NE - NANOENGINEERING (NE)

NE 180 - Engineering at the Nanoscale 2 Credits

Hours: 1R-1L-2C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

Introduction to nanoscience and engineering: properties and behavior of materials, devices, and systems (natural and artificial) at nanoscale; applications of nanoscience. A brief introduction to nanoscale materials-modeling methods (e.g., density-functional theory and molecular dynamics) to link atomic structure with observable properties; characterization techniques; thin-film measurements; basic cleanroom safety and hands-on experience; microfabrication processing techniques: photolithography, thin-film deposition; software, and data analysis.

NE 199 - Professional Experience 1 Credit

Hours: 1R-0L-1C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

The professional experiences course captures the practical work experiences related to the student's academic discipline. Students are required to submit a formal document of their reflections, which communicates how their employment opportunity reinforced and enhanced their academic studies.

NE 280 - Introduction to Nanoengineering 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 113 (may be taken concurrently)

Scaling laws in small systems; electronics and photonics devices and systems, basics of quantum and statistical mechanics, nanomaterials and fabrication: examples of zero, one, two, and three dimensional nanostructures, carbon nanotubes, Nanoelectronics: basics of solid state physics; electron energy band, semiconductors, tunneling and quantum structures, molecular electronics, Nanophotonics in metals and semiconductors, surface plasmon resonance and applications, photonic bandgap crystals.

NE 280L - Intro to Nanoeng Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: No
Prerequisites: None

NE 290 - Directed Research 1-4 Credits

Hours: (1 - 4)R-0L-(1 - 4)C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: None

Research for freshmen and sophomore students under the direction of a physics or optical engineering faculty member. May earn up to a maximum of 2 credits for meeting the graduation requirements. The student must make arrangements with a faculty member for the research project prior to registering for this course.

NE 320 - Fundamentals of Thin Films: Fabrication and Applications 4 Credits

Hours: 3R-3L-4C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: NE 280 or EP 280

Two- and three-dimensional nanostructures, including thin film materials, single and multi-layer nano-films, electronic energy band structures, thin-film and high-k electronics, multiple quantum well devices, and optical bandgap engineering. Thin film characterization, thermal properties of thin films, growth kinetics, coating and thin film fabrication techniques: sputtering, thermal evaporation, PECVD, and atomic layer deposition.

NE 330 - Material Failure 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 112

Principles of material failure; appearance, physical cause and mathematical description with emphasis on the materials used for micro-scale devices and assemblies. Failure types considered include Rupture, Fatigue, Creep, Corrosion, Electromigration, Electrical Overstress, Electrical Discharge and Thermal. Experiments illustrate the failure type and the machines used to study them. These include Electron, Optical and X-ray microscopes, Spectroscopy and Tension machines. A brief description of the working of each machine will be given.

NE 380 - Nanotechnology, Entrepreneurship & Ethics 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: NE 280 or EP 280

Scaling laws in small systems; mechanical, biological, fluidics, and thermal systems. Nanomaterials and nanofabrication. Nanomechanics: cantilever oscillation, atomic-force microscopy (AFM) and its applications, nano-biotechnology, machinery of cell, and molecular motors. Nanoscale optics, Nanoscale heat: conduction, convection, and blackbody radiation. Basics of fluidics, nanoscale fluidics and applications, entrepreneurship and ethics, concepts and tools in innovation and social impacts of nanotechnology.

NE 395 - Nanoscale Fabrication & Characterization Techniques 4 Credits

Hours: 3R-3L-4C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: NE 280 or EP 280

Fabrication and characterization techniques for zero- and one-dimensional nanoscale materials and devices. Process design and development. Bottom-up and top-down synthesis techniques. Assembly and self-assembly of nanomaterials into macro-articles. Synthesis techniques including liquid phase growth, chemical vapor deposition, and plasma synthesis. Characterization techniques such as microscopies, various spectroscopies, thermogravimetric analysis, and differential scanning calorimetry. Laboratory is a team project in which students will design, fabricate, and characterize nanomaterials.

NE 406 - Semiconductor Devices & Fabrication 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: PH 405 or PH 505

Metal-semiconductor interfaces; photoresist and photolithography; thin film deposition; design and fabrication of semiconductor diodes; characterization of process diodes and transistors; MOSFETS; optoelectronic devises and lasers. Laboratory is a design project, the production and characterization of a diode and bipolar transistor. The project is a team exercise. Cross-listed with EP 506.

NE 406L - Semicond Devices & Fab Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: Yes
Prerequisites: None

NE 407 - Nanoelectronic and Semiconductor Devices 4 Credits

Hours: 2R-6L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: NE 406 or NE 506 or EP 406 or EP 506

Fabrication and characterization of micro/nanoelectronic devices; Process integration of various technologies, including CMOS, 2D materials, and nanowires; Surface processing for improved performance, including passivation, anti-reflection structures, and protective coatings. Process and device simulators illustrate concepts introduced in class. Laboratory is an integral component of this class in which students will fabricate a multi-junction semiconductor device. In-process measurement results are compared with final electrical test results and simulated designs.

NE 408 - Microsensors and Actuators 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: NE 410 or EP 410

Microelectromechanical (MEMS) systems composed of microsensors, microactuators, and electronics integrated onto a common substrate. Design, fabrication, and operation principles. Examples of microsensors covered in the course include: thermal, radiation, mechanical, chemical, and biological. Laboratory is a team design project in which the students fabricate sensing devices such as pressure or thermal sensors and then characterize their behavior. Cross-listed with EP 508.

NE 410 - Introduction to MEMS: Fabrication & Applications 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

Properties of silicon wafers, wafer-level processes, vacuum systems, thin-film deposition via PVD, dry and wet etching, photolithography, surface and bulk micromachining, process integration, MEMS applications: heat actuators, capacitive accelerometer, DLP, bio-sensor, and pressure sensor. Cross-listed with ME 416, ECE 416, and CHE405.

NE 410L - Intro to MEMS: Fabr&Appl Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: No
Prerequisites: None

NE 411L - Adv MEMS: Mod & Pack Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: No
Prerequisites: None

NE 415 - NanoEngineering Design I 4 Credits

Hours: 2R-6L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: (NE 380 or EP 380) and (ENGL H290 (may be taken concurrently) or RH 330 (may be taken concurrently))

Principles of design. Codes of ethics appropriate to engineers.
Case studies related to optical engineering and engineering physics professional practice, teamwork, contemporary issues, patents and intellectual property. Team-oriented design project work on selected topics in optical engineering and engineering physics. Introduction to product development practices, product research, planning and project management. Preliminary design of a product and product specifications. Deliver a design document specific to customer needs and constraints. Cross-listed with OE 415.

NE 416 - NanoEngineering Design II 4 Credits

Hours: 2R-6L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: NE 415 or EP 415

Team-based capstone design project following structured design processes and utilizing knowledge gained from prior coursework. Project planning and budgeting, development of product/process specifications, application of engineering standards, system design and prototyping subject to multiple realistic constraints (cost, schedule, and performance). Formal midterm design review. Deliver initial statement of work and interim technical report. Laboratory activities supporting the formal design process. Cross-listed with OE 416.

NE 417 - NanoEngineering Design III 4 Credits

Hours: 2R-6L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: NE 416 or EP 416

Continuation of EP 416. System design and prototyping, performance testing, and data analysis. Formal midterm design review. Demonstration of a functional prototype. Deliver oral presentation and final technical report. Cross-listed with OE 417.

NE 450 - Nanomedicine 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 113

Material presented includes the functions and properties of medical nanodevices, the design and fabrication of nanorobots and nanoparticles, the current and potential applications of nanomedicine. Introduction to cancer cell biology and techniques for selective targeting of cancer cells, simulations of the optical and thermal properties of normal and cancerous cell organelles. Nanoplasmonics: Lorentz-Mie simulations of optical properties of nanoparticles, the use of plasmonic nanoparticles in diagnosis and therapy. Introduction to the nanophotodynamic therapies and the new dynamic modes in selective nanophotothermolysis of cancer, the design and methods of activation of nanodrugs. Time and space evolutions of thermal fields in and around the nano- bio-particles and nanoclusters. Ablation of the soft and hard biological tissues by activated nanoparticles.

NE 470 - Special Topics in NanoEngineering 2-4 Credits

Hours: (2 - 4)R-0L-(2 - 4)C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: None

Lectures on special topics in engineering physics.

NE 490 - Directed Research 1-4 Credits

Hours: 0R-0L-(1 - 4)C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: None

Research for junior and senior students under the direction of a physics and optical engineering faculty member. May earn up to a maximum of 2 credits for meeting the graduation requirements. The student must make arrangements with a faculty member for the research project prior to registering for this course.

NE 506 - Semiconductor Devices & Fabrication 4 Credits

Hours: 3R-3L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: PH 405 or PH 505

Metal-semiconductor interfaces; photoresist and photolithography; thin film deposition; design and fabrication of semiconductor diodes; characterization of process diodes and transistors; MOSFETS; optoelectronic devises and lasers. Laboratory is a design project, the production and characterization of a diode, bipolar transistor and MOSFET. The project is a team exercise. Students must do additional project work on a topic selected by the instructor. Cross-listed with EP 406.

NE 506L - Semicond Devices & Fab Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: Yes
Prerequisites: None

NE 507 - Nanoelectronic and Semiconductor Devices 4 Credits

Hours: 2R-6L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: NE 406 or NE 506 or EP 406 or EP 506

Fabrication and characterization of micro/nanoelectronic devices; Process integration of various technologies, including CMOS, 2D materials, and nanowires; Surface processing for improved performance, including passivation, anti-reflection structures, and protective coatings. Process and device simulators illustrate concepts introduced in class. Laboratory is an integral component of this class in which students will fabricate a multi-junction semiconductor device. In-process measurement results are compared with final electrical test results and simulated designs. Students must do additional project work on a topic selected by the instructor. Students may not receive credit for both EP 407 and EP 507.

NE 508 - Microsensors and Actuators 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: NE 410 or EP 410

Microelectromechanical (MEMS) systems composed of microsensors, microactuators, and electronics integrated onto a common substrate. Design, fabrication, and operation principles. Examples of microsensors covered in the course include: thermal, radiation, mechanical, chemical, and biological. Laboratory is a team design project in which the students fabricate sensing devices such as pressure or thermal sensors and then characterize their behavior. Cross-listed with EP 408.

NE 510 - Introduction to MEMS: Fabrication & Applications 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: None

Properties of silicon wafers, wafer-level processes, vacuum systems, thin-film deposition via PVD, dry and wet etching, photolithography, surface and bulk micromachining, process integration, MEMS applications: heat actuators, capacitive accelerometer, DLP, bio-sensor, and pressure sensor. Students must do additional project work on a topic selected by the instructor. Cross-listed with BE 516, CHE 505, ECE 516, and ME 516.

NE 510L - Intro to MEMS: Fabr&Appl Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: Yes
Prerequisites: None

NE 511L - Adv MEMS: Mod & Pack Lab 0 Credits

Hours: 0R-0L-0C
Graduate Studies Eligible: Yes
Prerequisites: None