Prerequisite Coursework

For Admission to Biomedical Engineering (PhD) | University of Nebraska-Lincoln

Applicant Full Name	*Applicant Email Address*	*Date*

Requirement (and Recommended Courses at UNL)	Equivalent Course You Have Completed or Will Complete *Grade column: If not yet completed/graded, enter expected completion date instead.*			
	Institution	**Course Title**	**Credit Hours**	**Grade**
Differential Equations (MATH 221)				
Two semesters of physics, preferably calculus-based (PHYS 211, PHYS 212)				
Three advanced engineering courses, junior-level or higher (BSEN 311, BSEN 317, BSEN 410, BSEN 412, BSEN 414, BSEN 416, BSEN 418, CHME 312, CHME 371, CHME 476, ECEN 304, ECEN 306, ECEN 325, ECEN 450, MECH 324, MECH 373, MECH 436, MECH 437, MECH 438)				
General Biology or Physiology with Lab (LIFE 120/120L, BIOS 213/213L)				
Additional course in the biological sciences (BIOS 206, BIOS 214, BIOS 312)				

Course Descriptions (for reference)

Math and Physics courses:

MATH 221: Differential Equations
First- and second-order methods for ordinary differential equations including: separable, linear, Laplace transforms, linear systems, and some applications.

PHYS 211: General Physics I
Calculus-based course intended for students in engineering and the physical sciences. Mechanics, fluids, wave motion, and heat.

PHYS 212: General Physics II
Continuation of PHYS 211. Electricity, magnetism, and optics.

Life science courses: The following are preferred for this category; this is not an exhaustive list of qualifying courses.

BIOS 206: General Genetics
Inheritance and regulation of genes in organisms and populations. Fundamentals of genomics and bioinformatics.

BIOS 213/213L: Human Physiology
Elementary survey of the basic functional systems of the human body: the muscular, nervous, receptor, circulatory, respiratory, digestive, excretory, endocrine, and reproductive systems.

BIOS 214: Human Anatomy
Introduction to the major organ systems of the human body including skeletal, major muscle, nervous, digestive, circulatory, excretory, and reproductive systems. Anatomical structures as they pertain to clinical anatomy.

BIOS 312: Microbiology
Microbial cell structure, genetics, metabolic and biosynthetic activity, diversity, ecology and evolution including host-microbe interactions.

LIFE 120/120L: Fundamentals of Biology I
First in a series of life sciences courses. A systems approach to the study of life at the cellular level, investigating cellular structures, chemical processes, cell metabolism, cell division, gene expression and introducing patterns of inheritance.

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Engineering courses: The following are preferred for this category; this is not an exhaustive list of qualifying courses.

BSEN 311: Biomedical Signal and System Analysis
Mathematical modeling of biophysical systems. Continuous and discrete signals. Signal representation, system classification, impulse response, convolution, Fourier analysis, transfer functions, difference-equation approximations of differential equations. Basic filtering concepts.

BSEN 317: Introduction to Biomedical Engineering
Research areas and applications related to biomedical engineering including bioelectricity, biosensors, biomechanics, cardiovascular mechanics, tissue engineering, biotechnology, and medical imaging. Identifying engineering methods used to develop biomedical technologies and communicating technical knowledge to a wide variety of audiences.

BSEN 410: Biomechanics of Human Movement
Introduction to basic human movement involving kinematics, kinetics, and other quantitative analysis including linear and angular position, velocity, and acceleration. Emphasis on the muscular and skeletal systems as well as other basic human systems. Human capabilities and injuries will demonstrate the limitations of the human body.

BSEN 412: Rehabilitation Engineering
Application of engineering methods to the development of assistive technology for people with injuries and disabilities. Characterization of the physical and mental capabilities of people with impairment, universal design, assistive technologies associated with seating, transportation, communication, and recreation. Integration of engineering design principles in a rehabilitation design project.

BSEN 414: Medical Imaging Systems
Underlying physics, instrumentation, and signal analysis of biomedical and biological imaging modalities. MRI, X-ray, CT, ultrasound, nuclear medicine, and the human visual system. Energy-tissue interactions. Resolution, point spread function, contrast, diffraction, comparisons. Information content in images for biological systems.

BSEN 416: Introduction to Biomaterials
Introduction to all types of bio-materials, metals, ceramics, polymers, and natural materials. Characterization of biomaterials, mechanical and physical properties, cell-biomaterials interactions, degradation, and host reaction to biomaterials. FDA testing and applications of biomaterials, implants, tissue engineering scaffolds, artificial organs, drug delivery, and adhesives.

BSEN 418: Tissue Engineering
Introduction to engineering biological substitutes that can restore, maintain or improve organ function in therapy of diseases. Engineering methods and principles to design tissues and organs, cell and tissue biology, tissue growth and development, biomaterial scaffolds, growth factor and drug delivery, scaffold-cell interactions, and bioreactors.

CHME 312: Chemical Engineering Computation
Computational methods in orthogonal polynomials, numerical integration, matrix operations and ordinary differential equations as they apply to chemical engineering problems such as separations, reactor design, transport operations and control.

CHME 371: Stem Cell Engineering and Regenerative Medicine
Introduction to stem cells and regenerative medicine with emphasis on stem cells and their application in the treatment of diseases and translational lab-to-clinic hurdles in stem cell therapy.

CHME 476: Micro/Nano Systems for Engineering and Life Sciences
Introduction to a number of biological problems facing living systems and show how micro/nanotechnology is being used to solve those problems. Emphasis on engineering perspectives of the life sciences.

ECEN 304: Signals and Systems I
Mathematical modeling of physical systems and signals. Representation of signals in terms of basis functions. Fourier series expansions, Fourier Transforms, Laplace and z-Transforms. Input-output relations, convolution. Transfer functions. System Stability. Poles/zeros and s- and z-plane methods. Applications.

ECEN 306: Electromagnetic Field Theory
Complex vectors. Maxwell's equations. Uniform plane waves. Wave reflection and transmission at interfaces. Waveguides and resonators. Transmission line principles. Antennas. Topics in waves.

ECEN 325: Communications Systems
Relevant communications systems; principles of transmission and reception; amplitude; frequency and phase modulation. Sampling theorem, pulse-code modulation and delta modulation.

ECEN 450: Bioinformatics
Examination of how information is organized in biological sequences such as DNA and proteins and computational techniques which make use of this structure. Various biochemical processes that involve these sequences are studied to understand how these processes affect the structure of these sequences. In the process bioinformatics algorithms, tools, and techniques which are used to explore genomic and amino acid sequences are also introduced.

MECH 324: Strength of Materials
Stress and strain analysis in elastic materials. Use of properties of materials in the analysis and design of welded and riveted connections, statically determinate and indeterminate flexure members, columns. Combined stresses, axial, eccentric and torsional loading. Observations of laboratory tests for axially loaded specimens. Introduction to shear and moment diagrams.

MECH 373: Engineering Dynamics
Force action related to displacement, velocity, and acceleration of rigid bodies. Kinematics of plane motion, kinetics of translation and rotation. Mass moment of inertia, vibration, work, energy and power, impulse and momentum.

MECH 436: Introduction to Continuum Biomechanics
An introduction to continuum biomechanics with an emphasis on soft tissues. Case studies covering diverse applications of biomechanics in biology and medicine, including in the areas of mechanobiology, medical devices, and tissue engineering. Continuum mechanics concepts include kinematics, kinetics, balance laws, and constitutive relations. Includes some programming in MATLAB.

MECH 437: Biomedical Device Design
Design of devices intended for use in biomedical environments. Introduction to modeling of the bio-environment, bio-materials, and material selection. Overview of design methodologies and strategies used in biomedical device design from a material properties perspective. Introduction to federal regulation and other pertinent issues.

MECH 438: Mechanics of Biomaterials
Theory, application, simulation, and design of biomaterials that apply mechanical principles for solving medical problems (case studies in artery, brain, bone, etc.). Tentative Topics include Mechanical characterization of biomaterials; Bio-manufacturing a tissue; Function-structure relationship; Design and analysis of medical implants; Active response of biomaterials: growth and remodeling mechanism; Cellular behavior and measurements, etc.