Fall 2020 Course Descriptions as of 04/05/2020 08:13 PM

Information in Browse Course Catalog is subject to change. Information is term specific. Please refer to the appropriate term when searching for course content. Key to Course Descriptions may be found at: **http://rcs.registrar.arizona.edu/course_descriptions_key**.

Optical Sciences (OPTI)

OPTI 100H: What is Light? (3 units)
Description: Light is an important aspect of our daily lives, from the lights that we use to see, to the displays that give us information and entertainment, to lasers that are used on optical fibers to transfer information from one place to another. This course will delve into what light is by presenting the technology, phenomena, and systems that we use on daily basis. It starts with our eyes used to view our smartphone or computer displays. The information for these displays is provided via networks, which in the long haul sector use fiber optics, lasers, and other optical subsystems. Along the way we will discuss the three interpretations of light: as a ray (geometrical), as a wave (physical), and as both known as the wave-particle duality (quantum).
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Field trip: Various on-campus field trips that will take place during the course. Locations include: the Mirror Lab, Optical Sciences, Solar Mirror Lab, Radiology/Bio5, and other TBD locations.
Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

OPTI 170B1: Optics and the Fourth Industrial Revolution (3 units)
Description: Optics is leading a revolution coming from the fields of science and engineering, it is increasingly embedded in the modern world through devices and technologies on which we depend. From the Internet, cell phones, visual displays, environmental sensors, illumination, medical imaging, and nanotechnology to quantum computing, invisibility, and teleportation, optics is an integral part of modern life, and determines what will be possible tomorrow. This course describes the role optics throughout history, culminating in its role in the collection of interrelated and rapidly-developing technologies that have had an exponential impact on society and have led to what is called the fourth industrial revolution.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion Required
Lecture Required
Course typically offered:
Main Campus: Spring

OPTI 200: Light, Color and Vision (3 units)
Description: Explore optical technology and phenomena, including color and vision, light in art and nature, lasers, telescopes, cameras and fiber optics. This course, designed for non-science majors, will feature demonstrations and hands-on learning, with only basic math.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Course typically offered:
Main Campus: Fall, Spring

General Education: Tier 2 Natural Sciences

OPTI 201L: Geometrical and Instrumental Optics Lab I (1 unit)
Description: This lab is designed to complement the major topics discussed in OPTI 201R, and it is recommended that these two courses be taken concurrently.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Concurrently enrolled in OPTI 201R.

OPTI 201R: Geometrical and Instrumental Optics I (3 units)
Description: Basic principles of geometric optics, refraction and reflection, Gaussian optics, paraxial optics, stops and pupils, simple optical instruments.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion May Be Offered
Lecture Required
Equivalent to: ECE 201R
Also offered as: ECE 201R
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. (MATH 122B or MATH 125), MATH 129, PHYS 141, and MSE 110.

OPTI 202L: Geometrical and Instrumental Optics Lab II (1 unit)
Description: This lab is designed to complement the major topics discussed in OPTI 202R, and it is recommended that these two courses be taken concurrently.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major or Minor: OSE. OPTI 201R. Prerequisite or concurrent enrollment in OPTI 202R.

OPTI 202R: Geometrical and Instrumental Optics II (3 units)
Description: Optical instruments, field and relay lenses, telescopes, microscopes, optical materials, achromatization, illumination, cameras, projectors.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 202R
Also offered as: ECE 202R
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major or Minor: OSE. OPTI 201R.

OPTI 205: Optics of Photography and Videography (3 units)
Description: Students completing this course will gain an understanding of the optical principles and sensor technologies that are employed in modern digital cameras, cell phones, and video cameras. They will have been exposed to the history of camera and lens development, and develop an appreciation for how choices of lens, aperture, exposure, and related settings affect the visual impact of the images that are captured. They will have learned the basics of post-acquisition processing software and have an understanding of display technologies ranging from projection to print.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Students should have completed a course in college algebra and trigonometry.
Field trip: There will be several homework activities based at the Center for Creative Photography.

OPTI 210: Physical Optics I (3 units)
Description: Electromagnetic fields and waves; Fourier series and Fourier transforms; interference and diffraction.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Completion of MATH 223, PHYS 241. Completion of or concurrent enrollment in MATH 254, OPTI 280.

OPTI 280: Computer Programming (1 unit)
Description: An introduction to computer programming and the use of mathematics programs such as Matlab or Mathcad to perform scientific and engineering calculations.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE.

OPTI 299: Independent Study (1 - 4 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study — Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

OPTI 299H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

OPTI 300: Practical Optics (3 units)
Description: This interdisciplinary course will introduce students, with little or no prior background in optics, to a broad variety of optical engineering designs and concepts related to optical systems. Students will understand how optics is an enabling technology for their own disciplines and apply basic optics concepts to their professions.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: PHYS 241

OPTI 306: Radiometry, Sources, and Detectors (3 units)
Description: The generation, propagation, modification, detection and measurement of optical radiation and the design of radiometric systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. Completion of OPTI 201R, 201L. Completion of or concurrent enrollment in OPTI 380A, (ECE 207 or ECE 220 or OPTI 360).

OPTI 330: Physical Optics II (3 units)
Description: Linear system theory, Fourier optics, image formation, interference, optical transfer function.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 310, MATH 322.

OPTI 340: Optical Design (3 units)
Description: Use of optical design software, optical materials, aberrations, image evaluation, aberration balancing, design examples
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 201R, OPTI 202R, OPTI 310.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 340A: Introduction to Optical Design (1 unit)
Description: Use and application of optical design software CODE V.
Grading basis: Student Option ABCDE/PF
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Adv Stdg: Engineering. OPTI 201R, 201L, 202R, and 202L.

OPTI 341: Semiconductor Physics and Lasers (3 units)
Description: Compound semiconductors are widely used in photonic components and lasers. This course covers the basic principles of semiconductor physics including: introduction to quantum mechanics; compound semiconductors; direct and indirect bands; p-n junctions; heterojunctions, light absorption and emission; LED and semiconductor lasers.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. PHYS 241, MATH 223. Prerequisite or concurrent enrollment in MATH 254.

OPTI 345: Quantum Mechanics and Optical Physics (3 units)
Description: This course will introduce students to the ideas and methods of quantum theory by building on their knowledge of waves from optics, and developing the tools needed for working with light and matter. After describing the underpinnings of quantum mechanics some key examples will be worked out in detail including the quantum harmonic oscillator. The quantum theory of atomic structure will next be developed in detail to expose the student to some key techniques and notions for understanding atoms. Finally, the interaction between light and matter is explored along with some basic paradigms for understanding optical physics, including Rabi oscillations, spontaneous emission, and the quantum theory of light.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Students must have advanced to at least their junior year and passed all Fall exams with at least B grades in OPTI240 (341 effective Fall 2019).

OPTI 370: Lasers and Photonics (3 units)
Description: Principles of lasers; properties and manipulation of laser light; physical effects and operating principles of photonic components and devices including light modulators, displays, and optical fibers; elements of photonic telecommunications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 370
Also offered as: ECE 370
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 240, OPTI 310.

OPTI 380A: Intermediate Optics Laboratory I (1 unit)
Description: Properties of electromagnetic waves, interference, the Michelson interferometer, Fresnel and Fraunhofer diffraction, polarization, Fresnel reflection, Brewster's angle, wave plates, coherent sources and Gaussian beams, laser cavities, gas lasers, and diode lasers.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. Concurrently enrolled in OPTI 210.

OPTI 380B: Intermediate Optics Laboratory II (1 unit)
Description: Diffraction gratings, spatial filtering, Fourier optics and imaging filtering, electronics (basic analytical instruments, linear and non-linear circuit elements, transistors, op-amps, active filters, oscillators, voltage regulators, logic, gates and flip-flops, counters and registers, data converters, and interfacing with Lab View and Excel).
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 360 or ECE 220 or ECE 207. Prerequisite or concurrent enrollment in OPTI 330, OPTI 340.

OPTI 392: Directed Research (1 - 3 units)
Description: Individual or small group research under the guidance of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Course typically offered:
Main Campus: Fall, Spring, Summer

Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 396H: Optical Sciences Honors Special Topics Seminar (1 unit)
Description: An Honors special topics seminar course for Honors Active Juniors and Seniors. Course includes small group discussion, research, and presentations on a variety of optical sciences related special topics of interest. Current research, relevant issues, historical perspectives and guest speakers may be included. Honors sophomores may enroll with consent of the department.
Grading basis: Student Option ABCDE/PF
Career: Undergraduate
Course Components: Seminar Required
Repeatable: Course can be repeated a maximum of 2 times.
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course

OPTI 399: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 399H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

OPTI 403A: Mathematical Methods for Optics & Photonics (3 units)
Description: This course covers the basic mathematics needed for an in-depth understanding of the science and technology of fiber-optical communication systems. Every mathematical tool/technique developed in this course will first be motivated by the relevant application. The students are not expected to have a broad-based prior knowledge of the topics covered in this course, but they should generally be familiar with the basics of algebra, Euclidean geometry, trigonometry, integral and differential calculus, simple differential equations, and the rudiments of complex number analysis. The course will cover Complex Analysis, Fourier transform theory, and method of stationary phase (in the context of optical diffraction), vector algebra, linear algebra, ordinary and partial differential equations (e.g., Maxwell¿s electrodynamics, wave equation, diffusion equation), special functions (e.g., Bessel functions needed to study the guided modes of optical fibers), and probability theory (needed for understanding various sources of noise in communication systems, photodetection theory, digital communication via noisy channels, Information theory, etc.).
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: ECE 403A
Co-convened with: OPTI 503A
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Students should have familiarity with basic calculus, Euclidean geometry, algebra, trigonometry and the complex number system.
Enrollment requirement: Major: OSE. Adv Stdg: Engineering. MATH 322.

OPTI 404: Optical Spectroscopy of Materials (3 units)
Description: The course provides a survey of Optical Spectroscopic Methods and underlying phenomena for the study of materials.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Equivalent to: ECE 404, OPTI 404
Also offered as: ECE 404, MSE 404
Co-convened with: OPTI 504
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: PHYS 141 or PHYS 241, MATH 223, MSE 110, and ECE 360.
Home department: Materials Science & Engineering
Enrollment requirement: Adv Stdg: Engineering.

OPTI 414: Optical Instrumentation (3 units)
Description: This course will introduce students to the 1) principles, 2) designs, 3) applications, and 4) recent developments of a broad variety of optical instruments. Upon completion of the course students will be able to understand optical metrology and laser interferometry principles, design requirements, and how to apply these instruments in practice.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Co-convened with: OPTI 514
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 340.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 414A: Photovoltaic Solar Energy Systems (3 units)
Description: This course is intended to provide an introduction to the theory and operation of different types of photovoltaic devices, the characteristics of solar illumination, and the advantages and characteristics of concentrating and light management optics. The physical limits on photovoltaic cell performance and practical device operation will be analyzed. The main device emphasis will focus on different types of silicon photovoltaics including crystalline, amorphous, multi-crystalline, and thin film solar cells. An overview of other types of photovoltaic cells including multi-junction III-V, CdTe, CuInSe2, and organics will also be given. A discussion of radiometric and spectral properties of solar illumination will be presented and the impact of these factors on solar cell design will be explored. Techniques for increasing the performance of solar cells by light trapping, photon recycling, and anti-reflection coatings will be covered. The design and operation of imaging and non-imaging concentrators will also be discussed. Basic experiments related to PV cell measurements and the optical properties of concentrators are also planned for the course.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture — Required
Equivalent to: OPTI 414A
Also offered as: ECE 414A
Co-convened with: OPTI 514A
Course typically offered:
Main Campus: Spring

Home department: Electrical & Computer Engr
Enrollment requirement: Adv Stdg: Engineering.

OPTI 415: Optical Specifications, Fabrication and Testing (3 units)
Description: Specification of optical components including tolerancing and drawing preparation, material properties, performance metrics; conventional fabrication methods for refractive and reflective optics; optical testing including interferometric testing of surface form and finish, special techniques for aspherics, error analysis, test calibration; and testing of optical systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Co-convened with: OPTI 515
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 201R, OPTI 202R, OPTI 310, OPTI 330, OPTI 340.

OPTI 415L: Optical Specifications, Fabrication, and Testing Laboratory (1 unit)
Description: Practical measurement techniques for optical surfaces, components and systems, comparing measurement data with specifications, relating fabrication issues with test methods.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory — Required
Lecture — May Be Offered
Co-convened with: OPTI 515L
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. Prerequisite or concurrent enrollment in OPTI 415.

OPTI 416: Modern Astronomical Optics (3 units)
Description: This course provides an overview of astronomical optical systems and techniques for the observation of exoplanets. It introduces astronomical and optical concepts related to exoplanets observations. By focusing on a particularly challenging observational problem of modern astronomy, the course will teach design and analysis of ultra high precision optical systems and measurement techniques, including spectroscopy, photometry, optical metrology and interferometry.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture — Required
Also offered as: ASTR 416
Co-convened with: OPTI 516
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering.

OPTI 420: Biophotonics (3 units)
Description: This course will cover the interaction of light with biological material. A particular focus will be the use of photonics in medical diagnostics. The course will include introductory biological concepts such as DNA, proteins, cells, and tissues. In addition, the course will teach the principles and applications of bioimaging, spectroscopy, and biosensors, as well as summarize recently published progress in the field.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: BME 420
Co-convened with: OPTI 520
Course typically offered:
Main Campus: Spring

Home department: Biomedical Engineering
Enrollment requirement: Junior or Senior, and must have taken prior or be co-enrolled in BME 330 or OPTI 210 or OPTI 310.

OPTI 421: Introductory Optomechanical Engineering (3 units)
Description: Optical materials, principles of opto-mechanical design, lens and mirror mounting, tolerancing, specification of optical components.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 521
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering.

OPTI 421L: Introductory Optomechanical Engineering Laboratory (1 unit)
Description: The course provides hands on experience to complement the lecture material in the Introductory Optomechanical Engineering course (OPTI 421/521).
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Co-convened with: OPTI 521L
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering.

OPTI 423: Optomechanical Design and Analysis (3 units)
Description: Principles that were taught in OPTI 421/521 (Introductory Optomechanical Engineering) will be applied to develop designs and to perform detailed analysis of optomechanical systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 523
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 421.

OPTI 423L: Optomechanical Engineering Laboratory (2 units)
Description: In this class students will work on independent projects involving design, analysis, hardware development, testing, and evaluation. Class meets weekly for assignment, planning, and review of the projects. Beyond the class, the students will schedule time in the Optomechanics Laboratory where they have access to necessary equipment and instruction. Students will be required to present their work to the class, and to provide written documentation.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture May Be Offered
Co-convened with: OPTI 523L
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. Prerequisite or concurrent enrollment in OPTI 423.

OPTI 424A: Optical Systems Engineering (4 units)
Description: This class provides opportunities for students to learn practical engineering skills for developing optical systems. Students will work in groups on case studies that provide the opportunity to learn systems engineering skills first-hand. Some of the case studies will look at just the necessary requirements, others will include more detailed design, and two or more will be built by the students using off the shelf optics and mechanics. Some examples of optical applications that may be covered are imaging, spectroscopy, illumination, adaptive optics, communication, detection and metrology. These systems will be used to teach fundamentals of systems engineering, optical system design, quantifying performance for optical systems, debugging hardware and professional engineering skills.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Co-convened with: OPTI 524A
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Course is intended for graduate students who have completed 3 semesters or more or undergrad students in their senior year. Please contact the instructor if you are not sure if you should take this course.
Enrollment requirement: Major: OSE. Adv Stdg: Engineering. Senior status only.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 425: Sol-gel Science (3 units)
Description: An in-depth review of the chemistry and physics of sol-gel processes used in materials science and engineering.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: MSE 425
Co-convened with: OPTI 525
Course typically offered:
Main Campus: Fall

Recommendations and additional information: CHEM 151.
Home department: Materials Science & Engineering
Enrollment requirement: Adv Stdg: Engineering.

OPTI 428: Adaptive Optics and Imaging through Random Media (3 units)
Description: This course provides an overview of adaptive optics fundamentals. The course consists of lectures and team projects. For each of the three team projects during the semester, astronomy and optics students will work together to design an instrument, using material presented during the lectures. Each team projects will result in an oral presentation.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: ASTR 428
Co-convened with: OPTI 528
Course typically offered:
Main Campus: Fall

Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 429: Integrated Optics for Information Technology (3 units)
Description: This course provides a fundamental understanding of the concept, fabrication, operation and performance of key integrated optic and photonic components that are widely used in optical communication and information technology. It intends to give students a broad understanding of the components and systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 529
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering.

OPTI 430: Optical Communication Systems (3 units)
Description: Physics of optical communication components and applications to communication systems. Topics include fiber attenuation and dispersion, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: OPTI 430
Also offered as: ECE 430
Co-convened with: ECE 530
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Students enrolling in this course should have completed ECE 207, ECE 220 or OPTI 360, OPTI 380A and 380B
Enrollment requirement: Adv Stdg: Engineering.

OPTI 434: Electrical and Optical Properties of Materials (3 units)
Description: Properties of semiconducting materials as related to crystal structure, interatomic bonding and defect structures.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 434, OPTI 434
Also offered as: ECE 434, MSE 434
Co-convened with:
Course typically offered:
Main Campus: Fall

Recommendations and additional information: PHYS 241.
Home department: Materials Science & Engineering
Enrollment requirement: Adv Stdg: Engineering.

OPTI 435: Visual Optics (3 units)
Description: Instrumentation and optics as they pertain to the human visual system.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Co-convened with: OPTI 535
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 202R and OPTI 330.

OPTI 439A: From Photonics Innovation to the Marketplace (3 units)
Description: This course covers the process of technology development in the photonics industry, both from the perspective of formal processes and case studies. Key aspects of the commercialization process including intellectual property, new product development processes, technical marketing and team building are treated in an interactive program informed by the instructor¿s 15 years of industry experience in both large corporate R&D organizations and entrepreneurial startups.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 539A
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 380A, OPTI 380B.
Student Engagement Activity: Entrepreneurship
Student Engagement Competency: Professionalism

OPTI 441: Introduction to Lasers I (3 units)
Description: This course will cover the fundamental physical processes and introduction of engineering relevant to lasers and explore a variety of specific laser systems. Topics to be covered include, optical laser gain and oscillation, resonators, numerical methods for beam propagation, and Q switching.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 541
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 370.

OPTI 447: Optical Physics (3 units)
Description: Review of math and classical mechanics, atomic models, Lorentz model, EM propagation, optical properties of dielectrics and metals, magneto- and electro-optics, concepts of nonlinear optics.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: PHYS 241, MATH 223, MATH 254, MATH 322, OPTI 280, OPTI 310, OPTI 330.

OPTI 468: Introduction to Optical Spectroscopy (3 units)
Description: The objective of this course is to introduce optical spectroscopy methods that widely used in physics, chemistry and biological sciences, provide knowledge for estimating applicability ranges of various methods, and teach basics of planning and designing spectroscopy instruments.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 568
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 340, OPTI 370, and one of OPTI 360 or ECE 220 or ECE 207.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 469L: System Programming for Engineers (2 units)
Description: The course aims to teach entry to intermediate level software development skills in the LabVIEW programming environment.LabVIEW is a graphic programming environment that specializes in software development for measurement and control instruments. It is widely used in science and industrial research labs for designing and testing systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Co-convened with:
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Students must have one prior course in programming language, such as C++, Java, MatLab. Knowledge about Object Oriented Programming is preferred.

OPTI 471A: Advanced Optics Laboratory (2 units)
Description: Beam alignment, data acquisition and signal processing, spectrometers, incoherent sources, thermal and photon detectors, array detectors, polarization, optical properties of materials, scanners and modulators, image acquisition and processing, properties of the eye.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Fall

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. (OPTI 330 and OPTI 370) and (ECE 207 or ECE 220).

OPTI 471B: Advanced Optics Laboratory (2 units)
Description: Kerr and Pockels cells, liquid crystal light valves, measurement of optical fiber characteristics, signal transmission, Fourier transforming properties of lenses, spatial filtering, transmission, reflection, image and rainbow holograms.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 471A.

OPTI 475: Optical Thin Films (3 units)
Description: The optical properties of single films, design and multilayer optical coatings, calculation and visualization aids, accurate computation methods, introduction to manufacturing methods, non-ideal behavior of thin films.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 575
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 310.

OPTI 481A: Innovation, Translation and Entrepreneurship (2 units)
Description: Where do new medical devices and therapeutic systems come from? In this course students will learn how one Innovates in the medical arena and how you take a concept of potential practical value and make it real. All the critical steps in medical innovation will be discussed.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ENGR 481, ENGR 481A, ENTR 481, MED 481, MED 481A, OPTI 481, OPTI 481A, PATH 481, PATH 481A
Also offered as: BME 481A, ENGR 481A, ENTR 481A, LAW 481A, MED 481A, PATH 481A, SOC 481A
Co-convened with: OPTI 581A
Course typically offered:
Main Campus: Spring

Home department: McGuire Center for Entrepreneurship

OPTI 484: Polarized Light and Polarimetry (3 units)
Description: Polarized light and the Poincare sphere. Polarization in natural scenes and animal vision. Polarization elements: polarizers, retarders, and depolarizers. Jones and Mueller polarization calculus. Polarimetry: measuring the polarization properties of optical elements and materials. Polarization modulators and controllers. Polarization dependent loss and polarization mode dispersion in fiber optics. Advanced polarization issues in optical devices and systems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 584
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 330 or equivalent.

OPTI 485: Illumination Engineering (3 units)
Description: Fields: Illumination, Nonimaging, and Concentrators; Sources: Incandescent, Fluorescent, LED, HID, Modeling, and Experimental Measurement; Modeling: Ray Tracing, Radiometry and Photometry, Color, Polarization, and Scattering; Theory: Radiometry, Photometry, Étendue, Skew Invariant, and Concentration; Design Methods: Edge Ray, Flow Line, Tailored Edge Ray, Non-Edge Ray, and Imaging; Optics: Reflectors, Lightpipes, Couplers, Films, and Hybrids; Applications: Displays, Automotive, Solar, Sources, and Lighting; Special Topics: Software Modeling, Optimization, Tolerancing, and Rendering.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Lecture Required
Co-convened with: OPTI 585
Course typically offered:
Main Campus: Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering. OPTI 406.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 489: Optics Outreach (1 unit)
Description: Students will explore a variety of methods for communicating with the general public about science and optics in particular. Students are expected to develop and apply the knowledge and skills useful for developing methods for communicating effectively with a wide range of audiences. The primary audience for applying the skills acquired in this course will be communicating with students in the high school setting.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: OPTI 589
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Major: OSE. Adv Stdg: Engineering.
Student Engagement Activity: Community Partnership
Student Engagement Competency: Professionalism

OPTI 489A: Optics Outreach (1 unit)
Description: Students will explore a variety of methods for communicating with the general public about science and optics in particular. Students are expected to develop and apply the knowledge and skills useful for developing methods for communicating effectively with a wide range of audiences. The primary audience for applying the skills acquired in this course will be communicating with students in the high school setting.
Grading basis: Student Option ABCDE/PF
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Co-convened with: OPTI 589A
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: OPTI 489.

OPTI 490: Remote Sensing for the Study of Planet Earth (3 units)
Description: Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $50
Course Components: Lecture — Required
Equivalent to: ARL 490, ATMO 490, GEN 490, GEOG 490, GEOS 490, HWRS 490, MNE 490, OPTI 490, RNR 490, SW 490, SWES 490
Also offered as: ATMO 490, ENVS 490, GEOG 490, GEOS 490, HWRS 490, REM 490, RNR 490
Co-convened with: OPTI 590
Course typically offered:
Main Campus: Fall

Home department: Committee on Remote Sensing and Spatial Analysis
Enrollment requirement: GEOG/GEN/GEOS/ENVS/WSM/GIST 330.

OPTI 492: Directed Research (1 - 6 units)
Description: Individual or small group research under the guidance of faculty.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 12 units.
Course typically offered:
Main Campus: Fall, Spring, Summer

Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

OPTI 493: Internship (1 - 12 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 12 units.
Course typically offered:
Main Campus: Fall, Spring, Summer

Student Engagement Activity: Professional Development
Student Engagement Competency: Professionalism

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 495B: Information in a Photon (3 units)
Description: This course will develop the mathematical theory of noise in optical detection from first principles, with the goal of understanding the fundamental limits of efficiency with which one can extract information encoded in light. We will explore how optical-domain interferometric manipulations of the information bearing light, i.e., prior to the actual detection, and the use of detection-induced electro-optic feedback during the detection process can alter the post-detection noise statistics in a favorable manner, thereby facilitating improved efficiency in information extraction. Throughout the course, we will evaluate applications of such novel optical detection methods in optical communications and sensing, and compare their performance with those with conventional ways of detecting light. We will also compare the performance of these novel detection methods to the best performance achievable---in the given problem context---as governed by the laws of (quantum) physics, without showing explicit derivations of those fundamental quantum limits. The primary goal behind this course is to equip students (as well as interested postdocs and faculty) coming from a broad background who are considering taking on theoretical or experimental research in quantum enhanced photonic information processing, with intuitions on a deeper way to think of optical detection, and to develop an appreciation of: (1) the value of a full quantum treatment of light to find fundamental limits of encoding information in the photon, and (2) how pre-detection manipulation of the information-bearing light can help dispose it information favorably with respect to the inevitable detection noise. This course will not assume any background in optics, stochastic processes, quantum mechanics, information theory or estimation theory. However, an undergraduate mathematical background and proficiency in complex numbers, probability theory, and linear algebra (vectors and matrices) will be assumed.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Colloquium Required
Co-convened with: OPTI 595B
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: An undergraduate mathematical background and proficiency in complex numbers, probability theory, and linear algebra (vectors and matrices) will be assumed.

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 498H: Honors Thesis (3 units)
Description: An honors thesis is required of all the students graduating with honors. Students ordinarily sign up for this course as a two-semester sequence. The first semester the student performs research under the supervision of a faculty member; the second semester the student writes an honors thesis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 9 units.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course
Writing Emphasis: Writing Emphasis Course

OPTI 499: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

OPTI 499H: Honors Independent Study (3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

OPTI 500A: Photonic Communications Engineering I A (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). Each part is further broken down into three courses: PCE IA, PCE IB, and PCE IC. PCE IA covers optical fiber light guiding, wave propagation characteristics, materials properties, and fabrication. PCE IB covers optical transmitters, receivers and amplifiers. PCE IC covers communications systems, fiber optics networks, and Internet infrastructure. Sections A, B, and C are each 1 credit and can be taken in any combination. When all three sections are taken together the course is designed as a survey, from the device to the systems level, of Photonic Communications Engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 500A
Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 500B: Photonic Communications Engineering I B (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). Each part is further broken down into three courses: PCE IA, PCE IB, and PCE IC. PCE IA covers optical fiber light guiding, wave propagation characteristics, materials properties, and fabrication. PCE IB covers optical transmitters, receivers and amplifiers. PCE IC covers communications systems, fiber optics networks, and Internet infrastructure. Sections A, B, and C are each 1 credit and can be taken in any combination. When all three sections are taken together the course is designed as a survey, from the device to the systems level, of Photonic Communications Engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 500B
Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 500C: Photonic Communications Engineering I C (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). Each part is further broken down into three courses: PCE IA, PCE IB, and PCE IC. PCE IA covers optical fiber light guiding, wave propagation characteristics, materials properties, and fabrication. PCE IB covers optical transmitters, receivers and amplifiers. PCE IC covers communications systems, fiber optics networks, and Internet infrastructure. Sections A, B, and C are each 1 credit and can be taken in any combination. When all three sections are taken together the course is designed as a survey, from the device to the systems level, of Photonic Communications Engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 500C
Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 500D: Photonic Communications Engineering II D (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). PCE I covers optical fiber light guiding and wave propagation characteristics, materials properties, optical transmitters, receivers and amplifiers, communications systems and fiber optics networks and the Internet. PCE II builds upon this knowledge with advanced subjects in system modeling, device integration, and systems-level engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge. The course is team taught by faculty from the Center for Integrated Access Networks (http://www.cian-erc.org/), which is a multi-institutional Engineering Research Center led by UA with partner schools: UCSD, UCLA, Columbia, Berkeley, Caltech, NSU, Tuskegee, and USC. Faculty from partner schools will deliver lectures via videoconference for live/synchronous student interaction.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 500D
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 500A, OPTI 500B, OPTI 500C.

OPTI 500E: Photonic Communications Engineering II E (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). PCE I covers optical fiber light guiding and wave propagation characteristics, materials properties, optical transmitters, receivers and amplifiers, communications systems and fiber optics networks and the Internet. PCE II builds upon this knowledge with advanced subjects in system modeling, device integration, and systems-level engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge. The course is team taught by faculty from the Center for Integrated Access Networks (http://www.cian-erc.org/), which is a multi-institutional Engineering Research Center led by UA with partner schools: UCSD, UCLA, Columbia, Berkeley, Caltech, NSU, Tuskegee, and USC. Faculty from partner schools will deliver lectures via videoconference for live/synchronous student interaction.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 500E
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 500A, OPTI 500B, OPTI 500C.

OPTI 500F: Photonic Communications Engineering II E (1 unit)
Description: Photonic Communications Engineering (PCE) consists of two parts (I and II). PCE I covers optical fiber light guiding and wave propagation characteristics, materials properties, optical transmitters, receivers and amplifiers, communications systems and fiber optics networks and the Internet. PCE II builds upon this knowledge with advanced subjects in system modeling, device integration, and systems-level engineering. Reference material for the course is in a digital platform to allow dense hyper-linking between topics so that students from various disciplines can customize the reading material to their individual background knowledge. The course is team taught by faculty from the Center for Integrated Access Networks (http://www.cian-erc.org/), which is a multi-institutional Engineering Research Center led by UA with partner schools: UCSD, UCLA, Columbia, Berkeley, Caltech, NSU, Tuskegee, and USC. Faculty from partner schools will deliver lectures via videoconference for live/synchronous student interaction.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 500F
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 500A, OPTI 500B, OPTI 500C.

OPTI 501: Electromagnetic Waves (3 units)
Description: Vector fields, Maxwell's equations, electromagnetic field energy, wave equation, polarized light, time average measurement, Fresnel equations, scalar and vector potentials, gauge transformations, dispersion, metal optics, crystal optics, dipole radiation, mathematical formalism of polarized light, guided waves.
Grading basis: Regular Grades
Career: Graduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: PHYS 241, MATH 223.

OPTI 502: Optical Design and Instrumentation I (3 units)
Description: Rays and wavefronts, Snell's Law, mirror and prism systems, Gaussian imagery and cardinal points, paraxial ray tracing, stops and pupils, illumination systems, elementary optical systems, optical materials, dispersion, systems of thin prisms, system analysis using ray trace code, chromatic aberrations and achromatization, monochromatic aberrations, ray fans, spot diagrams, balancing of aberrations, aspheric systems.
Grading basis: Regular Grades
Career: Graduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: PHYS 142 or PHYS 241.

OPTI 502L: Fundamentals of Applied Optics Laboratory (1 unit)
Description: Optical systems; Gaussian optics, aberrations, radiometry, sources, detectors, optical engineering.
Grading basis: Regular Grades
Career: Graduate

Course Components:	Laboratory	Required
	Lecture	Required

Course typically offered:
Main Campus: Fall

Recommendations and additional information: Concurrent or previous enrollment in OPTI 502.

OPTI 503: Optical Design and Instrumentation II (3 units)
Description: Aberrations of optical systems: wavefans and rayfans, spot diagrams, wavefront expansion, effects of aberrations on image quality, aberration balancing, image quality measures; Color: colorimetry, chromaticity, color gamut, additive and subtractive colors; Polarization Optics; Digital Imaging Systems: resolution and aliasing, color filter arrays, aliasing suppression, image displays and projectors; Diffractive Optical Elements: theory, diffraction efficiency, modeling, applications including achromatization.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 502.

OPTI 503A: Mathematical Methods for Optics & Photonics (3 units)
Description: This course covers the basic mathematics needed for an in-depth understanding of the science and technology of fiber-optical communication systems. Every mathematical tool/technique developed in this course will first be motivated by the relevant application. The students are not expected to have a broad-based prior knowledge of the topics covered in this course, but they should generally be familiar with the basics of algebra, Euclidean geometry, trigonometry, integral and differential calculus, simple differential equations, and the rudiments of complex number analysis. The course will cover Complex Analysis, Fourier transform theory, and method of stationary phase (in the context of optical diffraction), vector algebra, linear algebra, ordinary and partial differential equations (e.g., Maxwell¿s electrodynamics, wave equation, diffusion equation), special functions (e.g., Bessel functions needed to study the guided modes of optical fibers), and probability theory (needed for understanding various sources of noise in communication systems, photodetection theory, digital communication via noisy channels, Information theory, etc.). Graduate-level requirements include completion of additional readings and additional problems on various homework assignments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture — Required
Also offered as: ECE 503A
Co-convened with: OPTI 403A
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Familiarity with basic calculus, Euclidean geometry, algebra, trigonometry and the complex number system.

OPTI 503B: Software Tools for Photonics (3 units)
Description: A brief/concise course description: Many photonics software tools are available as off the shelf modeling programs, encompassing both active and passive photonics components. These products are now in use by a wide number of telecoms companies and laboratories around the world, helping to develop the next generation of telecoms components and systems. Experience in modeling enables the development of custom solutions for specialized industry telecommunication and photonics requirements
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 503B
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Familiarity with wave propagation analysis, component design, and network architecture as taught in OPTI/ECE 500A/B/C.

OPTI 504: Optical Spectroscopy of Materials (3 units)
Description: The course provides a survey of Optical Spectroscopic Methods and underlying phenomena for the study of materials. Graduate-level requirements include an individual research project with written report.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Also offered as: ECE 504, MSE 504
Co-convened with:
Course typically offered:
Main Campus: Spring (odd years only)

Home department: Materials Science & Engineering

OPTI 505L: Fundamentals of Physical Optics Laboratory (1 unit)
Description: Laboratory in support of OPTI 501 and OPTI 505R.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 501, OPTI 505R.

OPTI 505R: Diffraction and Interferometry (3 units)
Description: Interference and interferometry, concepts of coherence, holography, diffraction theory, Fraunhofer and Fresnel diffraction, volume diffraction, Gaussian beam propagation, optical transfer function, speckle.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 501, 512R.

OPTI 506: Radiometry, Sources, and Detectors (3 units)
Description: The generation, propagation, modification, detection and measurement of optical radiation and the design of radiometric systems. For graduate credit, graduate status and additional work will be required: The homework and the examinations will feature advanced problems for graduate students in the course.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502.

OPTI 507: Solid-State Optics (3 units)
Description: Basic concepts in crystals and in optical response, optical properties of phonons and semiconductors, quantum wells, electro-optical properties of semiconductors, optical nonlinearities, solid state devices and laser diodes.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture — Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 511R or PHYS 371.

OPTI 508: Probability and Statistics in Optics (3 units)
Description: Probability theory, stochastic processes, noise, statistical optics, information theory, hypothesis testing, estimation, restoration.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 501.

OPTI 509: Statistical Optics (3 units)
Description: earn the statistical nature of optical fields via concepts like spatial and temporal coherence. The second-order coherency theory of optical fields is crucial to gain a deeper understanding of optical instruments/systems such as interferometers and imaging systems. Students will be able to analyze partial coherence in imaging systems, laser speckle, and propagation in random medium.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 501, OPTI 508 or consent of instructor.

OPTI 510R: Photonics (3 units)
Description: Fundamentals of fiber and waveguide optics and applications to optical components and systems for fiber communication technology.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 501, OPTI 507, OPTI 511R, OPTI 505R.

OPTI 511L: Lasers and Solid-State Devices Laboratory (1 unit)
Description: The experiments in this lab deal with a number of the subjects addressed in courses OPTI 511R, 541 and 507.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: OPTI 511R. Concurrent registration, OPTI 507.

OPTI 511R: Optical Physics and Lasers (3 units)
Description: Fundamental concepts of quantum mechanics; application to model quantum systems; interaction of light with atoms; perturbation theory; two-level atom approximation; nonlinear optics; pulsed and CW laser operation; thermal sources; optical detectors.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Prerequisite or concurrent registration, OPTI 501.

OPTI 512L: Mathematical Optics Laboratory (1 unit)
Description: Laboratory in support of OPTI 508 and OPTI 512R.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Lecture May Be Offered
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 512R or OPTI 604; C SC 227 or SIE 270.

OPTI 512R: Linear Systems, Fourier Transforms (3 units)
Description: Mathematical background, convolution, the Fourier transform, linear filtering and sampling, two-dimensional operations, diffraction, image formation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: PHYS 142, PHYS 241, MATH 223.

OPTI 513L: Optical Testing Laboratory (1 unit)
Description: Measurement of paraxial properties of optical components, refractive index, surface figure, and surface finish.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Concurrent registration, OPTI 513R.

OPTI 513R: Optical Testing (3 units)
Description: Paraxial properties of optical systems, material qualification, ellipsometry, aberrations, basic interferometers, direct-phase measurement interferometry, measurement of surface quality, testing mirrors, windows, prisms and conercubes, measurement of index inhomogeneity, testing of spherical surfaces and lenses, aspheric testing, absolute measurements, system evaluation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: OPTI 505R.

OPTI 514: Optical Instrumentation (3 units)
Description: This course will introduce students to the 1) principles, 2) designs, 3) applications, and 4) recent developments of a broad variety of optical instruments. Upon completion of the course students will be able to understand optical metrology and laser interferometry principles, design requirements, and how to apply these instruments in practice.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Co-convened with: OPTI 414
Course typically offered:
Main Campus: Fall

OPTI 514A: Photovoltaic Solar Energy Systems (3 units)
Description: This course is intended to provide an introduction to the theory and operation of different types of photovoltaic devices, the characteristics of solar illumination, and the advantages and characteristics of concentrating and light management optics. The physical limits on photovoltaic cell performance and practical device operation will be analyzed. The main device emphasis will focus on different types of silicon photovoltaics including crystalline, amorphous, multi-crystalline, and thin film solar cells. An overview of other types of photovoltaic cells including multi-junction III-V, CdTe, CuInSe2, and organics will also be given. A discussion of radiometric and spectral properties of solar illumination will be presented and the impact of these factors on solar cell design will be explored. Techniques for increasing the performance of solar cells by light trapping, photon recycling, and anti-reflection coatings will be covered. The design and operation of imaging and non-imaging concentrators will also be discussed. Basic experiments related to PV cell measurements and the optical properties of concentrators are also planned for the course. Graduate-level requirements include a research report on a topic selected from the course material.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture — Required
Equivalent to: OPTI 514A
Also offered as: ECE 514A
Co-convened with: OPTI 414A
Course typically offered:
Main Campus: Spring

Home department: Electrical & Computer Engr

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 515: Optical Specifications, Fabrication and Testing (3 units)
Description: Specification of optical components including tolerancing and drawing preparation, material properties, performance metrics; conventional fabrication methods for refractive and reflective optics; optical testing including interferometric testing of surface form and finish, special techniques for aspherics, error analysis, test calibration; and testing of optical systems. Graduate-level requirements include two additional reports requiring independent research or design and one class presentation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 415
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 201R, OPTI 202R, OPTI 310, OPTI 330, OPTI 340. Open to majors only.

OPTI 515L: Optical Specifications, Fabrication, and Testing Laboratory (1 unit)
Description: Practical measurement techniques for optical surfaces, components and systems, comparing measurement data with specifications, relating fabrication issues with test methods. Graduate-level requirements include keeping a lab notebooks, project, and report.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Co-convened with: OPTI 415L
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Concurrent registration, OPTI 515.

OPTI 516: Modern Astronomical Optics (3 units)
Description: This course provides an overview of astronomical optical systems and techniques for the observation of exoplanets. It introduces astronomical and optical concepts related to exoplanets observations. By focusing on a particularly challenging observational problem of modern astronomy, the course will teach design and analysis of ultra high precision optical systems and measurement techniques, including spectroscopy, photometry, optical metrology and interferometry. Graduate- level requirements include a 45 minute final oral examination.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ASTR 516
Co-convened with: OPTI 416
Course typically offered:
Main Campus: Spring

OPTI 517: Lens Design (4 units)
Description: Fundamentals of optical system layout and design; exact and paraxial ray tracing; aberration theory; chromatic and monochromatic aberrations; use of computer programs in lens design.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502.

OPTI 518: Introduction to Aberrations (3 units)
Description: Advanced first-order tools, chromatic aberrations, monochromatic aberrations, sources of aberration, computation, simple systems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 502.

OPTI 520: Biophotonics (3 units)
Description: This course will cover the interaction of light with biological material. A particular focus will be the use of photonics in medical diagnostics. The course will include introductory biological concepts such as DNA, proteins, cells, and tissues. In addition, the course will teach the principles and applications of bioimaging, spectroscopy, and biosensors, as well as summarize recently published progress in the field.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: BME 520
Co-convened with: OPTI 420
Course typically offered:
Main Campus: Spring

Home department: Biomedical Engineering

OPTI 521: Introductory Optomechanical Engineering (3 units)
Description: Optical materials, principles of opto-mechanical design, lens and mirror mounting, tolerancing, specification of optical components. Graduate-level requirements include independent projects.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 421
Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 521L: Introductory Optomechanical Engineering Laboratory (1 unit)
Description: The course provides hands on experience to complement the lecture material in the Introductory Optomechanical Engineering course (OPTI 421/521). Graduate-level requirements include an additional written report.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Lecture Required
Co-convened with: OPTI 421L
Course typically offered:
Main Campus: Fall

Enrollment requirement: Completion or concurrent enrollment in OPTI 521.

OPTI 522: Contrast Agents, Molecular Imaging, and Kinetics (3 units)
Description: Current topics in drug discovery and molecular imaging involve the integration of a series of research modalities. The pharmaceutical Industry uses these modalities in their developmental and regulatory efforts to attain new indications. As well, the medical device community is continually developing new techniques to enhance medical imaging for the earliest detection of disease. Furthermore, kinetic ADME studies (absorbtion, distribution, metabolism, and excretion) are required so as to determine the fate of these agents as an indicator of efficacy and toxicity.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: CBIO 524, PHCL 524
Also offered as: BME 522, CBIO 522, PCOL 522, PHCL 522
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Undergraduate seniors wishing to enroll must have a 3.00 or greater GPA.
Home department: Biomedical Engineering

OPTI 523: Optomechanical Design and Analysis (3 units)
Description: Principles that were taught in OPTI 421/521 (Introductory Optomechanical Engineering) will be applied to develop designs and to perform detailed analysis of optomechanical systems. Graduate-level requirements include independent projects.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 423
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 521.

OPTI 523L: Optomechanical Engineering Laboratory (2 units)
Description: In this class students will work on independent projects involving design, analysis, hardware development, testing, and evaluation. Class meets weekly for assignment, planning, and review of the projects. Beyond the class, the students will schedule time in the Optomechanics Laboratory where they have access to necessary equipment and instruction. Students will be required to present their work to the class, and to provide written documentation. Graduate-level requirements include working independently. Undergraduate students will work as part of a team.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Co-convened with: OPTI 423L
Course typically offered:
Main Campus: Spring

OPTI 524A: Optical Systems Engineering (4 units)
Description: This class provides opportunities for students to learn practical engineering skills for developing optical systems. Students will work in groups on case studies that provide the opportunity to learn systems engineering skills firsthand. Some of the case studies will look at just the necessary requirements, others will include more detailed design, and two or more will be built by the students using off the shelf optics and mechanics. Some examples of optical applications that may be covered are imaging, spectroscopy, illumination, adaptive optics, communication, detection and metrology. These systems will be used to teach fundamentals of systems engineering, optical system design, quantifying performance for optical systems, debugging hardware and professional engineering skills. Graduate-level requirements include more assignments. Their role in the groups will be highly substantive in comparison to undergraduate student group student roles.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Lecture Required
Co-convened with: OPTI 424A
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Course is intended for graduate students who have completed 3 semesters or more or undergrad students in their senior year. Please contact the instructor if you are not sure if you should take this course.

OPTI 525: Sol-gel Science (3 units)
Description: An in-depth review of the chemistry and physics of sol-gel processes used in materials science and engineering. Graduate-level requirements include original research proposal.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: MSE 525
Co-convened with:
Course typically offered:
Main Campus: Fall

Home department: Materials Science & Engineering

OPTI 526: Optical Design in Multiscale Photonic System (2 units)
Description: This course provides students opportunities to understand basic theories and procedures to design and analyze multiscale and nanophotonic optical system such as nanoaperture scanning microscope, solar concentrator optical system with textured solar cells, holographic data storage employing volume grating as well as complex lens system.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502, 505R, 512R, or equivalent. Students enrolling in this course must also enroll in OPTI 600A.

OPTI 527: Holography and Diffractive Optics (3 units)
Description: This course describes the nature of holographic and lithographically formed diffraction gratings and the tools necessary for their design and analysis. Course topics include a description of the interference and Fourier relations that determine the amplitude of diffracted fields, analysis of volume gratings, properties of holographic recording materials, computer generated holograms, binary gratings, analysis of applications of holography including data storage, imaging systems, photovoltaic energy systems, polarization control elements, and associative memories. We will also have a number of lab demonstrations fabricating holograms in a new type of photopolymer.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture — Required
Equivalent to: ECE 527
Also offered as: ECE 527
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502, OPTI 505R or ECE 459 or ECE 559.

OPTI 528: Adaptive Optics and Imaging through Random Media (3 units)
Description: This course provides an overview of adaptive optics fundamentals. The course consists of lectures and team projects. For each of the three team projects during the semester, astronomy and optics students will work together to design an instrument, using material presented during the lectures. Each team projects will result in an oral presentation. Graduate students will be asked to solve problems using course material during the oral final exam.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ASTR 528
Co-convened with: OPTI 428
Course typically offered:
Main Campus: Fall

OPTI 529: Integrated Optics for Information Technology (3 units)
Description: This course provides a fundamental understanding of the concept, fabrication, operation and performance of key integrated optic and photonic components that are widely used in optical communication and information technology. It intends to give students a broad understanding of the components and systems. Graduate-level requirements include project reports more in-depth and longer as well as oral presentation of the project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 429
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: Undergraduate introduction to semiconductors and lasers is sufficient.

OPTI 530: Optical Communication Systems (3 units)
Description: Physics of optical communication components and applications to communication systems. Topics include fiber attenuation and dispersion, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications. Graduate-level requirements include additional homework and a term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 530
Also offered as: ECE 530
Co-convened with: OPTI 430
Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 532: Digital Image Analysis (3 units)
Description: Digital image analysis, including feature extraction, boundary detection, segmentation, region analysis, mathematical morphology, stereoscopy and optical flow.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 532
Also offered as: ECE 532
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 340.
Home department: Electrical & Computer Engr

OPTI 533: Digital Image Processing (3 units)
Description: [Taught alternate years beginning Fall 2006] Image transforms, filter design, spectrum estimation, enhancement, restoration, and data compression.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 533
Also offered as: ECE 533
Course typically offered:
Main Campus: Fall

Recommendations and additional information: ECE 529; Concurrent registration, ECE 503.
Home department: Electrical & Computer Engr

OPTI 534: Advanced Topics in Optical and Electronic Materials (3 units)
Description: Topics to be selected from opto-electronics, wave guides, non-linear optics, nano-materials and semiconductor materials
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 3 times.
Equivalent to: ECE 534, OPTI 534
Also offered as: ECE 534, MSE 534
Co-convened with:
Course typically offered:
Main Campus: Spring (even years only)
Online Campus: Spring (even years only)

Home department: Materials Science & Engineering

OPTI 535: Visual Optics (3 units)
Description: Instrumentation and optics as they pertain to the human visual system. Graduate-level requirements include completion of a final project and a written final exam.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Co-convened with: OPTI 435
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502, OPTI 512R ; Geometrical and Fourier optics.

OPTI 536: Introduction to Image Science (3 units)
Description: This course provides an introduction to the general field of image science. The course provides both an overview of the many application domains of imaging in the physical and biological sciences including biological imaging, astronomy, remote sensing, metrology, and industrial inspection and an in-depth review of the applications of medical imaging. The course is intended for graduate students interested in or working in any area of imaging.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 536A: Free-Space Optical Communications Systems (3 units)
Description: The purpose of the course is to give students a comprehensive introduction to free-space optical communication principles. This course offers in-depth exposition on: (1) propagation effects in free-space, both outdoor and indoor as well as deep-space; (2) channel impairments in these media including atmospheric turbulence effects and scattering effects; (3) noise sources, (4) channel capacity studies, (5) advanced modulation and multiplexing techniques for free-space applications, (6) advanced detection and channel compensation techniques; (7) diversity techniques, (8) MIMO techniques, (9) adaptive optics techniques to deal with atmospheric turbulence effects; (10) advanced coding and coded modulation techniques; and (11) software defined free-space optical communications.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 536A
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 530.
Home department: Electrical & Computer Engr

OPTI 537: Imaging Physics and Devices (3 units)
Description: Overview of basic physical principles and specific devices of use in imaging systems. Sources of light and other radiation, propagation of radiant energy, interaction of light and matter, photocathodes and photoelectronic imaging devices, semiconductor physics and devices. The course is intended for graduate students interested in any area of imaging.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 501; OPTI 511R or undergraduate course in quantum mechanics.

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May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 539A: From Photonics Innovation to the Marketplace (3 units)
Description: This course covers the process of technology development in the photonics industry, both from the perspective of formal processes and case studies. Key aspects of the commercialization process including intellectual property, new product development processes, technical marketing and team building are treated in an interactive program informed by the instructor's 15 years of industry experience in both large corporate R&D organizations and entrepreneurial startups. Graduate-level requirements include completing an executive summary of their business plan/invention disclosure project that is a portion of the Group Gate 2 presentation grade.grade.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ECE 539A
Co-convened with: OPTI 439A
Course typically offered:
Main Campus: Spring
Online Campus: Spring

OPTI 540: Medical Physics (3 units)
Description: Applications of physics in medicine. Physics of the human body, mechanics, thermodynamics, light and radiation and their roles in biological systems, biomedical applications. Graduate-level requirements include students to complete supplemental assignments at the graduate level.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: PHYS 540
Co-convened with:
Course typically offered:
Main Campus: Fall

Home department: Physics

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May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 541: Introduction to Lasers I (3 units)
Description: This course will cover the fundamental physical processes and introduction of engineering relevant to lasers and explore a variety of specific laser systems. Topics to be covered include, optical laser gain and oscillation, resonators, numerical methods for beam propagation, and Q switching. Graduate-level requirements include extra homework and the contents of the midterm and final exam problems will have a higher level of difficulty.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 441
Course typically offered:
Main Campus: Fall

Recommendations and additional information: OPTI 370 or consent of instructor.

OPTI 544: Foundations of Quantum Optics (3 units)
Description: Foundations of quantum optics, interaction of two-level atoms with light; basic elements of laser theory; fundamental consequences of the quantization of the light field; introduction to modern topics in quantum optics.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 570A or equivalent knowledge of graduate level quantum mechanics.
Field trip: Change the prerequiste from OPTI 543 to the following condition: OPTI 570A or equivalent knowledge of graduate level quantum mechanics.

OPTI 547: The Beam Propagation Method (3 units)
Description: Wave equations for propagation in dielectric media, solutions using the beam propagation method based on spectral (Fourier, Hankel transforms) and finite difference methods, with emphasis on thorough understanding of both the underlying physics and numerical simulation principles.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Working knowledge of either Matlab or Mathematica (or a compiled programming language). Basic knowledge of electro-magnetic theory and Maxwell's equations, e.g. OPTI 501, OPTI 512R, or OPTI 546.

OPTI 549: Atom Optics (2 units)
Description: Introduction to the experiments and theoretical concepts of atom optics and matter-wave optics. In atom and matter-wave optics, the wave-like properties of matter are utilized for the manipulation and control of matter (often by laser light), and are centrally important for an understanding of physics at the atomic level and for modern quantum optics applications. This course will introduce some new concepts, but will primarily cover foundational and groundbreaking atom-optics ideas and experimental results.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 511R or OPTI 543. Recommended: OPTI 546 or OPTI 505 (previous or concurrent enrollment).

OPTI 550: Quantized Matter Waves (2 units)
Description: This course will introduce students to the mathematical formalism of quantum field theory as it is applied in the area of atom optics, mainly ultracold atomic gases. More specifically the class will present a framework for the various approaches (eg. macroscopic wave functions versus second quantization) to quantum many-particle systems and their properties, the goal being to deepen the student's theoretical appreciation and working knowledge of the variety of theoretical techniques that underpin the area. The broad range of experimental and theoretical concepts underlying atom optics are covered in the companion class OPTI 549 Atom Optics. Although it is anticipated that most students will take both OPTI 549 and 550 they are designed so that they may be taken in either order or in isolation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Completion of OPTI 570, PHYS 570A or equivalent.

OPTI 553: Nonlinear Photonics (3 units)
Description: Enables students to use advanced optical waveguide analysis with knowledge of physics of nonlinear optics to understand, design and test nonlinear photonics devices. Balances treatment of advanced topics in optical waveguide theory. Introduces nonlinear optics, with emphasis being placed on technologically significant nonlinear photonics phenomena and devices.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 510R.

OPTI 555: Introduction to Atmospheric and Hydrology Remote Sensing (3 units)
Description: The purpose of this course is to introduce the basic remote sensing techniques and their applications to the atmosphere, hydrology and other fields. This includes understanding the basic concepts of radiation transfer, passive and active remote sensing, satellite and ground-based remote sensing and their retrieval techniques. Finally, inversion techniques in remote sensing will be briefly introduced and the uncertainties/errors of the retrieved cloud and precipitation properties will be estimated.Graduate students will do some homework, but primarily work on processing and analyzing the aircraft, ground-based and satellite remote sensing data collected from instructors research projects. Graduate students will get hands-on experience by doing these projects using IDL, MATLAB, FORTRAN, or other programs. For some projects, I may provide key codes as a reference.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: ARL 555, ATMO 555, ENVS 555, GEOS 555, HWRS 555, REM 555
Course typically offered:
Main Campus: Spring

Home department: Hydrology and Atmospheric Sciences

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-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 560: Quantum nanophotonics (3 units)
Description: This course will introduce the field of quantum nanophotonics: how to implement quantum technology and quantum information processing based on integrated photonic circuits. Different nanophotonic devices for quantum light control will be introduced. The methods to generate quantum states of light, manipulate light at quantum level with different degrees of freedoms, and detect quantum states of light with various approaches will be covered. Major achievements and future challenges in the field will be discussed. This course aims to provide basic knowledge about quantum nanophotonics from experiment prospective to students from broad backgrounds including quantum/classical photonics, quantum information theory, atomic physics, etc.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Knowledge of electromagnetic waves & optics is required. Knowledge in quantum mechanics & quantum optics is preferred. Prior consultation with instructor recommenced if student has not taken an undergraduate or graduate course in quantum physics.
Field trip: None.

OPTI 561: Physics of Semiconductors (3 units)
Description: Elementary excitations in solids, phonons, electrons and holes, dielectric formalism of optical response, many-body effects in a Coulomb system.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 561
Also offered as: PHYS 561
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: PHYS 460; OPTI 507 recommended but not formally required.
Home department: Physics

OPTI 567: Nanophotonics (3 units)
Description: This course will cover the interaction of light with nano-scale features on objects. Ways to focus light and image objects beyond the diffraction limit will be presented. The course will include mathematical foundations, including those of plasmonics and metamaterials, as well as a review of applications of nanophotonics and recently-published progress in the field.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Completion of OPTI 501 or instructor consent.

OPTI 568: Introduction to Optical Spectroscopy (3 units)
Description: The objective of this course is to introduce optical spectroscopy methods that widely used in physics, chemistry and biological sciences, provide knowledge for estimating applicability ranges of various methods, and teach basics of planning and designing spectroscopy instruments. Graduate requirements include an oral presentation during the last week of class on the topic of the term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 468
Course typically offered:
Main Campus: Spring

OPTI 569L: System Programming for Engineers (2 units)
Description: The course aims to teach entry to intermediate level software development skills in the LabVIEW programming environment.LabVIEW is a graphic programming environment that specializes in software development for measurement and control instruments. It is widely used in science and industrial research labs for designing and testing systems.Graduate student will have additional components on homework, including: code readability, program architecture, and the quality of user interface.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Co-convened with:
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Students must have one prior course in programming language, such as C++, Java, MatLab. Knowledge about Object Oriented Programming is preferred.

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-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 570: Quantum Mechanics (3 units)
Description: This is a one-semester course designed to provide students with a solid understanding of quantum mechanics formalism, techniques, and important example problems. With this background, students will be prepared for subsequent in-depth studies in optical physics, quantum optics, relativistic quantum mechanics and other advanced quantum mechanics topics, condensed matter physics, laser physics, and semiconductor physics and optics. The course emphasizes a formal mathematical treatment of quantum mechanics, and is therefore intended for students who have already completed at least a one-semester course in quantum mechanics where the basic concepts, symbols, and mathematical approaches have been introduced. OPTI 570A and PHYS 570A; students may register under either course number.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Course typically offered:
Main Campus: Fall

OPTI 571L: Optical Physics Computational Lab (1 unit)
Description: This course will introduce students to using computers for solving quantum mechanics and optical physics problems of relevance to optical physics. This computation lab course consists of weekly 1-hour lectures and weekly assignments to be completed independently by students and turned in for credit. The computational projects include topics that are discussed in OPTI 570, and topics that build from those covered in OPTI 570. The course is designed to be taken by students after completion of OPTI 570, rather than concurrently with OPTI 570.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory — Required
Repeatable: Course can be repeated for a maximum of 1 units.
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Completion of OPTI 570 or an equivalent course in graduate-level quantum mechanics. Some familiarity with MATLAB desired, but not required.

OPTI 573: Atomic and Molecular Spectroscopy for Experimentalists I (3 units)
Description: Experimental techniques to generate, analyze and detect photons from X-ray to infrared; interpretation of spectra from gases, liquids, solids and biological macromolecules; light scattering, polarization. Graduate-level requirements include homework problem assignments at an advanced level.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 573
Also offered as: PHYS 573
Co-convened with:
Home department: Physics

OPTI 575: Optical Thin Films (3 units)
Description: The optical properties of single films, design and multilayer optical coatings, calculation and visualization aids, accurate computation methods, introduction to manufacturing methods, non-ideal behavior of thin films. The grading policy for both graduate and undergraduate levels is identical, but the homework and exams on which the grades are based will be separately designed for each group. Graduate-Level requirements represent a more advanced level.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 475
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 310 or consent of instructor.

OPTI 576: Thin Film Optics (3 units)
Description: Provides an understanding of some of the significant physical mechanisms involved in the growth, structure and optical properties of thin films for us in the wavelength range ~1nm - 1um. The basic electromagnetic theory of multilayer thin films will be covered, with application to coatings including antireflection, reflection, beam splitters, diachronic filters, and bandpass filters. Examples ranging from the IR to soft x-rays will be discussed.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 581A: Assessing Early Stage Medical Technologies for Commercial Potential (2 units)
Description: Where do new medical devices and therapeutic systems come from? In this course students will learn how one Innovates in the medical arena and how you take a concept of potential practical value and make it real. All the critical steps in medical innovation will be discussed. Graduate-level requirements include graduate students serving as team leaders.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ENGR 581, ENGR 581A, ENTR 581, MED 581, MED 581A, OPTI 581, OPTI 581A, PATH 581, PATH 581A
Also offered as: ENGR 581A, ENTR 581A, LAW 581A, MED 581A, PATH 581A
Co-convened with: OPTI 481A
Course typically offered:
Main Campus: Spring

Home department: McGuire Center for Entrepreneurship

OPTI 583: Computational Optics: Ultra Fast Pulses & Strong Field Light Matter Interactions (3 units)
Description: Introduction to physics and computational methods for extreme nonlinear optics in high-power femtosecond pulses.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Knowledge of basic electromagnetic theory (e.g. PHYS241). Experience with compiled-language programming preferred. Must perform practical numerical work under mentorship or instructor and interact with computers and software.

OPTI 584: Polarized Light and Polarimetry (3 units)
Description: Polarized light and the Poincare sphere. Polarization in natural scenes and animal vision. Polarization elements: polarizers, retarders, and depolarizers. Jones and Mueller polarization calculus. Polarimetry: measuring the polarization properties of optical elements and materials. Polarization modulators and controllers. Polarization dependent loss and polarization mode dispersion in fiber optics. Advanced polarization issues in optical devices and systems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 484
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Completion of OPTI 501 or equivalent

OPTI 585: Illumination Engineering (3 units)
Description: Fields: Illumination, Nonimaging, and Concentrators; Sources: Incandescent, Fluorescent, LED, HID, Modeling, and Experimental Measurement; Modeling: Ray Tracing, Radiometry and Photometry, Color, Polarization, and Scattering; Theory: Radiometry, Photometry, Étendue, Skew Invariant, and Concentration; Design Methods: Edge Ray, Flow Line, Tailored Edge Ray, Non-Edge Ray, and Imaging; Optics: Reflectors, Lightpipes, Couplers, Films, and Hybrids; Applications: Displays, Automotive, Solar, Sources, and Lighting; Special Topics: Software Modeling, Optimization, Tolerancing, and Rendering. Graduate-level requirements include decidedly more involved project than that for undergraduates. Additionally, the final design review requirements are more extensive.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Lecture Required
Co-convened with: OPTI 485
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 502. Permission from instructor.

OPTI 586: Polarization in Optical Design (3 units)
Description: Principals of the calculation of polarization effects in optical systems; Geometrical optics; Polarization ray tracing. Polarization aberration function. Examples of polarization aberrations.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502.

OPTI 586L: Polarization in Optical Design Lab (1 unit)
Description: Polarization optical design software principals. Calculation of polarization effects in optical systems; Geometrical optics; Polarization ray tracing. Polarization aberration function. Examples of polarization aberrations.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Lecture May Be Offered
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: Must be taken concurrently with OPTI 586.

OPTI 587L: Photonic Communications Laboratory (1 unit)
Description: This course is designed to provide the hands-on experience needed to master the basic concepts and laboratory techniques of optical fiber technology.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Also offered as: ECE 587L
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Some knowledge of EM and semiconductor devices will be helpful.

OPTI 588: Introduction to Display Science & Technology (3 units)
Description: The class examines the fundamentals of 2D and 3D display technologies (e.g. human visual system, color and depth perception, color theory and metrology, and state-of-the-art display technologies), display performance evaluation and calibration, and display research frontiers. The class is suited for both graduate and undergraduate students. You are encouraged to talk to the Instructor to find out if this is the right course for you.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502 or 202.

OPTI 589: Optics Outreach (1 unit)
Description: Students will explore a variety of methods for communicating with the general public about science and optics in particular. Students are expected to develop and apply the knowledge and skills useful for developing methods for communicating effectively with a wide range of audiences. The primary audience for applying the skills acquired in this course will be communicating with students in the high school setting. Graduate-level requirements include an independent project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: OPTI 489
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: For majors only.

OPTI 589A: Optics Outreach (1 unit)
Description: Students will explore a variety of methods for communicating with the general public about science and optics in particular. Students are expected to develop and apply the knowledge and skills useful for developing methods for communicating effectively with a wide range of audiences. The primary audience for applying the skills acquired in this course will be communicating with students in the high school setting. Graduate-level requirements include an independent project to include a 3-page writing assignment and 15-20 minute presentation about a topic relating to optics (theory or applied).
Grading basis: Student Option ABCDE/PF
Career: Graduate
Course Components: Discussion — May Be Offered
Lecture — Required
Co-convened with: OPTI 489A
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: OPTI 589.

OPTI 590: Remote Sensing for the Study of Planet Earth (3 units)
Description: Remote Sensing for the Study of Planet Earth introduces basic and applied remote sensing science as a means to explore the diversity of our planetary environments (biosphere, atmosphere, lithosphere and hydrosphere) within the radiometric, spectral, spatial, angular and temporal domains of remote sensing systems. This survey course strikes a balance between theory, applications and hands-on labs and assignments. We explore how you can download, process, analyze and interpret multi-sensor data and integrate online remotely sensed data sources/products into your research of interest.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $50
Course Components: Lecture — Required
Equivalent to: ARL 590, ARL 590, ATMO 590, GEN 590, GEOG 590, GEOS 590, HWRS 590, MNE 590, OPTI 590, RNR 590, SW 590, SWES 590
Also offered as: ARL 590, ATMO 590, ENVS 590, GEOG 590, GEOS 590, HWRS 590, MNE 590, REM 590, RNR 590
Co-convened with: OPTI 490
Course typically offered:
Main Campus: Fall

Home department: GIDP on Remote Sensing and Spatial Analysis

OPTI 595A: Current Subjects in Optical Sciences (1 unit)
Description: Discussion of current research topics in Optics by Optical Sciences colloquium speakers.
Grading basis: Student Option ABCDE/PF
Career: Graduate
Course Components: Colloquium Required
Repeatable: Course can be repeated a maximum of 2 times.
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall, Spring

OPTI 595B: Information in a Photon (3 units)
Description: This course will develop the mathematical theory of noise in optical detection from first principles, with the goal of understanding the fundamental limits of efficiency with which one can extract information encoded in light. We will explore how optical-domain interferometric manipulations of the information bearing light, i.e., prior to the actual detection, and the use of detection-induced electro-optic feedback during the detection process can alter the post-detection noise statistics in a favorable manner, thereby facilitating improved efficiency in information extraction. Throughout the course, we will evaluate applications of such novel optical detection methods in optical communications and sensing, and compare their performance with those with conventional ways of detecting light. We will also compare the performance of these novel detection methods to the best performance achievable---in the given problem context---as governed by the laws of (quantum) physics, without showing explicit derivations of those fundamental quantum limits. The primary goal behind this course is to equip students (as well as interested postdocs and faculty) coming from a broad background who are considering taking on theoretical or experimental research in quantum enhanced photonic information processing, with intuitions on a deeper way to think of optical detection, and to develop an appreciation of: (1) the value of a full quantum treatment of light to find fundamental limits of encoding information in the photon, and (2) how pre-detection manipulation of the information-bearing light can help dispose it information favorably with respect to the inevitable detection noise.
Grading basis: Regular Grades
Career: Graduate
Course Components: Colloquium Required
Co-convened with: OPTI 495B
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Undergraduate mathematical background and proficiency in complex numbers, probability theory, and linear algebra (vectors and matrices) will be assumed.

OPTI 596C: Aberrated Imaging and Propagation (3 units)
Description: Diffraction effects of aberrations in imaging systems with circular, annular, and Gaussian pupils, and imaging through atmospheric turbulence.
Grading basis: Regular Grades
Career: Graduate

Course Components:	Lecture	May Be Offered
	Seminar	Required

Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 502, OPTI 503.

OPTI 597A: Optical Shop Practices (3 units)
Description: Experience with various techniques to produce optical surfaces--a sphere, a flat, or a paraboloid. These surfaces can be used as the mail components of a simple telescope of four inches aperture. The emphasis of the course is to produce actual elements be applying abstract optical concepts.
Grading basis: Regular Grades
Career: Graduate

Course Components:	Workshop	Required

Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 201R or OPTI 502.

OPTI 597B: Technical Writing and Communication (3 units)
Description: This class will review principles and procedures of technical communication; focus on analyzing audiences and purpose of communication; practice organizing information and writing specialized documents such as technical reports, funding proposals, journal publications, and dissertations/theses.
Grading basis: Regular Grades
Career: Graduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 599: Independent Study (1 - 5 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer
Online Campus: Fall, Spring, Summer

OPTI 600A: Photonics in Lens Design (1 unit)
Description: Understanding of physical optics along with skills to implement it into a ray-trace based optical design software is one of the essential skills for optical engineers and lens designers. In this class, we focus gratings, thin and thick holographic optical elements as an optical component used in modern complex optical system. The course provides fundamental understanding of theories used in optics and photonics system design with grating/holograms as well as skills to implement theories into software codes. During the 5 week course, student will acquire introductory knowledge of Photonics, fundamental theories in grating/holograms design and be able to implement gratings and holograms to optical systems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall

Recommendations and additional information: OPTI 502, 505R, and 512R (or equivalent). Students should be familiar with Ray Trace Code and Code V.

OPTI 600B: Linear Algebra for Optics (1 unit)
Description: Linear algebra techniques arise in many areas of optics. However, due to the diversity of backgrounds, students taking optics coursework may have limited or no exposure to these techniques. This course reviews the fundamentals of linear algebra and illustrates these concepts with applications to various fields of optics. The goal of the course is to improve the student's linear algebra skills and connect the mathematical concepts to real world applications.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall

Recommendations and additional information: Students should have a basic understanding of the concepts of geometrical optics, polarization, resonators and color spectra. Familiarity with a high level programming language such as Matlab for data analysis and matrix manipulation is required.

OPTI 600C: Computational Photography (1 unit)
Description: The modern cell phone has enormous image acquisition and computational power. Computational photography blends computer algorithms with traditional photography to create images that are not feasible with traditional digital imaging. This course examines several computational photography techniques to familiarize students with recent advances in the field.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall

Recommendations and additional information: Familiarity with a high level programming language such as Matlab for image analysis and image manipulation is required. A digital camera with manual settings will be useful for some assignments.

OPTI 600D: Diffractive Optical Elements - Theory and Design (1 unit)
Description: This course includes a physical optics approach to understanding computer-generated diffractive optical elements (DOEs) and their differences with respect to refractive lens elements. Included in the discussion are gratings, focusing elements, aberration compensators, servo-signal generators, axicons, computer-generated holograms (CGHs) and other elements. Design techniques using Zemax ray-tracing software will be demonstrated, and an open-source Matlab program called OptiScan will be used for project assignments.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall

Recommendations and additional information: OPTI 505R, access to computer with Matlab.

OPTI 600E: Diffractive Optical Elements - Fabrication and Testing (1 unit)
Description: This course is a hands-on fabrication and testing course in which students will learn characteristics of fabricating and testing different types of computer-generated diffractive optical elements (DOEs). Elements include binary amplitude, binary phase and gray-scale phase structures. Gratings, diffractive Fresnel lenses (DFLs) and computer-generated holograms (CGHs) will be fabricated. The primary fabrication tool will be the College of Optical Sciences Maskless Lithography Tool (MLT). Design techniques using Zemax ray-tracing software and an open-source Matlab program called OptiScan learned in the previous course will be used. Students will work in pairs.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory Required
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall

Recommendations and additional information: OPTI 505R. Prerequisite or concurrent enrollment in OPTI 600D. Access to a computer with Matlab.

OPTI 600F: Spatial Frequency Analysis of Optical Systems (1 unit)
Description: This course includes a physical approach to understanding coherent transfer function, optical transfer function, and partially coherent imaging. A mathematical development will be also be used to illustrate these imaging conditions using a thin object model. We will also analyze phase contrast, dark field, scanning optical microscopy, confocal, nonlinear imaging, Fourier ptychographic imaging and other imaging modalities.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 505R.

OPTI 600G: Laser Beams and Resonators (1 unit)
Description: Starting from the ray optical treatment of first-order optical systems this class develops the ideas and approaches underpinning the properties of laser beam propagation and its application to optical resonators. Topics range from ABCD ray transfer matrices, classification and stability of optical resonators, to the properties of a variety of common optical resonators. The goal of the class is to provide the students with the skills to analyze basic laser beam propagation and resonator properties.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 501 and OPTI 502 recommended. Basic understanding of geometrical optics- at the level of paraxial optics, and wave optics- at the level of Helmholtz equation. Familiarity with a high level programming language such as MATLAB is required.

OPTI 600K: Cavity Optomechanics I (1 unit)
Description: This course (1st in a two-module series) will introduce the field of cavity optomechanics. Early lessons will review mechanical resonators, optical cavities, and their coupling via radiation pressure. Detailed treatment will then be given to the canonical optomechanical system, a Fabry-Pérot cavity with a compliant end-mirror, leading to the concepts of radiation pressure dynamical back-action (optical stiffening and damping), stochastic back-action (radiation pressure shot noise), and the standard quantum limit for a continuous position measurement.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Students are furthermore encouraged to take OPTI-600G (1 unit, Laser Beams and Resonators), during the first 5 weeks of the term.
Enrollment requirement: Students must have completed a course in graduate level quantum mechanics (e.g. OPTI-570 or equivalent)

OPTI 600L: Cavity Optomechanics II (1 unit)
Description: This course (2nd in a two-module series) will explore contemporary topics in the field of cavity optomechanics. Early lectures will survey paradigmatic experimental systems such as gravitational wave detectors, optomechanical crystals, levitated nanoparticles, and superconducting LC circuits. Recent milestones in the field of cavity "quantum" optomechanics will then be studied, including ground-state cooling of a micromechanical oscillator, observation of radiation pressure shot noise, ponderomotive light usqueezing, and optomechanical entanglement. Finally, emerging applications such as ultra-sensitive accelerometry, quantum-noise-calibrated thermometry, and quantum-coherent electro-optic conversion will be discussed.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Enrollment requirement: Students must have completed a course in graduate level quantum mechanics (e.g. OPTI 570 or equivalent, and must have completed OPTI 600K (first module of course).

OPTI 604: Advanced Mathematical Methods for Optics (3 units)
Description: Complex variables. Fourier theory and applications to imaging. Coherent and incoherent imaging. Other integral transforms. Special functions and orthogonal polynomials. Linear algebra. Integral equations. Green's functions.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MATH 223, PHYS 142, and PHYS 241.

OPTI 617: Practical Optical System Design (3 units)
Description: Fundamentals of optical design methods and discussions of commonly used optical systems. Covers principles, design methods, and design examples for each system. Students will design one complete optical system.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: OPTI 517.

OPTI 630: Biomedical Optics and Biophotonics (3 units)
Description: [Taught alternate years beginning Fall 2004]. This course covers the basic optical principles, techniques, and instruments used in biomedical research and clinical medicine. It includes in-depth coverage of optical imaging and spectroscopy systems for biomedical research and clinical diagnosis, details of light interaction with tissue, and advanced optical therapeutic instruments and techniques. The course describes commercial devices and instruments as well as new devices and instruments under development for novel applications. This course is intended for advanced graduate students in optical sciences or engineering with a suitable background in optics and imaging.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: BME 630
Also offered as: BME 630
Course typically offered:
Main Campus: Fall

OPTI 632: Advanced Optical Communication Systems (3 units)
Description: Advanced technologies and methods that enhance the overall optical transmission system performance and throughput, and the trade-offs related to the system engineering process. Topics include advanced chromatic dispersion compensation, PMD compensation and the nonlinearity management. The spectral efficiency limits will be described and techniques to achieve it, such as turbo equalization, forward error correction (FEC), and coded modulation. Advanced modulation formats, and constrained coding techniques suitable to deal with fiber nonlinearities will be presented. The physics behind parametric amplification will be presented as well as its application to all-optical regeneration, wavelength conversion, and multibanded switching. Other topics include soliton and dispersion-managed soliton transmission. Several proof-of-concept experiments will be demonstrated in Optical Communication Systems Laboratory (OCSL).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 632
Also offered as: ECE 632
Course typically offered:
Main Campus: Spring

Recommendations and additional information: ECE 340; ECE 430 or ECE 530.
Home department: Electrical & Computer Engr

OPTI 636: Noise in Imaging Systems (3 units)
Description: Development of mathematical tools for describing stochastic processes in single optical detectors and complex imaging systems; understanding the effect of image processing and reconstruction algorithms on image noise; development of a quantitative approach to assessing and optimizing image quality.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: OPTI 508, OPTI 512R.

OPTI 637: Principles of Image Science (3 units)
Description: Mathematical description of imaging systems and noise; introduction to inverse problems; introduction to statistical decision theory; prior information; image reconstruction and radon transform; image quality; applications in medical imaging; other imaging systems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 508, OPTI 512R, OPTI 604.

OPTI 638: Advanced Medical Imaging (3 units)
Description: Describes the physical principles behind the medical cross-sectional imaging modalities of magnetic resonance imaging (MRI), computed tomography (CT), ultrasound (US), positron emission tomography (PET), and single photon emission computed tomography (SPECT).
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: BME 638
Also offered as: BME 638
Course typically offered:
Main Campus: Spring

Recommendations and additional information: OPTI 512R, OPTI 604.

OPTI 639: Image Science for Oncology (3 units)
Description: This course is for students who are interested in applying methods from modern image science to research or clinical practice related to cancer. It will impart the basic biomedical background needed for graduate-level research in oncological imaging, and it will survey the imaging methods and mathematical techniques needed to address current problems in this area.
Grading basis: Regular Grades
Career: Graduate
Course Components: Discussion Required
Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Any previous graduate-level course in image science or consent of instructor; some knowledge of linear algebra, differential equations and Fourier transforms. No prior background in cancer biology is needed.

OPTI 646: Introduction to Quantum Information and Computation (3 units)
Description: The course covers the foundations of quantum information and selected topics in quantum communication and quantum components, including physical implementations.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Solid knowledge and understanding of graduate level quantum mechanics is required.

OPTI 647: Photonic Quantum Information Processing (3 units)
Description: This course is for students who intend to partake theoretical or experimental research in any area of photonic quantum information processing, such as quantum communications, sensing and computation. The course will be aimed at developing a principled understanding of classical and non-classical light, and the generation, manipulation and detection of non-classical light. As application of material learnt in the course, examples will be drawn from important applications of photonic quantum information processing, such as linear optical quantum computing, quantum repeaters for entanglement distribution, and quantum sensing.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Knowledge of complex numbers, linear algebra, Fourier transforms, probability and random processes will be expected. Prior completion of a quantum physics course required. Completion of OPTI 570 is recommended.
Enrollment requirement: Completion of OPTI 511R or OPTI 544 required.

OPTI 656A: Atmospheric Radiation and Remote Sensing (3 units)
Description: Theory of atmospheric radiative transfer processes; specific methods for solving the relevant equations; applications to problems in radiative transfer; theoretical basis for remote sensing from the ground and from space; solutions to the "inverse" problem.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 656A, PTYS 656A
Also offered as: ATMO 656A, PTYS 656A
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MATH 254.
Home department: Hydrology and Atmospheric Sciences

OPTI 656B: Atmospheric Radiation and Remote Sensing (3 units)
Description: Theory of atmospheric radiative transfer processes; specific methods for solving the relevant equations; applications to problems in radiative transfer; theoretical basis for remote sensing from the ground and from space; solutions to the "inverse" problem.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: OPTI 656B
Also offered as: ATMO 656B, PTYS 656B
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MATH 254.
Home department: Hydrology and Atmospheric Sciences

OPTI 671: Advanced Optical Systems and Networks (3 units)
Description: Principles and procedures of optical networking with focus on high speed optical signal transmission between network nodes, lightpath routing and distribution, multilayer network design, and advanced photonic techniques and devices for optical signal transmission and switching.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: OPTI 370 or OPTI 510R or basic understanding of fiber optics.

OPTI 677: Micro/Nano- Fabrication in Optoelectronics (2 units)
Description: This course is intended to give an understanding of various fabrication techniques in photonic and optoelectronic components. It covers design step, epitaxial growth and processing steps frequently used in microfabrication of optical and optoelectronic devices. Fabrication of waveguides and laser diodes and various integration techniques are also discussed.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

OPTI 696A: Advanced Lens Design (2 units)
Description: Introduction to the design process; use of computers in design; definition of design parameters; ray tracing methods; review of Gaussian Optics layout of lens systems.
Grading basis: Regular Grades
Career: Graduate
Course Components: Seminar Required
Course typically offered:
Main Campus: Fall

Recommendations and additional information: OPTI 517.

OPTI 696D: Practical Optics Seminar Engineering of Optical Systems (1 unit)
Description: Introduction to systems engineering issues using commercial optical systems as examples.
Grading basis: Regular Grades
Career: Graduate
Course Components: Seminar Required
Course typically offered:
Main Campus: Fall

OPTI 792: Directed Introductory Graduate Research (1 - 3 units)
Description: This course is designed to aid PhD students in their search and selection of a research area and research advisor by incorporating research activities into the first year of the Optical Sciences PhD program. In this course, students select a faculty advisor who will supervise a research project and assign a grade at the end of the semester based on student performance in the course. For their research project, students may select from various options, including (but not limited to): assisting with an ongoing research project, creating and working on their own research project under their supervisor's guidance or the guidance of another mentor such as a more senior graduate student, choosing rotations through multiple research groups (in which case multiple single-credit research courses with different supervisors might be taken in a single semester), or theoretical or computational investigation into fundamental aspects of science and engineering that underlie specific research areas or specific projects.
Grading basis: Regular Grades
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 2 times.
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall, Spring

OPTI 900: Research (1 - 8 units)
Description: Individual research, not related to thesis or dissertation preparation, by graduate students.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer
Online Campus: Fall, Spring, Summer

OPTI 909: Master's Report (1 - 3 units)
Description: Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer
Online Campus: Fall, Spring, Summer

OPTI 910: Thesis (1 - 8 units)
Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer
Online Campus: Fall, Spring, Summer

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

OPTI 920: Dissertation (1 - 9 units)
Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer
Online Campus: Fall, Spring, Summer

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.