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Undergraduate Bulletin



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## Course Descriptions - Optical Engineering

Professors: Bunch, Ditteon, Duree, Granieri, Hening, Joenathan, Kirkpatrick, Kirtley, McNerney, Milanovic, Moloney, Siahmakoun, Syed, Tripathi, Vijayan, Wagner, and Western.

*NOTE:* In courses which include a laboratory, satisfactory completion of the laboratory work is required in order to pass the course.

### OE 171 Photography and Holography 2R-OL-2C F

Introduce students to basic knowledge of optics, principles and operation of a camera, shutters, films, and film development, color photography, basic understanding of interference of waves, concept of holography, properties of various holograms, application of holography, and each student makes individual hologram that can be seen in sunlight.

### OE 172 Optics in Technology 2R-OL-2C S

Introduction to the properties of lasers; types of lasers; characteristics of optical fibers, optical communication, applications of lasers and fibers in industry, medicine and commercial products.

### OE 280 Paraxial Optics 3.5R-1.5L-4C W Pre: PH 113

First order geometrical optics including image formation, y-nu ray tracing, cardinal points, stops and apertures, matrix methods and an introduction to optical instruments. Introduction to computer-aided analysis.

### OE 290 Directed Research Credit arranged Pre: Consent of instructor

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

### OE 295 Optical Systems 3.5R-1.5L-4C S Pre: PH 113 and MA 221

Components of optical systems; introduction to lasers light and Gaussian beams; Optical fibers; Fiber optic systems; radiometry and photometry; optoelectronics; LEDs; optical sources; detectors; noise in detectors; CCD arrays, optical instruments.

### OE 392 Wave Optics & Coherence 4R-0L-4C Arranged Pre: PH 292, MA 222

Propagation of light, Fresnel equations; Fraunhofer and Fresnel diffraction; coherence; Fourier transforms, convolution and correlation; optical transfer function (OTC), modulation transfer function (MTF); speckles; holography, moire.

### OE 393 Fiber Optics and Applications 3R-3L-4C W Pre: OE 295 and PH 316

Basic dielectric waveguide equations; wave optics and ray optics; step-index and graded-index fibers; single mode and multi-mode fibers; mode cutoff conditions; numerical aperture; fabrication of optical fibers; fiber measurements; fiber cable designs; source coupling, splices and connectors; fiber optic sensors; fiber optic components and systems.

### OE 395 Optical Instrumentation 3R-3L-4C Arranged Pre: OE 280 and PH 292

Radiometry and photometry; optoelectronics; LEDs; optical sources; detectors; signal conditioning and noise; CCD arrays; optical instruments; color; selected experiments on the application of optical instruments.

**OE 415 Optical Engineering Design I 2R-6L-4C S Pre: OE 295 and RH330 or consent of the instructor**

First half: Codes of ethics appropriate to optical engineers, case studies related to optical engineering professional practice and contemporary issues, Teaming role plays and lessons, Project management tasks and product life cycle, and analysis of case studies.

Second half: Team-oriented design project work on selected topics in optical engineering, introduction to product development practices, product research, preliminary design of product, deliver a detail design document specific to customer needs and constraints.

**OE 416 Optical Engineering Design II 2R-6L-4C F Pre: OE 415**

Follow up of 415, Continuation of OE415 design project, design of prototype product, building of prototype, experiments to test optical components and systems, electronic systems, optical measurement tools, mechanical measurements, design construction of optics, opto-mechanics, and opto-electronics in the system, construction of a device, test and refinement, and cost analysis. Grade is given after completing OE417.

**OE 417 Optical Engineering Design III 2R-6L-4C W Pre: OE416**

Follow up of 416, Market analysis, Acceptance test documents, documentation of the finished prototype, deliver a prototype, and deliver a written report and give an oral presentation. Grade includes both OE416 and OE417.

**OE 435 Biomedical Optics 4R-0L-4C W Pre: PH 113, MA 222, and SR/GR standing**

Optical techniques for biomedical applications and health care; laser fundamentals, laser interaction with tissues, laser diagnostics and therapy, laser surgery, endoscopy and applications; fiber optics; fiber optic biosensors; microscopes; optics-based clinical applications. Same as BE 435.

**OE 450 Laser Systems and Applications 3R-3L-4C S Pre: PH 292 and MA 222 or JR standing or consent of instructor**

Laser safety; Gaussian beam propagation; cavity design; longitudinal and transverse modes; stimulated emission; population inversion; rate equations; gain and threshold; Q-switching and mode-locking; types of laser systems; laser applications in communication; medicine, military, industry.

**OE 470 Special Topics in Optical Engineering 2-4 Credits Pre: Consent of instructor**

Lectures on special topics in optics.

**OE 480 Lens Design and Aberrations 4R-0L-4C F Pre: OE 280 or SR/GR standing or consent of instructor**

Chromatic and third order aberrations, exact ray tracing, y-y bar diagrams as a design tool, methods for reducing aberrations in initial designs, optimization. Design of simple lens systems. Introduction to computer-aided design, design of optical systems including camera lenses, mirror systems and catadioptric systems.

**OE 485 Electro-Optics and Applications 3R-3L-4C W Pre: PH 292 and PH 316 or SR/GR standing or consent of instructor**

Optical wave propagation in anisotropic media; normal surface, birefringence, index ellipsoid, optical activity, Faraday rotation, Pockels and Kerr effects, electro-optic modulators, electro-optic effect in liquid crystals, photorefractive effect, acousto-optic effect and modulators, second-harmonic generation, optical phase-conjugation and applications.

**OE 490 Directed Research Credit arranged Pre: Consent of instructor**

Research for junior and senior students under the direction of a physics and optical engineering faculty member. May earn a maximum of 8 credits between PH/OE 290 and PH/OE 490 for meeting graduation requirements. Maximum of

4 credits per term. The student must make arrangements with the faculty member for the research project prior to registering for this course.

**OE 493 Fundamentals of Optical Fiber Communications 3R-3L-4C S Pre: OE393 or graduate standing or consent of the instructor**

Evolution of fiber optics links and networks: information rate, evaluation of fiber optic systems, optical fiber transmission link. Digital transmission systems: point-to-point links, line coding, error correction. Analog systems: links, dynamic range, noise figure, bandwidth, carrier-to-noise, multi-channel transmission, cross talk. WDM concepts: operational principles, passive components, system considerations. Optical networks: network topologies, performance of linear bus, performance of star architecture, SONET, WDM networks, wavelength-routed networks, optical CDMA, ultra high capacity WDM networks, bit-interleaved optical TDM, time-slotted optical TDM.

**OE 495 Optical Metrology 3R-3L-4C F Pre: PH 292 or SR/GR standing or consent of instructor and Co-Req OE 480**

Optical testing: geometrical test methods (refractometers, knife edge, Ronchi, Wire, Hartmann); review of interference and coherence; fringe visibility; conventional interferometers (Newton, Fizeau, Twyman-Green and shearing); fringe localization; phase shifting, holographic, Moire, photoelastic and speckle interferometry; emerging optical methods.

**OE 497, OE 498, OE 499 Senior Thesis 1-2C F,W,S Pre: Consent of PHOE faculty**

Literature search, research proposal preparation, and laboratory project work. This sequence is designed to result in a completed senior thesis or initiation of research to be completed in an MSOE degree at Rose-Hulman.

## **GRADUATE COURSES**

*Note:* SR/GR standing is required for enrolling in the following 500-level courses.

**OE 520 Principles of Optics 2R-0L-2C F Pre: OE 295, PH 292, PH 316 or SR/GR standing or consent of instructor**

Classical optics; exact ray tracing; aberrations, interference, polarization, spatial and temporal coherence; lasers and Gaussian beam propagation; diffraction; optical sources and detectors; selected applications of optics.

**OE 535/BE 535 Biomedical Optics 4R-0L-4C W Pre: PH 113, MA 222 or SR/GR standing or consent of instructor**

Optical techniques for biomedical applications and health care; laser fundamentals, laser interaction with tissues, laser diagnostics and therapy, laser surgery, endoscopy and applications; fiber optics; fiber optic biosensors; microscopes; optics-based clinical applications. For graduate credit, students must do additional project work on a topic selected by the instructor.

**OE 570 Special Topics in Optics 2 or 4C F,W,S Pre: OE 295, PH 292, and PH 316**

Lectures on special topics in optics such as: optical materials, optics of thin films and infrared optics.

**OE 580 Lens Design and Aberrations 4R 0L 4C F Pre: OE 280 or SR/GR standing or consent of instructor**

Chromatic and third order aberrations, exact ray tracing,  $y$   $y$  bar diagrams as a design tool, methods for reducing aberrations in initial designs, optimization. Design of simple lens systems. Introduction to computer aided design, design of optical systems including camera lenses, mirror systems and catadioptric systems. For graduate credit, students must do additional project work on a topic selected by the instructor.

**OE 585 Electro Optics and Applications 3R 3L 4C W Pre: PH 292 and PH 316 or SR/GR standing or consent of instructor**

Optical wave propagation in anisotropic media; normal surface, birefringence, index ellipsoid, optical activity, Faraday rotation, Pockels and Kerr effects, electro-optic modulators, electro-optic effect in liquid crystals, photorefractive effect, acousto-optic effect and modulators, second-harmonic generation, optical phase-conjugation and applications. For graduate credit, students must do additional project work on a topic selected by the instructor.

**OE 592 Fourier Optics and Applications 3R-3L-4C F Pre: SR/GR standing or consent of instructor**

Two-dimensional linear systems; diffraction theory (Fresnel & Fraunhofer); imaging properties of lenses; frequency analysis of optical imaging systems; spatial filtering; optical information processing; Vander-Lugt filters; wavefront reconstruction; holography; optical computing.

**OE 593 Fundamentals of Optical Fiber Communications 3R-3L-4C S Pre: OE393 or graduate standing or consent of the instructor**

Evolution of fiber optics links and networks: information rate, evaluation of fiber optic systems, optical fiber transmission link. Digital transmission systems: point-to-point links, line coding, error correction. Analog systems: links, dynamic range, noise figure, bandwidth, carrier-to-noise, multi-channel transmission, cross talk. WDM concepts: operational principles, passive components, system considerations. Optical networks: network topologies, performance of linear bus, performance of star architecture, SONET, WDM networks, wavelength-routed networks, optical CDMA, ultra high capacity WDM networks, bit-interleaved optical TDM, time-slotted optical TDM. Students enrolled in OE593 must do project work on a topic selected by the instructor.

**OE 594 Guided-Wave Optics 3R-3L-4C S Pre: OE 485 or SR/GR standing or consent of instructor**

Theory of optical waveguides; waveguide modes; fabrication techniques; input and output coupling techniques; waveguide losses; waveguide gratings; electro-optic modulators; integrated optical detectors; applications of integrated optics.

**OE 595 Optical Metrology 3R 3L 4C F Pre: PH 292 or SR/GR standing or consent of instructor and Co-Req OE 480**

Optical testing: geometrical test methods (refractometers, knife edge, Ronchi, Wire, Hartmann); review of interference and coherence; fringe visibility; conventional interferometers (Newton, Fizeau, Twyman-Green and shearing); fringe localization; phase shifting, holographic, Moire, photoelastic and speckle interferometry; emerging optical methods. Students must do additional project work on a topic selected by the instructor.