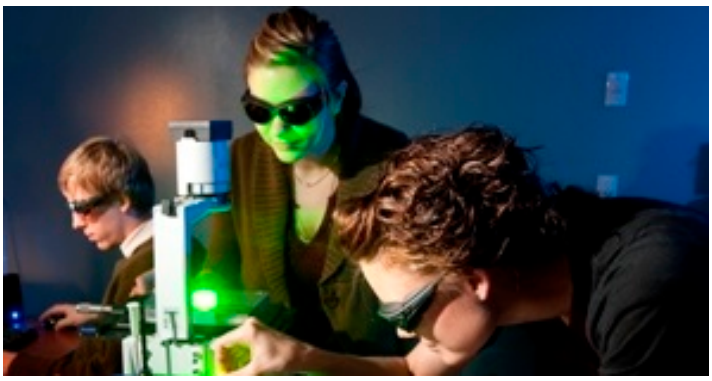
SCHOOL OF BIOMEDICAL ENGINEERING



Scott Bioengineering Building, Suite 225
engr.colostate.edu/sbme (http://www.engr.colostate.edu/sbme/)
(970) 491-7157

Professor Stuart Tobet, Director
Professor Kevin Lear, Associate Director; and Director, Undergraduate Programs
Associate Professor Ketul Popat, Interim Director, Undergraduate Programs

The School of Biomedical Engineering (SBME) stands on a foundation of strong faculty and research programs from four CSU colleges: the Walter Scott, Jr. College of Engineering, and the Colleges of Health and Human Sciences, Natural Sciences, and Veterinary Medicine & Biomedical Sciences. The unique structure of the School involves over 70 faculty members representing 14 departments to provide an interdisciplinary focus on improving health, fighting disease, and aiding persons with disabilities. Academic excellence across diverse fields converges into three primary areas of research: (1) regenerative and rehabilitative medicine, (2) imaging and diagnostics, and (3) medical devices and therapeutics.

At the graduate level, SBME offers a Master of Science and a Doctor of Philosophy in Bioengineering, and a Master of Engineering (online and on campus) with a specialization in Biomedical Engineering. See the Graduate and Professional Bulletin (http://catalog.colostate.edu/general-catalog/graduate-bulletin/) for graduate program listings. The Walter Scott, Jr. College of Engineering offers a Bachelor of Science in Biomedical Engineering with a unique five-year program where graduates receive two B.S. degrees: one in Biomedical Engineering and the other in one of four traditional engineering areas - Chemical & Biological Engineering, Computer Engineering, Electrical Engineering, or Mechanical Engineering. An undergraduate Biomedical Engineering Interdisciplinary Minor (http://catalog.colostate.edu/general-catalog/university-wide-programs/interdisciplinary-studies/biomedical-engineering-interdisciplinary-minor/) is also offered.

Biomedical engineering lies at the interface of engineering, biology, and medicine. With over 40 state-of-the-art biomedical and engineering research labs, including the world-renowned Veterinary Teaching Hospital and Animal Cancer Center, we offer hands-on experience for undergraduate and graduate students to work alongside leading researchers. CSU provides a rich environment for interdisciplinary research and day-to-day collaborations and is positioned to offer unique bioengineering degree programs due to our faculty expertise, the interdisciplinary nature of the SBME, and the highly-ranked veterinary program. Our Biomedical Engineering programs integrate biological, chemical, physical, and mathematical sciences with engineering principles and clinical studies, and our graduates are well prepared for careers in research, education, veterinary or human medicine, and industry.

Biomedical engineers are involved in a wide variety of activities on a daily basis. Practical applications of biomedical engineering include development, design, production, research, and/or teaching in areas such as:

- Designing biomedical materials, medical devices, instrumentation and equipment (software/firmware/hardware) for therapeutics such as pacemakers, assistive devices, joint replacement materials, prosthetics, surgical tools.
- Developing or improving therapies for fighting cancer, tuberculosis, or other illnesses and diseases (e.g., nanoscaffolding for localized chemotherapy delivery, telemetric sensors to determine healing rates in bone fractures or to detect key chemicals in live tissue with high temporal and spatial resolution)
- Finding better ways to image and/or diagnose illnesses (e.g., using laser-based imaging to detect viruses, developing ways to increase electrical signals to detect threats to food safety and security, designing biosensors to diagnose cancer cells, developing software to determine toxic pesticide levels in people)

Potential Occupations

Biomedical engineering applies engineering principles to medicine and improving quality of life for humans and animals. Biomedical engineers work in a variety of settings. Some biomedical engineers spend their days in the lab, researching new devices and systems that solve medical and health care-related problems. Others might work in clinical settings, run biomedical-focused enterprises, design/manufacture new therapies or diagnostics, assist medical facilities with engineering equipment, processes and/or systems, or engage in regulatory affairs or patent law. Our graduates are well prepared for careers in research, education, or industry.

Undergraduate

Undergraduate Bachelor of Science Programs in Biomedical Engineering

The Bachelor of Science program in Biomedical Engineering has five pathways, each of which provide depth in a traditional area of engineering and breadth in biomedical engineering knowledge and applications. The coursework in these five pathways is designed to support biomedical engineering, and to satisfy the curricular requirements of one of five traditional engineering degrees as administered by partner engineering departments.

The five curricular pathways for the BME B.S. degree are:

- B.S. degree in Biomedical Engineering combined with a B.S. degree in Chemical and Biological Engineering
- B..S. degree in Biomedical Engineering combined with a B.S. degree in Computer Engineering
- B.S. degree in Biomedical Engineering combined with a B.S. degree in Electrical Engineering, Electrical Engineering Concentration

- B.S. degree in Biomedical Engineering combined with a B.S. degree in Electrical Engineering, Laser and Optical Concentration
- B.S. degree in Biomedical Engineering combined with a B.S. degree in Mechanical Engineering

Each BME pathway requires a minimum of 157-158 credit hours of coursework, depending on the selected pathway, nominally distributed over five years.

In the first two years, students take introductory biomedical engineering courses as well as foundational math, science, and engineering courses. The third year and fourth years solidify expertise in the traditional engineering major while building strength in biomedical engineering, life and physical sciences courses. The following years allow students to build a more thorough understanding of biomedical engineering, and their studies culminate in a Senior Design project in the fifth year that provides hands-on experience with an interdisciplinary team of peers. This combination of practical application and traditional academic rigor support the breadth and depth of this fairly unique program, and provides excellent preparation and market value for graduates' next steps in industry, academia, or research.

The Bachelor of Science in Biomedical Engineering at Colorado State University is accredited by the Accreditation Board for Engineering and Technology (ABET). It was first accredited in 2016, and this accreditation is retroactive for all prior graduates of the B.S. in biomedical engineering program. The partner majors include electrical engineering (EE), chemical and biological engineering (CBE), and mechanical engineering (MECH) and these three degree programs are accredited by the Engineering Accreditation Commission of ABET.

The educational objectives of the biomedical engineering program are to prepare our students to:

- Demonstrate high professional, social, and ethical standards while examining and addressing the global impact of technology to improve quality of life in society and environment
- Apply broad and deep knowledge, practical experiences, and creativity to solving problems at the interface of engineering and the life sciences as individuals and team members
- Use their multidisciplinary background to foster communication and collaboration across professional and disciplinary boundaries
- Recognize and expand the scope of their knowledge, continue self-directed learning, and identify and create professional opportunities for themselves and others

Successful graduates in Biomedical Engineering will have the ability to:

- Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- Communicate effectively with a range of audiences
- Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- Function effectively on a multidisciplinary team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- Acquire and apply new knowledge as needed, using appropriate learning strategies
- Apply principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations), and statistics;
- Solve bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
- Analyze, model, design, and realize bio/biomedical engineering devices, systems, components, or processes; and
- Make measurements on and interpret data from living systems

Click here for more information on ABET accreditation requirements. (https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/)

BME Bachelor of Science Programs

- Biomedical Engineering, B.S. combined with Chemical and Biological Engineering, B.S. (http://catalog.colostate.edu/general-catalog/colleges/engineering/biomedical/chemical-biological-dual-degree-program/)
- Biomedical Engineering, B.S. combined with Computer Engineering, B.S. (http://catalog.colostate.edu/general-catalog/colleges/engineering/biomedical/computer-dual-degree-program/)
- Biomedical Engineering, B.S. combined with Electrical Engineering, B.S., Electrical Engineering Concentration (http://catalog.colostate.edu/general-catalog/colleges/engineering/biomedical/electrical-dual-degree-program/)
- Biomedical Engineering, B.S. combined with Electrical Engineering, B.S., Lasers and Optical Engineering Concentration (http://catalog.colostate.edu/general-catalog/colleges/engineering/biomedical/electrical-lasers-optical-concentration-dual-degree-program/)
- Biomedical Engineering, B.S. combined with Mechanical Engineering, B.S. (http://catalog.colostate.edu/general-catalog/colleges/engineering/biomedical/mechanical-dual-degree-program/)

Undergraduate Certificate

- Certificate in Global Biomedical Engineering (http://catalog.colostate.edu/general-catalog/colleges/engineering/biomedical/global-biomedical-engineering-certificate/)

Graduate

Graduate Program in Biomedical Engineering

Students interested in graduate work should refer to the Graduate and Professional Bulletin (http://catalog.colostate.edu/general-catalog/graduate-bulletin/) or the (http://www.engr.colostate.edu/ce/degreeinfo.shtml/)School of Biomedical Engineering.

Certificate

- Biomaterials and Tissue Engineering (http://catalog.colostate.edu/general-catalog/colleges/engineering/biomedical/biomaterials-tissue-engineering-graduate-certificate/)

Master's Programs

- Master of Engineering, Plan C, Biomedical Engineering Specialization (http://catalog.colostate.edu/general-catalog/colleges/engineering/me-biomedical-engineering-specialization/)
- Master of Science in Bioengineering (http://catalog.colostate.edu/general-catalog/colleges/engineering/bioengineering-ms/)

Ph.D.

- Ph.D. in Bioengineering (http://catalog.colostate.edu/general-catalog/colleges/engineering/bioengineering-phd/#text)

Courses
Biomedical Engineering (BIOM)

BIOM 100 Overview of Biomedical Engineering Credit: 1 (1-0-0)
Course Description: Overview of the field of biomedical engineering with an emphasis on the roles of mechanical, electrical, and chemical/biological engineering principles.
Prerequisite: None.
Restriction: Must be a: Undergraduate.
Registration Information: Sections may be offered: Online. Credit allowed for only one of the following: BIOM 100, BIOM 101, BIOM 109, or BIOM 180A1.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 101 Introduction to Biomedical Engineering Credits: 3 (3-0-0)
Course Description: Basic principles, fundamentals in biomedical engineering including molecular, cellular and physiological principles, major areas such as biomechanics.
Prerequisite: None.
Registration Information: Credit allowed for only one of the following: BIOM 100, BIOM 101, BIOM 109, or BIOM 180A1. Credit not allowed for both BIOM 101 and BIOM 200.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 109 Principles of Biomedical Engineering Credit: 1 (1-0-0)
Course Description: Fundamental principles of biomedical engineering and commonalities with mechanical, electrical, and chemical/biological engineering. Emphasis on the application of engineering design in a biomedical context. Introduction to industrial and academic career paths.
Prerequisite: None.
Registration Information: Offered as an online course only. Only offered for high school students who are concurrently enrolled in the complementary in-person course at a participating high school. Credit allowed for only one of the following: BIOM 100, BIOM 101, BIOM 109, or BIOM 180A1.
Terms Offered: Fall, Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 200 Fundamentals of Biomedical Engineering Credits: 2 (2-0-0)
Course Description: Application of engineering analysis to physiology and biomedical engineering topics.
Prerequisite: BIOM 100, may be taken concurrently and LIFE 102 and MATH 160.
Restriction: Must be a: Undergraduate.
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 101 and BIOM 200.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 300 Problem-Based Learning Biomedical Engr Lab Credits: 4 (1-4-1)
Course Description: Group problem-based learning approach to problems spanning all core areas of biomedical engineering.
Prerequisite: (BIOM 101 or BIOM 200 or BIOM 100 and CBE 205 and MECH 262) and (MATH 340 or MATH 345).
Registration Information: Junior standing. Must register for lecture, lab, and recitation.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: Yes.

BIOM 304 Global Challenges and Collaborations in BME Credits: 3 (3-0-0)
Course Description: Foundational elements of cross-cultural competence in the biomedical engineering field, considering social, political, and economic differences in areas such as medical device design, regulation, technology transfer, and ethics.
Prerequisite: BIOM 100 or BIOM 101.
Restrictions: Must not be a: Freshman. Must be a: Undergraduate.
Registration Information: Sophomore standing. Offered as Mixed Face-to-Face. Credit not allowed for both BIOM 304 and BIOM 380A2.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 306 Bioprocess Engineering Credits: 4 (3-2-0)
Also Offered As: BTEC 306.
Course Description: Material, energy balances; fluid flow, heat exchange, mass transfer; application to operations in food, fermentation, other bioprocess industries.
Prerequisite: (CHEM 107 or CHEM 111) and (PH 121 or PH 141).
Registration Information: Must register for lecture and laboratory. Credit not allowed for both BIOM 306 and BTEC 306.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 350A Study Abroad--Ecuador: Prosthetics Credits: Var[1-2] (0-0-0)
Course Description: Design and fabricate prosthetics for under-served populations in Ecuador. Course experience will occur in Quito, Ecuador in partnership with Range of Motion Project (ROMP), a non-profit healthcare organization.
Prerequisite: None.
Registration Information: Credit not allowed for both BIOM 350A and BIOM 382A.
Term Offered: Summer.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 350B Study Abroad--Portugal: Biomedical Engineering and Healthcare Credit: 1 (0-0-1)
Course Description: Intercultural exchange in Portugal, with a focus on becoming familiar with pharmaceutical production, regulatory affairs and quality control, product development, and practices in biotechnology and biomedical engineering. Visits to historic and cultural sites and pharmaceutical, biomedical, biotechnology, and healthcare facilities.
Prerequisite: None.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 403 Intro to Optical Techniques in Biomedical Eng Credits: 3 (3-0-0)
Also Offered As: ECE 403.
Course Description: Engineering design principles of optical characterization techniques for biomedical systems, including optical spectroscopy and microscopy of biomolecules and tissues.
Prerequisite: CHEM 111 and PH 142 with a minimum grade of C.
Restriction: Must not be a: Freshman, Sophomore.
Registration Information: Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 403, BIOM 481A3, ECE 403, or ECE 481A3.
Term Offered: Spring (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 421 Transport Phenomena in Biomedical Engineering Credits: 3 (3-0-0)
Course Description: Engineering models of active and passive mechanisms of momentum. Heat and mass transport in mammalian cells, tissues, and organ systems.
Prerequisite: (BMS 300) and (CBE 332 or MECH 344).
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 330 and BIOM 421.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 422 Quantitative Systems and Synthetic Biology Credits: 3 (3-0-0)
Course Description: In-depth analysis of the quantitative systems approach to biology and biological engineering at the molecular and cellular scales.
Prerequisite: BIOM 421 or CBE 320.
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 400 and BIOM 422.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 431 Biomedical Signal and Image Processing Credits: 3 (3-0-0)
Also Offered As: ECE 431.
Course Description: Principles, features and mathematical processing of biomedical signals and images including interference and noise filtering and feature enhancement.
Prerequisite: (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C) and (ECE 311 with a minimum grade of C and PH 142 with a minimum grade of C).
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 431 and ECE 431.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 441 Biomechanics and Biomaterials Credits: 3 (3-0-0)
Course Description: Principles of biomechanics, biofluids, and biomaterials.
Prerequisite: (BMS 300, may be taken concurrently and CIVE 360 and MECH 324, may be taken concurrently) and (MECH 331, may be taken concurrently or MECH 331B, may be taken concurrently and MECH 331A, may be taken concurrently) and (MECH 342).
Registration Information: Sections may be offered: Online.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 470 Biomedical Engineering Credits: 3 (3-0-0)
Also Offered As: MECH 470.
Course Description: Engineering application in human/animal physiology, diagnosis of disease, treatment, rehabilitation, human genome manipulation.
Prerequisite: (PH 141) and (MATH 155 or MATH 160).
Registration Information: Credit not allowed for both BIOM 470 and MECH 470.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 476 Biomedical Engineering Clinical Practicum Credits: Var[1-3] (0-0-0)
Course Description: Biomedical lab work or research project in hospital, clinical, or other medical environment.
Prerequisite: BMS 300.
Restrictions: Must not be a: Freshman, Sophomore. Must be a: Undergraduate.
Registration Information: Written consent of department chair. Written consent of instructor.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 486A Biomedical Design Practicum: Capstone Design I Credits: 4 (0-0-10)
Course Description:
Prerequisite: (BIOM 300) and (BIOM 421 and CBE 320 and CBE 442 or ECE 342 and BIOM 431 and ECE 311 and ECE 332 or MECH 301B, may be taken concurrently and MECH 307 and BIOM 441 and MECH 301A or BIOM 441 and MECH 301 and MECH 307).
Restrictions: Must not be a: Freshman, Sophomore, Junior. Must be a: Undergraduate.
Registration Information: Senior standing. Enrollment in biomedical engineering major.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 486B Biomedical Design Practicum: Capstone Design II Credits: 4 (0-0-10)
Course Description:
Prerequisite: (BIOM 486A) and (CBE 451 or ECE 312 or MECH 325 and MECH 344 or PH 353).
Restrictions: Must not be a: Freshman, Sophomore, Junior. Must be a: Undergraduate.
Registration Information: Senior standing. Enrollment in biomedical engineering major.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 495 Independent Study Credits: Var[1-6] (0-0-0)
Course Description:
Prerequisite: None.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 504 Fundamentals of Biochemical Engineering Credits: 3 (3-0-0)
Also Offered As: CBE 504.
Course Description: Application of chemical engineering principles to enzyme kinetics, fermentation and cell culture, product purification, and bioprocess design.
Prerequisite: CBE 205.
Registration Information: Senior standing. Sections may be offered: Online. Credit not allowed for both BIOM 504 and CBE 504.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 517 Advanced Optical Imaging Credits: 3 (3-0-0)
Also Offered As: ECE 517.
Course Description: Engineering design principles of advanced optical imaging techniques and image formation theory.
Prerequisite: ECE 342 with a minimum grade of C or MATH 340 with a minimum grade of C or MATH 345 with a minimum grade of C.
Restriction: Must not be a: Freshman, Sophomore.
Registration Information: Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 517, BIOM 581B7, ECE 517 or ECE 581B7.
Term Offered: Fall (even years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 518 Biophotonics Credits: 3 (3-0-0)
Also Offered As: ECE 518.
Course Description: Engineering design principles of optical instrumentation for medical diagnostics. Light propagation and imaging in biological tissues.
Prerequisite: ECE 342 with a minimum grade of C or ECE 457 with a minimum grade of C or MATH 340 with a minimum grade of C or MATH 345 with a minimum grade of C.
Restriction: Must not be a: Freshman, Sophomore.
Registration Information: Junior standing. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 518, BIOM 581A9, ECE 518 or ECE 581A9.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 522 Bioseparation Processes Credits: 3 (3-0-0)
Also Offered As: CBE 522.
Course Description: Analysis of processes to recover and purify fermentation products.
Prerequisite: CBE 331.
Registration Information: Sections may be offered: Online. Credit allowed for only one of the following: BIOM 522, CBE 522, or CBE 581A2.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 525 Cell and Tissue Engineering Credits: 3 (3-0-0)
Also Offered As: MECH 525.
Course Description: Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design.
Prerequisite: BC 351 or BMS 300 or BMS 500 or BZ 310 or NB 501.
Registration Information: Credit allowed for only one of the following: BIOM 525, CBE 525, MECH 525. Sections may be offered: Online.
Term Offered: Spring. (even years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 526 Biological Physics Credits: 3 (3-0-0)
Also Offered As: ECE 526.
Course Description: Mathematical and physical modeling of biological systems. Mass transport in cellular environments. Electrical/mechanical properties of biomolecules.
Prerequisite: (MATH 340 or MATH 345) and (PH 122 or PH 142).
Restriction: Must not be a: Freshman, Sophomore.
Registration Information: Credit not allowed for both BIOM 526 and ECE 526. Sections may be offered: Online.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 527A Biosensing: Cells as Circuits Credit: 1 (1-0-0)
Also Offered As: ECE 527A.
Course Description: Treatment of biological cells as circuits and their electrical time-dependent function and frequency-dependent impedance. Topics include the Hodgkin–Huxley circuit model, diffusion equation, and modeling action potential propagation.
Prerequisite: (BIOM 101 or LIFE 102) and (CHEM 111) and (MATH 340 or MATH 345) and (PH 142).
Registration Information: Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527A, BIOM 581B1, ECE 527A, or ECE 581B1.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 527B Biosensing: Signal and Noise in Biosensors Credit: 1 (1-0-0)
Also Offered As: ECE 527B.
Course Description: Quantitative treatment of concepts of noise, interference and signal including noise types and spectra, filtering, and limitations imposed by noise. Example applications to Biosensors.
Prerequisite: (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).
Registration Information: Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527B, BIOM 581B2, ECE 527B, or ECE 581B2.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 527C Biosensing: Sensor Circuit Fundamentals Credit: 1 (1-0-0)
Also Offered As: ECE 527C.
Course Description: Introduction to circuit concepts used in sensors, including review of basic circuit elements of resistors, capacitors, and MOS (Metal-Oxide-Semiconductor transistors) elements. Fundamentals of the application of MOS circuits for signal conditioning and amplification and how sensor's backend signal processing is carried out after the sensor signal transduction stage.
Prerequisite: (BIOM 101 or LIFE 102) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).
Registration Information: Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527C, BIOM 581B3, ECE 527C, or ECE 581B3.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 527D Biosensing: Electrochemical Sensors Credit: 1 (1-0-0)
Also Offered As: ECE 527D.
Course Description: Introduction to the electrochemistry, and applications of electrochemical methods, used for detection of certain classes of chemicals and molecules.
Prerequisite: (BIOM 101 or LIFE 102) and (CHEM 111) and (MATH 255 or MATH 261) and (PH 142).
Registration Information: Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527D, BIOM 581B5, ECE 527D, or ECE 581B5.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 527E Biosensing: Affinity Sensors Credit: 1 (1-0-0)
Also Offered As: ECE 527E.
Course Description: Fundamentals of affinity sensor application and design, including optical and electrical approaches and technologies.
Prerequisite: (BIOM 101 or LIFE 102) and (CHEM 111) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).
Registration Information: Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527E, BIOM 581B4, ECE 527E, or ECE 581B4.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 527F Biosensing: Biophotonic Sensors Using Refractive Index Credit: 1 (1-0-0)
Also Offered As: ECE 527F.
Course Description: Operating principles of optical biosensors based on changes in refractive index, such as thin films, ring-resonators, Mach-Zehnder interferometers, and other evanescent wave sensors. Basic supporting optical concepts, including thin-film interference, optical waveguides and evanescent waves.
Prerequisite: (BIOM 527F or ECE 527F) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).
Registration Information: Junior standing. This is a partial semester course. Credit allowed for only one of the following: BIOM 527F, BIOM 581B6, ECE 527F, or ECE 581B6.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 531 Materials Engineering Credits: 3 (3-0-0)
Also Offered As: MECH 531.
Course Description: Selection of structural engineering materials by properties, processing, and economics; materials for biomedical and biotechnology applications.
Prerequisite: MECH 331 or MECH 331A and MECH 331B or MECH 431.
Registration Information: Credit not allowed for both BIOM 531 and MECH 531. Sections may be offered: Online.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 532 Materials Issues in Mechanical Design Credits: 3 (3-0-0)
Also Offered As: MECH 532.
Course Description: Failure mechanisms from materials viewpoint with emphasis on use in design. Fracture, creep, fatigue, and corrosion.
Prerequisite: MECH 331 or MECH 331A and MECH 331B.
Registration Information: Credit not allowed for both BIOM 532 and MECH 532. Sections may be offered: Online.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 533 Biomolecular Tools for Engineers Credits: 3 (2-3-0)
Also Offered As: CIVE 533.
Course Description: Theoretical and practical aspects of biomolecular laboratory tools--PCR, cloning, sequencing, single-molecule optical techniques and live-cell imaging.
Prerequisite: BMS 300 or MIP 300.
Registration Information: Must register for lecture and laboratory. Credit not allowed for BIOM 533, CIVE 533 and ECE 533.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: Yes.

BIOM 537 Biomedical Signal Processing Credits: 3 (3-0-0)
Also Offered As: ECE 537.
Course Description: Modeling and classification of biosignals (e.g. EEG, ECG, EMG), covering adaptive filtering, wavelets, support vector machines, neural networks, and handling problems with overfitting of noisy data.
Prerequisite: ECE 303 or ECE 311 or MATH 340 or STAT 303.
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 537 and ECE 537.
Term Offered: Spring (even years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 570 Bioengineering Credits: 3 (3-0-0)
Also Offered As: MECH 570.
Course Description: Physiological and medical systems analysis using engineering methods including mechanics, fluid dynamics, control electronics, and signal processing.
Prerequisite: CBE 332 or ECE 311 or MECH 331A.
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 570 and MECH 570.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 573 Structure and Function of Biomaterials Credits: 3 (3-0-0)
Also Offered As: MECH 573.
Course Description: Structure-function relationships of natural biomaterials; application to analysis of biomimetic materials and biomaterials used in medical devices.
Prerequisite: MECH 331 or MECH 331A and MECH 331B.
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 573 and MECH 573.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 574 Bio-Inspired Surfaces Credits: 3 (3-0-0)
Also Offered As: MECH 574.
Course Description: Analysis of surface functionalities of various biological species; identification of design principles.
Prerequisite: MECH 342 and CHEM 111.
Registration Information: Sections may be offered: Online. Credit not allowed for both BIOM 574 and MECH 574.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 576 Quantitative Systems Physiology Credits: 4 (4-0-0)
Also Offered As: MECH 576.
Course Description: Quantitative, model-oriented approach to cellular and systems physiology with design examples from biomedical engineering.
Prerequisite: BMS 300 and CHEM 113 and MATH 340 and PH 142.
Registration Information: Credit not allowed for both BIOM 576 and MECH 576. Sections may be offered: Online.
Term Offered: Spring.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 578 Musculoskeletal Biosolid Mechanics Credits: 3 (3-0-0)
Also Offered As: MECH 578.
Course Description: Application of engineering concepts to quantify the mechanical behavior of load-bearing biological tissues and orthopaedic implant performance.
Prerequisite: CIVE 360.
Restriction: Must be a: Graduate.
Registration Information: Graduate standing. Sections may be offered: Online. Credit not allowed for both BIOM 578 and MECH 578.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 579 Cardiovascular Biomechanics Credits: 3 (3-0-0)
Also Offered As: MECH 579.
Course Description: Bio-mechanical principles and approaches applied in cardiovascular research.
Prerequisite: MATH 340 and PH 142.
Restriction: Must be a: Graduate.
Registration Information: Graduate students only. Sections may be offered: Online. Credit allowed for only one of the following: BIOM 579, BIOM 581A8, MECH 579, or MECH 581A8.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 586A Biomedical Clinical Practicum Credits: 2 (1-2-0)
Course Description: Graduate-level activity that includes biomedical research or design of a new medical device, as well as essential elements of professional development.
Prerequisite: (BMS 300 or BMS 500) and (BIOM 570 or MECH 570).
Registration Information: Must register for lecture and laboratory.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 586B Biomedical Clinical Practicum Credits: 4 (1-6-0)
Course Description: Graduate-level activity, such as biomedical research or design of a new medical device, for exposure to the hospital/clinical environment.
Prerequisite: (BMS 300 or BMS 500) and (BIOM 570 or MECH 570).
Registration Information: Must register for lecture and laboratory.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 592 Seminar Credits: Var[1-3] (0-0-0)
Course Description: Student and research faculty presentations, guest and invited extramural speakers.
Prerequisite: None.
Registration Information: Sections may be offered: Online.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 671 Orthopedic Tissue Biomechanics Credits: 3 (3-0-0)
Also Offered As: MECH 671.
Course Description: Linear elastic, finite deformation, and viscoelastic theories applied to the mechanical behavior of orthopedic tissues (bone, tendon, cartilage).
Prerequisite: CIVE 560.
Restriction: Must be a: Graduate, Professional.
Registration Information: Credit not allowed for both BIOM 671 and MECH 671.
Term Offered: Fall (odd years).
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 684 Supervised College Teaching Credits: Var[1-18] (0-0-0)
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Registration Information: Maximum of 6 credits allowed in course; may not be used to satisfy degree requirements requiring bioengineering courses.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 695 Independent Study Credits: Var[1-18] (0-0-0)
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 699 Thesis Credits: Var[1-18] (0-0-0)
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 750 Grant Proposal Writing and Reviewing Credit: 1 (1-0-0)
Course Description: Preparation and review of applications for fellowships and grants.
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Registration Information: Written consent of instructor.
Term Offered: Fall.
Grade Mode: Traditional.
Special Course Fee: No.

BIOM 784 Supervised College Teaching Credits: Var[1-6] (0-0-0)
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 786 Practicum-Laboratory Rotations Credits: Var[1-18] (0-0-0)
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 795 Independent Study Credits: Var[1-6] (0-0-0)
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall. Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 798 Research-Laboratory Rotations Credits: Var[1-6] (0-0-0)
Course Description: Doctoral laboratory rotation.
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.

BIOM 799 Dissertation Credits: Var[1-18] (0-0-0)
Course Description:
Prerequisite: None.
Restriction: Must be a: Graduate, Professional.
Terms Offered: Fall, Spring, Summer.
Grade Mode: Instructor Option.
Special Course Fee: No.