BIOENGINEERING

The Program

The master's degree in bioengineering is a 30-credit-hour program designed to prepare students in an area of rapid growth and profound impact on society. The curriculum consists of courses specifically designed to provide a comprehensive background in the bioengineering field. Bioengineering courses are 3 credit hours and most are offered in the evening from 6:00 to 8:45 p.m.

Degree Requirements

The degree requirements for this program consist of a minimum of 30 graduate-level semester credit hours (beyond an undergraduate degree from an accredited engineering program) and includes 6 credit hours of core courses, 18 credit hours of bioengineering elective courses, and 6 credit hours of cognate elective courses. Students must earn a C or better in every graduate course to be credited toward the degree requirements. In addition, students must maintain a cumulative GPA of 3.0 or higher.

Students eligible to pursue the Bioengineering 4+1 Option (https://umdearborn.edu/cecs/departments/mechanical-engineering/undergraduate-programs/41-bioengineering-program/) or the Dual Bioengineering/Mechanical Engineering Accelerated Undergraduate/Master's Studies Option (https://umdearborn.edu/cecs/departments/mechanical-engineering/undergraduate-programs/beme-dual-accelerated-masters-program/) may count up to 9 credits in the graduate program toward their undergraduate bioengineering major. Of these, only one cognate course is allowed. In practice with the usual graduate student program rules, accelerated master's students may also transfer a maximum of 6 additional 500 level credits toward the 30-credit master's degree.

Laboratory Facilities

The bioengineering laboratory is designed to provide students with hands-on experience in tissue engineering, biomechanics, and developing and characterizing biomaterials. The laboratory houses standard equipment and facilities required for biomaterial development, biomechanical testing, and tissue engineering. Equipment available for biomechanical testing includes eight axial test machines, a high rate tensile/compressive impact tester, a high speed imaging system, environmental chambers, and assorted fixtures.

Faculty

The BENG program faculty are engaged in research in orthopaedic biomechanics, human movement, ocular biomechanics, impact safety, biomaterials, tissue engineering, hypoxia, protein engineering, cellular engineering, biomineraliztion, biomimetics, biopreservation, bioprocessing, drug delivery, nanotheranostics, pharmaceutical formulation, microspectroscopy, thermogravimetrics, biophotonics, microoptics, biosensors, MEMS, and microfluidics.

Assistantships/Financial Assistance

Research assistantships may be available to exceptionally qualified students who are not otherwise employed. Tuition scholarships are available to qualified full-time graduate students. Find out more about bioengineering faculty and their research areas (http://umdearborn.edu/cecs/departments/mechanical-engineering/our-faculty-research/).

Requirements

Core Courses

Code	Title	Credit Hours
BENG 520	Adv Molecular and Cell Biology [1]	3
ME 518	Advanced Engineering Analysis [1]	3

[1] ME 518 and BENG 520 should be taken by all students within the first year of enrollment in the program.

Bioengineering Electives

Code	Title	Credit Hours
6 courses (18 credit hours) from the following list:		
BENG 521	Biomatls and Biochem Interface	3
BENG 526	Fundamentals of Drug Delivery	3
BENG 550	Biophotonics and Optical Metrology	3
BENG 551	Microfluidics	3
BENG 560	Nanobiosystems Engineering	3
BENG 570	Advanced Biomechanics	3
BENG 571	Impact Biomechanics	3
BENG 575	Regenerative Engineering	3
BENG 595	Digital Manufacturing and Product Innovation	3
BENG 600	Study or Research in BENG	1-3
BENG 699	Master's Thesis [1]	6
BIOL 552	Med & Env Toxicology	3
BIOL 561	Advances in Cell Biology	2
IMSE 511	Design and Analysis of Exp	3

[1] The student has the option of electing a thesis in lieu of 6 credit hours of coursework in the bioengineering electives area.

Cognate Electives

Code	Title	Credit Hours
2 courses (6 credit hours); select any 2 courses from the following list:		
CIS 515	Computer Graphics	3
CIS 551	Advanced Computer Graphics	3
ECE 502	Electromag Theory & Simul	3
ECE 545	Intro Robot Syst	3
ECE 552	Fuzzy Systems	3
ECE 554	Embedded Systems	3
ECE 560	Modern Control Theory	3
ECE 580	Digital Signal Processing	3
ECE 5831	Pat Rec & Neural Netwks	3
ECE 585	Pattern Recognition	3
IMSE 501	Human Factors & Ergonomics	3
IMSE 510	Probability & Statistical Mod	3
IMSE 514	Multivariate Statistics	3
IMSE 543	Industrial Ergonomics	3
IMSE 544	Industrial Biomechanics	3

IMSE 545	Vehicle Ergonomics I	3
IMSE 546	Safety Engineering	3
IMSE 561	Tot Qual Mgmt and Six Sigma	3
IMSE 567	Reliability Analysis	3
MATH 504	Dynamical Systems	3
MATH 514	Finite Difference Methods for Differential Equations	3
MATH 516	Finite Element Methods for Differential Equations	3
MATH 520	Stochastic Processes	3
MATH 523	Applied Linear Algebra	3
MATH 554	Fourier Series and Boundary Value Problems	3
MATH 555	Func of a Complex Var with App	3
MATH 562	Mathematical Modeling	3
MATH 572	Introduction to Numerical Analysis	3
MATH 573	Matrix Computation	3
ME 510	Finite Element Methods	3
ME 522	Advanced Fluid Mechanics	3
ME 525	Computational Fluid Mechanics and Heat Transfer	3
ME 540	Mechanical Vibrations	3
ME 542	Advanced Dynamics	3
ME 568	Computational Materials Design	3
ME 589	Composite Materials	3
ME 591	Degradation of Materials	3
STAT 530	Applied Regression Analysis	3
STAT 535	Data Analysis and Modeling	3
STAT 545	Reliability & Survival Analys	3
STAT 550	Multivariate Stat Analysis	3
STAT 560	Time Series Analysis	3

BENG 520 Adv Molecular and Cell Biology 3 Credit Hours
This course introduces the cell and molecular biology concepts from an engineering perspective and provides the foundation for modern biotechnology and bioengineering. This course is designed for a first year engineering graduate student to develop a comprehensive understanding of relevant applications in biology, including biochemical, cellular organizational, metabolic and genetics aspects. Advanced concepts including genomics, molecular biology, recombinant DNA technology and evolution are discussed. The course provides exposure to several key techniques used in biological engineering laboratories. Students will have chance to present and discuss individual application through team project. (YR)
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if Major is , Bioengineering

BENG 521 Biomatls and Biochem Interface 3 Credit Hours
The course will provide graduate-level foundation on biomaterials science and principles. Specifically, the course will involve discussion on the importance of surfaces and interfaces in biomaterial function and elements controlling host responses to materials, introduction to biomimetic and rational designing approaches, and develop critical analyses of biomaterials through reading research papers and developing projects. (YR)
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 526 Fundamentals of Drug Delivery 3 Credit Hours
This course is designed to provide students with an understanding on the concepts in drug delivery from an engineering perspective. The course will cover drug delivery mechanisms, quantitative understanding of drug transport, nanotechnology, drug delivery devices, toxicity and immune response, FDA regulations, clinical trials and technology transfer. The course will conclude with a design project on nanoparticles development for targeted drug delivery. (YR)
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 550 Biophotonics and Optical Metrology 3 Credit Hours
The recent explosion of interest in minimally invasive medical diagnostics and contactless metrology has been fueled in part by the development of novel optics and photonics. A large number of optically-based imaging and sensing techniques have moved beyond research laboratories into medical clinics, materials engineering, and industrial applications. Topics include design principles of optical instrumentation, techniques for diagnostics and metrology, and elastic and inelastic light scattering theory. Applications include optical metrology, confocal and multiphoton microscopy, light propagation and tomographic imaging in tissues, and design of minimally invasive spectroscopic systems. Optical systems design is included as a class project. (YR).
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 551 Microfluidics 3 Credit Hours
Microscaled systems and devices have enhanced reaction rates, predictable fluid mechanics, reduced reagent volumes, and a cheaper path to rapid prototyping. These advantages benefit many biomedical and processes engineering applications that require sensitive molecular detection and precise flow controls. In this course, a range of microsystem techniques will be discussed, including those based on microfluidics, MEMS, and optofluidics. The lectures will be accompanied by student-driven design projects that will be conducted in 3-hour laboratories. (YR).
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 560 Nanobiosystems Engineering 3 Credit Hours
Nanobiosystems Engineering is an emerging frontier in nanotechnology. It integrates materials science, bioengineering, physics and life science with the biological and biochemical applications. This fast-developing interdisciplinary field holds the promise to solve many of the medical problems of future. The course will introduce advanced concepts related to nanomaterials and nanofabrication and their application in medicine. The course will also focus on design and development of nano-devices for the applications of pharmaceuticals and healthcare. Typcial applications including nano-biosensor, targeted drug delivery, and tissue engineering will also be discussed. Students in Bioengineering will have chance to present and discuss individual application through team project. (YR)
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 570 Advanced Biomechanics 3 Credit Hours
This course covers intermediate level subject matter on structural biomechanics, analysis and design. Topics include: soft tissues biomechanics, human motion analysis including gait, orthopedic implants. fixation and reconstruction, head impact and injury, advanced bone models. (YR) (YR).
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 571 Impact Biomechanics 3 Credit Hours
This course focuses on the understanding of the behavior of human organs, bone and tissue at their point of mechanical or functional failure. Topics will include research methods in injury biomechanics, injury tolerance of the structures and materials of the head, brain, spine, thorax, abdomen and extremities and injury prevention focusing on safety equipment. Federal motor vehicle safety standards will be discussed. (YR)
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 575 Regenerative Engineering 3 Credit Hours
This course will discuss principles of tissue engineering whereby the properties of stem as well as primary cells, growth factors, and extracellular matrix and their impact in the development of engineered tissue constructs will be explored. In addition, the course will also focus on supporting/enabling technologies typically utilized in engineering these constructs including nano-and micro-fabrication techniques, 3D printing, micro-patterning as well designing principles of bioreactors, and drug and gene delivery techniques. Additionally, various tissue engineering applications will be discussed including synthetic tissues and organs that are currently under development for regenerative medicine application. (YR)
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or

BENG 595 Digital Manufacturing 3 Credit Hours
This combined lecture and hands on project course aims to train students to optimize the interplay of materials, people, machines and profitability. The course introduces methods to identify product concepts with commercial potential. Student teams will perform market analysis and explore the intellectual property space around their ideas and rapidly iterate them into a final prototype via direct digital manufacturing (e.g., 3D CAD/CAM files manifested via digital printing or machining). Advanced instruction on direct digital manufacturing tools will be given, and customer response will be used as feedback. Early stage prototypes will progress into more sophisticated designs, scaling up (cost, pricing, tooling, process flow and automation) scenario planning for mass manufacturing as well as Failure Mode Effect Analysis (FMEA) will be discussed. (W,YR)
Restriction(s):
Cannot enroll if Level is
Can enroll if Major is , Bioengineering

BENG 600 Study or Research in BENG 1 to 3 Credit Hours
Individual study or research in an area of bioengineering under supervision of a faculty member. The student will submit a written report at the close of the term. (YR)
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or

BENG 699 Master's Thesis 1 to 6 Credit Hours
Research project in the area of bioengineering conducted under supervision of a program faculty member. While guided by a faculty member, a student electing this course is expected to carry out the work him-or herself. Successful completion of the course requires completion and public defense of a written thesis. A student must satisfactorily complete all 6 credit hours, which can be distributed over multiple semesters. (YR)
Restriction(s):
Can enroll if Level is Rackham or Graduate

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally

Learning Goals

1. Students will be able to demonstrate ability to apply physical, chemical, and mathematical principles in bioengineering.
2. Students will be able to formulate, analyze, and solve complex health related problems using bioengineering tools.
3. Students will be able to utilize the rapidly advancing science and technologies of bioengineering in their professional endeavors.