Biomedical Engineering

Degrees Offered	MSBME, PhD
Website	www.uab.edu/bme
Program Director	Prasanna Krishnamurthy, PhD
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Biomedical Engineering (BME) is the application of engineering principles and technology to the solution of problems in the life sciences and medicine. UAB is a top-25 institution for NIH funding, and BME graduate students have many opportunities to conduct cutting-edge multidisciplinary research. BME researchers enjoy collaborations across UAB's very active medical and dental schools as well as with researchers across the United States and beyond.

The BME Department offers Master of Science and PhD degrees. Students enrolled in UAB's MD/PhD or DMD/PhD programs may receive the PhD portion of their training in the Biomedical Engineering department. Students in any BME graduate program who are interested in the commercialization of biomedical technology are encouraged to complete the 12-hour Graduate Certificate in Technology Commercialization and Entrepreneurship offered by the Collat School of Business.

Admitted PhD students begin Fall term while MSBME students may be admitted for Fall or Spring. For full consideration, applications should be submitted by the priority deadline of January 15. Applications submitted as late as the UAB Graduate School's Fall deadline may be considered depending on the availability of positions.

A minimum score of 80 on the TOEFL (minimum of 18 on each subscore) or 6.5 on the IELTS is required for international students whose native language is not English. Additional details on the BME graduate programs are available in the current BME Graduate Student Handbook available at uab.edu/engineering/bme.

Students entering the MSBME program normally have earned a bachelor's degree in Biomedical Engineering, another engineering discipline, or a closely-related field. Students with undergraduate degrees in the physical sciences, life sciences, or mathematics will also be considered for admission; however, such students must demonstrate preparation for the BME graduate curriculum.

Admission to the MS program is competitive. Successful applicants typically have an undergraduate GPA of at least 3.5 (on a 4-point scale). However, applications are reviewed holistically and applicants with lower grades may be admitted based on factors such as strong GRE scores, research experience, or professional experience. Scores on the GRE General Test are not required but are accepted.

UAB offers Accelerated Bachelor's / Master's and Early Acceptance. To learn more about these programs, including requirements and how to apply, visit the Graduate School's ALO page.

Accelerated Bachelor-Master's Program in Biomedical Engineering

Biomedical Engineering offers an accelerated Bachelor's / Master's (ABM) option for high-achieving undergraduate students pursuing a BS degree in Biomedical Engineering at UAB. A successful graduate of ABM will earn both a bachelor's degree and a master's degree in BME from the University of Alabama at Birmingham in an accelerated time-frame compared to the independent completion of the two degrees.

To be considered for this program, students must have junior-level standing (more than 60 hours completed), have completed at least 3 of the required junior-level BME courses, and have a UAB GPA of at least 3.5. Applicants are expected to have already selected a research mentor for their graduate studies, which will typically be a continuation of their undergraduate research. Application to the program is through the normal UAB Graduate School application portal. One of the letters of recommendation must be from the research mentor. Once enrolled in the program, before completing their undergraduate degree, students may take up to 12 credit hours of approved graduate courses that will be applied to the MSBME degree. Note that coursework may not be applied toward both the undergraduate and graduate degrees. Students may pursue either the Plan I or Plan II MSBME option.

Graduate courses allowed for credit sharing are: BME 524 Current Topics in Stem Cell Engineering, BME 535 Tissue Engineering, BME 543 Medical Image Processing, BME 544 Machine Learning for Biomedical Engineering Applications, BME 550 Computational Neuroscience, BME 562 Cardiac Electrophysiology, BME 571 Continuum Mechanics of Solids.

Additional Academic Policies

Students must maintain an overall GPA of 3.00 to remain in good academic standing in the BME Graduate Program.

Special Topics (590/690/790) courses and Independent Study (591/691/791) courses are reviewed for degree applicability for each program in the School of Engineering. No more than 6 combined hours of Special Topics and/or Independent Study courses will be applied to the MSBME without appeal to and approval from the Program Director.

The School of Engineering offers similar courses at the 400/500 and 600/700 levels. While the higher numbered course has more advanced content, there is a significant overlap in topics. Therefore, students are not allowed to take a 500-level or 700-level course for credit if they have previously taken the related 400-level or 600-level course, respectively.

MSBME Plan I (Thesis Option)

The Plan I Master's degree requires completion of at least 30 semester hours of graduate work.

A Graduate Study Committee consisting of at least three faculty members should be formed. At least one committee member must have a primary appointment within BME and one must have a primary appointment outside of BME. A student is eligible for admission to candidacy after (1) a written thesis proposal has been orally presented to the committee and approved and (2) completion of Responsible Conduct of Research (RCR) training. Admission to candidacy must take place at least one semester before the student may graduate. A written thesis embodying the results of the student's original research must then be publicly defended, approved by the committee, and submitted to the Graduate School.

Upon completing a Plan I MSBME degree, a student may petition to continue their graduate training in the BME PhD program. This does not require a new application to the UAB Graduate School.

Master of Science in Biomedical Engineering

MSBME Plan I (Thesis Option) - 30 hours

Requirements		Hours
BME 617	Engineering Analysis	3
or ME 661	Math Methods in EGR I	
BME 670	Quantitative Physiology	3
BST 621	Statistical Methods I	3
BME Elective 500-697		3
Life Science Elective at the 500+ level		3
BME/EGR/Math/Life Science Elective at the 500+ level [1, 2]		3
BME 601	Seminar in Biomedical Engineering (Must be taken three times)	1
BME 601	Seminar in Biomedical Engineering	1
BME 601	Seminar in Biomedical Engineering [3]	1
BME 698	Non-Thesis Research [4]	3
BME 699	Thesis Research [5]	6
Total Hours		**30**

1 One 3 hour course from another discipline (e.g., MBA) may substitute with approval of the BME Graduate Program Director
2 Students in the Graduate Certificate in Technology Commercialization and Entrepreneurship program are encouraged to choose BMEM 601
3 One hour of BME 697 may substitute for one hour of BME 601
4 An additional 3 hour BME/EGR/Science Elective at the 500+ level may substitute
5 Taken after admission to candidacy

MSBME Plan II (Non-Thesis Option) - 30 hours

The Plan II Master's degree requires completion of at least 30 semester hours of graduate-level work. It also requires completion of a research project and submission of a written project report that must be approved by the student's research advisor and submitted to the BME Graduate Program Director. Submission of the project report to the Graduate School is not required.

Requirements		Hours
BME 617	Engineering Analysis	3
or ME 661	Math Methods in EGR I	
BME 670	Quantitative Physiology	3
BST 621	Statistical Methods I	3
BME Elective 500-697		3
BME/EGR/MA/Life Science Elective at the 500+ level [1, 2]		9
Life Science 500+ level		3
BME 601	Seminar in Biomedical Engineering (Must be taken three times)	1
BME 601	Seminar in Biomedical Engineering	1
BME 601	Seminar in Biomedical Engineering [3]	1
BME 698	Non-Thesis Research [4]	3
Total Hours		**30**

1 One 3 hour course from another discipline (e.g., MBA) may substitute for 3 of these hours with approval of the BME Graduate Program Director
2 Students in the Graduate Certificate in Technology Commercialization and Entrepreneurship program are encouraged to choose BMEM 601
3 One hour of BME 697 may substitute for one hour of BME 601
4 An additional 3 hour BME/EGR/Science Elective at the 500+ level may substitute

PhD Program

Students entering the doctoral program will possess a BS, MS, or be currently enrolled in the DMD/PhD or MD/PhD program at UAB.

PhD students normally have earned a bachelor's degree in Biomedical Engineering, another engineering discipline, or a closely-related field. Students with undergraduate degrees in the physical sciences, life sciences, or mathematics will also be considered for admission; however, such students must demonstrate preparation for the BME graduate curriculum.

Admission to the BME PhD program is competitive. Successful applicants have a 3.5 or greater GPA from their previous degree(s) (on a 4-point scale) and significant research experience. Scores on the GRE General Test are not required but are accepted.

Students admitted to the doctoral program typically receive a competitive stipend that includes payment of tuition.

In addition to completing coursework requirements (see below), doctoral students must form a Graduate Dissertation Committee consisting of at least five faculty members, including the primary research mentor. At least one committee member must have a primary BME appointment and two must have a primary appointment outside of BME. A written dissertation proposal must be orally presented to the committee and approved, at which time the student is admitted to candidacy. This must take place at least two semesters before the student may graduate. A written dissertation embodying the results of the student's original research must then be publicly defended, approved by the committee, and submitted to the Graduate School.

Publication Requirement. Original peer-reviewed research articles in reputable journals are the standard for demonstrating scientific productivity. The research conducted by BME doctoral students is expected to result in such publications. Before the degree is awarded, students are required to have at least one "first-author" journal article that has been published (or accepted for publication) and a second that has been submitted to a journal. Typically, a student's doctoral research will result in at least three first-author articles. Many students will be co-authors on collaborative research articles and may also share authorship on review articles, book chapters, conference proceedings, and other forms of scientific communication. Although these works bolster the student's scientific credentials, they do not count toward the BME publication requirement. In some cases, first-authorship of an article is shared among multiple individuals. In these cases, the article may count toward the publication requirement of only one BME doctoral student.

Additional Academic Policies

Students must maintain an overall GPA of 3.00 to remain in good academic standing in the BME Graduate Program.

Special Topics (590/690/790) courses and Independent Study (591/691/791) courses are reviewed for degree applicability for each program in the School of Engineering. No more than 6 combined hours of

Special Topics and/or Independent Study courses will be applied to the PhD without appeal to and approval from the Program Director.

The School of Engineering offers similar courses at the 400/500 and 600/700 levels. While the higher numbered course has more advanced content, there is a significant overlap in topics. Therefore, students are not allowed to take a 500-level or 700-level course for credit if they have previously taken the related 400-level or 600-level course, respectively.

Coursework for PhD After BS Degree

Students entering the PhD program with a BS degree are required to complete at least 72 semester hours of graduate work.

Requirements		Hours
BME 717	Engineering Analysis	3
or ME 761	Math Methods in EGR I	
BME 770	Quantitative Physiology	3
BST 621	Statistical Methods I	3
GRD 717	Principles of Scientific Integrity	3
BME 773	Lab Rotation [1]	3
BME Elective 500+ level		6
BME/EGR/Science Elective 500+ level [2, 3]		9
Life Science Elective 500+ level		6
BME 701	Seminar in Biomedical Engineering [4]	6
BME 798	Non-Dissertation Research [5, 6]	6
BME 799	Dissertation Research [6]	24
Total Hours		**72**

1. If the lab rotation is not needed, student should substitute with an elective at the same or higher level with program director approval
2. One 3 hour course from another discipline (e.g., MBA) may substitute for 3 of these hours with approval of the BME Graduate Program Director
3. Students in the Graduate Certificate in Technology Commercialization and Entrepreneurship program are encouraged to choose BMEM 601
4. Up to three hours of BME 797 may substitute for three hours of BME 701
5. BME/EGR/Science Electives at the 500+ level may substitute
6. Up to twelve hours may be substituted with BME 798 hours taken before candidacy; A minimum of twelve hours of BME 799 must be taken after admission to candidacy over at least two terms

Coursework for PhD After MS Degree

Students entering the PhD program with an MS degree or those entering the PhD portion of the DMD/PhD or MD/PhD program are required to complete at least 51 additional semester hours of graduate work.

Requirements		Hours
BME 717	Engineering Analysis	3
or ME 761	Math Methods in EGR I	
BME 770	Quantitative Physiology [1]	3
BST 621	Statistical Methods I [1]	3
GRD 717	Principles of Scientific Integrity [1]	3
BME 773	Lab Rotation [2]	3
BME Elective 500+ level [3]		3
BME Science Elective 500+ level		3
BME 701	Seminar in Biomedical Engineering [4]	3
BME 798	Non-Dissertation Research [5, 6]	3
BME 799	Dissertation Research [5, 6]	24
Total Hours		**51**

1. If these classes were taken as part of an MS degree at UAB, they may be substituted with BME/EGR/Science Electives (500+ level)
2. If the lab rotation is not needed, student should substitute with an elective at the same or higher level with program director approval
3. Students in the Graduate Certificate in Technology Commercialization and Entrepreneurship program are encouraged to choose BMEM 601
4. One hour of BME 797 may substitute for one hour of BME 701
5. BME/EGR/Science Electives at the 500+ level may substitute
6. Up to twelve hours may be substituted with BME 798 hours taken before candidacy; A minimum of twelve hours of BME 799 must be taken after admission to candidacy over at least two terms

Coursework for PhD, Bioinformatics Track after BS Degree

Requirements		Hours
Core Required Courses		
BME 717	Engineering Analysis	3
or ME 761	Math Methods in EGR I	
BME 701	Seminar in Biomedical Engineering [1]	3
BME 770	Quantitative Physiology [2]	3
BME 773	Lab Rotation [3]	3
BST 621	Statistical Methods I [4]	3
GRD 717	Principles of Scientific Integrity	3
BME 799	Dissertation Research [5]	24
Required Bioinformatics Courses		
INFO 701	Introduction to Bioinformatics	3
INFO 702	Algorithms in Bioinformatics	3
INFO 703	Biological Data Management	3
INFO 704	Next-generation Sequencing Data Analysis	3
INFO 791	Bioinformatics Seminar I [6]	3
INFO 793	Bioinformatics Journal Club [7]	6
BME/EGR/Life Science Electives [8]		9
Total Hours		**72**

1. Students will register for BME 701 for at least 3 terms
2. Student may substitute with another GBS genetics or biology elective at the same or higher level with program director approval
3. If the lab rotation is not needed, student should substitute with an elective at the same or higher level with program director approval
4. Student may substitute with another biostatistics course at the same or higher level with program director approval
5. Dissertation research must be conducted after admission to candidacy and over at least 2 terms
6. Students will register for INFO 791 for at least 3 terms
7. Students will register for INFO 793 for at least 3 terms
8. Electives must be approved by the program director prior to registration in order to be applied to the degree

Coursework for PhD, Bioinformatics Track after MS Degree

Requirements		Hours
Core Required Courses		
BME 717	Engineering Analysis	3
or ME 761	Math Methods in EGR I	

BME 701	Seminar in Biomedical Engineering	1
GRD 717	Principles of Scientific Integrity	3
BME 799	Dissertation Research [1]	24
Required Bioinformatics Courses [2]		
INFO 701	Introduction to Bioinformatics	3
INFO 702	Algorithms in Bioinformatics	3
INFO 703	Biological Data Management	3
INFO 704	Next-generation Sequencing Data Analysis	3
INFO 791	Bioinformatics Seminar I [2]	3
INFO 793	Bioinformatics Journal Club	2
BME/Data Science Elective [4]		3
Total Hours		**51**

1. Dissertation research must be conducted after admission to candidacy over at least 2 terms
2. Students with post-graduate equivalence of the INFO courses, the program may allow substitution of up to 6 credits with BME/Data Science electives
3. Students will register for INFO 791 for at least 3 terms
4. Electives must be approved by the program director prior to registration in order to be applied to the degree

Courses

BME 520. Implant-Tissue Interactions. 3 Hours.
An overview of implant biocompatibility including tissue histology, histopathology of implant response and the regulatory process for medical devices.

BME 524. Current Topics in Stem Cell Engineering. 3 Hours.
This course is designed for students interested in the field of stem cells, regenerative medicine, and tissue engineering using stem cells and stem cell derived cells. The course will introduce the role of stem cells in tissue growth and development, the theory behind the design and in vitro construction of tissue and organ replacements, and the applications of biomedical engineering principles to the treatment of tissue-specific diseases. Students will have hands on experience on culturing and analyzing stem cells, stem cell differentiation, analysis of functional and physiological properties of differentiated cells, and fabricating basic engineered-tissues.

BME 535. Tissue Engineering. 3 Hours.
Principles underlying strategies for regenerative medicine such as stem cell based therapy, scaffold design, proteins or genes delivery, roles of extracellular matrix, cell-materials interactions, angiogenesis, tissue transplantation, mechanical stimulus and nanotechnology.

BME 543. Medical Image Processing. 3 Hours.
Fundamental topics of medical image processing to practical applications using conventional computer software.

BME 544. Machine Learning for Biomedical Engineering Applications. 3 Hours.
This course provides the introduction to the practical aspects of machine learning such that the students can apply some basic machine learning techniques in simple biomedical engineering problems. The course also provides the principle of machine learning 'thinking process' for the next machine learning – AI courses and more in-depth machine learning studies. By 'thinking process', at the beginning, it is better to view machine learning like human learning. Students who have experience with Data Mining may further understand the fundamental differences between Machine Learning and Data Mining, although these two fields share many concepts and techniques. Also, the student will learn fundamental theories in machine learning to be able to develop new machine learning techniques and research machine learning in biomedical engineering.

BME 550. Computational Neuroscience. 3 Hours.
This course examines the computational principles used by the nervous system. Topics include: biophysics of axon and synapse, sensory coding (with an emphasis on vision and audition), planning and decision-making, and synthesis of motor responses. There will be an emphasis on a systems approach throughout. Homework includes simulations.

BME 555. NextGen-BioMed Bootcamp: Lab Skills for Biomed Research. 3 Hours.
The course will provide students with a solid foundation in the principles, methods, and techniques used in biomedical research. The course will cover a range of topics, including experimental design, cell and molecular biology techniques, immunological techniques, animal models and in vivo studies, and laboratory safety and good laboratory practices.

BME 561. Bioelectric Phenomena. 3 Hours.
Quantitative methods in the electrophysiology of neural, cardiac and skeletal muscle systems.

BME 562. Cardiac Electrophysiology. 3 Hours.
Experimental and computational methods in cardiac electrophysiology, ionic currents, action potentials, electrical propagation, the electrocardiogram, electromechanical coupling, cardiac arrhythmias, effects of electric fields in cardiac tissue, defibrillation, and ablation.

BME 565. Mechanobiology. 3 Hours.
The overall course objective is to develop understanding of mechanobiological processes in cells as they relate to both development and disease pathways. The course will focus on cancer and vascular biology, however there is significant overlap of these pathways with developmental signaling pathways. Students will learn not only molecular biology techniques for characterizing mechanobiology and cell phenotype but also be able to describe biomechanical analysis protocols including micropipette aspiration, atomic force microscopy, traction force microscopy, and optical/magnetic tweezers. The course will include comprehensive literature reviews relevant to the subject area. Students will present formal presentations on articles discussing mechanobiology topics; students will prepare a written report in the style of a commentary article on a published journal article discussing a relevant mechanobiological project.

BME 571. Continuum Mechanics of Solids. 3 Hours.
Matrix and tensor mathematics, fundamentals of stress, momentum principles, Cauchy and Piola-Kirchoff stress tensors, static equilibrium, invariance, measures of strain, Lagrangian and Eulerian formulations, Green and Almansistrain, deformation gradient tensor, infinitesimal strain, constitutive equations, finite strain elasticity, strain energy methods, 2-D Elasticity, Airy Method, viscoelasticity, mechanical behavior of polymers.

BME 572. Industrial Bioprocessing and Biomanufacturing. 3 Hours.
This course will introduces students to the growing industries related to biomedical, biopharmaceutical and biotechnology. It is targeted to offer the students marketable skills to work in a vital area of economic growth and also convey some of the challenges and opportunities awaiting.

BME 590. Special Topic in Biomedical Engineering. 1-3 Hour.
Special Topic in Biomedical Engineering.

BME 591. Individual Study in Biomedical Engineering. 1-6 Hour.
Individual Study in Biomedical Engineering.

BME 601. Seminar in Biomedical Engineering. 1 Hour.
Current topics in biomedical engineering technology and applications.

BME 605. Insights to Innovations BME Journal Club. 1 Hour.
Insights to Innovations (i2i) BME Scholar's Pulse is a Journal Club designed to facilitate critical analyses and discussion of current research in the field of biomedical engineering. Students will learn how to conduct literature searches, read and evaluate scientific articles, and present research findings effectively. Students will develop their presentation and discussion skills and gain a deeper understanding of the various subfields of biomedical engineering.

BME 617. Engineering Analysis. 3 Hours.
Advanced ordinary differential equations, transform techniques, scalar and vector field theory, partial differential equations (heat, wave, Laplace). Students who register for this course are expected to have successfully completed courses in calculus and ordinary differential equations.

BME 623. Skin and Bone Regeneration. 3 Hours.
Study of principles of healing, methods to enhance, and clinical applications.

BME 625. Immune-Engineering: Biomaterial Toolbox for Immune-Modulation. 3 Hours.
This course introduces immunology and engineering approaches to study and control immune response using biomaterials. The course is geared towards students/engineers without a deeply established background in immunology. Basic principles in immunology will be covered and contemporary research directions will be discussed based on articles from the primary literature. Biomaterials will be presented as a tool for modifying immune responses.

BME 634. Dynamical Biological Systems. 3 Hours.
This course considers the dynamics of biological systems at a variety of levels from the cell/molecular to the circuit and system levels. Biological systems are typically nonlinear and their behavior is not usually analytically solvable. Yet it is possible to use the tools of nonlinear dynamical systems theory to approach understanding. In addition, it is important to understand how robust control theory can be applied to describe systems for which an exact mathematical model does not exist. The goal of this course is to examine a number of examples in some detail to gain insight into the dynamics of regulation in biology.

BME 643. Biomedical Imaging-Oncology. 3 Hours.
Advanced and quantitative medical imaging and image processing to understand biological processes related to cancer biology. Medical imaging technology will include molecular, functional and anatomical imaging related to the hallmarks of cancer.

BME 664. Neural Computation. 3 Hours.
This course examines the principal theoretical underpinnings of computation in neural networks. Emphasis will be placed on understanding the relationship between the different approaches: dynamical systems, statistical mechanics, logic, Kalman filters, and likelihood/Bayesian estimation.

BME 665. Computational Vision. 3 Hours.
This course approaches the study of biological and artificial vision from a theoretical perspective beginning with a comparative survey of visual systems and then examining vision algorithms and architectures.

BME 670. Quantitative Physiology. 3 Hours.
Study of physiological problems using advanced mathematical techniques. Topics covered include: mechanics, fluid dynamics, transport, electrophysiology of cell membranes, and control systems.
Prerequisites: BME 517 [Min Grade: C] or BME 617 [Min Grade: C] or BME 717 [Min Grade: C] or ME 661 [Min Grade: C] or ME 761 [Min Grade: C]

BME 672. Cellular Therapy. 3 Hours.
Introduction to research in cellular therapy, its clinical applications, and its potential for commercialization. Students will learn fundamental mechanisms, become familiar with the progress of several successful therapies that use human T cells and stem cells, and learn the challenges and opportunities for future biopharmaceutical and biotechnology industries.

BME 673. Lab Rotation. 3 Hours.
Entering BME graduate students will work in the laboratories of 2 or 3 potential research mentors. The duration of each rotation period will be by mutual agreement between student and faculty but must be at least 4 weeks. The goal is for students to match with their primary research mentor by the end of the course.

BME 680. Biomolecular Modeling. 3 Hours.
Molecular modeling principles and applications. Students will perform hands-on exercises using molecular modeling tools and software. Students will learn the critical relationships among structure, function, and thermodynamic driving forces in structural biology and become able to utilize molecular modeling techniques to explore biological phenomena at the molecular level.

BME 690. Special Topics in Biomedical Engineering. 1-6 Hour.
Special Topics in Biomedical Engineering.

BME 691. Individual Study in Biomedical Engineering. 1-6 Hour.
Individual Study in Biomedical Engineering.

BME 693. Internship in Biomedical Engineering. 1-6 Hour.

BME 697. Journal Club. 1-3 Hour.
Journal Club.

BME 698. Non-Thesis Research. 1-12 Hour.

BME 699. Thesis Research. 1-12 Hour.
Prerequisites: GAC M

BME 701. Seminar in Biomedical Engineering. 1 Hour.
Current topics in biomedical engineering technology and applications.

BME 705. Insights to Innovation BME Journal Club. 1 Hour.
Insights to Innovations (i2i) BME Scholar's Pulse is a Journal Club designed to facilitate critical analyses and discussion of current research in the field of biomedical engineering. Students will learn how to conduct literature searches, read and evaluate scientific articles, and present research findings effectively. Students will develop their presentation and discussion skills and gain a deeper understanding of the various subfields of biomedical engineering.

BME 717. Engineering Analysis. 3 Hours.
Advanced ordinary differential equations, transform techniques, scalar and vector field theory, partial differential equations (heat, wave, Laplace).

BME 723. Skin and Bone Regeneration. 3 Hours.
Study of principles of healing, methods to enhance, and clinical applications.

BME 725. Immune-Engineering: Biomaterial Toolbox for Immune-Modulation. 3 Hours.
This course introduces immunology and engineering approaches to study and control immune response using biomaterials. The course is geared towards students/engineers without a deeply established background in immunology. Basic principles in immunology will be covered and contemporary research directions will be discussed based on articles from the primary literature. Biomaterials will be presented as a tool for modifying immune responses.

BME 734. Dynamical Biological Systems. 3 Hours.
This course considers the dynamics of biological systems at a variety of levels from the cell/molecular to the circuit and system levels. Biological systems are typically nonlinear and their behavior is not usually analytically solvable. Yet it is possible to use the tools of nonlinear dynamical systems theory to approach understanding. In addition, it is important to understand how robust control theory can be applied to describe systems for which an exact mathematical model does not exist. The goal of this course is to examine a number of examples in some detail to gain insight into the dynamics of regulation in biology.

BME 743. Biomedical Imaging-Oncology. 3 Hours.
Advanced and quantitative medical imaging and image processing to understand biological processes related to cancer biology. Medical imaging technology will include molecular, functional and anatomical imaging related to the hallmarks of cancer.

BME 764. Neural Computation. 3 Hours.
This course examines the principal theoretical underpinnings of computation in neural networks. Emphasis will be placed on understanding the relationship between the different approaches: dynamical systems, statistical mechanics, logic, Kalman filters, and likelihood/Bayesian estimation.

BME 765. Computational Vision. 3 Hours.
This course approaches the study of biological and artificial vision from a theoretical perspective. We begin with a comparative survey of visual systems, and will examine vision algorithms and architectures.

BME 770. Quantitative Physiology. 3 Hours.
Study of physiological problems using advanced mathematical techniques. Topics covered include: mechanics, fluid dynamics, transport, electrophysiology of cell membranes, and control systems.
Prerequisites: BME 517 [Min Grade: C] or BME 617 [Min Grade: C] or BME 717 [Min Grade: C] or ME 661 [Min Grade: C] or ME 761 [Min Grade: C]

BME 772. Cellular Therapy. 3 Hours.
Introduction to research in cellular therapy, its clinical applications, and its potential for commercialization. Students will learn fundamental mechanisms, become familiar with the progress of several successful therapies that use human T cells and stem cells, and learn the challenges and opportunities for future biopharmaceutical and biotechnology industries.

BME 773. Lab Rotation. 3 Hours.
Entering BME graduate students will work in the laboratories of 2 or 3 potential research mentors. The duration of each rotation period will be by mutual agreement between student and faculty, but must be at least 4 weeks. The goal is for students to match with their primary research mentor by the end of the course.

BME 780. Biomolecular Modeling. 3 Hours.
Molecular modeling principles and applications. Students will perform hands-on exercises using molecular modeling tools and software. Students will learn the critical relationships among structure, function, and thermodynamic driving forces in structural biology and become able to utilize molecular modeling techniques to explore biological phenomena at the molecular level.

BME 790. Special Topics in Biomedical Engineering. 1-6 Hour.
Special Topics in Biomedical Engineering.

BME 791. Individual Study in Biomedical Engineering. 1-6 Hour.
Individual Study in Biomedical Engineering.

BME 793. Internship in Biomedical Engineering. 1-6 Hour.

BME 797. Journal Club. 1-3 Hour.
Journal Club.

BME 798. Non-Dissertation Research. 1-12 Hour.

BME 799. Dissertation Research. 1-12 Hour.
Prerequisites: GAC Z