Approved BME Elective Courses

ABE 4033 Fundamentals and Applications of Biosensors
Credits: 3; Prerequisite: MAP 2302, BSC 2010 and CHM 2200.
Provides a broad introduction to the field of biosensors, as well as an in-depth and quantitative view of biosensor design and performance analysis. Fundamental application of biosensor theory will be demonstrated, including: recognition, transduction, signal acquisition, and post processing/data analysis.

ABE 5038 Recent Developments and Applications in Biosensors
Credits: 3; Prerequisite: At least senior status in engineering and background in biology including biomolecules.
Introduction to biosensors, design and performance analysis. Fundamental application of biosensor theory will be demonstrated, including recognition, transduction, signal acquisition, and post processing/data analysis.

APK 2100C Applied Human Anatomy with Laboratory
Credits: 4.
Study of general anatomy of the human body from a systematic approach. Understanding anatomical terminology, gross structures, and locations of different body structures are primary concerns. Cells, tissues and organs of the integumentary, skeletal, muscular, nervous, circulatory, respiratory, digestive, urinary and reproductive systems are emphasized. (B)

APK 2105C Applied Human Physiology with Laboratory
Credits: 4.
Introduces body functions at the cellular, tissue, organ and systems level with emphasis on the mechanisms of operation. Designed for students interested in pursuing study in the health professions. (B)

BCH 4024 Intro to Biochemistry and Molecular Biology
Credits: 4; Prerequisite: CHM 2211 or CHM3217, or instructor permission.
Introduces physical biochemistry, intermediary metabolism and molecular biology. Topics include a survey of structure, chemistry and function of proteins and nucleic acids, enzyme kinetics and mechanisms of catalysis; a survey of the pathways of carbohydrate, lipid and nitrogen metabolism and their metabolic control; regulation of gene expression at the level of DNA, RNA and protein synthesis.

BME 3234 Mechanical Behavior of Biological Tissues and Systems
Credits: 3; Prerequisite: BME 3060 with a minimum grade of C and EGM 2511.
This course will focus on understanding the mechanical behavior of biological tissues and systems. The course will begin by evaluating structure-function relationships, stress-strain relationships, and the mechanical complexity of biological systems. In addition, the basics of viscoelastic behavior will be introduced as it applies to biological tissues.

BME 3941 Internship Experience in Biomedical Engineering
Credits: 0-3. Prerequisite: BME major.
0-3 credits repeatable. Engineering work experience under the supervision of an engineer.

BME 4361 Neural Engineering
Credits: 3; Prereq: BME 3508 or EEL 3135.
Applying engineering to neuroscience; includes such diverse areas as neural tissue engineering, models of neural function, and neural interface technology. Focuses mainly in the

context of neural interfaces and prosthetics, from basic neural physiology and models of neural mechanisms to advanced neural interfaces currently in development or produced commercially.

BME 4760 Biomedical Data Science
Credits: 3. Prereq: BME 3053C, COP 2271, and COP2271C.
Covers the biomedical applications of data science techniques, which include pre-processing techniques, machine learning data analysis, and data visualization techniques.

BME 4641 Biomaterials for Drug Delivery
Credits: 3.
This course focuses on the principles of engineering controlled release systems, and integrates topics in polymer chemistry, biomaterials, pharmacokinetics/pharmacodynamics, and mass transport phenomena.

BME 4160 Magnetic Biomaterials
Credits: 3; Prerequisite: PHY 2048 and CHM 2046 or CHM 2096 with minimum grades of C.
Consists of classroom lectures on fundamental concepts in magnetism and magnetic micro and nano-materials and their applications in biomedicine. Participants present a critical review of recent literature in the field and lead a group discussion on a specific, recent paper.

BME 5703 Statistical Methods for Biomedical Engineering
Credits: 3; Prerequisite: Knowledge of calculus, linear algebra and basic statistics.
Computational methods needed for biomedical engineering research. Students will be acquainted with a variety of techniques for analyzing and modeling experimental data arising in molecular, cellular, physiological, and pathological systems encountered in typical laboratory and clinical settings.

BME 5704 Advanced Computational Methods for Biomedical Engineers
Credits: 3; Prerequisite: A basic knowledge of physics and calculus is required. This can be met by PHY2053 and MAC2311.
Covering advanced computational methods from a biomedical engineering perspective. Linear and nonlinear systems, partial differential equations, optimization and inverse problems will be discussed. This course is geared towards the applications of the advanced computational techniques to various biomedical engineering problems.

BME 5743 Applied Data Mathematics
Credits: 3; Prerequisite: COP 2271 or equivalent & BME 3053L or equivalent.
Advanced data science technology with Matlab to analyze biomedical data.

BME 6164 Magnetic Biomaterials
Credits: 3; Prerequisite: Undergraduate physics and chemistry.
Consists of classroom lectures on fundamental concepts in magnetism and magnetic micro- and nano-materials and their applications in biomedicine. As part of the course, students will present a critical review of recent literature in the field and lead a group discussion on a specific recent paper.

BME 6324 Stem Cell Engineering
Credits: 3; Corequisite: Undergraduate cell biology and molecular biology and physiology, or enrollment in the Biomedical Engineering graduate program, or consent from instructor.

Including an historical review of stem cell research and policies surrounding stem cell research, current stem cell sources, strategies and reviews of current stem cell research. This information is essential for Biomedical Engineers to understand in repairing/rebuilding the human body after injury or disease using stem/progenitor cell strategies.

BME 6330 Cell and Tissue Engineering
Credits: 3; Prerequisite: GMS6421, *BME 5001, or consent of instructor.*
Applying engineering principles, combined with molecular cell biology, to developing a fundamental understanding of property-function relationships in cells and tissues. Exploiting this understanding to manipulate cell and tissue properties rationally to alter, restore, maintain, or improve cell and tissue functions; and to design bioartificial tissue substitutes.

BME 6360 Neural Engineering
Credits: 3; Prerequisite: Consent of the instructor.
Applying engineering to neuroscience including such diverse areas as neural tissue engineering, models of neural function, and neural interface technology. Focuses mainly in the context of neural interfaces and prosthetics, from basic neural physiology and models of neural mechanisms to advanced neural interfaces currently in development or produced commercially.

BME 6522 Biomedical Multivariate Signal Processing
Credits: 3; Prerequisite: Multivariate calculus and a basic knowledge of probability and statistics.
Statistical analysis of biomedical signals, emphasizing multivariate time series. Introduces analysis concepts and methods in the time domain and the spectral domain. Uses actual recordings from biomedical applications to demonstrate the methods.

BME 6533 Radiologic Anatomy
Credits: 3; Corequisite: BME 6590 Medical Physics.
Imaging techniques as they relate to human anatomy and physiology.

BME 6535 Radiological Physics, Measurements and Dosimetry
Credits: 3; Prerequisite: *Upper level college physics*.
Interacting and measuring techniques for x-rays, gamma rays, neutrons and charged particles with matter; radioactive decay processes ion chamber measurements, scintillation detectors, and dosimetry techniques. Applications of cavity theory and dosimetry measurement in medical physics.

CHM 3218 Organic Chemistry/Biochemistry 2
Credits: 4; Prerequisite: CHM 3217 or CHM 2211, or instructor permission.
Introduces the basic concepts of biochemistry and molecular biology from the structural and mechanistic perspective of organic chemistry.

EEE 4260C Bioelectrical Systems
Credits: 4; Prerequisite: EEL 3008 and EEL3112.
Covers the theoretical and quantitative perspective of bioelectrical signals reflecting the activity of the brain, the muscles, and the heart. Examines bases of modeling, measuring, processing and analyzing bioelectrical signals and systems, as well as common clinical applications. Laboratory.

Approved BME Elective Courses

EEL 4750 Foundations of Digital Signal Processing
Credits: 3; Prerequisite: EEL 3135.
Analysis and design of digital filters for discrete signal processing, spectral analysis and fast Fourier transform.

EEE 5502 Foundations of Digital Signal Processing
Credits: 3.
Analysis and design of digital filters for discrete signal processing, spectral analysis, and fast Fourier transform.

EEE 6561 Biometric Identification
Credits: 3; Prerequisite: Basic Mathematics – Knowledge and ability to use calculus, probability, and statistics are essential.
Methods and principles for the automatic identification/authentication of individuals. Technologies include fingerprint, face, and iris biometrics. Additional topics include biometric system design, performance evaluation, multi-modal biometric systems, and biometric system security.

EEL 5934 Neural Signals, Systems, and Technology
Credits: 3; Prerequisite: While there are no formal prerequisites, it is expected that students interested in this topic will have a graduate standing in engineering and/or neuroscience (or undergraduate senior standing with approval from the instructor). Even if class material may span topics in one discipline unfamiliar to students in the other discipline, it is expected that students will acquire the necessary knowledge during the semester, either by reading supplementary material or through interaction with the instructor.
Biophysical principles of neural signaling, characterization of neural circuits and systems, technology design principles for interfacing with biological neural systems, overview of clinical applications and industrial opportunities for neurotechnology.

EEL 6537 Spectral Estimation
Credits: 3; Prerequisite: EEL 5544, EEE 5502.
Measurement and analysis of signals and noise. Digital filtering and spectral analysis; fast Fourier transform.

EEL 6825 Pattern Recognition and Intelligent Systems
Credits: 3.
Decision functions; optimum decision criteria; training algorithms; unsupervised learning; feature extraction, data reduction; potential functions; syntactic pattern description; recognition grammars; machine intelligence.

EEL 6935 Deep Learning
Credits: 3.
Nonlinear modeling in neural networks and kernel spaces. Gradient descent learning in the additive neural model. Statistical Learning Concepts. Information theoretic cost functions. Convolution neural networks. Recurrent neural networks. Foundations of Deep Learning. Importance of Deep learning for representation. Current models for image and speech recognition. Challenges of Deep Learning.

EGM 3344 Introduction to Numerical Methods of Engineering Analysis
Credits: 3; Prerequisite: MAC 2313 and COP 2271; Corequisite: MAP2302.

Methods for numerical solution of mathematical problems with emphasis on engineering applications using MATLAB. Includes roots, optimization, linear algebraic equations, matrices, curve fitting, differentiation, integration and ordinary differential equations.

EGM 4313 Intermediate Engineering Analysis
Credits: 3; Prerequisite: MAP 2302 and EGM 3344.
Ordinary differential equations, systems of ordinary differential equations, partial differential equations, Fourier series and complex analysis. Also includes equations of heat conduction, wave propagation and Laplace.

EGM 3401 Engineering Mechanics-Dynamics
Credits: 3; Prerequisite: EGM 2511 or EGM 2500, and MAC 2313.
Continues the dynamics sequence begun in EGM 3400 plus extended coverage of three-dimensional rigid-body dynamics and orbital motion.

EGM 4590 Biodynamics
Credits: 3; Prerequisite: EGM 3400 or EGM 3401, or instructor permission.
Dynamic analysis of the human musculoskeletal system. Includes development of lumped mass, planar rigid body and 3-D rigid body models of human movement. Also includes calculation of internal forces in muscles and joints and analysis of muscle function using dynamics principles and musculoskeletal geometry.

EGM 4592 Bio-solid Mechanics
Credits: 3; Prerequisite: EGM 3520.
Introduction to solid and fluid mechanics of biological systems. Includes rheological behavior of materials subjected to static and dynamic loading, the mechanics of cardiovascular, pulmonary and renal systems, and the mathematical models and analytical techniques used in biosciences.

EGM 4853 Bio-fluid Mechanics and Bio-heat Transfer
Credits: 3; Prerequisite: EGN 3353C.
A study of biothermal fluid sciences with an emphasis on the physiological processes occurring in human blood circulation and the underlying mechanisms from an engineering prospective.

EGM 6352 Advanced Finite Element Methods
Credits: 3
The discontinuous Galerkin method applied to transient problems. Optimization theory applied to formulating mixed FEM; treatment of constraints (e.g., incompressibility). General shape functions. Electromagnetics, heat, fluids, and solids. Other advanced topics.

EGM 6611 Continuum Methods
Credits: 3; Prerequisite: EGM 3520
Tensors of stress and deformation. Balance and conservation laws, thermodynamic considerations. Examples of linear constitutive relations. Field equations and boundary conditions of fluid flow.

EGM 6671 Inelastic Materials
Credits: 3; Prerequisite: EGM 6611
Virtual work, stability, extremum principles. Applications on the microscale, miniscale, and

macroscale. Thermodynamics, internal variables, damage parameters, and time and temperature effects. Fracture mechanics. Finite elastoplasticity.

EGM 6812 Fluid Mechanics I
Credits: 3; Prerequisite: EGN 3353C
Flow kinematics. Fundamental laws and equations in integral and differential forms. Potential flows. Introduction to laminar flows in simple geometries, laminar and turbulent boundary layer flows. External flows. One-dimensional compressible flows.

EGM 6813 Fluid Mechanics II
Credits: 3; Prerequisite: EGM 6812
Mathematical and physical structures of the Navier-Stokes equation. Exact solutions of the Navier-Stokes equation for viscous flows. Low Reynolds number flows. Incompressible and compressible laminar boundary layer flows. Free shear flows. Energy equation and heat transfer. Unsteady flows. Instability. Turbulence.

EGM 6855 Bio-Fluid Mechanics and Bio-Heat Transfer
Credits: 3; Prerequisite: *undergraduate fluid mechanics*
Biothermal fluid sciences. Emphasizes physiological processes occurring in human blood circulation and underlying physical mechanisms, from an engineering perspective.

EGN 3353C Fluid Mechanics
Credits: 3; Prerequisite: MAC 2313, EGM 2511 and EML 3100, or EML 3007.
Statics and dynamics of incompressible fluids. Application to viscous and inviscid flows. Dimensional analysis. Compressible flow.

EGN 4641 Engineering Entrepreneurship
Credits: 3; Prerequisite: Junior or senior standing.
Engineering Entrepreneurship introduces engineering students to the concepts and practices of technological entrepreneurial thinking and entrepreneurship. Using lectures, case studies, business plans and student presentations, the course teaches life skills in entrepreneurial thought and action that students can utilize when starting technology companies or executing research and development projects in large companies.

EGN 4643 Engineering Innovation
Credits: 3; Prerequisite: Junior or senior standing.
Engineering Innovation introduces students to the concepts of innovative thinking and innovation practices. Using lectures, case studies, team exercises and guest speakers, the course teaches life skills in innovative thought and action that students can use in careers ranging from starting companies to executing research and development projects in large companies.

EGN 4912 Engineering Undergraduate Research
Credits: 0-3.
The primary purpose of this course is to provide the student an opportunity for firsthand, supervised research. “Research” is defined as mentored, but self-directed, work that enables individual students or a small group of students to explore an issue of interest to them and to communicate the results to others. Projects may involve inquiry, design, investigation, scholarship, discovery, or application, depending on the topic, and the student is aware of how her or his project fits into and contributes to solving the larger problem to which it belongs. The student will usually assist a faculty member with a research project by helping to prepare the

study and contributing in a meaningful way in meeting the objectives of the study. The student may work with a graduate student who is performing research supervised by a research faculty member.

EGN 6640 Entrepreneurship for Engineers
Credits: 3.
Introduction to entrepreneurship, idea generating and feasibility analysis, and business planning. Lectures, case studies, student-led discussions, team business plans, and investor presentations.

EGN 6642 Engineering Innovation
Credits: 3.
Concepts of innovative thinking and innovation practices. Using lectures, case studies, team exercises, and guest speakers, the course teaches life skills in innovative thought and action that students can use in careers ranging from starting companies to executing R&D projects in large companies.

EGS 4038 Engineering Leadership
Credits: 3; Prerequisite: Junior or senior standing.
Engineering Leadership introduces engineering graduate students to the concepts, theory and practice of engineering leadership; effective written and oral communications and presentations; engineering leadership characteristics, individual differences and self-awareness; developing and building teams; managing change, conflicts, and crises; and understanding real-world ethics and core values.

EGS 4625 Fundamentals of Engineering Project Management
Credits: 3; Prerequisite: Junior or senior standing.
Provides a comprehensive understanding of how to plan, optimize, and efficiently manage projects (or tasks) to implement products, services, or developments. Includes building the structure, processes, components, and linkages with a team for successful project delivery within schedule, budget, and quality requirements.

EGS 4680 Advanced Engineering Leadership Development
Credits: 3; Prerequisite: EGS4038 or instructor permission.
Further develops the leadership framework and capabilities; involves a case study-based instructional approach that reviews and applies strategic leadership concepts and knowledge critical to the success of engineering-based companies that operate in a highly uncertain and volatile business environment.

EGS 6039 Engineering Leadership
Credits: 3.
Concepts, theory and practice of engineering leadership; effective written and oral communications and presentations; engineering leadership characteristics, individual differences and self-awareness; developing and building teams; managing change, conflicts, and crises; and understanding real-world ethics and core values.

EGS 6626 Fundamentals of Engineering Project Management
Credits: 3.
Provides engineering students with a comprehensive understanding of how to plan, optimize and efficiently manage projects (or tasks) to implement products, services or developments.

This includes building the structure, processes, components and linkages with a team for successful project delivery within schedule, budget and quality requirements.

EGS 6681 Advanced Engineering Leadership
Credits: 3; Prerequisite: EGS 6039 or instructor approval.
Designed to further develop the leadership framework and capabilities of graduate engineering students. It involves a case study-based instructional approach that reviews and applies strategic leadership concepts and knowledge critical to the success of engineering-based companies that now operate in a highly-uncertain and volatile business environment.

EMA 3066 Introduction to Organic Materials
Credits: 3; Prerequisite: EMA 3010 and one of the following: EMA 3011, CHM 2200 or CHM 2210.
Uses, structure, processing and properties of organic materials, including polymers, biomacromolecules and small molecule organic materials. Scientific principles are introduced through discussion of developed organic materials for high technology applications.

EMA 3413 Introduction to Electronic Materials
Credits: 3; Prerequisite: EMA 3010.
Atomistic and quantum-mechanical description of the electrical, optical, magnetic and thermal properties of materials. Deals with metals, alloys, semiconductors, polymers, dielectrics and amorphous materials with special emphasis given to high technology applications of electronic materials.

EMA 3513C Analysis of the Structure of Materials
Credits: 4; Prerequisite: EMA 3010.
Laboratory fundamentals of crystallography, x-ray and electron diffraction, scanning and transmission electron microscopy, surface analysis and microprobe techniques.

EMA 4061 Biomaterials: Structure & Properties
Credits: 3; Corequisite: EMA 3066.
Materials commonly used for biomedical application, such as their properties from a biocompatibility or medical device perspective. In addition, materials interactions with biological systems are examined from the molecular (e.g., protein), cellular, tissue and systemic (whole body) perspective. This is the foundation for the second biomaterials class, which applies these principles toward the application of biomaterials in medical implants, prostheses and devices, along with the regulatory issues associated with biomaterials development.

EMA 4062 Biopolymers
Credits: 3; Prerequisite: EMA 3066.
Polymer manufacturing processes and biochemical/biophysical behavior are considered from the perspective of achieving those properties needed for the engineering of polymeric implants and devices. Unique economic, ethical and regulatory issues are also presented.

EMA 4161 Physical Properties of Polymers
Credits: 3; Prerequisite: EMA 3066 and EMA 3513C.
Molecular structure and the physical property relationships for polymers: viscoelastic behavior, the glass transition, thermomechanical and rheological properties, the crystalline and

amorphous molecular solid state. Correlation of properties with design engineering of polymer applications. Laboratory section included.

EMA 6580 Science of Biomaterials
Credits: 3.
Introduction to variables that control compatibility and performance of biomaterials, including physical and chemical properties, corrosion, fatigue, and interfacial histochemical changes.

EMA 6581 Polymeric Biomaterials
Credits: 3; Prerequisite: CHM2045 or CHM2095 & EMA3066 or equivalents.
Biomedical implant and device applications of synthetic and natural polymers. Biocompatibility and interfacial properties of polymers in physiological environment, especially concerning short-term devices (catheters) and long-term implants (intraocular lenses, vascular and mammary prostheses, etc.).

EMA 6938 Nanomaterials: Theory to Practice
Credits: 3.
Nanomaterials provide new and unique properties of materials not seen in the bulk. These properties can be exploited for a wide variety of applications ranging from electronics, magnetics, optics, to biomedicine. This course will cover the fundamental science behind the properties of nanomaterials. We will discuss the scaling laws of materials properties as they reach the nanometer size regime, and how these materials will drive new applications in a variety of areas.

EMA 6938 Polymers in Drug Delivery
Credits: 3.
Polymers have played a critical role in the design and application of drug delivery systems that can increase efficacy and reduce toxicity of therapeutics. This course will provide students with an understanding of the principles, strategies, and materials used in the engineering of controlled drug delivery systems. To this end, it will focus on topics at the interface between engineering and medicine such as polymer chemistry, biomaterials, mass transport, and pharmacokinetics. The course will first cover the fundamentals of drug delivery, including physiology, pharmacokinetics/pharmacodynamics, drug diffusion and permeation, and biomaterials used in drug delivery. Controlled release strategies for various administration routes will then be discussed. The course will conclude with special topics lectures from graduate students.

EML 4507 Finite Element Analysis and Design
Credits: 3; Prerequisite: EGM 3344, EGM 3520 and MAP 2302 with minimum grades of C.
Stress-strain analysis and design of machine elements and finite element analysis.

EML 5595 Mechanics of the Human Locomotor Systems
Credits: 3; Prerequisite: EGM 3401, 3520.
Analyzing the human musculoskeletal system as sensors, levers, and actuators. Joint articulations and their mechanical equivalents. Kinematic and kinetic analysis of human motion. Introduction to modeling human body segments to analyze human activities.
Spring

EML 5598 Orthopedic Biomechanics
Credits: 3; Prerequisite: Mechanics of Materials.
Mechanical properties of the human body's hard and soft tissues. Mechanical and biological considerations for repair and replacement of soft and hard tissues and joints. Fracture fixation, orthopedic implants for hip and knee, and orthotic and prosthetic devices.

ENU 4605 Radiation Interactions and Sources I
Credits: 4; Corequisite: ENU 4001.
Three one-hour lectures discussing interaction of ionizing radiation with matter; cross sections and radiation fields with emphasis on photons, heavy charged particles and electrons.

ENU 4630 Fundamental Aspects of Radiation Shielding
Credits: 3; Prerequisite: ENU 4605 with a minimum grade of C.
Three one-hour lectures discussing basic principles of radiation shielding. Study of radiation sources and shielding design for radiation facilities.

ENU 4641C Applied Radiation Protection
Credits: 2; Prerequisite: ENU 4605 with a minimum grade of C and ENU 4630.
Two one-hour lectures of introduction to practical radiation protection techniques and practices, including laboratory experiences. Examination of pertinent regulations, current practice, ethics and instrumentation/measurement practices. Design of facilities and controls to optimize benefits of radiation applications and minimize exposure risks. (WR)

ENU 5626 Radiation Biology
Credits: 3; Prerequisite: One year each of college biology, chemistry, and physics; permission of instructor.
Effects of radiation on biological molecules, cells, and man including cancer and mutagenesis; use of radiation in treatment of disease.

ENU 6659 Nuclear Medicine Instrumentation and Procedure
Credits: 3; Prerequisite: BME6535, BME6590 or equivalents or permission of instructor.
Theory, evaluation, applications of detecting and imaging systems in nuclear medicine including collimators, scintillation probes, cameras, data-processing devices; uses of radionuclides in medicine for radiopharmaceutical preparation.

ESI 4327C Matrix and Numerical Methods in Systems Engineering
Credits: 4; Prerequisite: MAC 2313 and MAP 2302 with minimum grades of C.
Theory and application of vector, matrix and other numerical methods to systems problems. Simultaneous linear equations, characteristic values, quadratic forms, error analysis, use of series, curve fitting, nonlinear equations, discrete methods. Laboratory emphasize numerical solutions using MATLAB.

GMS 5905 Biomechanics in Orthopedics and Rehabilitation
Credits: 3.
This course will offer an interdisciplinary approach to the study of biomechanics in orthopedic clinical populations including osteoarthritis, musculoskeletal pain, athletic populations, join replacement, shoulder mechanics, balance and obesity. The clinical correlations underlying musculoskeletal disease or post-surgical conditions that impact biomechanics will be presented. Discussion of the additional functional and survey-based outcome measures that are used in

parallel with biomechanical measures in the listed populations will be integrated into each class session. Participation in integrative laboratory experiences will provide opportunity to learn about motion analysis, basic joint modeling and gait measures. Development and completion of a group project is a key component of the course.

HSA 4191 Health Informatics and Emerging Health Technologies
Credits: 3.
Provides a fundamental understanding health informatics, healthcare information systems, and emerging healthcare technologies, starting with the core informatics competencies and the foundation of knowledge model.

MAS 3114 Comp Linear Algebra
Credits: 3; Prerequisite: MAC 2312, MAC 2512 or MAC 3473 with a minimum grade of C and experience with a scientific programming language.
Linear equations, matrices and determinants. Vector spaces and linear transformations. Inner products and eigenvalues. Emphasizes computational aspects of linear algebra.

MCB 3020 Basic Biology of Microorganisms
Credits: 3; Prerequisite: BSC 2010 and BSC 2010L, or ISC 2400L, or ISC 2401L, or equivalent, with minimum grades of C; BSC 2011 and BSC 2011L, or equivalent, or AGR 3303, with minimum grades of C; non-microbiology majors only. Corequisite: CHM 2200 or CHM 2210.
Introduces the principles and techniques of microbiology, genetics, taxonomy, biochemistry and ecology and microorganisms. Also studies virology, immunology, and the pathogenicity of microorganisms. (B)

MCB 3020L Laboratory for Biology of Microorganisms
Credits: 1; Corequisite: MCB 3020; non-microbiology majors only.
Laboratory exercises on the structure, nutrition and growth of prokaryotic and eukaryotic cells. Includes isolation and classification of representative microorganisms.

MCB 3023 Principles of Microbiology
Credits: 3 credits; Prerequisite: BSC 2010 and BSC 2010L, or ISC 2400L, or ISC 2401L, or equivalent, with minimum grades of C; BSC 2011 and BSC 2011L, or equivalent, or AGR 3303, with minimum grades of C; microbiology majors only; Corequisite: CHM 2200 or CHM 2210, with mini.
Introduces the principles and techniques of microbiology, genetics, taxonomy, biochemistry, and ecology of microorganisms. Required of all majors and students who will enroll in more advanced courses in the Department of Microbiology and Cell Science.

MCB 3023L Principles of Microbiology Laboratory
Credits: 2; Prerequisite: MCB or MCY major; Corequisite: MCB 3023.
Laboratory techniques on the structure, nutrition, biochemistry, genetics, and growth of microorganisms. Required of all majors and students who will enroll in more advanced courses in the Department of Microbiology and Cell Science.

PCB 3063 Genetics
Credits: 4; Prerequisite: BSC 2011 and BSC 2011L, or equivalent, with minimum grades of C and general chemistry.

The fundamental properties of inheritance in eukaryotic organisms emphasizing examples in man. Basic concepts are developed for the nature, organization, transmission, expression, recombination and function of genetic materials and principles are derived for genetically characterizing populations.

PHY 3101 Introduction to Modern Physics
Credits: 3; Prerequisite: PHY 2049 or the equivalent.
Modern and atomic physics, relativity, wave phenomena and the basis of quantum physics.

PHY 3323 Electromagnetism 1
Credits: 3; Prerequisite: PHY 2049 and PHY 2061, or the equivalent; MAP 2302 or the equivalent.
First part of the PHY 3323/4324 sequence in electromagnetism. Course covers static electric and magnetic fields, electric circuits, Maxwell's equations, radiation and propagation of electromagnetic waves.

PHY 4604 Introductory Quantum Mechanics 1
Credits: 3; Prerequisite: PHY 3101 or PHY 3063; MAP 2302 or the equivalent.
Frist of the PHY 4604/4605 sequence. Basic concepts of quantum mechanics with applications in atomic and nuclear physics and condensed matter.