DEPARTMENT OF APPLIED PHYSICAL SCIENCES

Contact Information
Department of Applied Physical Sciences
Visit Program Website (https://aps.unc.edu/apse-minor/)
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The Department of Applied Physical Sciences expands interdisciplinary research and teaching by strengthening an intellectual climate in which science is collaborative and focused on applications. The department has connections among disciplinary departments across the natural sciences. The doctoral graduate program in materials science is housed in the department. The department offers undergraduate courses (https://aps.unc.edu/coursework/) and a minor in applied sciences and engineering (http://catalog.unc.edu/undergraduate/programs-study/applied-sciences-engineering-minor/). APS is also home to BeAM (https://beam.unc.edu) (Be A Maker), the UNC network of makerspaces, and CHANL (https://chanl.unc.edu) (Chapel Hill Analytical and Nanofabrication Laboratory).

Minor
• Applied Sciences and Engineering Minor (http://catalog.unc.edu/undergraduate/programs-study/applied-sciences-engineering-minor/)

Graduate Programs
• Ph.D. in Materials Science (https://aps.unc.edu/graduate-program-overview/)

Professors
Theo J. Dingemans (APS), High-Performance Polymers and (Nano)composites.
Greg Forest (Mathematics), Flow and Structure of Complex Polymeric Fluids.
Jinsong Huang (APS), Perovskite Solar Cells, Photodetectors, X-ray Imaging, Radiation Detectors, Electronic Devices.
Peter Mucha (Mathematics), Complex Systems, Networks, Complex Fluids.
Richard Superfine (APS), Biological Physics, Soft Matter, Biomedical Device Technologies.
Sean Washburn (Physics and Astronomy – APS), Quantum Transport, Mechanical and Electrical Response of Nanostructures.

Associate Professor
Ronit Freeman (APS), Development of Novel Designer Materials Using Self-Assembling Biological Components.

Teaching Associate Professors
Richard Goldberg (APS), Assistive Technology, Rehabilitation Engineering, Engineering Education.

Assistant Professors
Daphne Klotza (APS), Computational Soft and Active Matter.
Ehssan Nazockdast (APS), Modeling/Simulation of Biophysical Phenomena.
Scott Warren (Chemistry – APS), Supramolecular and Solid-State Chemistry for Materials Design.
Zijie Yan (APS), Optical Trapping and Manipulation, Holography, Microfluidics, Electronic and Photonics Nanomaterials.

Affiliated Faculty
James Cahoon (Chemistry), Nanoparticle Synthesis and Characterization.
Orlando Coronell (Environmental Sciences and Engineering), Wet Chemistry, Polymer Synthesis, Membrane Systems.
Joseph M. DeSimone (Chemistry), Polymeric Materials Synthesis.
J. Michael Ramsey (Chemistry), Analytical Chemistry, Microfabricated Chemical Instrumentation, Microfluidics, Nanofluidics.
Edward T. Samulski (Chemistry – APS), Liquid Crystals and Liquid Crystal Polymers.
Wei You (Chemistry), Organic and Polymer Synthesis, Organic Solar Cells, Molecular Electronics, Organic Spintronics.

Advanced Undergraduate and Graduate-level Courses
APPL 405. Convergent Engineering: Team-Science Approaches to Discovery and Innovation. 3 Credits.
Students will participate in activities, group discussion, and problem-solving coaching to understand how chemistry, physics, materials science, and biology are applied to engineering. Topics are introduced through discussing relevant scientific literature, and guest lecturers and faculty discuss expertise in fields like mathematical modeling, mechanical engineering, or circuit design. Guest lecturers can provide new perspective on the problems so students gain an interdisciplinary view of the subject.
Grading status: Letter grade.

APPL 412. Turning Your Entrepreneurial Ideas Into Reality. 3 Credits.
Students will work in groups on a semester project to turn their entrepreneurial ideas into reality.
Requisites: Prerequisite, APPL 110; permission of the instructor for students lacking the prerequisite.
Gen Ed: EE- Field Work.
Grading status: Letter grade.

APPL 420. Introduction to Polymers. 3 Credits.
Chemical structure and nomenclature of macromolecules, synthesis of polymers, characteristic polymer properties.
Requisites: Prerequisite, CHEM 261 or 261H; pre- or corequisites, CHEM 262 or 262H, and 262L or 263L.
Grading status: Letter grade
Same as: CHEM 420.
APPL 421. Synthesis of Polymers. 3 Credits.
Synthesis and reactions of polymers; various polymerization techniques.
Requisites: Prerequisites, CHEM 251 and 262 or 262H.
Grading status: Letter grade
Same as: CHEM 421.

APPL 422. Physical Chemistry of Polymers. 3 Credits.
Polymerization and characterization of macromolecules in solution.
Requisites: Prerequisites, CHEM 420 and 481.
Grading status: Letter grade
Same as: CHEM 422.

APPL 423. Intermediate Polymer Chemistry. 3 Credits.
Plymer dynamics, networks and gels.
Requisites: Prerequisite, CHEM 422.
Grading status: Letter grade
Same as: CHEM 423.

APPL 430. Optical Instrumentation for Scientists and Engineers. 3 Credits.
This is an introduction to methods of automatic computation of specific relevance to biomedical problems. Sampling theory, analog-to-digital conversion, and digital filtering will be explored in depth. Previously offered as APPL 460.
Requisites: Prerequisite, MATH 383.
Grading status: Letter grade.

APPL 435. Nanophotonics. 3 Credits.
This course introduces the principles of nanophotonics - an emerging frontier at the nexus of nanotechnology and photonics that deals with light-matter interactions at the nanometer scale. The course will cover the theoretical foundations of nanoscale materials and optics, fabrication and characterization of optical nanostructures, plasmonics, nanomanipulation by optical tweezers, electrodynamic simulations, nanoscale light emitters, and applications of nanophotonics.
Requisites: Prerequisites, PHYS 117 and CHEM 251.
Grading status: Letter grade.

APPL 462. Engineering Materials: Properties, Selection and Design. 3 Credits.
This course will cover both fundamental and applied aspects of modern materials science. We will discuss how to select materials based on their properties and how they can be processed into products that you encounter in everyday life. A strong focus will be on the relationship between processing, structure (development), and properties of solid materials, such as metals, ceramics, and polymers.
Requisites: Prerequisite, CHEM 102, or PHYS 116 or PHYS 118.
Grading status: Letter grade.

APPL 465. Sponge Bob Square Pants and Other Soft Materials. 3 Credits.
What kind of material is Sponge Bob made of? What about the slime of his pet snail, Gary? We are taught that there are three states of matter: solid, gas, and liquid. However, in our daily lives we encounter materials that challenge this simple description such as foams, pastes, gels, soap, and rubber. These are Soft Materials and in this course we will learn about their special properties.
Grading status: Letter grade.

APPL 470. Fundamentals of Materials Science. 3 Credits.
Crystal geometry, diffusion in solids, mechanical properties of solids, electrical conduction in solids, thermal properties of materials, phase equilibria.
Requisites: Prerequisite, CHEM 482 or PHYS 128. Pre- or corequisite, PHYS 441.
Grading status: Letter grade
Same as: CHEM 470.

APPL 472. Chemistry and Physics of Electronic Materials Processing. 3 Credits.
Permission of the instructor. A survey of materials processing and characterization used in fabricating microelectronic devices. Crystal growth, thin film deposition and etching, and microlithography.
Requisites: Prerequisite, CHEM 482 or PHYS 117 or 119.
Grading status: Letter grade
Same as: PHYS 472, CHEM 472.

APPL 473. Chemistry and Physics of Surfaces. 3 Credits.
The structural and energetic nature of surface states and sites, experimental surface measurements, reactions on surfaces including bonding to surfaces and adsorption, interfaces.
Requisites: Prerequisite, CHEM 470.
Grading status: Letter grade
Same as: CHEM 473.

APPL 490. Special Topics. 1-3 Credits.
Topics vary from semester to semester.
Repeat rules: May be repeated for credit; may be repeated in the same term for different topics; 9 total credits. 9 total completions.
Grading status: Letter grade.

APPL 491L. Materials Laboratory I. 2 Credits.
Structure determination and measurement of the optical, electrical, and magnetic properties of solids.
Requisites: Prerequisites, APPL 470 and PHYS 351.
Grading status: Letter grade
Same as: PHYS 491L.

APPL 492L. Materials Laboratory II. 2 Credits.
Continuation of PHYS 491L with emphasis on low- and high-temperature behavior, the physical and chemical behavior of lattice imperfections and amorphous materials, and the nature of radiation damage.
Requisites: Prerequisite, APPL 491L or PHYS 491L.
Grading status: Letter grade
Same as: PHYS 492L.

APPL 493. Internship in Applied Physical Sciences. 3 Credits.
An ideal internship provides students with practical experience in an organization outside of UNC, doing work that is relevant to their UNC education. The internship should develop and enhance the students’ professional skill sets and involve experiences that allow students to have responsibility for results that are of value to the organization.
Gen Ed: EE- Academic Internship.
Grading status: Letter grade.

APPL 495. Mentored Research in Applied Physical Sciences. 3 Credits.
Students undertake independent research with a faculty mentor. In order to register for this class, students must submit a learning contract and research proposal for approval. At the end of the semester, students submit a final report that describes their research. Students are encouraged to present their work either internally at UNC or externally at a conference or symposium.
Gen Ed: EE- Mentored Research.
Grading status: Letter grade.

APPL 520L. Polymer Chemistry Laboratory. 2 Credits.
Various polymerization techniques and characterization methods. One four-hour laboratory each week.
Requisites: Pre- or corequisite, CHEM 420 or 421 or 425.
Gen Ed: EE- Mentored Research.
Grading status: Letter grade
Same as: CHEM 520L.
APPL 573. Introductory Solid State Physics. 3 Credits.
Crystal symmetry, types of crystalline solids; electron and mechanical waves in crystals, electrical and magnetic properties of solids, semiconductors; low temperature phenomena; imperfections in nearly perfect crystals.
Requisites: Prerequisite, PHYS 421; permission of the instructor for students lacking the prerequisite.
Grading status: Letter grade
Same as: PHYS 573.

APPL 590. Special Topics in Applied Physical Sciences. 3 Credits.
Advanced specialty topics in applied physical sciences for undergraduates and graduates.
Repeat rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading status: Letter grade.

APPL 690. Special Topics in Applied Physical Sciences. 3 Credits.
Advanced specialty topics in applied physical sciences for undergraduate and graduates.
Repeat rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading status: Letter grade.

Material Science (MTSC)
Advanced Undergraduate and Graduate-level Courses

MTSC 615. Structure of Solids. 3 Credits.
Crystallography, reciprocal lattices, Bloch waves, band structure, electronic wave functions, phonons, thermal expansion. Superlattice structures, including liquid crystals. Overview of properties of ceramic, amorphous, polymeric, and composite materials.
Grading status: Letter grade.