

MATERIALS SCIENCE AND NANOENGINEERING (MSNE)

MSNE 201 - DISCOVERING MATERIALS SCIENCE AND ENGINEERING: ENGINEERING SOLUTIONS FOR A CHANGING WORLD

Short Title: MATERIALS FOR THE FUTURE

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Introduction to the properties of materials and their applications to address global opportunities in engineering, technology, chemistry, energy, and medicine. Discovery of the role of materials in solving historical and future challenges. Discussion of materials science and nanoengineering as a foundational building block of our civilization. General discussion of nanotechnology, from multidisciplinary research to consumer products. Includes hands-on demonstrations, student-lead projects, and lab tours. Freshmen are encouraged to enroll. Open to ALL majors. Required for MSNE majors.

MSNE 203 - DATA SCIENCE, MACHINE LEARNING AND AI APPLIED TO MATERIALS SCIENCE

Short Title: AI FOR MATERIALS

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Many technologies will not be possible without the understanding and control of matter. Airplanes need to be built with advanced high strength yet lightweight aluminum alloys and your cell phone will not run without the complex transition metal oxides used in the battery. The field focusing on the development and discovery of new Materials: Materials Science has seen a growing use of machine learning and artificial intelligence (AI) approaches. This class will provide an introduction to data-driven approaches in physical science and engineering within the context of materials science. The class will introduce common machine learning and AI approaches (e.g., linear regression, decision trees, neural networks, ...) providing general guidelines for their proper use as well as materials science use cases. The class will in parallel introduce important concepts and data sets in materials science as well basic notions of coding in python. Recommended Prerequisite(s): MATH 101/105, Phys 101/111, Chem 121/111

MSNE 210 - WILD TOPICS IN CHEMISTRY AND NANOTECHNOLOGY

Short Title: WILD TOPICS CHEM AND NANOTECH

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hour: 1

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: A variety of topics related to chemistry and nanotechnology will be discussed. Some topics are classical while others are current. Topics may include nanocars, molecular electronics, how to form a start-up company. Grades will be based upon attendance and quizzes. Cross-list: CEVE 210, CHEM 210. Repeatable for Credit.

MSNE 211 - INTRODUCTION TO MATERIALS SCIENCE FOR ENGINEERS

Short Title: INTR MAT SCI FOR ENGINEERS

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Lecture

Distribution Group: Distribution Group III

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Freshman level introduction to the science of solid materials. Includes metals, ceramics, plastics, and semiconductors, as well as the properties of solid materials from atomic and macroscopic points of view. Required for materials science and engineering majors. NOTE: Freshman are encouraged to register for this course.

MSNE 222 - MATERIALS IN NATURE AND BIOMIMETIC STRATEGIES

Short Title: BIOMIMETIC MATERIALS

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hours: 3

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: This course will discuss the origin of several materials that exist in nature from a technology perspective and strategies to replicate them using synthetic materials processing protocols. Silicates, carbon-based materials, abalone shells, bone, etc. will be used to discuss the fascinating architecture developed by nature. Similarly, several functional structures designed by nature such as Gecko tape and IR sensors will be discussed for designing bio-medic structures and devices. NOTE: Not offered every year. Graduate/Undergraduate Equivalency: MSNE 555.

MSNE 238 - SPECIAL TOPICS

Short Title: SPECIAL TOPICS

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Internship/Practicum, Laboratory, Lecture, Seminar, Independent Study

Credit Hours: 1-4

Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.

Course Level: Undergraduate Lower-Level

Description: Topics and credit hours may vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.

MSNE 302 - MATERIALS PROCESSING AND NANOMANUFACTURING**Short Title:** MATERIALS PROCESSING**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 101 and CHEM 121 and PHYS 101**Description:** The course will discuss diverse materials forming processes, including applications for metals, ceramics and polymers. Forming processes from very large to nano scale will be discussed. Emphasis will be understanding how forming processes affect materials properties and how processes are selected based upon the materials and sizes of components being manufactured. Course content will be useful for diverse engineering majors and will be appropriate for sophomores - seniors.**MSNE 304 - MATERIALS SCIENCE JUNIOR LAB****Short Title:** MATERIALS SCIENCE JUNIOR LAB**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MSNE 211 or MSNE 301**Description:** Through this course, you will be able to independently operate various types of common materials testing and metallography equipment. The labs provide a path of self-discovery about the depth of your knowledge and your intuitive insight into the quality of experimental data. You will learn, acquire and demonstrate Materials Laboratory fundamentals. Required for materials science and engineering majors. To obtain registration permission, please email your MSNE degree plan to the instructor at the beginning of the Fall Registration period. The lab time will be decided through voting by the end of the Fall registration period. Instructor Permission Required. Mutually Exclusive: Cannot register for MSNE 304 if student has credit for MSNE 303.**MSNE 311 - MATERIALS SELECTION AND DESIGN****Short Title:** MATERIALS SELECTION & DESIGN**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to students with a major in Materials Science & NanoEng. Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MSNE 211 or MSNE 301) and MSNE 304**Description:** Diverse types of commercially available materials are considered for applications of current economic importance based on their various useful properties. Student learning is primarily through a hands-on team project and deconstruction of commercial products as well as individual oral presentations. Instructor Permission Required.**MSNE 366 - INTRODUCTION TO MATERIALS IN THE ENERGY TRANSITION****Short Title:** MATERIALS ENERGY TRANSITION**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Climate change and energy transition are two defining issues of our society. This course provides students with an overview of the complex interaction between energy, economics, politics, technology and society that determine the energy transition, with a special focus on materials needs to sustain this transition. The course uses a TECOP framework, that utilizes technology, economics, commercial, organizational and political/societal lenses to obtain a nuanced perspective of the energy transition. Cross-list: CHBE 366. Recommended Prerequisite(s): This course is open to Junior and Senior students enrolled in any of the disciplines in the School of Engineering and the School of Natural Sciences. An understanding of thermodynamics and basic chemistry are recommended.**MSNE 389 - ETHICS & SAFETY FOR MATERIALS ENGINEERS****Short Title:** ETHICS & SAFETY FOR MATER ENG**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Moral duty as well as legal and contractual obligations related to the practice of materials engineering. Issues of importance include safety, conflicts of interest, noncompetition & nondisclosure agreements, as well as confidential and proprietary information. Several examples of ethical lapses and various fraudulent activities will be reviewed, as well as "special processes" which pose the greatest risk for ethics violations. Graduate/Undergraduate Equivalency: MSNE 589.**MSNE 401 - THERMODYNAMICS IN MATERIALS SCIENCE****Short Title:** THERMODYNAMICS IN MAT SCIENCE**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (CHEM 112 or CHEM 122) and MATH 212**Description:** Unified presentation of the kinetics and thermodynamics of mass and energy transport. Includes heterogeneous equilibrium, diffusion in solids, and heat transfer, as well as their application to engineering design. Required for materials science and engineering majors. Graduate/Undergraduate Equivalency: MSNE 503. Mutually Exclusive: Cannot register for MSNE 401 if student has credit for MSNE 503.

MSNE 402 - MECH PROPERTIES OF MATERIALS**Short Title:** MECH PROPERTIES OF MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 211 and (MSNE 211 or MSNE 301)**Description:** Survey of the mechanical properties of solid materials. Includes basic mechanics, elasticity, plasticity, fracture, fatigue, creep, hardening mechanisms, mechanical testing, and structure-property relationships. Required for materials science and engineering majors. Graduate/Undergraduate Equivalency: MSNE 502. Mutually Exclusive: Cannot register for MSNE 402 if student has credit for MSNE 502.**MSNE 406 - PHYSICAL PROPERTIES OF SOLIDS****Short Title:** PHYSICAL PROPERTIES OF SOLIDS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MATH 211**Description:** An introduction to band theory, exploring how the collective behavior of electrons determines the electrical, magnetic, and optical properties of materials. Required for materials science and engineering majors. Graduate/Undergraduate Equivalency: MSNE 506. Mutually Exclusive: Cannot register for MSNE 406 if student has credit for MSNE 506.**MSNE 407 - CAPSTONE DESIGN PROJECT I****Short Title:** CAPSTONE DESIGN PROJECT I**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MSNE 304 and MSNE 311**Description:** An interdisciplinary capstone design experience in materials science and nanoengineering. This course provides an opportunity for students to apply knowledge and skills acquired in previous courses to the solution of a realistic engineering problem. Teams of students will specify, design, and build an engineering system/device to meet a prescribed set of requirements. Must complete MSNE 408 to receive credit for MSNE 407 and both courses must be taken the same academic year. Required for MSNE majors in B.S. program. Instructor Permission Required.**MSNE 408 - CAPSTONE DESIGN PROJECT II****Short Title:** CAPSTONE DESIGN PROJECT II**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** An interdisciplinary capstone design experience in materials science and nanoengineering. This course provides an opportunity for students to apply knowledge and skills acquired in previous courses to the solution of a realistic engineering problem. Teams of students will specify, design, and build an engineering system/device to meet a prescribed set of requirements. Must complete MSNE 407 to receive credit for MSNE 408 and both courses must be taken the same academic year. Required for MSNE majors in B.S. program. Instructor Permission Required.**MSNE 411 - MATERIALS CHARACTERIZATION FROM NANO TO MACRO****Short Title:** MATERIALS CHARACTERIZATION**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MSNE 211 or MSNE 301) and MSNE 304**Description:** This course provides a comprehensive introduction to the fundamental operating principles and physical mechanisms underlying a variety of characterization techniques widely used in materials science. Students will explore the theoretical foundations and practical applications of methods such as electron diffraction, X-ray diffraction, optical and infrared spectroscopy, and scanning probe microscopy. Emphasis will be placed on understanding how each technique probes different aspects of material properties—such as structure, composition, and surface characteristics—and how to interpret the resulting data. Real-world case studies will be examined to illustrate the application of these techniques in research and industry, providing students with a deeper appreciation of their relevance and utility in solving materials-related challenges. Graduate/Undergraduate Equivalency: MSNE 511.**MSNE 413 - 3D PRINTING AND ADDITIVE MANUFACTURING: THEORY AND APPLICATIONS****Short Title:** ADDITIVE MANUFACTURING**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Basic principles and applications of additive manufacturing (AM), Various AM processes. Materials science such as polymers, metals, ceramics, composites, and bio-materials for AM. Selection of material and process for design applications such as structures, electronics, biomedical, and consumer products. Hands-on experience and analysis from digital data to physical objects. Graduate/Undergraduate Equivalency: MSNE 513. Mutually Exclusive: Cannot register for MSNE 413 if student has credit for MSNE 513.

MSNE 414 - SOFT MATERIALS AND POLYMER PHYSICS**Short Title:** SOFT MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** By the end of the course, students should be able to evaluate and design polymer networks or hydrogels for various applications. A core aim is to relate structure of the polymeric network with its function. The course will include polymeric networks and also a module on soft materials, such as hydrogels, which are widely used in biological networks.**MSNE 415 - CERAMICS AND GLASSES****Short Title:** CERAMICS AND GLASSES**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MSNE 211 or MSNE 301**Description:** Fundamentals of ceramic and glassy materials, including phase relations, theoretical properties, structure, bonding, and design.**MSNE 417 - ORGANIC AND POLYMER SEMICONDUCTORS FOR ELECTRONICS AND PHOTONICS****Short Title:** ORGANIC ELECTRONICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** CHEM 211 or MSNE 211 or MSNE 301**Description:** Covers physical and material concepts and engineering applications of organic semiconductors. Examines the relationship between chemical structure and molecular packing on optoelectronic properties such as band gap, charge carrier mobility, and luminescence efficiency. Topics include synthesis, electronic structure, physico-chemical characterization, doping, applications in LEDs, solar cells, photodetectors, transistors, and bioelectronics. Graduate/Undergraduate Equivalency: MSNE 517. Mutually Exclusive: Cannot register for MSNE 417 if student has credit for MSNE 517.**MSNE 419 - SOLID-STATE QUANTUM MATERIALS AND TECHNOLOGIES****Short Title:** SOLID-STATE QUANTUM MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** The aim of this course is to serve as an introduction to the state-of-the-art research in the field of quantum science, with a focus on the fundamental aspects of quantum materials used in these technologies. In particular, it will introduce three types of quantum systems, superconducting, spin, and photonic qubits, implemented in solid-state materials. Concepts such as Josephson junction, single electron transistors, quantum states of light, and cavity quantum electrodynamics will also be introduced to familiarize the students with the current research in this field. Graduate/Undergraduate Equivalency: MSNE 519. Mutually Exclusive: Cannot register for MSNE 419 if student has credit for MSNE 519.**MSNE 421 - SEMICONDUCTING MATERIALS: PROPERTIES, DEVICES, ANALYSIS****Short Title:** SEMICONDUCTING MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** This course introduces semiconducting materials to upper undergraduate/junior graduate students, providing a comprehensive knowledge of the fundamental properties of semiconductors and the principles of basic devices for materials scientists and engineers. Topics include: growth of semiconductors, electrons in semiconductors, current in semiconductors, semiconductors in real worlds, analysis of semiconductors, and next-generation semiconductors. Graduate/Undergraduate Equivalency: MSNE 521. Mutually Exclusive: Cannot register for MSNE 421 if student has credit for MSNE 521.**MSNE 433 - COMPUTATIONAL MATERIALS MODELING****Short Title:** COMPUTATIONAL MATERIALS MODEL**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Physico-chemical principles augmented by ever-advancing computation technology have become a tool for explaining rich materials properties, designing nano-structures and their possible functionality. This course overviews basic quantum principles of materials structure, and a hierarchy of approximations broadly used in computational models. This includes classical multi-body potentials, tight-binding approximations, electronic density functional theory methods, etc. Graduate/Undergraduate Equivalency: MSNE 533. Mutually Exclusive: Cannot register for MSNE 433 if student has credit for MSNE 533.

MSNE 435 - CRYSTALLOGRAPHY & DIFFRACTION**Short Title:** CRYSTALLOGRAPHY & DIFFRACTION**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** MSNE 211 or MSNE 301**Description:** Study of crystals by diffraction techniques, focusing on x-ray, with an overview of electron and neutron diffraction as well as complementary techniques. Provides mathematical foundations and nomenclature for diffraction and related phenomena. Includes basics of crystallographic analysis and surface/point/space group symmetry, experiment design (sources, geometry, detectors), lab demos, and data analysis and interpretation. Required for undergraduate MSNE major. Meets with MSNE 535 (less course work for the undergraduate class). Graduate/Undergraduate Equivalency: MSNE 535. Mutually Exclusive: Cannot register for MSNE 435 if student has credit for MSNE 535.**MSNE 450 - MATERIALS SCIENCE SEMINAR****Short Title:** MATERIALS SCIENCE SEMINAR**Department:** Materials Science & NanoEng**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hours:** 0**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** A series of seminars on selected topics in Materials Science. Recommended for Materials Science and NanoEngineering majors.**MSNE 451 - MATERIALS SCIENCE SEMINAR****Short Title:** MATERIALS SCIENCE SEMINAR**Department:** Materials Science & NanoEng**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** A series of seminars on selected topics in Materials Science. Recommended for Materials Science and NanoEngineering majors.**MSNE 477 - SPECIAL TOPICS****Short Title:** SPECIAL TOPICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Internship/Practicum, Laboratory, Lecture, Seminar, Lecture/Laboratory**Credit Hours:** 1-4**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Topics and credit hours may vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.**MSNE 490 - MATERIALS SCIENCE RESEARCH PROJECTS****Short Title:** MATERIAL SCIENCE RESEARCH PROJ**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-6**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Independent investigation of a specific topic or problem in materials science. Research under the direction of a selected faculty member. Instructor Permission Required. Repeatable for Credit.**MSNE 491 - SUPERVISED RESEARCH****Short Title:** SUPERVISED RESEARCH**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Prerequisite(s):** (MATH 101 or MATH 105) and (MATH 102 or MATH 106)**Description:** Supervised research, reports and/or final reports required. Sponsorship by faculty member required. Instructor Permission Required. Repeatable for Credit.**MSNE 499 - CURRENT TOPICS****Short Title:** CURRENT TOPICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 1-9**Restrictions:** Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.**Course Level:** Undergraduate Upper-Level**Description:** Designed for undergraduate materials science students. Topics vary from term to term. Please consult with the department for additional information.**MSNE 500 - MATERIALS SCIENCE SEMINAR****Short Title:** MATERIALS SCIENCE SEMINAR**Department:** Materials Science & NanoEng**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Description:** A series of seminars on selected topics in Materials Science. Required for Materials Science and Engineering majors. Repeatable for Credit.

MSNE 501 - GRADUATE STUDENT SEMINAR**Short Title:** GRADUATE STUDENT SEMINAR**Department:** Materials Science & NanoEng**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Two graduate students will present every week, except for 1st year graduate students who will present 3 per class. Every week, students will be encouraged to fill out peer evaluation forms and include anonymous comments/suggestions for improving the presentation. The results of these comments will not be shared, but given to the presenter for their reference. Repeatable for Credit.

MSNE 502 - MECH PROPERTIES OF MATERIALS**Short Title:** MECH PROPERTIES OF MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Survey of the mechanical properties of solid materials. Includes basic mechanics, elasticity, plasticity, fracture, fatigue, creep, hardening mechanisms, mechanical testing, and structure-property relationships. Required for Materials Science and Engineering majors. Additional work required. Graduate/Undergraduate Equivalency: MSNE 402. Mutually Exclusive: Cannot register for MSNE 502 if student has credit for MSNE 402.

MSNE 503 - THERMODYNAMICS IN MATERIALS SCIENCE**Short Title:** THERMODYNAMICS IN MAT SCIENCE**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Unified presentation of the kinetics and thermodynamics of mass and energy transport. Includes heterogeneous equilibrium, diffusion in solids, and heat transfer, as well as their application to engineering design. Required for Materials Science and Engineering majors. Graduate/Undergraduate Equivalency: MSNE 401. Mutually Exclusive: Cannot register for MSNE 503 if student has credit for MSNE 401.

MSNE 505 - MICROSTRUCTURE AND NANOSTRUCTURE EVOLUTION**Short Title:** MICRO/NANO-STRUCTURE EVOLUTION**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Study of the thermodynamic and kinetic principles underlying structural evolution in materials at micro- and nanoscales. Includes atomic diffusion, phase transformations and morphological evolution of surfaces and interfaces under capillary and mechanical forces. Elucidation of atomistic mechanisms and mathematical treatment are emphasized. Undergraduates may register with instructor permission. Recommended Prerequisite(s): MSNE 503.

MSNE 506 - PHYSICAL PROPERTIES OF SOLIDS**Short Title:** PHYSICAL PROPERTIES OF SOLIDS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Survey of the electrical, magnetic, and optical properties of metals, semiconductors, and dielectrics based upon elementary band theory concepts. Required for Materials Science and Engineering majors. Graduate/Undergraduate Equivalency: MSNE 406. Mutually Exclusive: Cannot register for MSNE 506 if student has credit for MSNE 406.

MSNE 510 - SCALING CONCEPTS IN 2D MATERIALS AND POLYMER PHYSICS**Short Title:** SCALING CONCEPTS IN MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The course is an introduction to symmetry breaking, scaling and universality in low dimensional materials and polymers. Using simple models as examples, the course addresses 2D crystals and melting, surface roughening, scaling properties of polymers, phase transitions and the mean field approach. It then goes over to explain how renormalization works in condensed matter, and how it gives rise to universality. Recommended Prerequisite(s): MSNE 401

MSNE 511 - MATERIALS CHARACTERIZATION FROM NANO TO MACRO**Short Title:** MATERIALS CHARACTERIZATION**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course provides a comprehensive introduction to the fundamental operating principles and physical mechanisms underlying a variety of characterization techniques widely used in materials science. Students will explore the theoretical foundations and practical applications of methods such as electron diffraction, X-ray diffraction, optical and infrared spectroscopy, and scanning probe microscopy. Emphasis will be placed on understanding how each technique probes different aspects of material properties—such as structure, composition, and surface characteristics—and how to interpret the resulting data. Real-world case studies will be examined to illustrate the application of these techniques in research and industry, providing students with a deeper appreciation of their relevance and utility in solving materials-related challenges. Graduate/Undergraduate Equivalency: MSNE 411.

MSNE 512 - MATERIALS SCIENCE AND ENGINEERING WITH QUANTUM PHOTONICS**Short Title:** QUANTUM MATERIALS & PHOTONICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Introduction to the basic concepts of light-matter interaction with cavity electrodynamics, useful quantum (non-classical) properties of materials, and experimental techniques to probe/engineer materials with coherent or quantum light sources. Students are encouraged to have prior exposure to quantum mechanics and electronic properties of solids (or equivalent) before enrollment, although the principles will be refreshed at the beginning of the course. Cross-list: PHYS 512. Recommended Prerequisite(s): Quantum Mechanics; Physical Properties of Solids or Solid State Physics.

MSNE 513 - 3D PRINTING AND ADDITIVE MANUFACTURING: THEORY AND APPLICATIONS**Short Title:** ADDITIVE MANUFACTURING**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Basic principles and applications of additive manufacturing (AM), Various AM processes. Materials science such as polymers, metals, ceramics, composites, and bio-materials for AM. Selection of material and process for design applications such as structures, electronics, biomedical, and consumer products. Hands-on experience and analysis from digital data to physical objects. Graduate/Undergraduate Equivalency: MSNE 413. Mutually Exclusive: Cannot register for MSNE 513 if student has credit for MSNE 413.

MSNE 517 - ORGANIC AND POLYMER SEMICONDUCTORS FOR ELECTRONICS AND PHOTONICS**Short Title:** ORGANIC ELECTRONICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Covers physical and material concepts and engineering applications of organic semiconductors. Examines the relationship between chemical structure and molecular packing on optoelectronic properties such as band gap, charge carrier mobility, and luminescence efficiency. Topics include synthesis, electronic structure, physico-chemical characterization, doping, applications in LEDs, solar cells, photodetectors, transistors, and bioelectronics. Graduate/Undergraduate Equivalency: MSNE 417. Mutually Exclusive: Cannot register for MSNE 517 if student has credit for MSNE 417.

MSNE 518 - MATERIALS SELECTION FOR BIOLOGICAL SYSTEMS**Short Title:** BIO-MATERIAL INTERFACE(S)**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course will introduce students to various materials used to interface with biological systems, ranging from cells to organs. The goal(s) will be to understand the important materials properties to consider when building such systems, and general approaches of how to process materials in a bio-friendly manner. Content will be organized into different modules, including materials properties and processing, implantable materials systems, and in vitro materials systems. Each module will discuss how concepts relate to different tissue systems, with a focus often on the nervous system. Instruction will be delivered through a mixture of lectures, journal club-like discussions, seminars from experts in the area when applicable, and hands-on instruction. At the end, students will be expected to propose their own biological materials interface platform, motivate the selection of the materials, describe the device fabrication, and evaluate the advantages/disadvantages as compared to existing systems.

MSNE 519 - SOLID-STATE QUANTUM MATERIALS AND TECHNOLOGIES**Short Title:** SOLID-STATE QUANTUM MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The aim of this course is to serve as an introduction to the state-of-the-art research in the field of quantum science, with a focus on the fundamental aspects of quantum materials used in these technologies. In particular, it will introduce three types of quantum systems, superconducting, spin, and photonic qubits, implemented in solid-state materials. Concepts such as Josephson junction, single electron transistors, quantum states of light, and cavity quantum electrodynamics will also be introduced to familiarize the students with the current research in this field. Graduate/Undergraduate Equivalency: MSNE 419. Mutually Exclusive: Cannot register for MSNE 519 if student has credit for MSNE 419.

MSNE 521 - SEMICONDUCTING MATERIALS: PROPERTIES, DEVICES, ANALYSIS**Short Title:** SEMICONDUCTING MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course introduces semiconducting materials to upper undergraduate/junior graduate students, providing a comprehensive knowledge of the fundamental properties of semiconductors and the principles of basic devices for materials scientists and engineers. Topics include: growth of semiconductors, electrons in semiconductors, current in semiconductors, semiconductors in real worlds, analysis of semiconductors, and next-generation semiconductors. Graduate/Undergraduate Equivalency: MSNE 421. Mutually Exclusive: Cannot register for MSNE 521 if student has credit for MSNE 421.

MSNE 522 - EMERGING MATERIALS FOR NANO-ELECTRONICS DEVICES**Short Title:** MATERIALS FOR NANO-ELECTRONICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course provides a comprehensive overview of current and emerging material platforms for modern nanoelectronics. It aims to bridge the gap between modern topics in material science and its implementation in practical devices. Beginning with the historical development of the transistor, the course examines technological advancements such as high-k dielectrics, ferroelectric transistors, and contact/channel engineering. Finally, it broadens its focus to emerging materials, covering 2D materials, III-V compounds, Carbon Nanotubes, Complex Oxides, Spintronics, and NEMS/MEMS devices.

MSNE 523 - PROPERTIES, SYNTHESIS AND DESIGN OF COMPOSITE MATERIALS**Short Title:** DESIGN OF COMPOSITE MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Study of the science of interfaces and the properties that govern their use in composite materials. Not offered every year. The study of composite processing and methods for synthesis polymer, metal and ceramic matrix composition.

MSNE 532 - ATOMISTIC MODELING AND AI FOR MATERIALS DESIGN**Short Title:** MODELING AND AI FOR MATERIALS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Advances in first-principles simulation, high-throughput computation, and artificial intelligence have transformed modern materials science. This course introduces the methods and workflows used in computational materials design and discovery, with emphasis on density functional theory, materials databases, automated workflows, machine learning, machine-learned interatomic potentials, and emerging generative AI approaches. Students will gain practical experience using modern computational tools to set up, run, and interpret simulations and data-driven models for materials problems. Hands-on exercises using state-of-the-art codes, literature discussions, and a final project will reinforce the major concepts and applications.

MSNE 533 - COMPUTATIONAL MATERIALS MODELING**Short Title:** COMPUTATIONAL MATERIALS MODEL**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Physico-chemical principles augmented by ever-advancing computation technology have become a tool for explaining rich materials properties, designing nano-structures and their possible functionality. This course overviews basic quantum principles of materials structure, and a hierarchy of approximations broadly used in computational models. This includes classical multi-body potentials, tight-binding approximations, electronic density functional theory methods, etc. MSNE 533 requires additional work. Graduate/Undergraduate Equivalency: MSNE 433. Mutually Exclusive: Cannot register for MSNE 533 if student has credit for MSNE 433.

MSNE 534 - NANOSCIENCE AND NANOTECHNOLOGY I**Short Title:** NANOSCIENCE & NANOTECHNOLOGY**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Enrollment is open to all students. Undergraduate enrollment requires instructor permission via special registration form. An introduction to the basic principles of nanoscience and nanotechnology. Size dependent physical properties of nanoscopic solids will be described using solid state physics and molecular orbital theory as a foundation. Wet chemical techniques that produce nanoscale materials (e.g. carbon nanotubes, semiconductor and metallic nanocrystals, dendrimers...) will be introduced in the second half of the semester. Expected to be taught Spring 2019. Cross-list: CEVE 533, CHEM 533.

MSNE 535 - CRYSTALLOGRAPHY & DIFFRACTION**Short Title:** CRYSTALLOGRAPHY & DIFFRACTION**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Study of crystals by diffraction techniques, focusing on x-ray, with an overview of electron and neutron diffraction as well as complementary techniques. Provides mathematical foundations and nomenclature for diffraction and related phenomena. Includes basics of crystallographic analysis and surface/point/space group symmetry, experiment design (sources, geometry, detectors), lab demos, and data analysis and interpretation. Required for undergraduate MSNE major. Meets with MSNE 435 (additional work for the graduate version). Cross-list: PHYS 535. Graduate/Undergraduate Equivalency: MSNE 435. Mutually Exclusive: Cannot register for MSNE 535 if student has credit for MSNE 435.

MSNE 538 - COMPUTATIONAL NANOSCIENCE FOR GREEN INFRASTRUCTURE**Short Title:** COMPUTATIONAL NANOSCIENCE**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Seminar**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Computational methods such as first principles, kinetic Monte Carlo (KMC), classical MC (in Canonical, Grand Canonical, and isobaric-isothermal ensembles), and classic MD in predicting materials formation and properties. Case studies include cementitious materials, metals, and thermoelectric materials. Other case studies are possible depending on the student's background and instructor's approval. Cross-list: CEVE 538.

MSNE 540 - THIN FILM AND DEVICE PHYSICS**Short Title:** THIN FILM AND DEVICE PHYSICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course is designed to equip junior graduate students with the practical skills for nanomaterials growth and fabrication and fundamental knowledge of semiconductor devices as materials scientists. The topics include: thin film deposition, lithography, etching, properties of semiconductors, field effect transistor, metal-semiconductor contact and more

MSNE 555 - MATERIALS IN NATURE AND BIO-MIMETIC STRATEGIES**Short Title:** BIO-MIMETIC STRATEGIES**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This graduate level course will discuss the origin of several materials that exists in nature from a technology perspective and strategies to replicate them using synthetic materials processing protocols. Silicates, carbon based materials, abalone shell, bone etc. will be used to discuss the fascinating architecture developed by nature. Similarly several functional structures designed by nature such as Gecko tape and IR sensors will be discussed for designing bio-medic structure and devices. NOTE: Not offered every year. Graduate/Undergraduate Equivalency: MSNE 222.

MSNE 560 - COLLOIDAL AND INTERFACIAL PHENOMENA**Short Title:** COLLOIDAL & INTERFACIAL PHENOM**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The course will provide knowledge into the fundamentals of colloidal interactions (e.g., stabilisation, adsorption, self-assembly) and the techniques currently applied for their assessment. Apart from the theoretical background, the course will also provide applicable knowledge by covering current and emerging applications involving these phenomena. Interfacial tension, wetting and spreading, contact angle hysteresis, interaction between colloid particles, stability of interfaces, flow and transport near interfaces will be covered. NOTE: Offered in alternative year with MSNE 594/CHBE 594. Cross-list: CHBE 560.

MSNE 569 - SCIENCE AND APPLICATIONS OF CORROSION SCIENCE AND ENGINEERING**Short Title:** CORROSION SCIENCE& ENGINEERING**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** MSCI 301 or MSNE 301

Description: Students will learn basics of corrosion science of metals and alloys exposed to different classes of conditions, prevalent forms of corrosion, consequences of corrosion and corrosion mitigation approaches in a range of industries. Discussion of nano science aspects related to corrosion control in industry will be included.

MSNE 570 - SENIOR DESIGN THESIS PROJECT**Short Title:** SENIOR DESIGN THESIS PROJECT**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Independent Study**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: A design project in the materials science field will be undertaken by the student in close collaboration with at least one materials science faculty member.

MSNE 571 - SENIOR DESIGN THESIS PROJECT**Short Title:** SENIOR DESIGN THESIS PROJECT**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Independent Study**Credit Hours:** 2**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: A design project in the materials science field will be undertaken by the student in close collaboration with at least one materials science faculty member. Instructor Permission Required.

MSNE 580 - MICROSCOPY METHODS IN MATERIALS SCIENCE**Short Title:** MICROSCOPY METHODS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture/Laboratory**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This course covers theory and applications of electron microscopy techniques with an emphasis on transmission and scanning transmission electron microscopy (TEM, STEM). Topics include modern instrumentation and hardware, electron diffraction, imaging modes, tomography, and spectroscopy (energy dispersive x-ray spectroscopy (EDS), electron-energy loss spectroscopy (EELS), cathodoluminescence (CL)). Previous experience with electron microscopes recommended. This course includes lab demos of SEM and TEM. Cross-list: CHEM 580.

MSNE 581 - MICRO AND NANO HEAT TRANSPORT METHODOLOGIES AND DESIGN**Short Title:** MICRO & NANO HEAT TRANSPORT**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3

Restrictions: Enrollment is limited to students with a major in Mechanical Engineering or Materials Science & NanoEng. Enrollment is limited to Graduate level students.

Course Level: Graduate**Prerequisite(s):** MECH 481

Description: A thorough explanation of the methodologies used for solving conduction, convection and radiation heat transport problems in macro, micro and nanosystems. Phonon, photon and electron transfer fundamentals. Equilibrium Statistics. Basic kinetic theory and transport properties of ideal gases. Microchannel heat transfer. Nanofluid heat transfer. Non-Fourier heat Conduction. Boltzmann transport equation. Molecular dynamics and lattice dynamics numeric methods. Applications and design problems in contemporary technologies. To be taught alternating years for MECH and MSNE Seniors and Graduate students. Cross-list: MECH 581.

MSNE 589 - ETHICS & SAFETY FOR MATERIALS ENGINEERS**Short Title:** ETHICS & SAFETY FOR MATER ENG**Department:** Materials Science & NanoEng**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Seminar**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Moral duty as well as legal and contractual obligations related to the practice of materials engineering. Issues of importance include safety, conflicts of interest, noncompetition & nondisclosure agreements, as well as confidential and proprietary information. Several examples of ethical lapses and various fraudulent activities will be reviewed, as well as "special processes" which pose the greatest risk for ethics violations. Graduate/Undergraduate Equivalency: MSNE 389.

MSNE 593 - INTRODUCTION TO POLYMER PHYSICS AND ENGINEERING**Short Title:** POLYMER PHYSICS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** CHEM 211 and CHEM 212

Description: The course focuses on demonstrating how the physical properties of polymers can be understood from simple models. Students will be introduced to the terminology and mathematics involved in the physical understanding of polymer systems. The course is intended for students who would like to gain an understanding of modern approaches to polymer physics. NOTE: Not offered every year. Cross-list: CHBE 593.

MSNE 594 - PROPERTIES OF POLYMERS**Short Title:** PROPERTIES OF POLYMERS**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate**Prerequisite(s):** (CHEM 211 or CHEM 251) and (MATH 211 or MATH 221)

Description: The course will introduce basic concepts in polymer science including the synthesis and chemical modification of polymers as well as physical properties of polymers. Topics include approaches to polymer synthesis, processing and characterization of polymer materials, and an introduction to mathematical models applied to describe the structure and dynamics of polymeric materials. NOTE: Offered in alternative year with MSNE 560/CHBE 560. Cross-list: CHBE 594. Repeatable for Credit.

MSNE 599 - LAB ROTATIONS AND ADVISOR SELECTION**Short Title:** LAB ROTATION ADVISOR SELECTION**Department:** Materials Science & NanoEng**Grade Mode:** Satisfactory/Unsatisfactory**Course Type:** Laboratory**Credit Hour:** 1**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Open to first year doctoral students. Students will rotate through three research groups to familiarize themselves with the research projects and environment offered by each group, and complete the advisor selection form at the end of the rotations.

MSNE 609 - RISK ASSESSMENT AND ASSET INTEGRITY IN OIL AND GAS PRODUCTION AND REFINING OPERATIONS I**Short Title:** OIL AND GAS ASSET INTEGRITY I**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The course integrates risk assessment and mitigation, asset integrity management, corrosion control and materials selection across the oil and gas value chain, from production to refining and retail. The full course covers 2 semesters. Session "I," to be delivered in the Spring 2017 semester. Session "II" will be delivered in the Fall 2017 semester. Instructor Permission Required. Cross-list: CHBE 609.

MSNE 613 - SPECIAL TOPICS I**Short Title:** SPECIAL TOPICS I**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: For Spring 2023: The course integrates fundamental knowledge of vibrational [Raman ,IR], electronic, magnetic resonance and X-ray spectroscopic techniques [including XPS and AUGER] to solve challenges in applied science and engineering research. Theoretical principles and symmetry rules are used to predict, generate and interpret atomic and molecular spectra. Instrumental component of the course gives special attention to operando in situ characterization. Will be a three-credit-hour course. Repeatable for Credit.

MSNE 614 - SPECIAL TOPICS II**Short Title:** SPECIAL TOPICS II**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: INDUSTRIAL NANOTECHNOLOGY. The course will provide knowledge of industrial applications of nanotechnology enabled by research advances in different areas of nanoscience and engineering, including materials science, chemistry, physics, energy, environment, and aerospace. Overview of synthesis of nanomaterials through bottom-up and top-down strategies. Characterization of nanomaterials, particle size, shape and surface properties relationships, surface modification tailored to specific industrial applications. Safety related to nanomaterials and nanostructures in the environment and industrial nanotechnology development projects. Discussion of selected application case studies originating from nanotechnology invention and commercial implementation. At the end of the course, student will be able to explain the advantages of nanotechnology, give examples of current industrial applications of nanotechnology, and forecast the future technological advancements and increasing role of nanotechnology in each industry. This will be a 3 credit hour course. Repeatable for Credit Repeatable for Credit.

MSNE 615 - SPECIAL TOPICS III**Short Title:** SPECIAL TOPICS III**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: MATERIALS ELECTROCHEMISTRY-The course emphasizes the principles of electrochemical devices including batteries, supercapacitors, fuel cells, and electrochemical sensors. Topics will emphasize the latest trends and challenges in the chemistry, materials, and physics involved in the materials design, electrochemical measurements, and characterization of these devices as well as the thermodynamics and kinetics related to different electrode processes at the macroscopic and microscopic levels. This will be a three-credit-hour course. Repeatable for Credit. Repeatable for Credit.

MSNE 616 - AUTOMOTIVE ENGINEERING: MATERIALS AND DYNAMICS**Short Title:** AUTOMOTIVE ENGINEERING**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Discussion of the engineering and materials technology that is involved in modern automotive design. Topics include: chassis design and construction; composite design and fabrication; aerodynamics and ground effects; suspension dynamics; performance technology. External expert speakers will provide a real-world perspective. Course will only be offered with sufficient demand. Check with the instructor. Instructor Permission Required. Repeatable for Credit.

MSNE 617 - AUTOMOTIVE ENGINEERING: LAB**Short Title:** AUTOMOTIVE ENGINEERING: LAB**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Laboratory**Credit Hours:** 1-3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: Laboratory application of engineering skills towards the materials technology and dynamics of chassis design, composite design, and fabrication, aerodynamics, and performance technology. Not offered every year. Instructor Permission Required. Recommended Prerequisite(s): MSCI 616 or MSNE 616. Repeatable for Credit.

MSNE 618 - RISK ASSESSMENT AND ASSET INTEGRITY IN OIL AND GAS PRODUCTION AND REFINING OPERATIONS II**Short Title:** OIL AND GAS ASSET INTEGRITY II**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Lecture**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: The course integrates risk assessment and mitigation, asset integrity management, corrosion control and materials selection across the oil and gas value chain, from production to refining and retail. The full course covers 2 semesters. Session "I," to be delivered in the Spring 2017 semester. Session "II" will be delivered in the Fall 2017 semester. Instructor Permission Required. Cross-list: CHBE 618.

MSNE 621 - M.M.S. RESEARCH PROJECT I**Short Title:** M.M.S. RESEARCH PROJECT I**Department:** Materials Science & NanoEng**Grade Mode:** Standard Letter**Course Type:** Research**Credit Hours:** 3**Restrictions:** Enrollment is limited to Graduate level students.**Course Level:** Graduate

Description: This is the first part of the M.M.E. research project course. The faculty advisor, taking into account the background and research interests of the student as well as the research interests of the faculty advisor, will determine the contents. Course requirements will include a final report. Instructor Permission Required. Repeatable for Credit.

MSNE 622 - M.M.S. RESEARCH PROJECT II

Short Title: M.M.S. RESEARCH PROJECT II

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Research

Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: This is the second part of the M.M.E. research project and continuation of MSNE 621. Course requirements will include a final report. Instructor Permission Required. Repeatable for Credit.

MSNE 650 - NANOMATERIALS AND NANOMECHANICS

Short Title: NANOMATERIALS & NANOMECHANICS

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Lecture

Credit Hours: 3

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: The primary goal of this course is to introduce important current developments in the field of nanomaterials and nanomechanics. The course will discuss synthesis and characterization of nanomaterials, the behaviors especially mechanical behaviors in the broad sense of such materials, and their technological applications. The basic physics and fundamental mechanisms responsible for nanoscale induced changes in properties will be stressed.

MSNE 677 - SPECIAL TOPICS

Short Title: SPECIAL TOPICS

Department: Materials Science & NanoEng

Grade Mode: Standard Letter

Course Type: Internship/Practicum, Laboratory, Lecture, Seminar, Independent Study

Credit Hours: 1-4

Restrictions: Enrollment is limited to Graduate or Visiting Graduate level students.

Course Level: Graduate

Description: Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.

MSNE 700 - TEACHING PRACTICUM

Short Title: TEACHING PRACTICUM

Department: Materials Science & NanoEng

Grade Mode: Satisfactory/Unsatisfactory

Course Type: Internship/Practicum

Credit Hour: 1

Restrictions: Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: Students who serve as teaching assistants are required to register this course. Students will hold recitations or office hours and assist instructors in lectures. Open to graduate students in Materials Science and NanoEngineering and only in exceptional circumstances to undergraduates. Repeatable for Credit.

MSNE 800 - RESEARCH AND THESIS

Short Title: RESEARCH AND THESIS

Department: Materials Science & NanoEng

Grade Mode: Satisfactory/Unsatisfactory

Course Type: Research

Credit Hours: 1-12

Restrictions: Enrollment is limited to students with a major in Materials Science & NanoEng. Enrollment is limited to Graduate level students.

Course Level: Graduate

Description: Thesis research Repeatable for Credit.