DEPARTMENT OF APPLIED PHYSICAL SCIENCES (GRAD)

The Department of Applied Physical Sciences combines applied science and engineering to solve real problems for North Carolina and the world through technology, innovation and partnerships, and the preparation of knowledgeable and responsible students, citizens, and researchers. The department expands interdisciplinary research and teaching by strengthening an intellectual climate in which science is collaborative and focused on applications.

The doctoral program in materials science is an interdisciplinary graduate program that brings together faculty members from chemistry, mathematics, physics and astronomy, and various departments across the University to engage in research and training in applications of the physical sciences. The primary areas of emphasis in the program are optical and electronic materials, nanomaterials, polymers, and biomaterials. Students pursuing Ph.D. degrees in materials science begin their studies with a core curriculum covering the fundamentals of materials, including their structures, surfaces, fabrication, thermodynamics, and materials science laboratory techniques. They continue with elective courses offered within APS or other departments as appropriate to their area of research concentration. Graduate students engage in research under the supervision of one of the participating materials science faculty in APS.

APS is also home to BeAM (https://beam.unc.edu) (Be A Maker), the UNC network of makerspaces.

Research Interests

The four areas of research emphasized in the program are electronic, nano, polymer, and biomaterials. These four areas are not discrete, however, as research projects in solar energy, soft and biological matter, structural materials, optical engineering and neuroscience, data science and computational modeling demonstrate. Individual faculty members typically have research interests in more than one of the primary areas, and collaborate with others to address several grand challenges. For detailed information on the graduate program, please email (apsssm@unc.edu) or call the graduate program coordinator at (919) 966-2291.

Facilities and Equipment

Students and faculty members have access to state-of-the-art central facilities for materials synthesis, processing and characterization. These capabilities are located within individual research laboratories and, especially, within the Chapel Hill Analytical and Nanofabrication Laboratory (CHANL (https://chanl.unc.edu)). Faculty and students also have access to the expertise, tools, and equipment in BeAM (https://beam.unc.edu/) (Be A Maker), the network of UNC campus makerspaces.

Fellowships and Assistantships

Research and teaching assistantships are available to qualified graduate students. The duties of teaching assistants can include guiding students in BeAM (https://beam.unc.edu) (Be A Maker, the UNC–Chapel Hill network of makerspaces) and teaching laboratory sections, and assisting in the supervision of advanced laboratories, teaching recitation sections, and grading papers. Summer support is generally available. A variety of fellowships (https://gradschool.unc.edu/funding/gradschool/fellowshipsandgrants.html) are available.

Degree Requirements

The Ph.D. degree requirements include completion of a suitable set of courses, literature review, prospectus, a first doctoral oral exam, an original research project culminating in a dissertation, and a final oral exam. The general regulations of The Graduate School govern credit hour, residency, and examination requirements.

Courses

All graduate students must pass the following courses, or must have passed their equivalents elsewhere:

Code	Title	Hours
MTSC 710	Materials Science First Year Seminar: Resources for success in your PhD program	1
MTSC 711	Materials Science First Year Seminar: Developing your plan for success	1
MTSC 718	Seminar in Materials Science and Engineering	1
MTSC 780	Advanced Materials Science	3
MTSC 785	Introduction to Scientific Computing for Materials	3

Each student also takes additional courses offered by Applied Physical Sciences (APS) or participating departments, as appropriate for his or her area of study.

Literature Review

At the end of the first year students write a literature review. The literature review is intended to prepare students and their advisor for their specific research, the oral defense, which will take place towards the end of the second year, and future publications.

Prospectus and First Doctoral Oral Exam

There are two oral exams. The first oral exam is coordinated with the student's doctoral advisory committee (DAC). The oral exam will ascertain if the student has acquired the knowledge and skills needed to be successful in research. Two weeks prior to the exam students submit a written prospectus to their DAC. The prospectus describes a detailed research proposal.

The first oral exam includes a 45-minute presentation of the student's research project aim in the context of the existing literature and research results to date. It is recommended that students also present their possible next steps (future work!) and elaborate on what is needed in order to be successful in their research. For example, it could be that the research would benefit from an internship at another university or industrial partner, or from collaborative research at one of the national labs. Committee members review proposals and research plans during the oral exam, ask questions, and give suggestions and feedback.

Dissertation and Final Oral Exam

The final oral exam is coordinated with the student's DAC and is a defense of the research thesis.

Professors

Theo J. Dingemans, High-Performance Polymers and (Nano)composites
Jinsong Huang, Perovskite Solar Cells, Photodetectors, X-ray Imaging, Radiation Detectors, Electronic Devices

Rene Lopez (Physics and Astronomy), Optical Materials, Photonic Structures, Photovoltaics
Richard Superfine, Biological Physics, Soft Matter, Biomedical Device Technologies

Associate Professors

Ronit Freeman, Development of Novel Designer Materials Using Self-Assembling Biological Components
Daphne Klotsa, Computational Soft and Active Matter
Nico Pegard, Computational Optics, Imaging Systems, Optical Instrumentation and Digital Interfaces for Systems Biology and Neuroscience

Assistant Professors

Wubin Bai, Bioelectronics, Soft Materials, Advanced Manufacturing, Microsystems, Electronic Materials, Photonic Materials, and Biomaterials
Ehssan Nazockdast, Modeling/Simulation of Biophysical Phenomena
Youhong (Nancy) Guo, Materials Science and Engineering, Separation Processes, Renewable Energy Harvesting and Utilization, Advanced Manufacturing

Teaching Associate Professor

Richard Goldberg, Assistive Technology, Rehabilitation Engineering, Engineering Education

Teaching Assistant Professor

Alexis Gillmore, Engineering Education, Epistemology, Design, Soil Biogeochemistry

Professor of the Practice

Dedric Carter, Vice Chancellor, Innovation, Entrepreneurship and Economic Development and Chief Innovation Officer, Systems Applications to Technical, Business and Policy Issues with an Emphasis on the Entrepreneurial Process, Innovation and New Venture Creation
Glenn Walters, Instrumentation for Innovation, BeAM Design and Innovation Hub, Engineering Education

Affiliated Faculty

James Cahoon (Chemistry), Nanoparticle Synthesis and Characterization
Praneeth Chakravarthula (Computer Science), Optics, Perception, Graphics, Optimization, Machine Learning
Orlando Coronell (Environmental Sciences and Engineering), Wet Chemistry, Polymer Synthesis, Membrane Systems
Greg Forest (Mathematics), Flow and Structure of Complex Polymeric Fluids
Boyce Griffith (Mathematics and Biomedical Engineering), Cardiovascular Modeling and Simulation
Yun Li (Genetics and Biostatistics), Statistical Methods and Computational Tools and Applications to Genetic Dissection of Complex Diseases
Jianping Lu (Physics), Nanotechnology, Carbon Nanotube X-rays, Tomosynthesis and Computed Tomography
Gerald Meyer (Chemistry), Inorganic Materials, Spectroscopy, and Electrochemistry
Cass T. Miller (Environmental Sciences and Engineering), Environmental Physics, Soft Matter, Continuum Mechanics, Applied Mathematics, Computational Science
J. Michael Ramsey (Chemistry), Analytical Chemistry, Microfabricated Chemical Instrumentation, Microfluidics, Nanofluidics
Jose Rodríguez-Romaguera (Neuroscience Center), Neuronal Circuits, Imaging, Optogenetics
Edward T. Samulski (Chemistry), Liquid Crystals and Liquid Crystal Polymers
Alexander Tropsha (Eshelman School of Pharmacy), Computational Chemistry, Cheminformatics and Structural Bioinformatics
Scott Warren (Chemistry), 2D Materials, Energy Storage, Solar Energy, Nanoelectronics, Supramolecular and Solid-State Chemistry for Materials Design
Yue Wu (Physics and Astronomy), Water and Gas Configuration at a Nanometric Level
Wei You (Chemistry), Organic and Polymer Synthesis, Organic Solar Cells, Molecular Electronics, Organic Spintronics

APPL

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.

Rules & Requirements
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.

Rules & Requirements

IDEAs in Action Gen Ed: FC-CREATE.
Requisites: Prerequisite, APPL 110; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

APPL 430. Optoelectronics from Materials to Devices. 3 Credits.
At the intersection between electrical engineering, optics, and computer science, this course explores how optoelectronic materials can be turned into optoelectronic devices to build high performance optical instruments. The course features many hands-on activities that include electronics, with the study of sensors operating under low light and high noise conditions, custom optical system design, imaging and holography systems, as well as computational imaging techniques using MATLAB (basic programming experience in any language is sufficient).

Rules & Requirements
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.

Rules & Requirements
Requisites: Prerequisite, PHYS 117 or 119.
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.

Rules & Requirements
Requisites: Prerequisite, CHEM 102; or PHYS 116 or PHYS 118.
Grading Status: Letter grade.

APPL 463. Bioelectronic Materials. 3 Credits.
Developing electronic systems that can seamlessly integrate with biological systems represents a pivotal foundation for building a smart healthcare platform, advanced clinical technology, and beyond. Through multiple hands-on projects, this course will explore and discuss: 1) electronic materials, mechanisms, and designs at the biotic-abiotic interface, 2) their impacts for a wide range of applications ranging from medicine, robotics, to human augmentation, and 3) the associated ethics that aim to harmonize the development pathways.

Rules & Requirements
Requisites: Prerequisites, BMME 209 or APPL 260 or CHEM 102 and PHYS 115 or PHYS 119 and permission of the instructor.
Grading Status: Letter grade.

APPL 465. Engineering of Soft Materials: SpongeBob Squarepants and Other Squishy Things. 3 Credits.
What kind of material is Sponge Bob? What about his pet snail, Gary? We are taught that there are solids, liquids, and gases. However, some materials challenge this description, such as foams, plastics, pastes, skin, hair, and nails. These are soft materials, and they are everywhere: sunscreen, insulation, and car tires. In this course, we will learn about soft materials' properties, how they are processed in industry, and how to design novel soft materials.

Rules & Requirements
Grading Status: Letter grade.

APPL 467. Materials Design for Biomedicine. 3 Credits.
The 21st century has already been marked with substantial discoveries in the interface of materials science, biology, and medicine that have a profound effect on our future. The course will focus on all classes of biological materials such as: biologically derived materials, natural and synthetic biomaterials, and bioinspired materials. In addition, the course will highlight the use of nanoscale materials and techniques to rapidly advance our understanding of human biology and the practice of medicine.

Rules & Requirements
Requisites: Prerequisite, CHEM 102.
Grading Status: Letter grade.

APPL 490. Special Topics. 1-3 Credits.
Topics vary from semester to semester.

Rules & Requirements
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 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.

Rules & Requirements
IDEAs in Action Gen Ed: HI-INTERN.
Grading Status: Letter grade.

APPL 495. Mentored Research in Applied Sciences and Engineering. 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.

Rules & Requirements
IDEAs in Action Gen Ed: RESEARCH.
Grading Status: Letter grade.

APPL 496. Independent Study in Applied Sciences and Engineering. 1-3 Credits.
Permission of the director of undergraduate studies is required. Independent study under a member of the applied physical sciences faculty. Approved learning contract required.

Rules & Requirements
Repeat Rules: May be repeated for credit. 6 total credits. 6 total completions.
Grading Status: Letter grade.

APPL 590. Special Topics in Applied Physical Sciences. 3 Credits.
Advanced specialty topics in applied physical sciences for undergraduates and graduates.

Rules & Requirements
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.

Rules & Requirements
Repeat Rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading Status: Letter grade.

Graduate-level Courses

APPL 710. Design and Making for the Researcher. 3 Credits.
In this course intended for graduate student researchers, we will parallel the discovery process taught in APPL 110: human-centered design, needs identification, and the iterative design and prototyping process. You will learn technical areas common to research laboratories - hardware selection, gas and liquid management, material compatibilities, electronics and data acquisition. In addition to the BeAM makerspace focused skills development activities, students will work on a personal project related to their laboratory work or research topic.

Rules & Requirements
Grading Status: Letter grade.

APPL 760L. Nanofabrication/micro-electromechanical systems (MEMS) Laboratory. 2 Credits.
Permission of the instructor. A laboratory course covering fabrication technologies for building materials and structures in biomedical devices, electronics, MEMS, and nanomedicine. The course includes lectures on thin film deposition, etching, and photolithography and hands-on laboratories to apply knowledge and practice skills covered in the lectures.

Rules & Requirements
Grading Status: Letter grade.

APPL 763. Bioelectronic materials. 3 Credits.
Developing electronic systems that seamlessly integrate with biological systems represents a pivotal foundation for building a smart healthcare platform, advanced clinical technology, and beyond. This course will explore: 1) electronic materials, mechanisms, and designs at the biotic-abiotic interface, 2) their impacts for a wide range of applications from medicine, robotics, to human augmentation, and 3) the associated ethics. It will also highlight a multifaceted understanding of materials and their integration strategies that improve functionalities (sensing, stimulation, or others) of fabricated devices, and innovate the ways electronics interact with biological counterparts. We will utilize BeAM makerspace for implementing our hands-on activities.

Rules & Requirements
Requisites: Prerequisites, an introductory materials sciences class such as BMME 209 or APPL 260; or CHEM 102 and PHYS 115/PHYS 119 and permission of the instructor.
Grading Status: Letter grade.

MTSC

Advanced Undergraduate and Graduate-level Courses

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Grading Status: Letter grade.

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Rules & Requirements
IDEAs in Action Gen Ed: FC-CREATE.
Requisites: Prerequisite, APPL 110; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

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Requisites: Prerequisite, MATH 383.
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Rules & Requirements
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Topics vary from semester to semester.

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IDEAs in Action Gen Ed: RESEARCH.
Grading Status: Letter grade.

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Rules & Requirements
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Grading Status: Letter grade.

APPL 590. Special Topics in Applied Physical Sciences. 3 Credits.
Advanced specialty topics in applied physical sciences for undergraduates and graduates.

Rules & Requirements
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.

Rules & Requirements
Repeat Rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading Status: Letter grade.

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.

Rules & Requirements
Grading Status: Letter grade.

Graduate-level Courses

MTSC 710. Materials Science First Year Seminar: Resources for success in your PhD program. 1 Credits.
The Materials Science graduate student seminar series is a 1-credit course required for first year MTSC students. It is designed to expose students to APS research and key resources and skills outside of course work that they will need to be successful in the PhD program and beyond. Sessions will include research talks by APS faculty, workshops by invited speakers internal and external to UNC, and presentations by second year PhD students.

Rules & Requirements
Grading Status: Letter grade.

MTSC 711. Materials Science First Year Seminar: Developing your plan for success. 1 Credits.
Students gain knowledge and learn key skill-sets outside of their technical course work needed for success in their PhD program and beyond. MTSC 711 follows on the topics learned in MTSC 710 to broaden the professional development of materials science PhD students. Students work to develop an Individual Development Plan, to understand the variety of career paths available for PhD-holders, and to practice research presentations.

Rules & Requirements
Grading Status: Letter grade.

MTSC 718. Seminar in Materials Science and Engineering. 1 Credits.
The Seminar in Materials Science and Engineering is a required 1-credit course for all Materials Science students in fall and spring semesters of years 2-5 of their doctoral program. The course tracks attendance at the required APS departmental seminars. Attending departmental seminars is an important component of training for MTSC doctoral students. Engaging in the seminars will help students gain a working knowledge of a variety of research areas important to their doctoral research.

Rules & Requirements
Grading Status: Letter grade.

MTSC 720. Materials Fabrication. 3 Credits.
Permission of the department. Introduction to materials fabrication and characterization techniques. Includes single crystal growth, thin film deposition, synthesis of quantum dots and nanotubes/nanowires, dielectric and electron emissive materials, nanocomposites, bioceramics, and energy storage materials.

Rules & Requirements
Grading Status: Letter grade.

MTSC 730. Statistical Thermodynamics. 3 Credits.
Permission of the instructor. Theory of ensembles and interactions in statistical mechanics. Classical and quantum statistics. Applications to simple systems: ideal gas, heat capacity of solids, blackbody radiation, phase transitions.

Rules & Requirements
Grading Status: Letter grade.

MTSC 735. Techniques in Materials Science. 3 Credits.
Permission of the department. Lecture and laboratory in materials analysis techniques, including microscopy, X-ray diffraction and fluorescence, magnetic resonance, thermal analysis, XPS, channeling and RBS, mechanical properties, optical spectroscopy.

Rules & Requirements
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

MTSC 740. Advanced Biomaterials. 3 Credits.
Medical or dental implants or explants are highlighted from textbooks, scientific literature, and personal accounts.

Rules & Requirements
Requisites: Prerequisite, BMME 510; Permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: BMME 740.

MTSC 745. Chemistry of Biomaterials. 3 Credits.
Focuses on the chemistry and chemical structure-function relationships of soft synthetic biological materials. Topics include chemistry of proteins, peptides, nucleic acids, polysaccharides and lipids, and their incorporation into biomaterials and biosensors; enzymatic reactions; chemical modification of organic and inorganic surfaces using self-assembled monolayer chemistries, bioconjugation chemistries, synthesis of nanoparticles and their application as sensors, application of biological materials for logic operations, fundamentals of supramolecular chemistry.

Rules & Requirements
Grading Status: Letter grade.

MTSC 750. Kinetics, Diffusion, and Phase Transitions of Materials. 3 Credits.
Reaction kinetics in bulk materials. Mass transport, microstructural transformations, and phase transitions in condensed phases. Atom diffusion in solids. Spinodal decomposition.

Rules & Requirements
Grading Status: Letter grade.

MTSC 755. Polymer Processing and Properties. 3 Credits.
How does one process ultrahigh molecular weight polyethylene into ultra-strong fibers or how would you design a polymer shape-memory actuator? Polymer chemistry is important but equally important is the way how polymers are processed. In this course we will discuss the relationship between polymer chemistry, processing and the final, after processing, properties. (We will discuss different processing methods that are currently in use), and which parameters play a role in controlling the final properties.

Rules & Requirements
Grading Status: Letter grade.

MTSC 760. Complex Fluids: Theory and Applications. 3 Credits.
Complex fluids are materials we encounter everyday such as pastes, gels, foams, blood, and tissue, yet ones that cannot be categorized within the traditional three states of matter (solid/gas/liquid). In this course, we introduce the main physical and mathematical concepts of the continuum mechanics of complex fluids and follow with microscopic approaches. The course is designed to focus on both theory and applications with hands-on activities and examples.

Rules & Requirements
Grading Status: Letter grade.

MTSC 765. Electronic Materials and Devices - Organic and Inorganic. 3 Credits.
The course introduces the electronic and optical processes in organic molecules and polymers that govern the behavior of practical organic optoelectronic devices. The course begins with an overview of fundamental science of electronic materials and devices. We then discuss their optoelectronic properties of organic molecules, including topics from photophysics, charge transport and injection. Emphasis will be equally placed on the use of both inorganic and organic electronic materials in organic electronic devices.

Rules & Requirements
Grading Status: Letter grade.

MTSC 780. Advanced Materials Science. 3 Credits.
This course covers the physical fundamentals of material science with an in-depth discussion of structure formation in soft and hard materials and how structure determines material mechanical, electrical, thermal, and optical properties. Topics include amorphous and crystal structures, defects, dislocation theory, thermodynamics and phase diagrams, diffusion, interfaces and microstructures, solidification, and theory of phase transformation. Special emphasis will be on the structure-property relationships of (bio)polymers, (nano)composites, and their structure property relationships.

Rules & Requirements
Grading Status: Letter grade.
Same as: BMME 780, CHEM 780, PHYS 780.

MTSC 785. Introduction to Scientific Computing for Materials. 3 Credits.
An introduction to scientific computing key concepts and applying these concepts to solve problems, focusing on materials science and engineering. An overview of the mathematics basis of each numerical technique is followed with computer programming during and outside of class to apply those techniques. The course will require a final project to understand application software commonly used in materials science and engineering, including molecular dynamics (MD) software and in continuum modeling software.

Rules & Requirements
Grading Status: Letter grade.

MTSC 810. Device Physics and Electronic Properties of Solids. 3 Credits.
Survey of crystal structure, bandstructure, transport. Overview of FETs, heterostructures, light emission, dissipation, noise, integrated circuits, solar cells, and ceramics. Emphasis on physical sources of device behavior.

Rules & Requirements
Requisites: Prerequisites, APPL 470 or PHYS 573, MTSC 615, and 730; permission of the instructor for students lacking the prerequisites.
Grading Status: Letter grade.

MTSC 820. Optical Properties of Solids. 3 Credits.
Reflection, waveguides, nonlinear optics, optical switching, photorefraction, optical storage. Optical coupling to electronic states, device applications, optical computing.

Rules & Requirements
Requisites: Prerequisites, APPL 470 or PHYS 573, and PHYS 415; permission of the instructor for students lacking the prerequisites.
Grading Status: Letter grade.

MTSC 830. Ion-Solid Interactions. 3 Credits.
Interatomic potentials, range distribution, radiation damage, annealing, secondary defects, analytical techniques, silicon-based devices, implantation in compound semiconductors, and buried layer synthesis. Ion implantation in metals, ceramics, polymers, and biomaterials.

Rules & Requirements
Requisites: Prerequisite, APPL 470 or PHYS 573; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

MTSC 840. New Technologies and Device Architecture. 3 Credits.
Survey of novel and emerging device technologies. Resonant tunneling transistors, HEMT, opto-electronic devices and optical communication and computation, low-temperature electronic, hybrid superconductor devices.

Rules & Requirements
Requisites: Prerequisites, APPL 470 or PHYS 573, MTSC 615, and 730; permission of the instructor for students lacking the prerequisites.
Grading Status: Letter grade.

MTSC 871. Solid State Physics. 3 Credits.
Topics considered include those of PHYS 573, but at a more advanced level, and in addition a detailed discussion of the interaction of waves (electromagnetic, elastic, and electron waves) with periodic structures, e.g., X-ray diffraction, phonons, band theory of metals and semiconductors.

Rules & Requirements
Requisites: Prerequisite, PHYS 421; equivalent experience for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: PHYS 871.

MTSC 872. Solid State Physics II. 3 Credits.
Topics considered include quantum and thermal fluctuations, and thermodynamics of phase transitions in a broad variety of condensed matter systems, their kinetic theory and hydrodynamics, novel materials (two-dimensional electron gas, graphene, topological insulators and superconductors, Dirac/Weyl/nodal line semimetals), condensed matter applications of modern field-theoretical methods (path integral, renormalization group, holography).

Rules & Requirements
Requisites: Prerequisite, PHYS 871.
Grading Status: Letter grade.
Same as: PHYS 872.

MTSC 891. Special Topics in Material Science. 1-3 Credits.
Permission of the department. Current topics in materials science, including electronic and optical materials, polymers, and biomaterials.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics.
Grading Status: Letter grade.

MTSC 892. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduate students.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

MTSC 893. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduate students.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

MTSC 894. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduate students.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

MTSC 895. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduate students.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

MTSC 896. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduates.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 1 total completions.
Grading Status: Letter grade.

MTSC 897. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduate students.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

MTSC 898. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduate students.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

MTSC 899. Special Topics in Material Sciences. 3 Credits.
Advanced specialty topics in material sciences for graduate students.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

MTSC 989. Materials Science internship. 1-3 Credits.
An internship can be an important component of graduate training for students earning a Materials Science doctoral degree. The purpose of the internship is to expand research training and exposure to non-academic workplace environments. The student's faculty advisor and an onsite internship mentor will supervise the internship. Students work directly with their faculty advisor and their external contacts to identify internship opportunities and complete a learning agreement for the internship experience.

Rules & Requirements
Repeat Rules: May be repeated for credit. 3 total credits. 3 total completions.
Grading Status: Letter grade.

MTSC 992. Master's (Non-Thesis). 3 Credits.

MTSC 993. Master's Research and Thesis. 3 Credits.
Permission of the department.

Rules & Requirements
Repeat Rules: May be repeated for credit.

MTSC 994. Doctoral Research and Dissertation. 3 Credits.
Permission of the department.

Rules & Requirements
Repeat Rules: May be repeated for credit.

Contact Information

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