APPLIED SCIENCE (APSC)

APSC 530 Biofabrication in Tissue Engineering (3 Credits)
This course explores the rapidly evolving field of biofabrication, focusing on its application in tissue engineering to design and create advanced tissue constructs. Biofabrication integrates biomaterials, living cells, and cutting-edge fabrication techniques to engineer structures that mimic native tissues and support tissue regeneration. Through lectures, discussions, and critical reviews, students will learn about key methods, including 3D bioprinting, hydrogel fabrication, and decellularization, for developing and selecting bioinks. The course will delve into the interdisciplinary principles of biofabrication, covering material science, cellular biology, and engineering design. Topics include scaffold design, the role of biomaterials such as hydrogels and thermal plastics, and strategies to address challenges like vascularization and mechanical stability. Students will also examine real-world applications in regenerative medicine, from bone and cartilage repair to organoid development, while exploring the future of biofabrication, including emerging technologies and bioink innovations. By the end of the course, students will gain a deep understanding of biofabrication techniques, critical considerations in tissue engineering, and the challenges and opportunities shaping the field's future. This course is designed to engage students from diverse disciplines, including biology, chemistry, and applied science, who are eager to bridge the gap between engineering and biology to address pressing challenges in healthcare and regenerative medicine.

APSC 566 Directed Studies (3-4 Credits)
No credits earned in this course may be applied to the number of credits required to satisfy graduate degree requirements. This course may be repeated for credit.

APSC 603 Introduction to Scientific Research I (2 Credits)
This course sequence, designed for the first year graduate student, acquaints them with the range and scope of research opportunities in Applied Science and the skills and knowledge necessary to function as a professional researcher. Provides training in the responsible and ethical conduct of research, including discussions of fabrication, falsification, and plagiarism.

APSC 604 Introduction to Scientific Research II (2 Credits)
Continuation of APSC 603.
Prerequisite(s): APSC 603

APSC 607 Mathematical and Computational Methods I (4 Credits)
This course is a survey of important mathematical principles and techniques used to solve problems encountered in a variety of scientific disciplines and industrial applications. These disciplines and applications include chemistry, physics, and materials science. Computation is a major aspect of the course and will occupy a substantial portion of the curriculum. Computational instruction will include both analytical and numerical techniques and will make use of symbolic and numerical software packages.

APSC 608 Mathematical and Computational Methods II (4 Credits)
Continuation of APSC 607.
Prerequisite(s): APSC 607

APSC 621 Applied Solid State Science (4 Credits)
Students learn advanced concepts for bonding, macromolecular ordering, and structure-property relationships in materials. The course begins with macromolecular bonding as it relates to material dipoles, crystallographic ordering, and surfaces/interfaces. The second unit focuses on processing and morphology involving metals, ceramics, polymers, composites, adhesives, plasticizes, and solvents. The final portion of the course considers material interactions (with other materials or with electromagnetic radiation). Feynman's Coupled States approach is invoked for determining energies of electronic states arising in solid materials. Reduction/oxidation potentials, acidity/basicity, corrosion, adsorption, adhesion, electronic mobility/polarizability, and optical phenomenon are discussed in the context of the perturbation or interaction of electronic states.

APSC 622 Quantitative Materials Characterization (4 Credits)
This course presents a wide variety of means by which the properties and characteristics of materials can be experimentally determined. These include electrical, optical, acoustic, thermal, spectroscopic, and resonance methods. The objective is to discuss these separate means under the umbrella of fundamentals of interactions of matter with particles and waves. The course will address issues of data acquisition, such as sampling, discretization, and signal processing. Applications of these techniques to research in materials development, synthesis, processing, and in situ manufacturing. Cross-listed with CHEM 622

APSC 623 Materials Science of Surfaces and Interfaces (3 Credits)
Fundamental and applied aspects of metal, inorganic, polymer and other organic surfaces. Solid/solid, solid/liquid and solid/vapor interfaces. Their structure and defects, thermodynamics, reactivity, electronic and mechanical properties. Applications depend on class interests, but have previously included microelectronics, soils, catalysis, colloids, composites, environment sensitive mechanical behavior, UHV single crystal studies, materials durability, batteries and fuel cells, vacuum science and technology, and surface bioactivity. Cross-listed with CHEM 623

APSC 624 Supercomputing for Science (3 Credits)
Introduces computational data skills for scientists with a focus on big-data project management, command-line usage, and pipeline development. Develops competence in interacting with a remote high-performance computing environment. Applies the principles of project organization and reproducibility to create and benchmark analysis pipelines. Develops competence in installing, parsing, and linking novel computational tools. Cross-listed with APSC 424.

APSC 627 Lasers in Medicine, Science, and Technology (3 Credits)
A basis for understanding and use of lasers and modern optics in medicine, science, and technology. Particularly interaction of laser beams with biological materials and tissue, refractive surgery, spectroscopic applications including Raman and fluorescence imaging, laser remote sensing, and laser safety. Pre-requisites: PHYS 101/102 or PHYS 107/108.

APSC 628 Scanning Probe Nanoengineering: Visualization and Manipulation of Matter at Atomic Scales (3 Credits)
The ability to engineer smaller and smaller structures and devices has enabled great progress across many disciplines ranging from microelectronics to biomedicine. Scanning probe techniques, including scanning tunneling microscopy and atomic force microscopy, have been transformational and inspiring tools to visualize, study, and govern the nanocosmos: they have allowed us not only to image structures of atomic dimensions but also helped us to measure molecular-scale forces and interactions, and they have enabled manipulation, building, and milling of things at the nanoscale. This class covers the fundamental relationships governing the interactions of objects and structures at such small length scales. Connections are made between nanoscale behavior of materials and their practical con-sequences for everyday macroscale phenomena. Designs, imaging modes and capabilities of the scanning probe microscopes are discussed, as well as their application for nanoengineering and sensing. These techniques are discussed in the context of many other micro- and nanoscale manufacturing methods, which are also introduced. The class includes hands-on computer simulations and a hands-on tour of a state-of-the-art scanning probe microscopy laboratory.

APSC 629 Optical Microscopy - Fundamentals and Applications (3 Credits)
For centuries, optical microscopy has been an essential tool for fundamental research and applications in physical sciences, life sciences, and engineering alike. This course first introduces the fundamentals of optics necessary to rigorously understand the imaging and contrasting mechanisms of optical microscopes and their capabilities, including the wave nature of light and the resulting diffraction limit. Opportunities, limitations, and practical aspects of optical imaging are then discussed. The course then treats optical microscopes, their different modes of imaging/spectroscopy operation, and their application. Some of the latest technological developments and advancements of light microscopy are introduced. Cross-listed with APSC 429.
Prerequisite(s): (PHYS 101 or PHYS 101H or PHYS 1017) or CHEM 103 or BIOL 225

APSC 631 Applied Cellular Neuroscience (3 Credits)
We examine cellular neurophysiology including topics such as: membrane potentials, ion channels and permeability, electrical signaling and cable properties, synaptic transmission, and neuromodulation. We apply these concepts to motor control, homeostatic regulation, and special senses.

APSC 632 Applied Systems Neuroscience (3 Credits)
We explore how behaviors emerge through multiple levels of organization in the nervous system. Topics include: cranial and spinal reflexes, central pattern generator networks, the neural control of breathing, the neural control of appetite, body weight, and obesity, and finally, the neuropharmacology of nicotine addiction. Pre-requisite: APSC 631 or permission of the instructor.

APSC 637 Introduction to Optoelectronics (3 Credits)
This course is a comprehensive introduction to waveguide optics and photonics in semi-conductor structures, and provides the basic knowledge for understanding the concepts of optoelectronic devices for transmission and processing of optical signals. These optical communications engineering devices are becoming increasingly important for optical disk storage systems, optical chip-chip interconnections and optical fiber transmission and exchange. Recommended pre-requisites: PHYS 621, PHYS 741, and APSC 627.

APSC 640 Membrane Proteins: Structure, Function, and Biomedical Research (3 Credits)
Biological membranes and their constituents are involved in virtually all processes vital to living organisms, including nutrient uptake, information transfer between the inside and outside of the cell, and the mediation of vital activities such as nerve impulse propagation and hormone signaling. It is therefore not surprising that our modern view of biological cells is profoundly related to the descriptions of their membranes and that membrane-associated receptors, enzymes, and ion channels are prime drug targets. This multi-disciplinary course will cover the interplay between the three-dimensional structures, dynamics, and functions of membrane proteins and lipids, the technical approaches used to characterize their functions and active sites under physiologically-relevant conditions, and the therapeutic potential of targeting membrane proteins to treat a broad range of illnesses, such as neurological disorders, infectious diseases, inflammation, cystic fibrosis, autoimmune disorders, and cancer. Pre-requisite: Permission of the instructor. Note: CHEM 415 or the equivalent is highly recommended.

APSC 642 Applied Machine Learning (3 Credits)
This course will focus on the technical application of machine learning algorithms, their nature, and discussions regarding the potential drawbacks and advantages of different classes of algorithms. Students entering into this course should have, at a minimum, a background in Python, linear algebra, and vector calculus. No single algorithm will be covered in great depth, and the course will place a focus on the code and implementation choices necessary for each class of algorithm. Topics covered will include introductory data engineering, linear regression, decision trees, forests, k-nn, support vector machines, kernel SVM, naive Bayes, k-means and hierarchical clustering, association rules, natural language processing, neural networks, and dimensionality reduction strategies.

APSC 645 Lipids: Biochemistry, Diseases, and Applications (3 Credits)
This multi-disciplinary course will deepen basic lipid biochemistry knowledge, with a focus on how lipids contribute to (dys)functions at the chemical, molecular and cellular levels, thereby influencing vital biological processes. Specific areas explored will include the properties and functions of lipids involved in biological membranes and intracellular signaling; the biological significance of protein-lipid interactions; the influence of pathogenic lipids on host cell homeostasis; the technical approaches employed to characterize their functions, and the therapeutic approaches used to target lipid-related diseases. Assignments will emphasize reading the original literature, writing a proposal that extends current work in the field, and developing advanced analytical and problem-solving skills. Pre-requisite: Permission of the instructor. BIOL/CHEM 314 (Biochemistry) or the equivalent is highly recommended.

APSC 647 Correlated Electron Systems (3 Credits)
This course is concerned with the microscopic aspects of magnetic and superconducting states encountered in nature, their properties, and possible technological applications. The following topics will be discussed: Itinerant Electron Magnetism, Spin Waves, BCS Theory of Superconductors, Vortices in Type II Superconductors, Josephson Effect, and Quantum Interferometers. The course can be understood with minimal prerequisites and the mathematical techniques used are fairly elementary. However a basic knowledge of spin and angular momentum is essential, since quantum mechanics lies at the heart of both magnetism and superconductivity. Recommended pre-requisites: PHYS 621 and PHYS 741.

APSC 651 Cellular Biophysics and Modeling (3 Credits)
This course is an introduction to simulation and modeling of dynamic phenomena in cell biology and neuroscience. Topics covered include membrane transport and diffusion, the biophysics of excitable membranes, the gating of voltage and ligandgated ion channels, intracellular calcium signaling, and electrical bursting in neurons and other cell types.

APSC 653 Cellular Signaling in MATLAB (3 Credits)
An introduction to computer modeling of cell signal transduction, that is, how cells convert external stimuli such as hormones and neurotransmitters into an integrated and coordinated intracellular response. Topics covered include: binding of ligand to receptors, ion channels and electrical signals, metabotropic signaling (G protein coupled receptors, effector molecules, second messengers), intracellular calcium dynamics, and sensory transduction in the visual and auditory systems. Each topic will be introduced from the biological perspective and studied by simulation using MATLAB. Prior experience with mathematical and computer modeling is not required.

APSC 654 Bioinformatics and Molecular Evolution (3 Credits)
An introduction to computational molecular biology and molecular evolution including nucleotide and amino acid sequence comparison, DNA fragment assembly, phylogenetic tree construction and inference, RNA and protein secondary structure prediction and substitution models of sequence evolution. Cross-listed with BIOL 454.

APSC 685 Colloquium (0-2 Credits)
No credits earned in this course may be applied to the number of credits required for a degree. This course may be repeated.

APSC 690 Readings in Applied Science (1-9 Credits)
Subject and text to be selected by the instructor and the students. This course may be repeated for credit.

APSC 691 Topics in Applied Science (1-5 Credits)
Subject and text to be selected by the instructor and the students.

APSC 694 Directed Non-thesis Master's Research (1-12 Credits)
Students design and conduct research on a relevant topic with a faculty advisor. Students who are submitting a master's thesis may not use this course to satisfy degree requirements. Course may be repeated, but no more than 12 semester credit hours may be used to satisfy degree requirements.

APSC 695 Directed Thesis Masters Research (1-9 Credits)
Note: Students who are not submitting a master's thesis may not use this course to satisfy degree requirements. Students design and conduct research in support of their master's thesis under the direction of a faculty advisor. This course may be repeated, but no more than 9 semester credit hours may be used to satisfy degree requirements for submitting a master's thesis.

APSC 700 Thesis (1-12 Credits)
Grade of either G or U converts to P upon successful completion of a defense and submission and acceptance of the thesis. Students finish the research for and the writing of their master's thesis under the direction of a faculty advisor. Students who are not submitting a master's thesis may not use this course to satisfy degree requirements. This course may be repeated, but no more than 6 semester credit hours may be used to satisfy degree requirements for a thesis master's (only)

APSC 701 Fundamentals of Data Acquisition and Signal Processing (3 Credits)
Data acquisition of signals; sampling and discretization; the sampling theorem; undersampling and aliasing; convolution; correlation; frequent domain representation and analysis; discrete Fourier transform and FFT spectrum and filters; power spectrum estimation; z-transform and time-representation and analysis; wave shaping. Pre-requisites: MATH 109/109L, MATH 212, and MATH 302.

APSC 710 Research Project (2 Credits)
Grade of either G or U converts to P upon submission and acceptance of the paper documenting the independent research project. Students will select a faculty advisor in their area of research interest, undertake a research project, and write a paper describing their research. This course is normally taken after a student has completed 18 credit hours toward the MS degree. However, students are advised to begin the process of selecting a research area and an advisor, and to begin meeting with the advisor before completing 18 credits. It is not open to students who receive credit for APSC 700. Students wishing to register for APSC 710 must submit a short abstract describing their research project to the Graduate Director at least two weeks before the class is scheduled to begin. The faculty member who will direct the research must sign this abstract. Any tenure track faculty may direct a research project. Any student, who is unable to convince any other faculty member to be their APSC 710 advisor, will be assigned to the Applied Science graduate program director. Any student in this situation must still submit a short abstract to the Graduate Director for approval at least two weeks before the semester begins. Completion of the course includes completion of the project, writing a report and receiving approval from the advisor. All requirements must be completed by the last day of classes (not of the exam period) for the student to receive credit in a given semester. May not be repeated. Semester credit hours earned may be used to satisfy degree requirements for a non-thesis master's (only).

APSC 722 Quantitative Nondestructive Evaluation I (3 Credits)
An overview of techniques and physical principles for determining material properties and detecting and characterizing defects in materials. Ultrasonic and thermographic methods receive special emphasis.

APSC 723 Quantitative Nondestructive Evaluation II (3 Credits)
This course is a continuation of APSC 722, and covers nondestructive evaluation techniques such as acoustic microscopy, optical, eddy current and radiographic NDE. Pre-requisite: APSC 722.

APSC 751 Mathematical Physiology I (3 Credits)
Computational and mathematical aspects of electrophysiology and cellular biophysics emphasizing stochastic and spatial modeling applied to cell signal transduction, the dynamics of intracellular calcium, and the visual neurosciences. Pre-requisites: APSC 651 or permission of the instructor.

APSC 752 Mathematical Physiology II (3 Credits)
This course is a continuation of APSC 751 - Mathematical Physiology I. Pre-requisite: APSC 751 or permission of the instructor.

APSC 766 Directed Studies (1-12 Credits)
No credits earned in this course may be applied to the number of credits required to satisfy graduate degree requirements. This course may be repeated.

APSC 772 Tensor Interactions in Magnetic Resonance (3 Credits)
This course is intended for graduate students who have begun Ph.D. thesis work in magnetic resonance. Topics to be covered include: angular momentum theory, spherical representation of tensors, the Wigner-Eckart theorem and matrix elements of tensor operators, operator bases for representing the spin density matrix, and the theory and applications of spin relaxation. Pre-requisite: Permission of instructor.
Prerequisite(s): APSC 671

APSC 776 Acoustic Wave Propagation in Solids (3 Credits)
Wave propagation in solids with emphasis on the evaluation of materials and defects. Linear and non-linear wave propagation, mode analysis and mixing, reflection and refraction at interfaces, and wave scattering from defects in isotropic and anisotropic media will be discussed, along with the relationship between wave behavior and the reconstruction of material constitutive equations. The course also will describe the practical aspects of the generation and detection of acoustic waves for non-destructive evaluation of materials. Pre-requisite: APSC 722.

APSC 784 Imaging Methods (3 Credits)
Fundamentals and applications of imaging techniques: microscopy and other optical imaging techniques, and scanning probe methods. Topics covered include geometric and wave optics, Fourier optics, basic forms of light-matter interaction, all major optical microscopy modes (including fluorescence and confocal), atomic force microscopy, and near-field optics. Pre-requisite: Permission of instructor.

APSC 785 Acoustic and EM Scattering (3 Credits)
Acoustic, electromagnetic and elastic wave scattering for materials characterization and remote sensing. Subjects to be covered are: field equations, boundary conditions, Green's functions; integral representations and integral equations, scattering amplitude and scattering matrices; plane, spherical and cylindrical scalar and vector wave functions; scattering of waves by spheres and cylinders; inverse scattering techniques. Pre-requisite: APSC 723.

APSC 790 Readings in Applied Science (1-5 Credits)
Subject and text to be selected by the instructor and students.

APSC 791 Topics in Applied Science (1-5 Credits)
Subject and text to be selected by the instructor and students.

APSC 795 Directed Dissertation Research (3-12 Credits)
Students design and conduct research in support of their dissertation under the direction of a faculty advisor. This course may be repeated, but no more than 12 semester credit hours may be used to satisfy degree requirements for a student submitting a dissertation. Students who are not submitting a dissertation may not use this course to satisfy degree requirements.

APSC 800 Dissertation (1-12 Credits)
Students finish the research for and the writing of their dissertation under the direction of a faculty advisor. This course may be repeated, but no more than 24 semester credit hours may be used to satisfy degree requirements for a doctorate only.