BIOENGINEERING (BEN)

BEN 101 Computing for Bioengineers (3 Credits)
Engineering & Comp Sci
Introduction to desktop computing applications: word processing; statistical analysis; bitmap, object-oriented, and engineering graphics; circuit analysis; image processing; spread sheets. Introduction to programming, general principles of program organization, bioengineering applications, verification, reliability.

BEN 105 Bioengineering Seminar I (1 Credit)
Engineering & Comp Sci

BEN 200 Selected Topics (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

BEN 201 Biological Principles for Engineers (4 Credits)
Engineering & Comp Sci
Introduction to cell types and structure, nucleic acids, proteins and enzyme kinetics. Gene expression including transcription, translation and post-translational modification. Introduction to genomics, proteomics and bioinformatics. Genetic engineering and tissue engineering. Applications to biotechnology.
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 212 Experimental Methods in Chemical Engineering and Bioengineering (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 212
Statistical analysis and presentation of experimental data. Parameter estimation. Design of experiments. Hardware and software for computer interfacing. Collection, analysis, and reporting of laboratory data.
Prereq: MAT 296 and ECS 104.
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 231 Bioengineering Fundamentals (3 Credits)
Engineering & Comp Sci
Introduction to material, energy, charge, and momentum balances in biological systems. Overview of the field of bioengineering. Technological bases for established and emerging subfields.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 270 Experience Credit (1-6 Credits)
Engineering & Comp Sci
Participation in a discipline- or subject-related experience. Students must be evaluated by written or oral reports or an examination. Limited to those in good academic standing.
Repeatable

BEN 271 Clinical Immersion (3 Credits)
Engineering & Comp Sci
Clinical experiences via in-person shadowing and/or technology-enhanced simulation. Application of bioengineering to clinical practices, healthcare technology, medical device design and application, and electronic medical record. Team-based design project on clinical needs identification, ideation and prototyping.

BEN 280 International Course (1-12 Credits)
Engineering & Comp Sci
Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the S.U. academic department to assign the appropriate course level, title, and grade for the student's transcript.
Repeatable

BEN 290 Independent Study (1-6 Credits)
Engineering & Comp Sci
In-depth exploration of a problem or problems. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor or instructors and the department.
Repeatable

BEN 300 Selected Topics (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

BEN 310 Bioenrgtcs & Transprt Phenomna (4 Credits)
Engineering & Comp Sci
Introduction to equilibrium and nonequilibrium thermodynamics. Basic equations of momentum, mass and energy transfer. Applications in physiology and medicine.
Repeatable
Prereq: (PHY 211 or 215) and (211 or 216) and MAT 397

BEN 333 Fluid Transport (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 333
Fluid statics. Shear stress and viscosity. Energy and momentum balances for flow systems. Dimensional analysis. Friction and drag coefficients. Turbulent flow of compressible and incompressible fluids. Non-Newtonian fluids.
Prereq: MAT 397 and (PHY 212 or 216)
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 338 Biocontrol Systems (4 Credits)
Engineering & Comp Sci

BEN 341 Fundamentals of Heat and Mass Transfer (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 341
Principles of heat and mass transfer. Conduction, convection, and radiation. Thermal properties of materials. Solutions of steady state and transient heat and mass transfer problems. Diffusion with chemical reaction. Convective mass transfer.
Prereq: CEN 333 or BEN 333
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 355 Fundamntls Bioinstrumentation (0 Credits)
Engineering & Comp Sci

BEN 364 Quantitative Physiology (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 664
Introduction to mammalian physiology from an engineering perspective. Each of the major systems of the body will be addressed, with an emphasis on electrical, mechanical, and thermodynamic principles Lecture and laboratory. Additional work required of graduate students.
Prereq: BEN 201
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 375 Biomedical Systems, Signals, & Control (3 Credits)
Engineering & Comp Sci
Basic analysis and design techniques for signals and linear systems in bioengineering. Laplace and Fourier Transforms, time-frequency analysis. PID and fuzzy to optimal control. Applications include signals and noise, ECG processing, mathematics of imaging.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 380 International Course (1-12 Credits)
Engineering & Comp Sci
Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the S.U. academic department to assign the appropriate course level, title, and grade for the student's transcript.
Repeatable

BEN 385 Bioengineering Laboratory I (3 Credits)
Engineering & Comp Sci
Practical experience in the design, execution and analysis of experiments related to biomechanics and bioinstrumentation. Technical writing skills will also be emphasized.
Advisory recommendation Coreq: BEN 364
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 400 Selected Topics (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

BEN 412 BioMEMS, Biosensors & Biophotonics (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 612
Building blocks, fabrication techniques, sensing and actuation principles of biomedical microelectromechanical systems (bioMEMS). Case studies on biosensors, biophotonics and microsystem technologies that enhance biomedical research and healthcare. Additional work required of graduate students.
Shared Competencies: Communication Skills (https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 421 Biochemical Engineering (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 421
Double-numbered with BEN 621, CEN 621
Introduction to microbiology, biochemical kinetics. Biochemical-reactor design, including methods for oxygen transfer and control. Introduction to separation processes in biochemical engineering. Additional work for graduate students.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 422 Immunoengineering (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 622
Strategies and technologies to modulate and deconvolute the immune process for therapeutic purposes. Fundamentals of immunology, tools and methods, engineering strategies for vaccination, immunotherapy, and immunomodulation. Additional work required of graduate students.
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 423 Wave Phenomena (3 Credits)
Engineering & Comp Sci
Derivation of the wave equation for electromagnetic and mechanical waves. Wave phenomena; standing waves, reflections, resonance, impedance transformations, surface waves.

BEN 430 Sports Engineering (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 630
Study of engineering principles involved in sports: body systems in human motion, analysis of gait, basic performance patterns in athletic movements, performance improvements, and design of sports equipment. Additional work required of graduate students.

BEN 431 Introduction to Global Regulatory Affairs (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 631
An introduction to Global Regulatory Affairs. Providing a foundational understanding of how regulatory and health authorities regulate products to bring safe and effective solutions to patients and consumers. Additional work required of graduate students.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Communication Skills (https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/)

BEN 433 Drug Delivery (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 433
Double-numbered with BEN 633, CEN 633
Integration of biology, chemistry, and engineering to understand how pharmaceuticals are delivered to, and behave within, the body. Includes drug formulation, pharmacokinetics, pharmacodynamics, controlled release, and targeted delivery. Additional work is required of graduate students.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 438 Biocontrol Systems (4 Credits)
Engineering & Comp Sci

BEN 441 Mobile Health (mHealth) Device Design and Application (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 641
This course will introduce students to the rapidly growing field of Mobile Health (mHealth), including concepts of mHealth design, hardware, software, wireless integration, and mobile apps, with application of those concepts to problems faced by different patient and user populations. Additional work required of graduate students.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

BEN 450 Environmental Risk Assessment & Toxicology (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 450, CEE 450
Double-numbered with BEN 650, CEE 650, CEN 650
Students will analyze the human health impact of exposure to toxic chemicals in air, water, and soil according to USEPA Risk Assessment Guidance for Superfund. Additional work required of graduate students.
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 455 Bioinstrumentation Design (0 Credits)
Engineering & Comp Sci

BEN 458 Biomedical Imaging (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 658
Basics of imaging techniques useful for biological and medical applications. Microscopy, electron microscopy, acoustic microscopy, atomic force microscopy, magnetic resonance imaging. Discussion of images and literature. MRI laboratory exercises.
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 462 Biofuels, Bioproducts, and Biorefining (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 462
Double-numbered with CEN 662, BEN 662
Survey of modern technologies available for the production of transportation fuels from abundant natural resources. Additional work required of graduate students.

BEN 466 Advanced Biomechanics (3-4 Credits)
Engineering & Comp Sci
Double-numbered with BEN 666
Introduction to kinesiology and kinematics; finite element method; joint force analysis and the properties of bone cartilage and tendon as related to functional analysis of bone-joint systems.
Prereq: BEN 465

BEN 470 Experience Credit (1-6 Credits)
Engineering & Comp Sci
Participation in a discipline- or subject-related experience. Students must be evaluated by written or oral reports or an examination. Limited to those in good academic standing.
Repeatable

BEN 473 Biomanufacturing (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 473
Double-numbered with BEN 673, CEN 673
Students learn the governing principles of conventional and advanced manufacturing techniques, which are adapted/modified to engineer living tissues/organs, biomedical products and test-platforms for investigating fundamental cell biology. Additional work required for grad students.
Prereq: BEN 364 or BEN 664
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 474 Medical Image Processing & Analysis (3 Credits)
Engineering & Comp Sci
Double-numbered with BEN 674
Introductory medical image processing and analysis. An open source software that has been developed for this purpose will be used. Additional work required of graduate students.

BEN 480 International Course (1-12 Credits)
Engineering & Comp Sci
Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the S.U. academic department to assign the appropriate course level, title, and grade for the student's transcript.
Repeatable

BEN 481 Bioinstrumentation (3 Credits)
Engineering & Comp Sci
Measurement and analysis of biological signals in the time and frequency domain. Operational amplifiers, analog, and digital signal processing; sensors and sources of biopotentials; biopotential electrodes. Matlab, Labview and C programming.
Prereq: ELE 231
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 485 Bioengineering Laboratory II (3 Credits)
Engineering & Comp Sci
Practical experience in the design, execution and analysis of experiments related to biomechanics and bioinstrumentation. Technical writing skills will also be emphasized. One four-hour laboratory a week.
Prereq: BEN 385 Coreq: BEN 465 and 481
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 486 Bioengineering Capstone Design I (1 Credit)
Engineering & Comp Sci
Bioengineering design experience. Lecture, discussion, active learning components. Team design of biomedical system, device, or process from concept through prototype production. Includes design strategy, reliability, FDA regulations, patents, oral, and written presentations.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Civic and Global Responsibility (https://coursecatalog.syracuse.edu/shared-competencies/civic-and-global-responsibility/)

BEN 487 Bioengineering Capstone Design II (3 Credits)
Engineering & Comp Sci
Bioengineering design experience. Lecture, discussion, active learning components. Team design of biomedical system, device, or process from concept through prototype production. Includes design strategy, reliability, FDA regulations, patents, oral, and written presentations.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Civic and Global Responsibility (https://coursecatalog.syracuse.edu/shared-competencies/civic-and-global-responsibility/)

BEN 490 Independent Study (1-6 Credits)
Engineering & Comp Sci
In-depth exploration of a problem or problems. Individual independent study based on a plan submitted by the student.
Repeatable

BEN 498 Senior Thesis (3 Credits)
Engineering & Comp Sci
Mentored investigation of an approved topic under the supervision of a member of the faculty. A written report and oral presentation are required in accordance with program guidelines.

BEN 499 Honors Capstone Project (1-3 Credits)
Engineering & Comp Sci
Completion of an Honors Capstone Project under the supervision of a faculty member.
Repeatable 3 times for 3 credits maximum

BEN 500 Selected Topics (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

BEN 521 Stem Cell Engineering (3 Credits)
Engineering & Comp Sci
Covers wide-ranging topics related to stem cell and regenerative biology, including: introduction of cell and developmental biology, stem cell biology, tissue engineering, regenerative medicine, and the political and ethical issues surrounding the stem cell debate.
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

BEN 522 Biomedical-Device Infections (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 522
Discussion of the complex issues related to biomedical-device infections. Investigation of the impact of biomaterials, microbiology, detection, and device regulation to reduce biomedical-device infections.
Shared Competencies: Communication Skills (https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 541 Principles of Tissue Engineering (3 Credits)
Engineering & Comp Sci
Cellular and biomaterials principles relevant to tissue engineering, focusing on cellular and tissue organization; regulation of cell behavior; biomaterials for tissue regenerations; tissue engineering applications in cardiovascular, neurological, and musculoskeletal and other organ systems.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 561 Polymer Science & Engineering (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 561
Polymer structure, physical properties, and applications of polymers. Polymer synthesis, characterization of molecular structure, and copolymerization and blending. Unique physical properties of polymeric materials. Processing and applications of polymers.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 565 Biomechanics (3 Credits)
Engineering & Comp Sci
Functions and mechanical properties of cells and tissues, how those cells and tissues combine to form structures, the properties and behaviors of those structures, and biomechanical techniques to analyze the structures and individual components.
Prereq: ECS 221 and MAT 485 and BEN 364
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

BEN 568 Biomaterials & Medical Devices (3 Credits)
Engineering & Comp Sci
Materials science and biological issues associated with medical devices and biomaterials are discussed. Bulk and surface materials science, tissue engineering, degradation and biocompatibility are addressed and related to medical device design and regulatory issues.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

BEN 580 International Course (1-12 Credits)
Engineering & Comp Sci
Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the S.U. academic department to assign the appropriate course level, title, and grade for the student's transcript.
Repeatable