SCHOOL OF BIOMEDICAL ENGINEERING
COLORADO STATE UNIVERSITY

Master of Engineering-Specialization in Biomedical Engineering Curriculum Requirements & Course Information

Curriculum Requirements:

The following lists the specific requirements for the Master of Engineering degree. (Students must be able to answer yes to the following statements to earn your ME at CSU.):

- □ Minimum of 30 equivalent semester credits including 7 credits of Core courses, 12 credits of Foundation courses, at least 8 credits in the Depth area, and 3 credits in a Breadth area. Seminar, thesis, and independent study credits will not apply.
- □ Minimum of 24 semester credits earned at CSU (21 while in the graduate program).
- □ Minimum of 24 credits at the Graduate level- courses numbered 500 or above.
- □ Minimum of 15 credits of biomedical engineering (BIOM) courses. Additional courses may need to be taken as a Supplemental Requirement to satisfy provisional admission requirements, course prerequisites, or supplemetal coursework stipulations.
- □ Program of study must be approved by an advisor prior to completing 15 credits toward the degree.

The degree awarded upon completion will be a Masters of Engineering in Engineering. Transcripts will indicate the specialty in Biomedical Engineering.

Core Courses

The following courses represent the core course requirements for the proposed graduate program. All ME students are required to complete the core course requirements.

Course Number	Title	Credits	Prerequisite(s)	Semesters Taught	Catalog Description
BIOM/MECH 570	Bioengineering	3	MECH 307 and MECH 324	F	Introduction to the various fields within bioengineering, includesresearch lectures from expert guest lecturers and significant engineering content.
BMS 500* **-OR-**	Mammalian Physiology I	4	BMS 300 or BMS 360	F	Membrane function and electrical activity of cells, neurophysiology, blood and immune, muscle physiology, and cellular endocrinology.
BIOM/MECH 576*	Quantitative Systems Physiology	4	BMS 300 and CHEM 113 and MATH 340 and PH 142.	S	Quantitative, model-oriented approach to cellular and systems physiology with design examples from biomedical engineering.

*Students must either take BMS 500 or BIOM 576

Foundation Courses

A requirement of 12 credits designed to develop a foundation in biomedical engineering which is any 500-level or above regular BIOM coursework.

Course Number	Title	Credits	Prerequisite(s)	Semesters Taught	Catalog Description
BIOM/ECE 526	Biological Physics	3	(Math 340 or MATH 345) and (PH 122 or PH 142)	F	Mathematical and physical modeling of biological systems. Mass transport in cellular environments. Electrical/mechanical properties of biomolecules.
BIOM/MECH 525	Cell and Tissue Engineering	3	BC 351 or BMS 300 or BMS 500 or BZ 310 or NB 501	S, E	Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design.
BIOM/MECH 531	Materials Engineering	3	MECH 331 or MECH 431	S, O	Structural engineering materials and their selection on basis of property, processing, and economic considerations, application of engineering materials for biomedical and biotechnology applications.
BIOM/MECH 532	Materials Issues in Mechanical Design	3	MECH 331	F	Failure mechanisms from materials viewpoint with emphasis on use in design. Fracture, creep, fatigue and corrosion.
BIOM/CIVE 533	Biomolecular Tools for Engineers & Lab	3	BMS 300 or MIP 300	F	Basic qualitative and quantitative biomolecular analyses of microbial communities, including PCR, cloning, FISH, and microbial community profiling. The application of biomolecular tools to engineered systems will be a major theme.
BIOM/MECH 573	Structure and Function of Biomaterials	3	MECH 331	S	Structure-function relationships of natural biomaterials; application to analysis of biomimetic materials and biomaterials used in medical devices.
BIOM/MECH 574	Bio-Inspired Surfaces	3	CHEM 111 and MECH 342	S	Analysis of surface functionalities of various biological species; identification of design principles.

Depth Courses

Each student will select a depth area and take courses totaling at least 8 credits. The courses that are typically selected are listed for each interest area, however courses may be selected from more than one interest area.

Course Number	Title	Credits	Prerequisite(s)	Semesters	Catalog Description
ANEQ 565	Interpreting Animal Science Research	3	ANEQ 101 or ANEQ 102; 3 credits of statistics	S	Designing, conducting, analyzing, and reporting of animal science research.
BC 565	Molecular Regulation of Cell Function	4	LIFE 210 and (BC 403 or BC 351 - may be taken concurrently)	S	Molecular regulations of cell organization, membrane formation, organelle biogenesis, cell communication, shape and motility, growth, aging, and death.
BIOM/ECE 517	Advanced Optical Imaging	3	ECE 342 or MATH 340 or MATH 345	F, E	Engineering design principles of advanced optical imaging techniques and image formation theory.

BIOM/ECE 518	Biophotonics	3	ECE 342 or ECE457 or MATH 340 or MATH 345	F, O	Engineering design principles of optical instrumentation for medical diagnostics. Light propagation and imaging in biological tissues.
BIOM/ECE 527A	Cells as Circuits	1	BIOM 101 or LIFE 102; CHEM 111; PH 142; MATH 255 or MATH 261; MATH 340 or MATH 345, may be taken concurrently.\	F	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 definitions of biosensor performance metrics.
BIOM/MECH 532	Materials Issues in Mechanical Design	3	MECH 331	F	Failure mechanisms from materials viewpoint with emphasis on use in design. Fracture, creep, fatigue and corrosion.
BIOM/ECE 537	Biomedical Signal Processing	3	MATH 340 or ECE 311 or STAT 303	S	Measuring, manipulating, and interpreting biomedical signals.
BIOM/MECH 578	Musculoskeletal Biosolid Mechanics	3	CIVE 360	F	Application of engineering concepts to quantify the mechanical behavior of load-bearing biological tissues and orthopaedic implant performance.
BIOM/MECH 579	Cardiovascular Biomechanics	3	MATH 340; PH 142	F	Bio-mechanical principles and approaches applied in cardiovascular research.
BMS 501	Mammalian Physiology II	4	BMS 300 or BMS 360	S	Cardiovascular, respiratory, renal, digestive, endocrine, metabolic, reproductive function.
BMS/NB 505	Functional Neurobiology	3	BMS 325 or NB 501 or	S	Anatomical and physiological organization of the nervous system.
BMS 575	Human Anatomy Dissection	4		F	Human cadaver dissection.
BMS 631	Mechanisms of Hormone Action	2	BMS 430 or BMS 501	S, O	Synthesis, secretion, and mechanisms of action of hormones.
CBE 502	Advanced Reactor Design	3	CBE 320; CBE 322	F	Nonideal flow and tracers, reactions and diffusion, evaluation of complex kinetics, stability of reactors. Biochemical reactor examples.
CBE 503	Transport Phenomena Fundamentals	3	CBE 406	S	General topics in transport phenomena; analytical and numerical solutions of laminar flows; perturbation techniques; coupled transport.
CBE 570	Biomolecular Engineering/ Synthetic Engineering	3	BCE 351; CHEM 341 or 345	S	Rational design and evolutionary methods for engineering functional protein and nucleic acid systems.
CS 514	Software Product and Process Evaluation	4	CS 414	F, O	Software development process modeling and evaluation; software metrics, testing, verification, validation; experimental methods in software engineering.
CS 517	Software Specification and Design	4	CS 414	S, O	Rigorous techniques for modeling, specifying, and analyzing software requirements and designs; reusable software development.

ECE 512	Digital Signal Processing	3	ECE 312 with a minimum grade of C-	F, online	Linear and nonlinear optimization theory and methods; applications in systems, control, and communication.
ECE 513	Digital Image Processing	3	ECE 303/STAT 303 with a grade of C or better and ECE 312	S	Image acquisition and display systems, image enhancement, restoration and encoding, image analysis; real-life applications.
MECH 502	Advanced/Additive Manufacturing Engineering	3	MECH 202, MECH 331	S	Materials, controls, and mechanics applied to additive manufacturing; rapid prototyping; direct digital manufacturing.
MECH 530	Advanced Composite Materials	3	CIVE 360 and MECH 337	F	Materials aspects of advanced composite constituents and how their combination yields synergistic results.
MECH 543	Biofluid Mechanics	3	BIOM 421 or CBE 331 or CIVE 300 or MECH 342; (BMS 300 and PH 121) or (BMS 300 and PH 141) or BMS 420	S	Fluid dynamic concepts for understanding fluid motion in living organs/organisms; advanced research applications.
MIP 651	Immunobiology	3	MIP 342	F, E	Structure, function, regulation of immunoglobulins and the immune system. Cellular immunity including transplantation and cancer.

Breadth Courses

Each student will select at least 3 credits in advanced or applied mathematics normally selected from, but not limited to:

Course Number	Title	Credits	Prerequisite(s)	Semesters	Catalog Description
1 MATH CLASS	MATH 530, 532, 535, 545, or 560	3	See course catalog to view prerequisites.	F, S	See course catalog for detailed descriptions.
ECE 514	Applications of Random Processes	3	(ECE 303 or STAT 303) and ECE 312 - with a min. grade of C- for all classes.	F	Bit-error rates, signal-to-noise power ration, signal detection, signal estimation, Wiener filter, application.
2 Modules^	STAA 551, 552, 553, 554, 561, 562, 572, 573, 574, 575, or STAA 576	2 per module	**	STAA 551-572: F STAA 573: S	See course catalog for detailed descriptions.
STAT 512	Design and Data Analysis for Researchers II	4	STAT 511A or 511B	S	Statistical methods for experimenters and researchers emphasizing design and analysis of experiments.

** STAA 552: STAA 551 or written consent of instructor
STAA 562: STAA 561 or written consent of instructor.
STAA 572: STAA 551; STAA 561 or written consent of instructor.
STAA 573: STAA 551; STAA 561 or written consent of instructor

^ Strongly Encouraged

F=Fall **S=** Spring **SS=** Summer **E=** Even Years