The objectives of the biomedical engineering program are to produce high-quality graduates with a broad-based education in engineering, life sciences and natural sciences; who:

1. are well prepared for further graduate studies, careers in the biomedical or biotechnology industries or entry into medical or other professional schools;
2. will make significant contributions in biomedical industries, medicine and other sectors;
3. will apply acquired knowledge appropriately, work professionally with others, effectively communicate ideas and technical information and continue to learn and improve their knowledge base and skills.

These objectives are met through a modern and comprehensive curriculum taught by a well prepared, professionally active and dedicated faculty. In addition, the program actively supports professional development among the students through individual study and research opportunities, cooperative education and internships, and student society activities. These goals are measured by the success of the graduates in finding rewarding professional employment, and by admission to respected graduate and professional schools.

Design is an important part of biomedical engineering and design skills are emphasized throughout the curriculum, beginning in the freshman year, and culminating in the two-semester senior design course sequence that requires application of a wide range of engineering methods to a focused design project. Other courses in biomedical engineering and in supporting disciplines include examples of the application of the principles to design, as well as specific design exercises. The Biomedical Engineering curriculum is accredited by the Engineering Accreditation Commission of ABET, www.abet.org.

Before commencing course work in the major, students must be admitted to the major or have the approval of the department.

Faculty

Alge, Daniel, Assistant Professor
Biomedical Engineering
PhD, Purdue University, 2010

Applegate, Brian, Associate Professor
Biomedical Engineering
PhD, Ohio State University, 2000

Brewer, Maurice, Professor Of The Practice
Biomedical Engineering
MBA, Harvard Graduate School of Business Administration, 1984

Cosgriff-Hernandez, Elizabeth, Associate Professor
Biomedical Engineering
PhD, Case Western Reserve University, 2005

Cote, Gerard, Professor
Biomedical Engineering
PhD, University of Connecticut, 1990

Criscone, John, Associate Professor
Biomedical Engineering
PhD, John Hopkins University, 2005

Gaharwar, Akhilesh, Assistant Professor
Biomedical Engineering
PhD, Purdue University, 2011

Gibbs, Holly, Lecturer
Biomedical Engineering
PhD, Texas A&M University, 2015

Grunlan, Melissa, Associate Professor
Biomedical Engineering
PhD, University of South Carolina, 2004

Hanks, John, Professor Of The Practice
Biomedical Engineering
MS, University of Texas, Austin, 1989

Haridas, Balakrishna, Professor Of The Practice
Biomedical Engineering
PhD, University of Cincinnati, 2001

Hwang, Wonnuk, Associate Professor
Biomedical Engineering
PhD, Boston University, 2001

Jo, Javier, Associate Professor
Biomedical Engineering
PhD, University of Southern California, 2002

Kaunas, Roland, Associate Professor
Biomedical Engineering
PhD, University of California, San Diego, 2003

Madigan, Michael, Professor
Biomedical Engineering
PhD, Virginia Commonwealth University, 2001

Maitland, Duncan, Professor
Biomedical Engineering
PhD, Northwestern University, 1995

Maitland, Kristen, Associate Professor
Biomedical Engineering
PhD, University of Texas, 2006

McDougall, Mary, Associate Professor
Biomedical Engineering
PhD, Texas A&M University, 2004

McShane, Michael, Professor
Biomedical Engineering
PhD, Texas A&M University, 1999

Meissner, Kenneth, Tees Research Professor
Biomedical Engineering
PhD, University of Arizona, 1994

Ober, Raimund, Professor
Biomedical Engineering
PhD, Cambridge University, 1987
Trache, Andreea, Associate Professor
Biomedical Engineering
PHD, Institute of Atomic Physics, Romania, 1996

Yakovlev, Vladislav, Professor
Biomedical Engineering
PHD, Moscow State University, 1990

Yeh, Alvin, Associate Professor
Biomedical Engineering
PHD, University of California, Berkeley, 2000

Majors
• Bachelor of Science in Biomedical Engineering

Minors
• Biomedical Engineering Minor

Certificates
• Engineering Therapeutics Manufacturing Certificate
• Quality Engineering for Regulated Medical Technologies Certificate

Courses

BMEN 101 Introduction to Biomedical Engineering
Credit 1. 1 Lecture Hour.
Overview of biomedical engineering and the biomedical engineering industry, including specialties, degree requirements and scholastic programs in the Department of Biomedical Engineering.
Prerequisite: Freshman or sophomore classification.

BMEN 207 Computing for Biomedical Engineering
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Introduction to the principles of computer programming for biomedical applications including program design and development, programming techniques and documentation; introduction to and programming in the LabVIEW and MATLAB environments.
Prerequisite: Admitted to major degree sequence; PHYS 208, CHEM 101/111, MATH 152, ENGR 112.

BMEN 211 Biomedical Applications of Circuits, Signals and Systems
Credits 3. 3 Lecture Hours.
Quantitative analysis of biomedical and physiological signals; A/D conversion and sampling; Fourier and Laplace transforms; filtering of biomedical signals and images; electrical circuits and analog representations of physiological systems as model systems.
Prerequisites: Admitted to major degree sequence in biomedical engineering, BMEN 207, MATH 308 or concurrent enrollment, or approval of instructor.

BMEN 231 Foundations of Biomechanics
Credits 3. 3 Lecture Hours.
Introduction of biomechanics in formulating and solving problems in basic science, medical device development, and clinical intervention: emphasis on deriving differential equations in one spatial dimension for the five basic postulates of continuum biomechanics, identifying illustrative constitutive relations, and providing a unified approach to studying biosolid mechanics, biofluid mechanics, bioheat and mass transport, and biothermomechanics.
Prerequisite: Admitted to major degree sequence in biomedical engineering.

BMEN 253 Medical Device Design I
Credit 1. 3 Lab Hours.
FDA design controls for medical device development in a regulated environment; small-scale team biomedical engineering design project.
Prerequisites: Admitted to major degree sequence in biomedical engineering; VTPP 434; or approval of instructor.

BMEN 282/CHEN 282 Engineering Biology
Credits 3. 3 Lecture Hours.
Application of engineering principles to biological function at the molecular and cellular level.
Prerequisites: Admitted to major degree sequence and CHEM 111 or CHEM 107 and CHEM 117.

BMEN 285 Directed Studies
Credits 1 to 4. 1 to 4 Other Hours.
Permits students to undertake special projects in biomedical engineering at an earlier point in their studies than required for BMEN 485.
Prerequisite: Approval of Director of Undergraduate Programs.

BMEN 289 Special Topics in...
Credits 1 to . 1 to 4 Lecture Hours. 0 to 4 Lab Hours.
Selected topics in an identified area of biomedical engineering. May be repeated for credit.
Prerequisite: Approval of instructor.

BMEN 291 Research
Credits 1 to 4. 1 to 4 Other Hours.
Research conducted under the direction of faculty member in biomedical engineering. May be repeated 2 times for credit.
Prerequisite: Freshman or sophomore classification and approval of instructor.

BMEN 305 Bioinstrumentation
Credit 1. 3 Lab Hours.
Introduction to biomedical instrumentation design; hands on acquisition of biomedical signals; design, building and testing of bioinstrumentation circuits including analog signal amplifiers and analog filter circuits.
Prerequisites: Admitted to major degree sequence in biomedical engineering; BMEN 211, VTPP 434 and 435; junior or senior classification; or approval of instructor.

BMEN 306 Biomeasurements Lab
Credit 1. 3 Lab Hours.
Introduction into experimental methods useful in biomedical engineering; includes the role of empiricism in biomedical research and development; the differences between observation and experimentation; and how to acquire, reduce, interpret, and present data.
Prerequisites: Admitted to major degree sequence in biomedical engineering; BMEN 240 and BMEN 341.

BMEN 310 Clinical Engineering
Credits 3. 3 Lecture Hours.
Equipment control concepts and techniques and their application in hospitals and in the medical profession; device evaluation specifications; preventative maintenance and service; calibration, regulation and medical product liability.
Prerequisites: Admitted to major degree sequence in biomedical engineering; BMEN 321.
BMEN 321 Biomedical Electronics
Credits 3.3 Lecture Hours.
Introduction to biomedical signals; basic circuit analysis for biomedical signals; design of bioamplifier circuits; characteristics of linear and nonlinear circuit elements; design of basic electronic circuits, principles and practice of bioelectronic measurements.
Prerequisites: BMEN 211; VTPP 435; junior or senior classification; or approval of instructor.

BMEN 322 Biosignal Analysis
Credits 3.3 Lecture Hours.
Design and application of analog and digital signal analysis in biomedical engineering; characteristics of biomedical signals; design considerations for analog-to-digital and digital-to-analog circuitry; biosignal transformation methods; analog and digital filter design for biomedical signals.
Prerequisites: BMEN 321, VTPP 434 and VTPP 435; junior or senior classification.

BMEN 341 Biofluid Mechanics
Credits 3.3 Lecture Hours.
Introduction into the mechanics of fluids in biomechanics, including blood, synovial fluid and physiological solutions, with an emphasis on the importance of mecanobiology and the formation of biological problems within the context of 1) kinematics, 2) the concept of stress, 3) linear momentum balance, 4) constitutive relations, and 5) boundary conditions.
Prerequisites: Admitted to major degree sequence in biomedical engineering; VTPP 435; MATH 308; junior or senior classification; or approval of instructor.

BMEN 342 Biomaterials and Medical Devices
Credits 3.3 Lecture Hours.
Selection and use of materials in implantable and tissue contacting medical devices; mass transport in medical devices; regulation and testing of medical devices.
Prerequisites: VTPP 435 and BMEN 341; junior or senior classification.

BMEN 343 Introduction to Biomaterials
Credits 3.3 Lecture Hours.
Properties of natural and man-made materials commonly encountered in biomedicine and biomedical engineering; an integrated approach in the presentation of material structures, characteristics and properties; the basics of material structures, including crystalline and chemical structure, and microstructure; and bulk properties and characteristics of the materials developed from the microscopic origins.
Prerequisites: Admitted to major degree sequence in biomedical engineering; VTPP 435; MATH 308; junior or senior classification; or approval of instructor.

BMEN 344 Biological Responses to Medical Devices
Credits 3.3 Lecture Hours.
Selection and characterization of materials in implantable and tissue contacting medical devices; biodegradation, biocompatibility, hemocompatibility and cell-material interactions of biomaterials.
Prerequisites: Basic knowledge of biomaterials, cell biology, human anatomy/physiology and engineering principles (VTPP 435 or equivalent); BMEN 343 highly recommended.

BMEN 345 Biomaterials Lab
Credit 1.3 Lab Hours.
Experimental methods used to prepare and characterize polymeric biomaterials used in biomedical engineering; related fundamental aspects of forming a hypothesis, experimental design, empirical observation, data collection, interpretation and presentation of data.
Prerequisite: BMEN 343.

BMEN 350 Statistics for Biomedical Engineering
Credits 3.3 Lecture Hours.
Evaluation of the efficacy of clinical research; quantitative methods used in clinical trials in biomedical engineering; ethical and regulatory issues that must be considered during the design and implementation of any clinical trial, or pre-clinical study.
Prerequisites: Junior classification; admitted to the major degree sequence (upper level).

BMEN 353 Medical Device Design II
Credit 1.3 Lab Hours.
Identification of needs for biomedical engineering design solutions, development of design proposals, analysis of design project requirements and constraints.
Prerequisite: BMEN 253 or equivalent; junior or senior classification.

BMEN 361 Biosolid Mechanics
Credits 3.3 Lecture Hours.
Introduction to the mechanics of deformable media in biomedical engineering, including medical devices, biomaterials, and soft and hard biological tissues; emphasis on biomechanics and mechanobiology and formulation of problems within the context of basic continuum biomechanics; problems include analytical solutions for stress-strain analysis of extension, distension, bending, buckling, and torsion of biosolids.
Prerequisites: Admitted to major degree sequence in biomedical engineering; BMEN 341.

BMEN 400/VTPP 401 History of Human and Veterinary Medicine in Europe
Credits 4.4 Lecture Hours.
Addresses the major developments in human and veterinary medicine in Europe from the Middle Ages to the present; explores key events and figures in medical history and analyzes issues of current biomedical concern in a historical context; for example, animal rights, ethics of humane experimentation, euthanasia.
Prerequisites: Admitted to major degree sequence in biomedical engineering; VTPP 434.
Cross Listing: VTPP 401.

BMEN 401 Principles and Analysis of Biological Control Systems
Credits 3.3 Lecture Hours.
Techniques for generating quantitative mathematical models of physiological control systems and devices; the behavior of physiological control systems using both time and frequency domain methods.
Prerequisites: BMEN 321; MATH 308; VTPP 434 and VTPP 435.

BMEN 402 Biomedical Optics Laboratory
Credits 3.2 Lecture Hours. 3 Lab Hours.
Biomedical optics technology; basic engineering principles used in developing therapeutic and diagnostic devices; hands-on labs including optical monitoring, diagnostic and therapeutic experiments.
Prerequisite: PHYS 208 or approval of instructor.

BMEN 404 FDA Good Laboratory and Clinical Practices
Credits 3.3 Lecture Hours.
Implementation of Good Laboratory Practices (GLP) for the submission of preclinical studies and use of Good Clinical Practices (GCP) in clinical trials in accordance with Food and Drug Administration (FDA) regulations; includes similarities and differences in GLP and GCP critical for the introduction of new drugs and medical devices.
Prerequisites: Admitted to major degree sequence and BMEN 430; junior or senior classification.
A page from the Department of Biomedical Engineering curriculum document is shown with text describing courses and their prerequisites. Each course is listed with its title, credits, and description, along with the prerequisites required. The text is formatted in a standard academic document style, with proper headings, subheadings, and paragraphs. The courses cover a wide range of topics including optical biosensors, magnetic resonance engineering, biophotonics, bioelectromagnetism, and more. Each course description includes a brief overview of the content covered, the intended audience, and the prerequisites needed to enroll. The document is well-organized, making it easy for students to navigate and understand the requirements for different courses within the department.
BMEN 451 Cell Mechanobiology
Credits 3.3 Lecture Hours.
Focus on how mechanical forces influence cell behavior through physical and biochemical mechanisms; integration of engineering and cell biology to solve biomedical problems, which includes developing models for applying forces to cultured cells and tissues and measuring changes in cell biochemistry, structure, and function.
Prerequisites: BMEN 282/CHEN 282 and admitted to major degree sequence in biomedical engineering.

BMEN 452 Mass and Energy Transfer in Biosystems
Credits 3.3 Lecture Hours.
Transport phenomena associated with physiological systems and their interaction with medical devices; exchange processes in artificial life support systems and diagnostic equipment.
Prerequisites: BMEN 341; MATH 308; VTPP 434 and VTPP 435.

BMEN 453 Analysis and Design Project I
Credits 2.2 Lecture Hours.
Group or team biomedical engineering analysis and design project involving statement, alternative approaches for solution, specific system analysis and design.
Prerequisites: BMEN 321, BMEN 322, BMEN 344; BMEN 253 and BMEN 353; senior classification or approval of instructor.

BMEN 454 Analysis and Design Project II
Credits 2.2 Lecture Hours.
Continuation of BMEN 453.
Prerequisites: BMEN 321, BMEN 322, BMEN 344 and BMEN 453; senior classification; or approval of instructor.

BMEN 457 Orthopedic Biomechanics
Credits 3.3 Lecture Hours.
Development of competencies in biomechanical principles using practical examples and clinical case studies; application of biomechanical knowledge to the evaluation of musculoskeletal tissues and structures, and treatment options for musculoskeletal dysfunction.
Prerequisites: Admitted to major degree sequence in biomedical engineering; junior or senior classification.

BMEN 460 Vascular Mechanics
Credits 3.3 Lecture Hours.
Application of continuum mechanics to the study of the heart arteries; emphasis on the measurement and quantification of material properties, and the calculation of vascular stresses; analysis of several cardiovascular devices to reinforce the need for careful analysis in the device design.
Prerequisites: BMEN 240.

BMEN 461 Cardiac Mechanics
Credits 3.3 Lecture Hours.
Application of continuum mechanics and computational solid mechanics to the study of the mammalian heart; utilization of continuum mechanics and finite element analysis in solving non-linear boundary value problems in biomechanics.
Prerequisites: BMEN 240, BMEN 341, and BMEN 463; approval of instructor.

BMEN 462 Vascular Fluid Mechanics
Credits 3.3 Lecture Hours.
Bio-fluid mechanics of the human circulatory system including examination of disease development and medical treatments.
Prerequisites: BMEN 240 or equivalent; junior or senior classification.

BMEN 463 Soft Tissue Mechanics and Finite Element Methods
Credits 3.3 Lecture Hours.
Application of continuum mechanics and finite element methods to the study of the mechanical behavior of soft tissues and associative applications in biomedicine.
Prerequisites: BMEN 240 or equivalent; junior or senior classification.

BMEN 465 Biomechanics Experiential Learning Lab
Credit 1.3 Lab Hours.
Applications in biomechanics (solid and fluid); includes experimental methods used to investigate biomechanical factors in the assessment of therapeutic interventions; mechanical testing load frames; motion capture systems, high speed imaging and flow systems; hypothesis forming, experimental design, empirical observation, data collection and interpretation, and presentation of results.
Prerequisites: Admitted to major degree sequence in biomedical engineering; junior or senior classification or approval of instructor.

BMEN 468 Advanced Biomechanics
Credits 3.3 Lecture Hours.
Application of fluid and solid mechanics to problems in biomedical engineering ranging from molecular-level to organ-level, including the mechanics of the cell cytoskeleton, whole cells, blood, arteries and the heart.
Prerequisites: Admitted to major degree sequence in biomedical engineering; BMEN 361; or approval of instructor.

BMEN 469 Entrepreneurial Issues in Biomedical Engineering
Credits 3.3 Lecture Hours.
Description and analysis of issues associated with initiating business ventures to transfer biomedical technologies into the health care sector, including intellectual property protection, seed funding alternatives, and business strategies relevant to the biomedical engineering technology area; utilizing recent case studies of previous ventures.
Prerequisite: Admitted to major degree sequence (upper-level) in biomedical engineering.

BMEN 470/CHEN 470 Introduction of Biomedical Optics
Credits 3.3 Lecture Hours.
Fundamentals of biomedical optics; basic engineering principles used in optical therapeutics, optical diagnostics and optical biosensing.
Prerequisites: MATH 308; PHYS 208.
Cross Listing: CHEN 470/BMEN 470.

BMEN 471 Numerical Methods in Biomedical Engineering
Credits 3.3 Lecture Hours.
Application of numerical analysis to analyze molecular, cellular and physiological systems, using general techniques including programming in MATLAB to analyze steady and dynamic systems.
Prerequisites: BMEN 207 and VTPP 434.

BMEN 480 Biomedical Engineering of Tissues
Credits 3.3 Lecture Hours.
Introduction to aspects of tissue engineering with and emphasis placed on tissue level topics including tissue organization and biological processes, with insights from recent literature (state-of-the-art).
Prerequisite: Admitted to major degree sequence (upper level) in biomedical engineering.
BMEN 482 Polymeric Biomaterials
Credits 3. 3 Lecture Hours.
Preparation, properties, and biomedical applications of polymers including: polymerization; structure-property relationships; molecular weight and measurement; morphology; thermal transitions; network formation; mechanical behavior; polymeric surface modification; polymer biocompatibility and bioadhesion; polymers in medicine, dentistry, and surgery; polymers for drug delivery; polymeric hydrogels; and biodegradable polymers.
**Prerequisites:** BMEN 342 or approval of instructor; junior or senior classification.

BMEN 483 Polymeric Biomaterial Synthesis
Credits 3. 3 Lecture Hours.
Overview of polymer synthetic routes and key structure-property relationships with emphasis on the design of polymeric systems to achieve specific properties; tissue engineering and drug delivery applications will be used as model systems to explore the process of biomaterial design from synthesis to device evaluation.
**Prerequisite:** BMEN 343 or approval of instructor.

BMEN 485 Directed Studies
Credits 1 to 6. 1 to 6 Other Hours.
Permits students to undertake special projects in biomedical engineering.
**Prerequisite:** Approval of Director of Undergraduate Programs.

BMEN 486 Biomedical Nanotechnology
Credits 3. 3 Lecture Hours.
Nanotechnology applications in biomedicine; concepts of scale; unique properties at the nanoscale; biological interaction, transport, and biocompatibility of nanomaterials; current research and development of nanotechnology for medical applications, including sensors, diagnostic tools, drug delivery systems, therapeutic devices, and interactions of cells and biomolecules with nanostructured surfaces.
**Prerequisite:** BMEN 343, senior classification or approval of instructor.

BMEN 487 Drug Delivery
Credits 3. 3 Lecture Hours.
Mechanisms for controlled release of pharmaceutically active agents and the development of useful drug delivery systems; controlled release mechanisms including diffusive, convective, and erosive driving forces by using case studies related to oral, topical and parenteral release in a frontier interdisciplinary scientific research format.
**Prerequisite:** Senior classification in biomedical engineering or approval of instructor.

BMEN 489 Special Topics in...
Credits 1 to 4. 1 to 4 Lecture Hours. 1 to 4 Lab Hours.
New or unique areas of biomedical engineering which are of interest to biomedical engineering and other undergraduate students.

BMEN 491 Research
Credits 1 to 4. 1 to 4 Other Hours.
Research conducted under the direction of faculty member in biomedical engineering. May be repeated 2 times for credit. Registration in multiple sections of this course is possible within a given semester provided that the per semester credit hour limit is not exceeded.
**Prerequisites:** Junior or senior classification and approval of instructor.