Biomedical Engineering (BIEN)

BIEN 1100 Introduction to Biomedical Engineering Methods 1 (2 credits)
Students are introduced to biomedical engineering design and problem-solving processes. Key topics include the measurement of physiological signals, signal acquisition, biomedical instrumentation, and image processing. Students will work in cross-disciplinary teams, enhancing their collaboration, teamwork, and decision-making skills. The course emphasizes practical applications, preparing students to tackle complex issues at the intersection of engineering, medicine, and technology.
Prerequisite: Enrolled in the Opus College of Engineering.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%201100)

BIEN 1110 Introduction to Biomedical Engineering Methods 2 (2 credits)
Students build upon concepts from BIEN 1100, covering topics in fluid mechanics, rehabilitation engineering, biomaterials and business concepts. Emphasis is placed on a hands-on design challenge, where students gain essential skills in problem identification, prototype development and technical communication. Students enhance their abilities in teamwork, critical thinking and entrepreneurial innovation, preparing them for diverse roles in biomedical engineering.
Prerequisite: BIEN 1100, CEEN 1200, EECE 1200, or GEEN 1200; enrollment in the Opus College of Engineering.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%201110)

BIEN 1120 Introduction to Computing for Biomedical Engineers (2 credits)
Introductory hands-on experience in computer programming for biomedical engineers. Involves learning linear programming in C and creating flow-charts to solve biomedical applications. Computing topics include syntax, data types, control flow and algorithm development. Biomedical applications include analyzing physiological signals, biological event detection, and biomechanical analysis. Students learn how to use MATLAB to solve biomedical applications. Laptop required.
Prerequisite: BIEN 1100, which may be taken concurrently.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%201120)

BIEN 2100 Statistics for Biomedical Engineering (3 credits)
Numerical and graphical summary of biomedical data and the use of statistics in problem solving for a variety of case studies in biomedical research, medical device design and clinical trials.
Prerequisite: MATH 1450.
Level of Study: Undergraduate
Marquette Core Curriculum: NSM Expanding Our Horizons
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%202100)

BIEN 2200 Engineering Design with SolidWorks (1 credits)
Computer-aided design (CAD) with SolidWorks includes 3D solid part/component and assembly modeling and drafting with various modeling techniques to create virtual and actual 3D computer models, along with the introduction to engineering graphics fundamentals with orthographic project views and geometric dimensioning & tolerancing (GD&T) rules and standards to create professional engineering document drawing. Students develop practical CAD skills for internships and full-time employment.
Prerequisite: Enrolled in Opus College of Engineering.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%202200)

BIEN 2300 Biomedical Circuits and Electronics (4 credits)
An experience in electrical circuits (AC and DC), electronic devices (Junction, Transistor, Operational, Amplifier) bridges, digital circuits and Boolean implementation, combinational and sequential logic, memories. Analysis and design. 3 hrs. lec., 3 hrs. lab
Prerequisite: PHYS 1004 or PHYS 1014. Enrolled in the Opus College of Engineering.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%202300)

BIEN 3200 Computer Applications in Biomedical Engineering (3 credits)
Design and implement computer techniques for the acquisition and analysis of biomedical data and the modeling of physiologic phenomena. Emphasis on physiological data acquisition, statistical description of physiological data, time domain and frequency domain methods for physiological signal conditioning and processing and numerical methods for quantitative interpretation of physiological data using C programming language.
Prerequisite: BIEN 1120 or equiv.
Level of Study: Undergraduate
Marquette Core Curriculum: NSM Crossing Boundaries
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%203200)

BIEN 3300 Signals and Systems for Biomedical Engineering (3 credits)
Mathematical models of continuous-time signals and systems are studied. The time domain viewpoint is developed for linear time invariant systems using the impulse response and convolution integral. The frequency domain viewpoint is also explored through the Fourier Series and Fourier Transform. Basic filtering concepts including simple design problems are covered. Application of the Laplace transform to block diagrams, linear feedback and stability including Bode plots are discussed. The sampling theorem, the z-transform and the Discrete Fourier Transform are introduced. Examples of electrical, mechanical and biomedical signals and systems are used extensively throughout the course. 3 hrs. lec.
Prerequisite: One of the following: ELEN 2020 with minimum grade of C and MATH 2451; or BIEN 2300 with minimum grade of C and MATH 2451; or ELEN 2020 with minimum grade of C and MATH 2455; or BIEN 2300 with minimum grade of C and MATH 2455. BIEN 1120 or concurrent enrollment.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%203300)

BIEN 3310 Control Systems for Biomedical Engineering (3 credits)
Provides an introduction to the principles of control systems theory for biomedical engineers. Mathematical techniques to characterize and design control systems will be studied in the context of physiological, bioelectrical, biochemical and biomechanical systems. Topics include frequency and time-domain modeling of physiological control systems, feedback, stability, steady-state error, design, root-locus, state-space techniques, and nonlinear control. Simulation using MATLAB and Simulink will be used to provide hands-on experience in the design of biomedical control systems.
Prerequisite: BIEN 3300.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%203310)

BIEN 3400 Clinical and Regulatory Issues in Medical Device Design (3 credits)
Students develop clinical literacy in areas including medical terminology, working with medical professionals, professional conduct in the clinical environment, operating room workflow and the technical needs of surgeons, nurses, and other stakeholders. They observe procedures in the clinical environment and learn to identify problems, unmet needs and opportunities for new product development. Students participate in field trips to obtain hands-on experience with various medical devices. Lecture topics include clinical perspectives and current needs and regulatory issues associated with the medical device design. A project proposal for a new medical device or technology is required at the end of the course.
Prerequisite: BIEN major and Jr. stndg; or cons. of instr.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%203400)

BIEN 4220 Embedded Biomedical Instrumentation (3 credits)
Fundamentals of digital circuit design and analysis and the application to embedded biomedical instrumentation. Topics include microprocessor principles and programming and system design constraints for medical electronics. Laboratory will provide applications of concepts introduced in class.
Prerequisite: BIEN 2300.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204220)

BIEN 4280 Biocomputers Design Lab 1 (3 credits)
Hands-on experience in software design and validation, microprocessors, computer architecture, real-time computing, embedded software, graphical user interface and networking. An emphasis on medical devices with embedded software and hardware.
Prerequisite: BIEN 2300, BIEN 3300 and BIEN 4220.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204280)

BIEN 4290 Biocomputers Design Lab 2 (3 credits)
Continuation of BIEN 4280 with emphasis on high performance computing in workstation environments.
Prerequisite: BIEN 4280.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204290)

BIEN 4320 Biomedical Instrumentation Design (3 credits)
Fundamental knowledge and skills needed to solve instrumentation problems relating to biomedical and physiological measurements in the laboratory and clinic. Key elements include biosignals, signal conditioning, sensors and transducers, data acquisition, instrument design and safety requirements. Includes hands-on experiences in basic instrumentation lab skills, needs identification, design, implementation, testing and troubleshooting, and report writing.
Prerequisite: BIEN 2300 or ELEN 2020; and BIEN 3300, which may be taken concurrently.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204320)

BIEN 4380 Bioelectronics Design Lab 1 (3 credits)
Students learn the principles of medical device design, safe operating procedures and the practical issues associated with designing and validating electronic systems to measure physiological parameters. Emphasis is placed on open ended design examples and hands-on experience designing, troubleshooting, and validating electronic systems. Topics include electrical safety; myography; force measurement; minimizing sources of noise, operational amplifier characterization; active filtering; microprocessors. Students gain experience conveying information using different styles of reporting. 2 hrs. lec., 3 hrs. lab.
Prerequisite: EECE 2015, EECE 2035, ELEN 3030.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204380)

BIEN 4390 Bioelectronics Design Lab 2 (3 credits)
Students integrate the concepts from Design Lab 1 to design, implement and test an example medical device based in research and clinical applications. Emphasis is placed on open ended design examples and hands-on experience designing, troubleshooting and validating electronic systems. Topics include patient isolation from electrical hazard, biopotential measurement, myoelectric control, EMF and inductive loads, signal multiplexing and demultiplexing, analog to digital conversion, and electrical stimulation. Design projects incorporating microprocessors are also included. Students gain experience conveying information using different styles of reporting. 2 hrs. lec., 3 hrs. lab.
Prerequisite: BIEN 4380 and EECE 3015.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204390)

BIEN 4400 Transport Phenomena (3 credits)
Introduction to fluid mechanics and its applications in biomedical engineering. Covers key concepts in fluid mechanics, such as conservation of mass, momentum, and energy in fluids, the Reynolds number, laminar vs. turbulent flows, Poiseuille flow, the Bernoulli equation, and the Navier-Stokes equations. Concepts are applied to physiological phenomena with an emphasis on the cardiovascular and respiratory systems.
Prerequisite: Jr. stndg. and PHYS 1003, or cons. of instr.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204400)

BIEN 4410 Applied Finite Element Analysis (3 credits)
Introduction to the finite element method, used for numerical integration of partial differential equations in solid mechanics, fluid mechanics and heat transfer. Summarizes various numerical integration schemes. Assignments include development of finite element code (e.g., Matlab or Python) and/or use of commercial software (e.g., ANSYS, Abaqus). Emphasis is on the application of the finite element method to biomedical applications, such as cardiovascular flows, respiratory flows, or orthopedic biomechanics.
Prerequisite: Sr. stndg., BIEN 1110 and GEEN 2130; or Sr. stndg., GEEN 1210, and GEEN 2130.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204410)

BIEN 4420 Biomaterials Science and Engineering (3 credits)
Designed to introduce the uses of materials in the human body for the purposes of healing, correcting deformities and restoring lost function. The science aspect of the course encompasses topics including: characterization of material properties, biocompatibility and past and current uses of materials for novel devices that are both biocompatible and functional for the life of the implanted device. Projects allow students to focus and gain knowledge in an area of biomaterials engineering in which they are interested.
Prerequisite: MEEN 2460 or equiv.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204420)

BIEN 4430 Introduction to Tissue Engineering (3 credits)
Introduces the scientific field of tissue engineering, a discipline of biomedical engineering that uses a combination of living cells, biomaterials, and biomechanical and biochemical stimuli to restore or replace damaged or diseased biological tissues. Covers advanced topics in foundational sciences as applicable to the engineering of living tissues. Topics include stem cell biology, biomaterials, immunology, bioreactors and molecular biology. Discusses pathophysiology and engineering strategies for specific tissues, along with examples of current research. Covers the following tissue applications: skin, blood vessels, nervous tissue, heart tissue, heart valves, tendons, ligaments, bone and whole organs.
Prerequisite: Jr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204430)

BIEN 4480 Biomechanics Design Lab 1 (3 credits)
Intended for those students pursuing the Biomedical Engineering Biomechanics option. The application of principles of engineering mechanics, data acquisition and basic electronics in the design and utilization of biomechanical instrumentation. Principles of transduction, mechanics, sampling theory, strain, temperature, and flow measurement as applied to biomechanical systems. A background in data acquisition, electrical safety, operational amplifier and bridge circuits, and measurements is provided. Experiments investigate biomechanics of the musculoskeletal and cardiovascular systems and include design content. Report writing. 2 hrs. lec., 3 hrs. lab.
Prerequisite: BIEN 2300, GEEN 2120, and GEEN 2130.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204480)

BIEN 4490 Biomechanics Design Lab 2 (3 credits)
Provides students with experience in the design and implementation of appropriate experimental procedures to analyze biomechanical problems. Students will become familiar with various types of advanced transducers which will be used in conjunction with data acquisition workstations to obtain thermal, flow, strain, and related physiological data from biomechanical systems. Topics include mechanical properties of active muscle; analysis of human motion; postural stability; thermal regulation; cardiovascular mechanics; stress distribution in skeletal system; and comparison of static and dynamic biomechanical responses to load. 2 hrs. lec., 3 hrs. lab.
Prerequisite: BIEN 4480.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204490)

BIEN 4500 Medical Imaging Physics (3 credits)
Students learn how light, X-rays, radiopharmaceuticals, ultrasound, magnetic fields, and other energy probes are generated and how they interact with tissues and detectors to produce useful image contrast. Practical issues such as beam generation, dose limitations, patient motion, spatial resolution and dynamic range limitations, and cost-effectiveness will be addressed. Emphasis is placed upon diagnostic radiological imaging physics, including the planar X-ray, digital subtraction angiography mammography, computed tomography, nuclear medicine, ultrasound, and magnetic resonance imaging modalities.
Prerequisite: PHYS 1004 or PHYS 1014.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204500)

BIEN 4510 Image Processing for the Biomedical Sciences (3 credits)
This course serves as an introduction to biomedical image processing. Topics explored included the human visual system, spatial sampling and digitization, image transforms, spatial filtering, Fourier analysis, image enhancement and restoration, nonlinear and adaptive filters, color image processing, geometrical operations and morphological filtering, image coding and compression image segmentation, feature extraction and object classification. Applications in diagnostic medicine, biology and biomedical research are emphasized and presented as illustrative examples.
Prerequisite: MATH 1450 and MATH 1451 or MATH 1455; knowledge of C programming; or cons. of instr.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204510)

BIEN 4520 Introduction to Optics for Biomedical Engineers (3 credits)
Introduces the fundamentals of optics, the science and technology of how light is generated, propagated, interacts with matter and detected. Concentrates on geometrical (or ray) optics, which focuses on light reflection, refraction, lenses, mirrors, prisms, fiber optics, GRIN lens and simple imaging systems, as well as wave optics, which focuses on wave equations, superposition, diffraction, interference, polarization, dispersion and electro-optic effects. Also studies more advanced topics, such as fluorescence imaging, optical microscopy, diffuse optical tomography, optical coherence tomography and optical spectroscopy.
Prerequisite: PHYS 1004, BIEN 4320.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204520)

BIEN 4600 Neural Engineering (3 credits)
Basic principles of neural engineering and the nervous system, properties of excitable tissues, quantitative models used to examine the mechanisms of natural and artificial stimulation. Basic concepts for the design of neuroprosthetic devices for sensory, motor and therapeutic applications. Design issues including electrode type, biomaterials, tissue response to implanted electrodes, stimulus parameters for electrical stimulation and artificial control and emerging neuromodulation technologies such as optogenetics. Examples of how neural interfaces show increasing promise in the rehabilitation of individuals with various motor or sensory impairments.
Prerequisite: PHYS 1004 or PHYS 1014; programming experience in MATLAB or equiv.
Level of Study: Undergraduate
Marquette Core Curriculum: NSM Cgntn, Lang, Mmry/Intlgnc
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204600)

BIEN 4610 Introduction to Rehabilitation Robotics (3 credits)
Presents the fundamentals of robotics as it is applied to rehabilitation engineering. Specific topics include: the fundamentals of analysis and design of robot manipulators with examples and mini-projects taken from rehabilitation applications pertaining to robotic therapy devices and personal assistants. Additional topics include: overview of rehabilitation robotics field, human-centered design of rehabilitation robots issues and challenges, robot configurations, rigid motions and homogeneous transformations, Denavit-Hartenberg representation, robot kinematics, and inverse kinematics, Euler-Lagrange equations, trajectory generation, sensors, actuators, independent joint control, force control and safety.
Prerequisite: Jr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204610)

BIEN 4620 Rehabilitation Science and Engineering (3 credits)
Introduces rehabilitation science as the study of tissue and functional change, including:overview of key human sensory modalities and neuromotor systems in the context of functional capabilities and human performance metrics; review of spontaneous recovery mechanisms in response to various types of tissue trauma; review of roles of genetics and gene transcription networks in pathology and functional recovery prognosis; and the concept of rehabilitative assessment and therapeutic interventions as an optimization problem. Also focuses on the use of assistive technology to enhance access to independent living and to optimize the delivery of rehabilitative healthcare services. Includes rehabilitation biomechanics of physical interfaces, use of access and usability engineering in product design and innovative assessment and intervention strategies for neurorehabilitation.
Prerequisite: BIEN 2300 or equiv.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204620)

BIEN 4700 Systems Physiology (3 credits)
Analyses of the underlying physiologic and bioengineering aspects of the major cell and organ systems of the human from an engineer's point of view. Classic physiologic approaches used to introduce topics including cell functions, nervous system, nerve, muscle, heart, circulation, respiratory system, kidney, reproduction and biomechanics. Design problems including models of cell-organ-system function and problems in biomechanics illuminate topics covered. Experts on related topics are invited to speak as they are available.
Prerequisite: BIOL 1001 and Jr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204700)

BIEN 4710 Analysis of Physiological Models (3 credits)
Development of continuous (compartmental), and distributed-in-space-and-time mathematical models of physiological systems and molecular events. Analytical and numerical methods for solving differential equations of the initial and boundary value types. Simulation of model response, and estimation of model parameters using linear and nonlinear regression analysis.
Prerequisite: Jr. stndg. and MATH 2451; or jr. stndg. and MATH 2455.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204710)

BIEN 4720 Cardiopulmonary Mechanics (3 credits)
Examination of cardiovascular and respiratory physiology from an engineering perspective. Emphasis is on understanding the mechanical basis of physiologic phenomena via mathematical and computational models.
Prerequisite: BIEN 4700, which may be taken concurrently, or equiv.; and BIEN 4400, which may be taken concurrently, or equiv.; or cons. of instr.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204720)

BIEN 4920 Senior Capstone Design 1 (3 credits)
Course content focuses on a structured product design and development process that includes project definition, customer needs identification, product specification, concept generation, and concept selection. Course also focuses on issues related to teamwork, project management, and effective communication. Student team design projects culminate in the development of a technically and economically viable concept and a proposal for future development of this concept (done in the second semester of this two-course sequence). 2 hr. lec., 1 hr. disc.
Prerequisite: Sr. stndg.; co-op students, jr. stndg. Cross-listed with COEN 4920, ELEN 4920 and MEEN 4920.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204920)

BIEN 4931 Topics in Biomedical Engineering (1-3 credits)
Course content announced prior to each term. Students may enroll in the course more than once because subject matter changes. Possible topics include biomechanics, experimental methods, neuroanatomy, telemetry, etc.
Prerequisite: Jr. stndg.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204931)

BIEN 4995 Independent Study in Biomedical Engineering (1-4 credits)
Undergraduate independent study project of either a theoretical or experimental nature.
Prerequisite: Jr. stndg., 3.000 GPA, cons. of instr., and cons. of dept. ch.; or Sr. stndg., 3.000 GPA, cons. of instr., and cons. of dept. ch. Consent required.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204995)

BIEN 4998 Senior Capstone Design 2 (3 credits)
Course focuses on detailed design, prototyping, and testing design concepts. Course includes topics directly relevant to student design projects and careers in the engineering profession. Student team design projects culminate in a final report that documents the performance and details (engineering drawings and/or documentation) of their final design. 2 hrs. lec., 1 hr. disc.
Prerequisite: BIEN 4920. Cross-listed with COEN 4998, ELEN 4998 and MEEN 4998.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204998)

BIEN 4999 Senior Thesis within the Department of Biomedical Engineering (3 credits)
Preparation of a thesis by approved students to gain experience in the type of critical research and analysis that an advanced degree requires. The associated extended project is designed to enhance research and communication skills leading to a high quality manuscript that could be submitted for peer-reviewed journal publication.
Prerequisite: MU GPA greater than or equal to 3.5, BIEN 4995, cons. of dept. ch. Consent required.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%204999)

BIEN 5220 Embedded Biomedical Instrumentation (3 credits)
Fundamentals of digital circuit design and analysis and the application to embedded biomedical instrumentation. Topics include microprocessor principles and programming and system design constraints for medical electronics. Laboratory provides applications of concepts introduced in class.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205220)

BIEN 5320 Biomedical Instrumentation Design (3 credits)
Fundamental knowledge and skills needed to solve instrumentation problems relating to biomedical and physiological measurements in the laboratory and clinic. Key elements include biosignals, signal conditioning, sensors and transducers, data acquisition, instrument design and safety requirements. Includes hands-on experiences in basic instrumentation lab skills, needs identification, design, implementation, testing and troubleshooting, and report writing.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205320)

BIEN 5400 Transport Phenomena (3 credits)
Introduction to fluid mechanics and its applications in biomedical engineering. Covers key concepts in fluid mechanics, such as conservation of mass, momentum, and energy in fluids, the Reynolds number, laminar vs. turbulent flows, Poiseuille flow, the Bernoulli equation, and the Navier-Stokes equations. Concepts are applied to physiological phenomena with an emphasis on the cardiovascular and respiratory systems.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205400)

BIEN 5410 Applied Finite Element Analysis (3 credits)
Introduction to the finite element method, used for numerical integration of partial differential equations in solid mechanics, fluid mechanics and heat transfer. Summarizes various numerical integration schemes. Assignments include development of finite element code (e.g., Matlab or Python) and/or use of commercial software (e.g., ANSYS, Abaqus). Emphasis is on the application of the finite element method to biomedical applications, such as cardiovascular flows, respiratory flows, or orthopedic biomechanics.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205410)

BIEN 5420 Biomaterials Science and Engineering (3 credits)
Designed to introduce the uses of materials in the human body for the purposes of healing, correcting deformities and restoring lost function. The science aspect of the course encompasses topics including: characterization of material properties, biocompatibility and past and current uses of materials for novel devices that are both biocompatible and functional for the life of the implanted device. Projects allow students to focus and gain knowledge in an area of biomaterials engineering in which they are interested.
Prerequisite: MEEN 2460 or equivalent.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205420)

BIEN 5430 Introduction to Tissue Engineering (3 credits)
Introduces the scientific field of tissue engineering, a discipline of biomedical engineering that uses a combination of living cells, biomaterials, and biomechanical and biochemical stimuli to restore or replace damaged or diseased biological tissues. Covers advanced topics in foundational sciences as applicable to the engineering of living tissues. Topics include stem cell biology, biomaterials, immunology, bioreactors and molecular biology. Discusses pathophysiology and engineering strategies for specific tissues, along with examples of current research. Covers the following tissue applications: skin, blood vessels, nervous tissue, heart tissue, heart valves, tendons, ligaments, bone and whole organs.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205430)

BIEN 5500 Medical Imaging Physics (3 credits)
Examines how light, X-rays, radiopharmaceuticals, ultrasound, magnetic fields, and other energy probes are generated and how they interact with tissues and detectors to produce useful image contrast. Addresses practical issues such as beam generation, dose limitations, patient motion, spatial resolution and dynamic range limitations, and cost-effectiveness. Emphasizes diagnostic radiological imaging physics, including the planar X-ray, digital subtraction angiography mammography, computed tomography, nuclear medicine, ultrasound, and magnetic resonance imaging modalities.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205500)

BIEN 5510 Image Processing for the Biomedical Sciences (3 credits)
Introduces biomedical image processing. Topics explored include: the human visual system, spatial sampling and digitization, image transforms, spatial filtering, Fourier analysis, image enhancement and restoration, nonlinear and adaptive filters, color image processing, geometrical operations and morphological filtering, image coding and compression image segmentation, feature extraction and object classification. Applications in diagnostic medicine, biology and biomedical research are emphasized and presented as illustrative examples.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205510)

BIEN 5520 Introduction to Optics for Biomedical Engineers (3 credits)
Introduces the fundamentals of optics, the science and technology of how light is generated, propagated, interacts with matter and detected. Concentrates on geometrical (or ray) optics, which focuses on light reflection, refraction, lenses, mirrors, prisms, fiber optics, GRIN lens and simple imaging systems, as well as wave optics, which focuses on wave equations, superposition, diffraction, interference, polarization, dispersion and electro-optic effects. Also studies more advanced topics, such as fluorescence imaging, optical microscopy, diffuse optical tomography, optical coherence tomography and optical spectroscopy.
Prerequisite: Physics, analog circuits, or cons. of instr.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205520)

BIEN 5600 Neural Engineering (3 credits)
Basic principles of neural engineering and the nervous system, properties of excitable tissues, quantitative models used to examine the mechanisms of natural and artificial stimulation. Basic concepts for the design of neuroprosthetic devices for sensory, motor and therapeutic applications. Design issues including electrode type, biomaterials, tissue response to implanted electrodes, stimulus parameters for electrical stimulation and artificial control and emerging neuromodulation technologies such as optogenetics. Examples of how neural interfaces show increasing promise in the rehabilitation of individuals with various motor or sensory impairments.
Level of Study: Graduate
Marquette Core Curriculum: NSM Cgntn, Lang, Mmry/Intlgnc
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205600)

BIEN 5610 Introduction to Rehabilitation Robotics (3 credits)
Presents the fundamentals of robotics as it is applied to rehabilitation engineering. Specific topics include: the fundamentals of analysis and design of robot manipulators with examples and mini-projects taken from rehabilitation applications pertaining to robotic therapy devices and personal assistants. Additional topics include: overview of rehabilitation robotics field, human-centered design of rehabilitation robots issues and challenges, robot configurations, rigid motions and homogeneous transformations, Denavit-Hartenberg representation, robot kinematics, and inverse kinematics, Euler-Lagrange equations, trajectory generation, sensors, actuators, independent joint control, force control and safety.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205610)

BIEN 5620 Rehabilitation Engineering: Telerehabilitation Research Tools (3 credits)
Introduces rehabilitation science as the study of tissue and functional change, including: overview of key human sensory modalities and neuromotor systems in the context of functional capabilities and human performance metrics; review of spontaneous recovery mechanisms in response to various types of tissue trauma; review of roles of genetics and gene transcription networks in pathology and functional recovery prognosis; and the concept of rehabilitative assessment and therapeutic interventions as an optimization problem. Also focuses on the use of assistive technology to enhance access to independent living and to optimize the delivery of rehabilitative healthcare services. Includes rehabilitation biomechanics of physical interfaces, use of access and usability engineering in product design and innovative assessment and intervention strategies for neurorehabilitation.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205620)

BIEN 5700 Systems Physiology (3 credits)
Analyses of the underlying physiologic and bioengineering aspects of the major cell and organ systems of the human from an engineer's point of view. Classic physiologic approaches used to introduce topics including cell functions, nervous system, nerve, muscle, heart, circulation, respiratory system, kidney, reproduction and biomechanics. Design problems including models of cell-organ-system function and problems in biomechanics illuminate topics covered. Experts on related topics are invited to speak as they are available.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205700)

BIEN 5710 Analysis of Physiological Models (3 credits)
Development of continuous (compartmental) and distributed-in-space-and-time mathematical models of physiological systems and molecular events. Analytical and numerical methods for solving differential equations of the initial and boundary value types. Simulation of model response, and estimation of model parameters using linear and nonlinear regression analysis.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205710)

BIEN 5720 Cardiopulmonary Mechanics (3 credits)
Examination of cardiovascular and respiratory physiology from an engineering perspective. Emphasis is on understanding the mechanical basis of physiologic phenomena via mathematical and computational models.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205720)

BIEN 5931 Topics in Biomedical Engineering (1-3 credits)
Course content announced prior to each term. Students may enroll in the course more than once as subject matter changes. Possible topics include biomechanics, experimental methods, neuroanatomy, telemetry, etc.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%205931)

BIEN 6120 Introduction to the Finite Element Method (3 credits)
Introduces finite element analysis as applied to linear, static problems. Application to problems in plane strain, plane stress, and axisymmetry. Development of shape functions and element stiffness matrices. Although primarily structural analysis, also considers problems in heat transfer and fluid mechanics. Use of user-written and packaged software.
Prerequisite: GEEN 2130; and matrix/linear algebra or equiv.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206120)

BIEN 6121 Applied Finite Element Analysis and Modeling (3 credits)
Advanced finite element analysis as applied to nonlinear (both material and geometric nonlinearities), dynamic problems. Use of penalty methods and perturbed Lagrangian methods. Use of user-written and packaged software. Critical reviews of finite element analysis in biomechanical research.
Prerequisite: BIEN 6120; or CEEN 6120 or equiv.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206121)

BIEN 6200 Biomedical Signal Processing (3 credits)
Introduces students to statistical processing of biomedical data. Topics include: data acquisition, probability and estimation, signal averaging, power spectrum analysis, windowing, digital filters and data compression. Students complete several computer projects which apply these processing methods to physiologic signals.
Prerequisite: MATH 2451; and proficiency in C or FORTRAN.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206200)

BIEN 6210 Advanced Biomedical Signal Processing (3 credits)
Covers modern methods of signal processing encountered in the bio-medical field including parametric modeling, modern spectral estimation, multivariate analysis, adaptive signal processing, decimation/interpolation, and two-dimensional signal analysis. Students complete several computer projects which apply these modern techniques to physiologic data.
Prerequisite: BIEN 6200 or equiv.; knowledge of C or FORTRAN.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206210)

BIEN 6300 Biomedical Instrumentation (3 credits)
Explores relationships between instruments for physiologic measurement and monitoring with living systems. Physiologic signals, noise, and available sensors and transducers and their characteristics are discussed from time and frequency domain points of view. Systems topics include various new and conventional medical instrumentation. Other topics include clinical and new clinical laboratory instrumentation, instrumentation for research, artificial organs and prostheses. Includes the use of scientific literature, literature searches, design projects, computer projects.
Prerequisite: BIEN 5700; or BIEN 5320; and high level computer language or equiv.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206300)

BIEN 6301 Clinical Need Finding (3 credits)
Provides students with the tools and mindset to be able to identify needs within the clinical environment. A key element presented is the ability to employ observational research techniques to identify capability gaps, employed workarounds, and undiscovered opportunities – without exclusively relying on what the end user communicates. Topics include clinical terminology and common devices, stakeholder perspectives, U.S. FDA regulatory requirements, international standards, systems and inclusive design methodologies, observation and ethnographic skills, and bioethical considerations. Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206301)

BIEN 6302 Clinical Observation (3 credits)
Provides students with an immersive, experiential learning opportunity within the clinical environment. Students complete a series of immersion experiences with different clinics to facilitate clinician-designer interactions that cannot otherwise be easily replicated. These interactions will help designers to identify new opportunities, improve medical devices, or create new approaches to solve problems often encountered by clinicians and medical professionals. Students also complete simulation lab experience as part of their immersion experience.
Prerequisite: BIEN 6301. Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206302)

BIEN 6420 Biomechanical and Biomaterial Systems Analysis (3 credits)
Using fundamentals of biomaterials engineering and biocompatibility, analyzes the functions that organs serve and to analyze the efficacy and safety of artificial organs systems. Some organs/tissues discussed include the kidneys, liver, skeleton, skin, heart, muscles, eyes, and ears. Critically examines the suitability of state-of-the-art artificial organ systems, including artificial hearts, orthopaedic prostheses, kidney dialyzers, and cochlear devices to fulfill the functions of the replaced organs/tissues.
Prerequisite: BIEN 5420.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206420)

BIEN 6430 Advanced Tissue Engineering (3 credits)
Explores advanced topics in the scientific field of tissue engineering, a discipline of biomedical engineering that uses a combination of living cells, biomaterials, and biomechanical and biochemical stimuli to restore or replace damaged or diseased biological tissues. Covers advanced topics in foundational sciences as applicable to the engineering of living tissues. Students select applications of tissue engineering, review recent academic research as reported in the scientific literature, and present their findings to the class. Example tissue applications to be covered include: skin, blood vessels, nervous tissue, heart tissue, heart valves, tendons, ligaments, bone, muscle, pancreas, bladder and whole organs.
Prerequisite: BIEN 5430 recommended.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206430)

BIEN 6440 Biomedical Engineering Analysis of Trauma (3 credits)
An engineering analysis of the physiological changes following impact to the head, spinal cord, and limbs, and electrical events and effects on tissues are treated.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206440)

BIEN 6450 Musculoskeletal Biomechanics 1 (3 credits)
Emphasizes the interrelationship of force and motion as related to anatomic structure and function. Examines the forces and motions acting in the skeletal system and the various techniques used to describe them. Highlights current concepts as revealed in the recent scientific and engineering literature. Topics include: bone mechanics, joint mechanics, gait kinematics, instrumentation and measurement of biomechanical phenomena, and computer modeling of the musculoskeletal system.
Prerequisite: GEEN 2120 and GEEN 2130.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206450)

BIEN 6451 Musculoskeletal Biomechanics 2 (3 credits)
Advanced concepts of kinematics and mechanics as they apply to the fields of biomechanics and rehabilitation. Covers aspects of gait, bone and joint surgery, and soft tissue surgery. Detailed study of joint mechanics, implant applications and mobility device function is performed. Includes advanced analysis and modeling as well as laboratory-based final project.
Prerequisite: BIEN 6450.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206451)

BIEN 6500 Mathematics of Medical Imaging (3 credits)
Begins with an overview of the application of linear systems theory to radiographic imaging (pinhole imaging, transmission and emission tomography), and covers the mathematics of computed tomography including the analytic theory of reconstructing from projections and extensions to emission computed tomography and magnetic resonance imaging. Topics may also include three-dimensional imaging, noise analysis and image quality, and optimization. Contains advanced mathematical content.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206500)

BIEN 6600 Neuromotor Control (3 credits)
Overview of current issues in neuromotor control and movement biomechanics. Special emphasis on the study of normal and impaired human movement. Topics include: muscle mechanics, biomechanics of movement, neural circuitry, strategies for the neural control of movement (including a discussion of adaptation and motor learning) and potential applications of biomedical engineering techniques to the study and improvement of impaired motor function.
Prerequisite: BIEN 3300 which may be taken concurrently or equiv.; or cons. of instr.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206600)

BIEN 6610 Rehabilitative Biosystems (3 credits)
Examines the plastic changes in biological systems that occur in response to targeted stimuli. These processes involve responses by cells to chemical, mechanical, or electrical stimuli (which may be related), which may be influenced or directed using engineering techniques. Examines the homeostasis of physiologic systems and their response to pathologic and rehabilitative stimuli. Examines engineering applications involving the diagnosis and rehabilitation of musculoskeletal, neurologic and cardiopulmonary biosystems in the context of the underlying cellular mechanisms.
Prerequisite: BIEN 5700 which may be taken concurrently; and PHYS 1004.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206610)

BIEN 6620 Modeling Rehabilitative Biosystems (3 credits)
Introduction to large-scale mathematical models of various physiological systems of interest in rehabilitation (e.g., cardiovascular, pulmonary, musculoskeletal, etc.). Discusses mathematical modeling, a widely used tool for testing hypotheses regarding the underlying mechanisms of complex systems such as physiological systems in health, disease and recovery. For each, simulation is used to further our understanding of the adaptive processes of these systems in response to physiological/pathophysiological stresses and rehabilitative interventions.
Prerequisite: BIEN 5710 and BIEN 5700.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206620)

BIEN 6700 Analysis of Physiological Systems (3 credits)
Introduction to the use of mathematical models in quantifying physiological systems. Analyzes model formulation. Applications of analytical and numerical solution techniques and parameter estimation methods.
Prerequisite: BIEN 5710.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206700)

BIEN 6710 Cellular and Molecular Bioengineering (3 credits)
Main topics include: cellular biomechanics with an emphasis on the cardiovascular system, molecular bioengineering, biotransport phenomena, and tissue engineering with focus on artificial internal organs. Cellular biomechanics topics covered are biomechanics of the endothelium, endothelial-immune cell interactions, and blood cell structural biomechanics. Topics in molecular bioengineering include chemotaxis and chemokinesis, and modeling of receptor-mediated endocytosis. Biotransport and tissue engineering topics include bioreactor design and the analysis and development of artificial internal organs like the liver and pancreas.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206710)

BIEN 6931 Topics in Biomedical Engineering (3 credits)
Subject matter variable as determined by needs of biomedical graduate students. Students may enroll more than once as the subject matter changes. Possible topics: biostatistics, experimental methods, neuro-anatomy, etc.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206931)

BIEN 6932 Advanced Topics in Biomedical Engineering (3 credits)
Advanced topics in design and analysis of biomedical instruments, devices and interfaces. Project approach drawing from current literature and current projects of laboratories of affiliated institutions. Topics include bioelectronics, biomechanics, biomaterials, and rehabilitation engineering.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206932)

BIEN 6947 Medical College of Wisconsin/Joint Degree (1-8 credits)
Graduate-level course in selected areas of the life sciences offered at the Medical College of Wisconsin. May be taken by doctorate BIEN students at Marquette University.
Prerequisite: Cons. of dept. ch. Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206947)

BIEN 6953 Seminar in Biomedical Engineering (0 credits)
Scholarly presentations on current topics in biomedical engineering and related areas by visiting professors, resident faculty and graduate students. Attendance is required of all full-time graduate students. Mandatory for all full-time BIEN graduate students. S/U grade assessment.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206953)

BIEN 6954 Seminar in Biomedical Computing (0 credits)
Scholarly presentations on current topics in biomedical engineering and related areas by visiting professors, resident faculty and graduate students. Attendance is required of all full-time graduate students. Mandatory for all full-time BIEN graduate students. S/U grade assessment.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206954)

BIEN 6960 Seminar: Journal Club (0-3 credits)
0 credit will be SNC/UNC grade assessment; 1-3 credits will be graded.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206960)

BIEN 6995 Independent Study in Biomedical Engineering (1-3 credits)
Faculty-supervised, independent study/research of a specific area or topic in Biomedical Engineering.
Prerequisite: Cons. of instr. and cons. of dept. ch. Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206995)

BIEN 6999 Master's Thesis (1-6 credits)
S/U grade assessment.
Prerequisite: Cons. of instr. Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%206999)

BIEN 8995 Independent Study in Biomedical Engineering (1-3 credits)
In-depth research on a topic or subject matter usually not offered in the established curriculum with faculty and independent of the classroom setting.
Prerequisite: Cons. of instr. and cons. of dept. ch.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%208995)

BIEN 8999 Doctoral Dissertation (1-12 credits)
S/U grade assessment.
Prerequisite: Cons. of instr. Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%208999)

BIEN 9002 Student Study/Research Placeholder in Biomedical Sciences (0 credits)
Used to enroll a MU or non-MU student who is not enrolled in the term, but is on campus for an educational experience other than academic credit, such as work in a lab or clinic. Used for tracking purposes only. S/U grade assessment.
Prerequisite: Consent required.
Level of Study: Undergraduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209002)

BIEN 9970 Graduate Standing Continuation: Less than Half-Time (0 credits)
Fee. S/U grade assessment. Designated as less than half-time status only, cannot be used in conjunction with other courses, and does not qualify students for financial aid or loan deferment.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209970)

BIEN 9974 Graduate Fellowship: Full-Time (0 credits)
Fee. S/U grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209974)

BIEN 9975 Graduate Assistant Teaching: Full-Time (0 credits)
Fee. S/U grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209975)

BIEN 9976 Graduate Assistant Research: Full-Time (0 credits)
Fee. S/U grade assessment. Designated as full-time status. If a student is already registered in other courses full time, this continuation course is not needed.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209976)

BIEN 9984 Master's Comprehensive Examination Preparation: Less than Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week toward their master's comprehensive exam.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209984)

BIEN 9985 Master's Comprehensive Examination Preparation: Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week toward their master's comprehensive exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209985)

BIEN 9986 Master's Comprehensive Examination Preparation: Full-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week toward their master's comprehensive exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209986)

BIEN 9987 Doctoral Qualifying Examination Preparation: Less than Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week toward their doctoral qualifying exam.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209987)

BIEN 9988 Doctoral Qualifying Examination Preparation: Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209988)

BIEN 9989 Doctoral Qualifying Examination Preparation: Full-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week toward their doctoral qualifying exam. May be taken in conjunction with credit-bearing or other non-credit courses to result in the status indicated, as deemed appropriate by the department.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209989)

BIEN 9991 Professional Project Continuation: Less than Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their professional project. Any professional project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209991)

BIEN 9992 Professional Project Continuation: Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their professional project. Any project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209992)

BIEN 9993 Professional Project Continuation: Full-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their professional project. Any professional project credits required for the degree should be completed before registering for non-credit Professional Project Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209993)

BIEN 9994 Master's Thesis Continuation: Less than Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209994)

BIEN 9995 Master's Thesis Continuation: Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209995)

BIEN 9996 Master's Thesis Continuation: Full-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their master's thesis. All six thesis credits required for the degree should be completed before registering for non-credit Master's Thesis Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209996)

BIEN 9997 Doctoral Dissertation Continuation: Less than Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of less than half-time status. Requires that the student is working less than 12 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209997)

BIEN 9998 Doctoral Dissertation Continuation: Half-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of half-time status. Requires that the student is working more than 12 to less than 20 hours per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209998)

BIEN 9999 Doctoral Dissertation Continuation: Full-Time (0 credits)
Fee. S/U grade assessment. Allows a student to be considered the equivalent of full-time status. Requires that the student is working 20 hours or more per week on their doctoral dissertation. All 12 dissertation credits required for the degree should be completed before registering for non-credit Doctoral Dissertation Continuation.
Prerequisite: Consent required.
Level of Study: Graduate
Schedule of Classes (https://bulletin.marquette.edu/class-search/?details&code=BIEN%209999)