REQUIREMENTS FOR THE BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING/MASTER OF SCIENCE

GALLOGLY COLLEGE OF ENGINEERING

THE UNIVERSITY OF OKLAHOMA

For Students Entering the Oklahoma State System for Higher Education
Summer 2018 through Spring 2019

GENERAL REQUIREMENTS

Total Credit Hours **150**
Minimum Retention/Graduation Grade Point Averages:
Overall - Combined and OU **3.25**
Major - Combined and OU **3.25**
Curriculum - Combined and OU **3.25**
A minimum grade of C is required for each course in the curriculum.

Bachelor of Science in Biomedical Engineering **A108**/Master of Science (Biomedical Engineering)
F109 Q062

OU encourages students to complete at least 32 hours of applicable coursework each year to have the opportunity to graduate in four years.

Year	FIRST SEMESTER	Hours	SECOND SEMESTER	Hours
FRESHMAN	**ENGL 1113**, Prin. of English Composition (Core I)	3	**ENGL 1213**, Prin. of English Composition (Core I), **or**	3
	***CHEM 1315**, General Chemistry (Core II)	5	**EXPO 1213**, Expository Writing (Core I)	
	❖***MATH 1914**, Differential and Integral Calculus I (Core I)	4	***CHEM 1415**, General Chemistry	5
	HIST 1483, U.S., 1492-1865, **or**	3	❖***MATH 2924**, Differential and Integral Calculus II	4
	1493, U.S., 1865-Present (Core IV)		***PHYS 2514**, General Physics for Engineering & Science	4
	ENGR 1411, Freshman Engineering Experience	1	Majors (Core II)	
	TOTAL CREDIT HOURS	**16**	**TOTAL CREDIT HOURS**	**16**
SOPHOMORE	**MATH 2934**, Differential and Integral Calculus III	4	**MATH 3113**, Introduction to Ordinary Differential Equations	3
	PHYS 2524, General Physics for Engineering & Science Majors	4	**C S 1213,** Python Language	3
	BIOL 1124, Molecules/Cells/Physiology (Core II)	4	**CHEM 3053**, Organic Chemistry I: Biological Emphasis	3
	ENGR 2431, Electrical Circuits	1	**CHEM 3152**, Organic Chemistry Lab: Biological Emphasis	2
	ENGR 2002, Engineering Professional Development	2	**BME 2433**, Signals and Systems for Biomedical Engineering	3
	BME 2333, Biomedical Engineering Fundamentals	3	**ISE 3293,** Applied Statistical Methods	3
	TOTAL CREDIT HOURS	**18**	**TOTAL CREDIT HOURS**	**17**
JUNIOR	•**BME Core Area Course** 1 (Approved Area Core Course)	3	•**BME Core Area Course** 3 (Approved Area Core Course)	3
	§**BME Core Area Lab** 1 (Corresponding Area Core Lab)	1	§**BME Core Area Lab** 3 (Corresponding Area Core Lab)	1
	•**BME Core Area Course** 2 (Approved Area Core Course)	3	•**BME Core Area Course** 4 (Approved Area Core Course)	3
	§**BME Core Area Lab** 2 (Corresponding Area Core Lab)	1	**BME 4813,** Quantitative Physiology	3
	BME 3722, Numerical Methods in Biomedical Engineering	2	**BME 3533**, Biomedical Instrumentation	3
	COMM 2613, Public Speaking (Core I-Other)	3	†Approved Elective, **Social Science (Core III)**	3
	Upper-Division Biology Elective (per BME faculty)	3	**P SC 1113, American Federal Government (Core III)**	3
	TOTAL CREDIT HOURS	**16**	**TOTAL CREDIT HOURS**	**19**
SENIOR	**BME 4713**, Biomedical Engineering Design I	3	**BME 4823**, Biomedical Engineering Design II (Capstone)	3
	BME 3233, Biomaterials	3	Graduate-level Biomedical Engineering Elective (per a list maintained by the department)	3
	BME 5203, Biomedical Eng. Principles (offered alternate fall) **or,** Graduate-level Science, Math, Eng. Elective (per advisor)	3	Graduate-level Science, Math, Eng. Elective (per advisor)	3
	Graduate-level Biomedical Engineering Elective (per a list maintained by the department)	3	†Approved Elective: **Western Civ. & Culture (Core IV)**	3
	†Approved Elective: **Artistic Forms (Core IV)**	3	†Approved Elective: **Non-Western Culture (Core IV)**	3
	TOTAL CREDIT HOURS	**15**	**TOTAL CREDIT HOURS**	**15**
FIFTH YEAR	Graduate-level Life Science Elective (per a list maintained by the department)	3	Graduate-level Life Science Elective (per a list maintained by the department)	3
	Graduate-level Biomedical Engineering Elective (per a list maintained by the department)	3	Graduate-level Elective in Engineering, Science, or Math	3
	BME 5980, Research for Master's Thesis	2	**BME 5980**, Research for Master's Thesis	4
	TOTAL CREDIT HOURS	**8**	**TOTAL CREDIT HOURS**	**10**

NOTE: Engineering transfer students may take ENGR 3511 in place of ENGR 1411. CHEM 1315 and CHEM 1415 can be substituted with CHEM 1335 (Fall only) and 1435 (Spring only), respectively.

Courses designated as Core I, II, III, IV or Capstone are part of the General Education curriculum. Students must complete a minimum of 40 hours of General Education courses, chosen from the approved list.

* The prerequisite courses for BME 2333 require a minimum grade of B.

The College of Engineering requires a minimum grade of C for each course in the curriculum. Students must successfully complete prerequisite courses (with a minimum C grade) before proceeding to the next course. Please refer to the General Catalog, College of Engineering, Undergraduate Study section for additional enrollment limitations.

†To be chosen from the **University-Wide General Education Approved Course List**. Three of these 12 hours must be upper-division (3000-4000). One of these courses should be an English course 2000-level or above. See list in the Class Schedule.

Note: Two college-level courses in a single foreign language are required; this may be satisfied by successful completion of 2 years in a single foreign language in high school. Students who must take foreign language at the University will have an additional 6-10 hours of coursework.

•**BME Area Core Courses: BME 3113,** Bioimaging**; BME 3123,** Biotransport**; BME 3133,** Bioelectricity**; BME 3143,** Biomechanics**; BME 3153,** Molecular, Cellular and Tissue Engineering**; BME 3163,** Biomedical Micro-Nano-Technology.

§**Corresponding BME Area Core Labs: BME 3111,** Bioimaging Lab**; BME 3121,** Biotransport Lab**; BME 3131,** Bioelectricity Lab**; BME 3141,** Biomechanics Lab**; BME 3151,** Molecular, Cellular and Tissue Engineering Lab**; BME 3161,** Biomedical Micro-Nano-Technology Lab**.**

❖MATH 1823, 2423, 2433, and 2443 sequence can be substituted for MATH 1914, 2924, and 2934.

COURSES IN CHEMISTRY AND BIOCHEMISTRY (CHEM)

1315 General Chemistry. Prerequisite: Mathematics 1503 or 1643, or math ACT equal to or greater than 23. General Chemistry is an overview of the chemical basis of natural phenomena. First of a two-semester sequence in general chemistry. Topics covered: basic measurement, atomic theory, electron configuration, periodicity, chemical reactivity and energetics, stoichiometry, gas laws and changes in state, bonding and molecular structure. A student may not receive credit for this course and CHEM 1335. **Laboratory.** (F, Sp, Su) [II-LAB]

1415 General Chemistry (Continued). Prerequisite: CHEM 1315 with a minimum grade of C or CHEM 1335 with a minimum grade of C or a satisfactory score on the chemistry placement examination. Topics covered include thermochemistry, equilibrium, thermodynamics, acid and base properties, kinetics and electrochemistry. A student may not receive credit for this course and CHEM 1435. **Laboratory.** (F, Sp, Su) [II-LAB]

3053 Organic Chemistry I: Biological Emphasis. Prerequisite: CHEM 1415 or CHEM 1425. Intended for life science majors. First course in a two-semester sequence (3053 and 3153). This course will cover the concepts of organic structure, nomenclature, and reactivity with an emphasis on biological applications. (F, Sp, Su)

3152 Organic Chemistry Laboratory: Biological Emphasis. Prerequisite: CHEM 3053 or concurrent enrollment. Intended for life science majors. Laboratory course designed to accompany CHEM 3053 and CHEM 3153. Selected experiments designed to illustrate the fundamental techniques used in organic chemistry, to develop familiarity with the properties of organic compounds and to introduce analytical techniques including spectroscopy. (F, Sp, Su)

COURSES IN BIOLOGY (BIOL)

1124 Introductory Zoology. Content is focused toward life science majors. Major principles and concepts are presented in the function and physiology of animals, plants, fungi and microbes. Emphasis is on biological chemistry, cell structure and function, cellular energetics, molecular genetics, homeostasis and physiology. Includes biological laboratory experience with emphasis on critical thinking and problem solving, and topics include biochemistry, molecular genetics, cell processes and physiology. Laboratory. (F) [II-LAB]

COURSES IN ENGINEERING (ENGR)

1411 Freshman Engineering Experience. Prerequisite: declared major in Engineering or permission of instructor. Required of all entering freshmen with a declared Engineering major. Lecture hours cover a variety of topics including: majors and minors; career planning; advising; and extra-curricular activities. Students also work on multi-disciplinary engineering projects in smaller groups during the lab hour. (F)

2002 Professional Development. Prerequisite: ENGR 1410 or ENGR 1411, or ENGR 3511 or ENGR 3410 or concurrent enrollment; ENGL 1213 or EXPO 1213, and sophomore standing. Develop an understanding of engineering ethics, teamwork, leadership, and professional responsibility through the concepts of contemporary, social, and global issues. (F, Sp)

2431 Electrical Circuits. Prerequisite: MATH 2423 or 2924; and PHYS 2524 or concurrent enrollment. Introduction to basic principles of electrical circuits. Topics include DC circuits analysis, DC transients, static electrical fields, static magnetic fields, capacitors, inductors, and filters. (F, Sp)

COURSE IN INDUSTRIAL AND SYSTEMS ENGINEERING (ISE)

3293 Applied Engineering Statistics. Prerequisite: MATH 2433 or MATH 2924. Introduction to probability, one and higher dimensional random variates, function of random variables, expectation, discrete and continuous distributions, sampling and descriptive statistics, parameter estimation, use of statistical packages. (F, Sp)

COURSES IN MATHEMATICS (MATH)

1914 Differential and Integral Calculus I. Prerequisite: satisfactory score on the placement test or, for incoming freshmen direct from high school, satisfactory score on the ACT/SAT. Duplicates three hours of 1823 and one hour of 2423. Limits and continuity, differentiation, applications of differentiation to optimization and curve sketching, integration, the fundamental theorem of calculus, the substitution rule, applications of integration to computation of areas. (F, Sp, Su) [I-M]

2924 Differential and Integral Calculus II. Prerequisite: 1914 with a grade of C or better. Duplicates two hours of 2423 and two hours of 2433. Further applications of integration, the natural logarithmic and exponential functions, indeterminate forms, techniques of Vector integration, improper integrals, parametric curves and polar coordinates, infinite sequences and series. (F, Sp, Su)

2934 Differential and Integral Calculus III. Prerequisite: 2924 with a grade of C or better. Duplicates one hour of 2433 and three hours of 2443. Vectors and vector functions, functions of several variables, partial differentiation and gradients, multiple integration, line and surface integrals, Green-Stokes-Gauss theorems. (F, Sp, Su)

†G3113 Introduction to Ordinary Differential Equations. Prerequisite: MATH 2423 or MATH 2924. Duplicates two hours of 3413. First order ordinary differential equations, linear differential equations with constant coefficients, two-by-two linear systems, Laplace transformations, phase planes and stability. (F, Sp, Su)

COURSES IN PHYSICS (PHYS)

2514 General Physics for Engineering and Science Majors. Prerequisite: MATH 1823 or MATH 1914 with grade of C or better. Not open to students with credit in 1205. Vectors, kinematics and dynamics of particles, work and energy systems of particles, rotational kinematics and dynamics, oscillations, gravitation, fluid mechanics, waves. (F, Sp, Su) [II-NL]

2524 General Physics for Engineering and Science Majors. Prerequisite: PHYS 2514 and MATH 2423 or MATH 2924 with grade of C or better. Not open to students with credit in PHYS 1215. Temperature, heat, thermodynamics, electricity, magnetism, optics. (F, Sp, Su)

COURSES IN BIOMEDICAL ENGINEERING (BME)

2333 Biomedical Engineering Fundamentals. Majors only; MATH 1914 or 1823; MATH 2924 or 2423; CHEM 1315; CHEM 1415; and PHYS 2514 all with a grade of B or better. Introduction to material, energy, charge, and momentum balances in biological systems. Steady state and transient conservation equations for mass, energy, charge, and momentum will be derived and applied using basic mathematical principles, physical laws, stoichiometry, and thermodynamic properties. (F)

2433 Signals and Systems for Biomedical Engineering. Prerequisite: BME 2333. Students learn circuits and linear systems concepts necessary for analysis and design of biomedical systems. Theory is motivated by examples from biomedical engineering. Topics covered include electrical circuit fundamentals, operational amplifiers, frequency response, electrical transients, impulse response, transfer functions, and convolution, all motivated by circuit and biomedical examples. Elements of continuous time domain-frequency domain analytical techniques are developed. (Sp)

3111 Bioimaging Lab. Prerequisite: ISE 3293; completion or concurrent enrollment in BME 3113; majors only. Hands-on lab that teaches students technical skills associated with bioimaging. Lab components include hypothesis testing and analysis, computer simulation, lab safety and instrument training, and technical communication. (F, Sp)

3113 Bioimaging. Prerequisite: BME 2333; BME 2433; PHYS 2524 and MATH 3113. Introduction to medical imaging techniques such as x-ray, computed tomography, magnetic resonance, and ultrasound. (F, Sp)

3121 Biotransport Lab. Prerequisite: ISE 3293; completion or concurrent enrollment in BME 3123; majors only. Hands-on lab that teaches students technical skills associated with biotransport. Lab components include hypothesis testing and analysis, computer simulation, lab safety and instrument training, and technical communication. (F, Sp)

3123 Biotransport. Prerequisite: BME 2333; PHYS 2524 and MATH 3113. Covers key transport concepts in biomedical engineering. Emphasis is put on mass and momentum transport with applications related to biology, medical science and biotechnology. (F, Sp)

3131 Bioelectricity Lab. Prerequisite: ISE 3293; completion or concurrent enrollment in BME 3133; majors only. Hands-on lab that teaches students technical skills associated with electrobiology. Lab components include hypothesis testing and analysis, computer simulation, lab safety and instrument training, and technical communication. (F, Sp)

3133 Bioelectricity. Prerequisite: BME 2333; 2433; PHYS 2524 and MATH 3113. The electrophysiology of excitable cells from a quantitative perspective. Topics include the ionic basis of action potentials, quantitative models for nerve and muscle including the Hodgkin-Huxley equations, impulse propagation, synaptic dynamics, source-field relationships, and an introduction to functional electrical stimulation. (F, Sp)

3141 Biomechanics Lab. Prerequisite: ISE 3293; completion or concurrent enrollment in BME 3143; majors only. Hands-on lab that teaches students technical skills associated with biomechanics. Lab components include hypothesis testing and analysis, computer simulation, lab safety and instrument training, and technical communication. (F, Sp)

3143 Biomechanics. Prerequisite: BME 2333; PHYS 2524 and MATH 3113. Mechanical characterization of biological tissues at the cellular, organ, and system level; exploration of biomechanical factors of physiological and pathological conditions. (F, Sp)

3151 Molecular, Cellular and Tissue Engineering Lab. Prerequisite: ISE 3293; completion or concurrent enrollment in BME 3153; majors only. Hands-on lab that teaches students technical skills associated with molecular, cell, and tissue engineering. Lab components include hypothesis testing and analysis, computer simulation, lab safety and instrument training, and technical communication. (F, Sp)

3153 Molecular, Cellular and Tissue Engineering. Prerequisite: BME 2333 and MATH 3113; majors only. Application of engineering methods to study, measure, repair, or replace biological functions at the molecular, cellular, or tissue-level length scales. (F, Sp)

3161 Biomedical Micro-/Nano-Technology Lab. Prerequisite: ISE 3293; completion or concurrent enrollment in BME 3163; majors only. Hands-on lab that teaches students technical skills associated with BME micro/nanotechnology. Lab components include hypothesis testing and analysis, computer simulation, lab safety and instrument training, and technical communication. (F, Sp)

3163 Biomedical Micro-/Nano-Technology. Prerequisite: BME 2333; PHYS 2524; MATH 3113; majors only. Introduction to micro/nanotechnology in biomedical settings, including micro/nanotechnologies used to investigate biological systems, physiological responses to nanotherapeutics, and first principles of microfluidics and microfabrication. (F, Sp)

3233 Biomaterials. Prerequisite: PHYS 2524; majors only and junior or senior standing in the Gallogly College of Engineering, or permission of instructor. Introduction to materials used in biomedical environment, the design and use of implantable materials, such as metals, polyethylene, ceramics, and composites, biocompatibility, test methods, and tissue growth on biomaterials. (F)

3533 Biomedical Instrumentation. Prerequisite: BME 2433. Measurement and analysis of biopotentials and biomedical transducer characteristics; electrical safety applications of FET's; integrated circuits, operational amplifiers for signal processing and computer interfacing; signal analysis and display on the laboratory minicomputer. (Sp)

3722 Numerical Methods in Biomedical Engineering. Prerequisite: C S 1213 and MATH 3113; majors only. Introduces principles and techniques of numerical analysis of biomedical engineering problems. Covers numerical methods of integration, differentiation, interpolation, curve fitting, data analysis, sampling and estimation, error analysis, analysis of ordinary differential equations, numerical modeling of biomedical engineering systems, symbolic computation, and scientific visualization. (F)

4713 Biomedical Engineering Design I. Prerequisite: Senior standing in the BS in BME curriculum. Structured methodologies for designing systems or to interface with living systems. Creative design, analysis, selection, development, and fabrication of biomedical components and systems. (F)

4813 Quantitative Physiology. Prerequisite: BME 3722. Introduces students to the mathematical and numerical techniques used to develop, solve, and analyze quantitative models of physiology systems. (Sp)

4823 Biomedical Engineering Design II (Capstone). Prerequisite: BME 4713. Development of team projects in biomedical engineering with emphasis on prototype development and quantitative analysis, and written and oral reporting of the outcome. (Sp)