Biomedical Engineering (BME)

B.S. in Biomedical Engineering (https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/engineering/biomedical-engineering/)

Minor in Biomedical Engineering (https://catalog.und.edu/undergraduateacademicinformation/departmentalcoursesprograms/electricalengineering/ee-minor-be/)

BME 101. Introduction to Biomedical Engineering. 1 Credit.
This course is designed to orient the new BME student to the Biomedical Engineering curriculum and area of research. Students will be introduced to the BME faculty and their research. The three specialization areas will be discussed: bioinstrumentation, biomaterials, and biomechanics. Important resources including the BMES student society, tutoring mentoring, and career-building will be presented. Medical device regulatory issues will be also addressed in the course. S/U grading. F.

BME 180. Biomedical Engineering Innovation-Based Learning I. 2 Credits.
The first course in the BME innovation-based learning series. This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. F.

BME 181. Biomedical Engineering Innovation-Based Learning II. 2 Credits.
The second course in the in the BME innovation-based learning series. This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 180 with a C or higher. Prerequisite or Corequisite: MATH 165. S.

BME 280. Biomedical Engineering Innovation-Based Learning III. 2 Credits.
The third course in the BME innovation-based learning series. This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 181 with a C or higher. Prerequisite or Corequisite: MATH 166. F.

BME 281. Biomedical Engineering Innovation-Based Learning IV. 2 Credits.
This is the fourth course in the in the BME innovation-based learning series. This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 280 and MATH 166, both with a C or higher. Prerequisite or Corequisite: MATH 265. S.

BME 380. Junior Innovation-Based Learning I. 2 Credits.
This course is fifth in the in the BME innovation-based learning series. This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: MATH 265 with a C or higher. Corequisite: BME 180 and MATH 266. F.

BME 381. Junior Innovation-Based Learning II. 2 Credits.
This course is sixth in the in the BME innovation-based learning series. This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 180, BME 380, and MATH 266, all with a C or higher. Prerequisite or Corequisite: BME 181. S.

BME 397. Cooperative Education. 1-2 Credits.
A practical work experience with an employer closely associated with the student's academic area. Arranged by mutual agreement among student, department, and employer. A final report is to be submitted and evaluated by the instructor. Prerequisite: Department consent. Repeatable to 4.00 credits. S/U grading. F,S,SS.

BME 421. Software for Biomedical Engineering. 3 Credits.
This course is designed to develop the student in; 1) the exposure at a high-level to various biomedical engineering software tools, 2) applying one software tool applied to the team innovation project chosen by the student, 3) the software engineering perspectives of biomedical concepts, 4) professionalism, and 5) ethical and regulatory issues. The course is delivered via in-person, synchronous, and asynchronous modes using an established experiential learning model termed Innovation-Based learning. In innovation-based learning, students select an innovation project, form teams, and throughout the semester, learn to integrate engineering knowledge with ethical and regulatory constraints to produce an innovation in the biomedical engineering space while gaining professional skills. Students in this class must show mastery in the use of at least one software in the innovation projects. Student assessment of learning is accomplished through mastery of pillar concepts, generation of project tokens, and communicating the innovation to society. Prerequisite: Programming course - ENGR 200 or CSCI 130 or EE 304; or by instructor approval. Prerequisite or Corequisite: BME 380 or BME 631 or BME 630 or by instructor approval. F.

BME 422. Introduction to NeuroEngineering. 3 Credits.
This course is designed to develop the student in; 1) the understanding and application of fundamental neural engineering concepts, 2) understanding and analysis of the nervous system and neurological disorders 3) the design, analysis, and evaluation of current neural engineering challenges, 4) professionalism, and 5) ethical and regulatory issues. The course is delivered via in-person, synchronous, and asynchronous modes using an established experiential learning model termed Innovation-Based learning. In innovation-based learning, students select an innovation project, form teams, and throughout the semester, learn to integrate physiological knowledge with ethical and regulatory constraints to produce an innovation in the biomedical engineering space while gaining professional skills. The role of the students in innovation projects must include the use of software. Student assessment of learning is accomplished through mastery of pillar concepts, generation of project tokens, and communicating the innovation to society. Prerequisite: Background knowledge in differential equations, physics of electric and magnetic fields, introductory chemistry, or by instructor approval. Corequisite: BME 381 or by instructor approval. On demand.

BME 424. Computational NeuroEngineering of Innovation. 3 Credits.
This course is designed to develop the student in: 1) navigating the balance between reductive science and complexity, 2) applying inductive, deductive, and abductive reasoning, 3) exploring the integration of wetware with computational models, 4) understanding and analyzing learning models, including artificial neural networks (ANN) and reinforcement learning (RL), 5) addressing professionalism, and ethical and regulatory issues. Prerequisite or Corequisite: BME 422 or BME 381 or by instructor approval. On demand.

BME 425. Biomedical Applications of RF/Microwaves. 3 Credits.
This course is designed to develop the student in: 1) microwave radiation and its applications to biological systems for communications, power, sensing, and therapy, 2) the practice of medical device and process innovation, 3) professionalism, and 4) ethical and regulatory issues. The course is delivered via in-person, synchronous and asynchronous modes using an established experiential learning model termed Innovation-Based learning. In innovation-based learning, students select an innovation project, form teams, and throughout the semester, learn to integrate physiological knowledge with ethical and regulatory constraints to produce an innovation in the biomedical engineering space while gaining professional skills. Student assessment of learning is accomplished through mastery of pillar concepts, generation of project tokens, and communicating the innovation to society. Prerequisite: BME 180 and EE 316 both with a C or better; or Instructor Approval. F.

BME 430. Fundamentals of Biomedical Imaging. 3 Credits.
This course will discuss the physics, instrumentation, and data processing methods used in common medical imaging modalities including X-ray radiography, X-ray computed tomography, ultrasound imaging, nuclear medicine, magnetic resonance imaging. The course will also introduce emerging optical imaging techniques in medical diagnosis, including optical coherence tomography and photoacoustic imaging. The course is suitable for graduate and advanced undergraduate students. There is a strong research component to the course expecting the students to produce a written report at the end and present their results to the class. This course is also designed to bring together students with various backgrounds in physics, math and programming. Prerequisite: EE 314 or consent of instructor. F.

BME 432. Fundamentals of Biomedical Optics. 3 Credits.
Biomedical optics is an emerging interdisciplinary field where optical methods are utilized to reveal biological mechanisms, diagnose and treat diseases. This course will cover the fundamental principle of optical instruments and their applications in biology and medicine. Topics of the course include modern optical devices, optical system design, tissue optical properties, light-tissue interactions, and applications of optical instruments in biomedicine. This course is interdisciplinary and is suitable for graduate and advanced undergraduate students. There is a strong research component to the course expecting the students to produce a written report at the end and present their results to the class. This course is also designed to bring together students with various backgrounds in physics, math and programming. Prerequisite: PHYS 252 and EE 314. S.

BME 444. Advanced Imaging Systems in Biomedicine. 3 Credits.
This course will cover the advanced topics on imaging systems in biomedicine, focusing on both foundational and emerging modalities. It is designed for students majoring in Biomedical Engineering, Electrical Engineering, and other engineering disciplines who are interested in learning about the principles, techniques, and applications of medical imaging. In this course, we will explore the fundamental concepts of medical imaging, including X-ray, MRI, ultrasound, spectroscopy, and optical imaging. Special emphasis will be placed on emerging optical imaging techniques, such as optical coherence tomography and hyperspectral imaging, and their applications in clinical and research settings. We will cover various imaging modalities, discussing the principles behind each, their advantages, and their limitations. Topics will include image quality, resolution, contrast, and the impact of tissue scattering and absorption. By the end of the course, students will have gained a comprehensive understanding of the principles of medical imaging across different modalities. They will also have practical experience with imaging equipment and techniques, as well as an appreciation of the ethical and societal implications of medical imaging. Prerequisite: MATH 266 and BME 180. On demand.

BME 450. Biomedical Instrumentation (Medical IoT Innovation I). 3 Credits.
The goal of this course is to introduce students to engineering principles of biomedical devices. The particular emphasis is on electrical devices but an introduction to biomedical imaging modalities, biomechanics and biomaterials is also provided. The course focuses on both theoretical and practical aspects of biomedical instruments. The course includes a special emphasis on campus laboratory activities. There is also a strong research component to the course expecting the students to produce a written report at the end and present their results to the class. A student with a strong background in physics, math and also programming will be able to benefit from this course. Familiarity with electrical circuits is an asset. Prerequisite: EE 314 and EE 321. S.

BME 451. Medical IoT Innovation II: Digital Data Use. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. The course utilizes innovation-based learning where the students select an innovation project, form teams, learn to integrate physiological knowledge with ethical and regulatory constraints to produce an innovation in the biomedical engineering space while gaining professional skills. Student assessment of learning is accomplished through mastery of pillar concepts, generation of project tokens, and communicating the innovation to society. Prerequisite: BME 180; CEM Core Programming Course - ENGR 200, CSCI 130, or EE 304; CEM Core Statistics Course - CHE 315, EE 318, or MATH 321; all with a grade of C or better, or Instructor Approval. On demand.

BME 460. Computational Biology. 3 Credits.
Students will be introduced to the fundamentals of molecular biology and recent advance in genomics technology. The students will be shown how to use basic computational approaches in the field. This course also aims to provide students with a practical and hands-on experience with common bioinformatics tools and databases. Students will be trained in the basic theory and application of programs used for database searching, genomic/protein sequence analysis, and prediction of genomic/protein functions. Students will also discuss the social impact of this emerging technology and overwhelming information. Hence, bioinformatics can be considered as a field of data science for solving problems in biology and human health. This course is geared toward biologists who routinely work with data and need to analyze it in a novel way, above and beyond statistical analysis, using the "machine learning" paradigm. This course teaches students how to identify variables (that explain outcomes) in an experiment and use techniques to filter, manipulate and act upon the data. Prerequisite: EE 304 and BIMD 221. F.

BME 471. Medical Device Regulatory and Commercialization. 3 Credits.
This course is to provide a roadmap for medical device commercialization and to address various requirements of regulatory considerations for inventors. There is an emphasis on verifying an Idea has the potential to be developed into a Product and can be viable in the Marketplace. A commercialization plan for a medical device typically includes the successful implementation of several key elements and strategies to achieve commercial success. Prerequisite: BME 180 with a grade of C or better. On demand.

BME 472. Quality Engineering. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) best practices in quality engineering, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 471 with a grade of C or higher. On demand.

BME 473. Risk Management. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) best practices in risk management, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 471 with a grade of C or higher. On demand.

BME 474. Good Manufacturing Practice. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) FDA CGMP (Current Good Manufacturing Practice) requirements and processes, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 471 with a grade of C or higher. On demand.

BME 475. Medical Device Commercialization. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) commercialization, reimbursement, supply chain, patenting, fundraising, product pipeline, and exit strategy, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 471 with a grade of C or higher. On demand.

BME 476. Product Safety. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) product safety design and testing requirements, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 471 with a grade of C or higher. On demand.

BME 477. FDA Regulatory Approval Pathways. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) different FDA Regulatory Approval Pathways, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 471 with a grade of C or higher. On demand.

BME 478. Verification & Validation. 3 Credits.
This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) industry best practices related to formal verification and validation of products and processes, 3) professionalism, and 4) ethical and regulatory issues. Prerequisite: BME 471 with a grade of C or higher. On demand.

BME 480. Senior Innovation Based Learning I. 3 Credits.
This is the seventh course in the in the BME innovation-based learning series. This capstone course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) summative engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. Note, BME 480 and BME 481 must be taken in immediately consecutive semesters. Prerequisite: BME 381 with a C or higher. Prerequisite or Corequisite: BME 280. F.

BME 481. Senior Innovation Based Learning II. 3 Credits.
This is the eighth and final course of the in the BME innovation-based learning series. This course is designed to develop the student in; 1) the practice of medical device and process innovation, 2) the engineering perspective of physiological concepts, 3) professionalism, and 4) ethical and regulatory issues. Note, BME 480 and BME 481 must be taken in immediately consecutive semesters. Prerequisite: BME 480 with a C or higher. Prerequisite or Corequisite: BME 281. S.

BME 490. Special Topics. 1-6 Credits.
Investigation of special topics dictated by student and faculty interests. Prerequisite: Department approval. On demand.