Topics in cell physiology and modeling, bioinstrumentation, biomaterials, tissue engineering, and bioimaging are covered. The course provides sophomore-level biomedical engineering students with both fundamentals and applications in contemporary biomedical science and engineering.

BME 3100 Biomaterials (3). Prerequisites: BME 3361, BME 3622, BME 3702, and BME 4403C. Corequisites: BME 4211, BME 4503, BME 4503L, and BME 4404C. This course introduces fundamental concepts of biomaterials science and engineering. The course covers the basic properties of major classes of biomaterials including natural, polymeric, metallic, ceramic, carbon-based, composite, and nano-biomaterials. It also presents critical interactions between the biomaterials and biological systems, such as biocompatibility of biomaterials and foreign body reaction of the host to biomaterials. Since characterization tools are indispensable for biomaterials science and engineering, major techniques for characterizing biomaterials are taught, with an emphasis on introducing their basic principles.

BME 3361. Biotransport Phenomena (3). Prerequisites: ECH 3024, ECH 3301, PHY 2049C, and BME 3009. Corequisites: BME 3622, BME 3702, and BME 4403C. This course presents the fundamental concepts of transport phenomena in biological systems and applies these concepts to the solutions of problems relevant to biomedical engineering.

BME 3622. Biothermodynamics (3). Prerequisites: "C" grade or better in ECH 3024, ECH 3301, PHY 2049C, and BME 3009. Corequisites: BME 3361, BME 3702, and BME 4403C. This course covers the fundamental principles of thermodynamics and their application to biochemical, cellular, and physiological function. In addition, the principles of chemical kinetics of biochemical reactions and metabolic reaction networks are addressed.

BME 3702. Biocomputations (4). Prerequisites: ECH 3024, ECH 3301, Phy 2049C, BE 3009, and CHM 2210. Corequisites: BME 3622, BME 3361, and BME 4403C. This course covers structured programming techniques; numerical techniques useful in the solution of biomedical engineering problems: root finding techniques, direct and iterative approaches to solve linear systems, linear and nonlinear regression, interpolation, numerical differentiation and integration, and statistical analysis of data; numerical solutions of ordinary differential equations; and applications from physiological, cell, and molecular systems.

BME 4007. Biomedical Engineering (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267. Corequisites: ECH 4404L, ECH 4504, and ECH 4604. This course introduces the major principles of the life sciences (microbiology, cell biology, and genetics) that are important for biomedical engineering applications. The application of the chemical engineering principles of kinetics, mass transport, bioreactor design, and separation processes to solve the important problems in the biomedical engineering are emphasized.

BME 4211. Biomechanics (3). Prerequisites: "C" grade or better in the following courses: BME 3361, BME 3622, and BME 3702. Corequisites: BME 3100, BME 4503, BME 4503L, and BME 4404C. The course introduces the mechanical behavior of biological tissues and living systems, the mechanical properties of biological materials and its influence on the structure and function of living systems. Methods for the analysis of both rigid body and deformational mechanics are introduced as they apply to biological tissues including bone, muscle, and

connective tissues. The course also introduces the methods of continuum mechanics to biomechanical phenomena at cellular to tissue or organ level.

BME 4332. Cell and Tissue Engineering (3). Prerequisites: BME 3361 and BME 3622.

Corequisite: BME 4322L. This course covers the common techniques and fundamentals of cell culture for use in Biomedical Engineering investigations. Students acquire basic skills in cell culture, quantitative cell and molecular analyses, and report writing and oral presentation.

BME 4332L. Cell and Tissue Engineering Lab (1). Prerequisites: BME 3361 and BME 3622.

Corequisite: BME 4322. This course covers the common techniques and fundamentals of cell culture for use in Biomedical Engineering investigations. Students acquire basic skills in cell culture, quantitative cell and molecular analyses, and report writing and oral presentation.

BME 4403C. Quantitative Anatomy and Systems Physiology I (3). Prerequisites: BME 3009,

ECH 3024, and ECH 3301, all with a grade of "C" or higher; and PHY 2049C. Corequisites:

ECH 3101, ECH 3266, and ECH 3854. This course introduces engineering students to

engineering principles of the anatomy and physiology of the human body. The lecture portion of

the course focuses on relating fundamental biomedical engineering concepts to the human

physiological system. The laboratory portion of the course involves a practical, in-depth study of

the physical and chemical interrelationships in the form and function of all human anatomical

and physiological subsystems.

BME 4404C. Quantitative Anatomy and Systems Physiology II (3). Prerequisites: BME

4403C, ECH 3101, ECH 3266, and ECH 3854. Corequisites: ECH 3274L, ECH 3418, and ECH

4267. This course focuses on introducing fundamental concepts of anatomy and physiology of

the human nervous, digestive, and urinary systems, quantitative aspects of systems, and scientific

principles underlying the systems, diseases and disorders of systems, and biomedical engineering techniques related to the systems.

BME 4503. Bioinstrumentation (3). Prerequisites: BME 3702, BME 4403C. Corequisite:

BME 4404C. This course is an overview of instrumentation used in clinical and biomedical

research. The course reviews circuit theory and its application to systems measuring for

biopotentials, stress and strain, pressure, temperature, and optical properties.

BME 4503L. Bioinstrumentation Laboratory (1). Prerequisites: BME 3702, BME 4403C. This

laboratory course provides hands-on use and construction of components and instrumentation

used in clinical and biomedical research. The laboratory focuses on electrical components,

transducers/sensors, and control systems.

BME 4508. Biosignals and Systems (3). Prerequisite: BME 4503. This course introduces fundamental concepts of signal processing, particularly linear systems and stochastic processes.

In this course, various estimation, detection, and filtering methods are developed and

demonstrated on biomedical signals. The methods include harmonic analysis, autoregressive

model, Wiener and Matched filters, linear discriminants, and independent components. All

methods are developed to answer concrete questions on specific data set in clinical diagnosis

modalities. The lectures are accompanied by data analysis assignments using MATLAB.

BME 4531. Medical Imaging (3). Prerequisites: BME 3702 and BME 4404C. Corequisite:

BME 4531L. This course examines the fundamentals and applications of five biomedical

imaging techniques: x-ray imaging and computer tomography, nuclear medicine, magnetic

resonance imaging, ultrasound and optical imaging. Additionally, as a basis for biomedical

imaging, the course presents introductory material on general image formation concepts and

characteristics, including the mathematics of image processing and the complexities of human

visual perception.

BME 4531L. Medical Imaging Laboratory (1). Prerequisites: BME 3702 and BME 4404C.

Corequisite: BME 4531. This laboratory course provides hands-on use and construction of

software, components, and instrumentation used in medical imaging. The laboratory focuses on

two aspects: image processing and medical imaging transducers.

BME 4801. Biomedical Engineering Process Design I (3). Prerequisites: BCH 4053 and

BME 4404C. Corequisite: Senior standing. This course is the first of a two-semester sequence on the design of biomedical engineering processes and products. The first semester consists of introducing students to the principles of engineering economics and cost estimation techniques relating to principles of biomedical engineering design. Included is an introduction to computer-aided design calculations.

BME 4802. Biomedical Engineering Process Design II (3). Prerequisites: BCH 4053, BME 4403C, and BME 4801. Corequisite: Senior standing. This course is the second of a two-semester sequence on the design of biomedical engineering processes and products. The second term focuses on the actual design of a biomedical engineering process or product using computer-aided design calculations. This is the capstone senior design course in biomedical engineering. An individual design project is completed by each student.

BME 4904r. Undergraduate Research Project (1–3). Prerequisite: BME 4403C, CHM 4410, ECH 3101, ECH 3266, ECH 3854, a 3.0 GPA, and instructor permission. Corequisites: ECH 3274L, ECH 3418, and ECH 4267. This course involves the completion of an Honors Undergraduate Research Program (URP) for six hours with a minimum grade of "C". This program requires independent student research on a topic relevant to biomedical engineering and may be used to satisfy the Chemical Engineering Elective requirement. May be repeated to a maximum of six (6) credit hours; repeatable within the same term.

BME 4905r. Directed Individual Study (3). Prerequisite: Department chair permission. This course offers a supervised program of study approved by the department chair. May be repeated to a maximum of twelve semester hours. May be repeated within the same semester.

BME 4906r. Honors URP in Biomedical Engineering (1–3). Prerequisite: BME 4403C, CHM 4410, ECH 3101, ECH 3266, ECH 3854, a 3.2 GPA, and instructor permission. Corequisites: ECH 3274L, ECH 3418, and ECH 4267. This course involves the completion of an Honors Undergraduate Research Program (URP) for six hours with a minimum grade of "C". This program requires independent student research on a topic relevant to biomedical engineering and may be used to satisfy the Chemical Engineering Elective requirement. May be repeated to a maximum of six semester hours. May be repeated within the same semester.

BME 4937r. Special Topics in Biomedical Engineering (3). Prerequisite: BME 4404C, ECH 3274L, ECH 3418, and ECH 4267. Corequisite: ECH 4504. This course emphasizes recent developments in the field of biomedical engineering. Selected readings are assigned by the instructor. Structure of the course varies by instructor and topic, but generally involve lectures and a final project on a topic in biomedical engineering. May be repeated to a maximum of twelve semester hours.

ECH – Chemical Engineering

ECH 2050. Engineering Communications (2). This course includes techniques for effective oral communication in settings most frequently encountered by the practicing engineer. Speaking skills are applied in informal presentations, formal presentations, and interviews.

ECH 3023. Mass and Energy Balances I (3). Prerequisites: CHM 1046 and MAC 2312. Corequisites: CHM 2210, MAC 2313, and PHY 2048C. This course covers mass and energy balances related to chemical process systems and measurements, as well as to the development of problem-solving methodologies in mass and energy balances.

ECH 3024. Mass and Energy Balances II (4). Prerequisites: CHM 2210, MAC 2313, and PHY 2048C; as well as ECH 3023 with a grade of "C" or higher. Corequisites: BSC 2010, ECH 3301, and PHY 2049C. This course introduces the general concepts of chemical engineering. In this course, the applications of mass and energy balances are extended to include reactive systems, and systems undergoing phase changes as well as transient processes. Computational tools such as Excel and MATLAB are used to demonstrate the use of a structured programming language for material and energy balances.

ECH 3101. Chemical Engineering Thermodynamics (3). Prerequisites: ECH 3023, ECH 3024, and ECH 3301, all with a grade of "C" or higher; and PHY 2049C. Corequisites: ECH 3266 and ECH 3854. In this course, students learn the basics of classical and solution thermodynamics. The course forms the link between the mass and energy balance courses, and separations.

ECH 3266. Transport Phenomena I (3). Prerequisites: ECH 3024 and ECH 3301, both with a grade of "C" or higher; and PHY 2049C. Corequisites: ECH 3101 and ECH 3854. This course examines integral balance equations for conservation of momentum, energy, and mass. Topics include the following: analysis of chemical processes involving fluid flow and heat and mass transfer, estimation of friction factors, and heat and mass transfer coefficients, pump selection and sizing, piping network analysis, and design of heat exchangers.

ECH 3274L. Transport Phenomena Laboratory (3). Prerequisites: ECH 3101, ECH 3266, and ECH 3854. Corequisites: ECH 3418 and ECH 4267. This course enables students to design and conduct experiments on fluid mechanics and heat transfer; analyze and interpret data; apply spreadsheets, statistical methods, and process models; as well as gain proficiency in operating basic chemical-engineering equipment and instruments. Emphasis is placed on safety, professionalism, teamwork, and oral/written communication.

ECH 3301. Process Analysis and Design (4). Prerequisite: MAC 2312. Corequisites: ECH 3023 and MAC 2313. This course examines the development and analysis of process models for systems that arise in chemical engineering applications.

ECH 3330. Statistical Approach to Process Improvement (3). Prerequisite: Completion of the academic requirements through the sophomore year in chemical engineering or in other engineering disciplines. This course covers ways to apply statistical process control and methods of planned experimentation to the design of products and processes, as well as to continuous quality improvement. Topics covered include control charts; process-capability studies; loss functions; acceptance sampling; design of experiments for screening studies and response-surface modeling; and analysis of variance. The course also introduces case studies in chemical processes, food engineering, and health care.

ECH 3418. Separations Processes (3). Prerequisites: ECH 3101, ECH 3266, and ECH 3854. Corequisites: ECH 3274L and ECH 4267. This course examines the principles of equilibrium and transport-controlled separations. Topics include analysis and design of stagewise and continuous separation processes, including distillation, absorption, extraction, filtration, and membrane separations.

ECH 3844. Chemical Engineering Statistics (3). This course introduces basic statistical analysis with an emphasis on applications relevant to Chemical Engineering. Applications covered include design of experiments and analysis of experimental data and modern software tools are utilized.

ECH 3854. Chemical Engineering Computations (4). Prerequisites: ECH 3024, ECH 3301, and PHY 2049C, all with a grade of "C" or higher. Corequisites: ECH 3101 and ECH 3266. This course covers topics such as structured programming techniques; numerical techniques useful in the solution of chemical engineering processes: root-finding techniques, direct and iterative approaches to solve linear systems, linear and nonlinear regression, interpolation, numerical differentiation and integration, statistical analysis of data; solutions of ordinary differential equations.

ECH 4267. Transport Phenomena II (3). Prerequisites: ECH 3101, ECH 3266, and ECH 3854. Corequisites: ECH 3274L and ECH 3418. This course focuses on the critical analytical and mathematical skills for analyzing fundamental concepts in transport phenomena (including fluid mechanics, heat transfer, and mass transfer) and the application of these concepts to the solution of problems relevant to chemical and biomedical engineering. The focus is on the microscopic description of momentum, energy, and mass transfer to obtain balance equations and to utilize information obtained from solutions of the balance equations to calculate

engineering quantities of interest drag force, rate of heat and mass transfer in a wide variety of problems.

ECH 4323. Process Control (3). Prerequisites: ECH 4404L, ECH 4504, and ECH 4604.

Corequisite: ECH 4615. This course focuses on the design and implementation of model-based control systems for chemical and biochemical systems. Topics include formulation of dynamic models, time and Laplace domain analysis of open-loop and closed-loop systems, and design of single variable and multivariable controllers. MATLAB and SIMULINK are used for dynamic process simulation and control system development. The lab is comprised of experiments designed to illustrate and apply control theory, measurement techniques, calibration, tuning of controls, characterization of sensors, and control circuits.

ECH 4323L.Process Control Lab (1). Prerequisites: ECH 4404L, ECH 4504, and ECH 4604.

Corequisite: ECH 4615. This lab is comprised of experiments designed to illustrate and apply control theory, measurement techniques, calibration, tuning of controls, characterization of sensors, and control circuits.

ECH 4404L.Unit Operations Lab (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267.

Corequisites: ECH 4504 and ECH 4604. This course includes activities such as designing and conducting experiments in reaction kinetics and chemical separations, analyzing and interpreting data, applying spreadsheets, statistical methods, and process models. Students gain proficiency in operating basic chemical engineering equipment and instruments. Emphasis on safety, professionalism, teamwork, and oral and written communication.

ECH 4504. Kinetics and Reactor Design (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267. This course covers the following topics: homogeneous and heterogeneous reaction kinetics; analysis of batch, mixed, plug, and recycle reactors; analysis of multiple reactions and multiple reactors; reactor temperature control; and catalytic reactor design.

ECH 4604. Chemical Engineering Process Design I (4). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267. Corequisites: ECH 4404L and ECH 4504. This course is the first in a two-semester sequence on the analysis, synthesis, and design of chemical processes, preparing students for engineering practice. Students integrate knowledge from prior courses with process economics, computer-aided design, engineering standards, and realistic constraints to solve open-ended process problems.

ECH 4615. Chemical Engineering Process Design II (3). Prerequisites: ECH 4404L, ECH 4504, and ECH 4604. Corequisites: ECH 4323 and ECH 4323L. This course is the second in a two-semester sequence on the analysis, synthesis, and design of chemical processes, and prepares students for engineering practice. Students integrate knowledge from prior courses with process economics, computer-aided design, engineering standards, and realistic constraints to the design of chemical-process facilities.

ECH 4705. Electrochemical Engineering Science (3). Prerequisites: Senior standing in Chemical Engineering or instructor permission. This course examines electrochemistry and electrochemical engineering science and their application in batteries and fuel cells, with emphases on quantitative analysis and the role of transport and kinetics.

ECH 4743. Bioengineering (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267.

Corequisites: ECH 4404L, ECH 4504, and ECH 4604. This course introduces chemical engineering students to the major principles of life sciences that are important for biotechnological applications, and extends and applies the students' knowledge of the chemical engineering principles of kinetics, mass transfer, separation, purification, and characterization to important problems in bioprocess engineering.

ECH 4781. Chemical Engineering—Environmental (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267. Corequisites: ECH 4404L, ECH 4504, and ECH 4604. This course is an introduction to the history and development of environmental regulation and its scientific basis. Application of fundamental chemical engineering techniques involving mass transfer theory and reaction kinetics to problems associated with the fate of contaminants in the environment.

ECH 4822. Polymer Physical Science and Engineering (3). Prerequisites: PHY 2048C (or at least one semester of General Physics) or instructor permission. This course is an introduction to static and dynamic polymer physics, including models of chains and macroscopic properties.

ECH 4823. Polymer Science and Engineering (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267. Corequisites: ECH 4404L, ECH 4504, and ECH 4604. This course offers an introduction to different types of polymers and their physical properties. Topics include major synthetic paths and reaction kinetics, properties of macromolecules in solution, methods of molecular weight determination, and the role of phase transitions in amorphous and crystalline polymers.

ECH 4824. Chemical Engineering Materials (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267. Corequisites: ECH 4404L, ECH 4504, and ECH 4604. This course provides an introduction to engineering materials, with emphasis on understanding the relation between structure, processing, and properties. In particular, the role of the atomic structure and arrangement, as well as the microstructure, in determining the physical properties of these materials is examined. In addition, polymers and modern processing techniques for improving material performance are studied. Finally, the resistance of materials to environmental factors, and factors in selection of materials for engineering applications are discussed.

ECH 4904r. Undergraduate Research Project in Chemical Engineering (1–3).

Prerequisites: CHM 4410, ECH 3101, ECH 3266, ECH 3854, a 3.0 GPA, and instructor permission. Corequisites: ECH 3274L, ECH 3418, and ECH 4267. This course involves the completion of an Honors Undergraduate Research Program (URP) for six hours with a minimum grade of "C". This program requires independent student research on a topic relevant to biomedical engineering and may be used to satisfy the Chemical Engineering Elective requirement. May be repeated to a maximum of six semester hours.

ECH 4905r. Directed Individual Study (1–3). Prerequisite: Permission of department chair. This is a supervised program of study. May be repeated to a maximum of twelve semester hours.

ECH 4906r. Honors URP in Chemical Engineering (1–3). Prerequisites: BME 4403C, CHM 4410, ECH 3266, ECH 3854, a 3.2 GPA, and instructor permission. Corequisites: ECH 3274L, ECH 3418, and ECH 4267. This course involves the completion of an Honors Undergraduate Research Program (URP) for six hours with a minimum grade of "C". This program requires independent student research on a topic relevant to biomedical engineering and may be used to satisfy the Chemical Engineering Elective requirement. May be repeated to a maximum of six (6) credit hours; repeatable within the same term.

ECH 4937r. Special Topics in Chemical Engineering (3). Prerequisites: ECH 3274L, ECH 3418, and ECH 4267. Corequisite: ECH 4504. This course covers selected topics in chemical engineering with emphasis on contemporary developments in the field. May be repeated within the same term to a maximum of twelve semester hours.

EGN – General Engineering

EGN 3032. Engineering Ethics (3). Prerequisite: EGN 1004L. This course introduces the key theories, concepts, principles, and methodology relevant to the development of professional engineering ethics. Students are guided in their development of a code of professional ethics through written work, class discussion, and case analysis.