Optical Engineering - Course Descriptions

OE 171 Photography and Holography 2R-0L-2C F
Prerequisites: There are no prerequisites for this course.
Corequisites: There are no corequisites for this course.
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 an individual hologram that can be seen in sunlight.

OE 172 Lasers and Fiber Optics 2R-0L-2C S
Prerequisites: There are no prerequisites for this course.
Corequisites: There are no corequisites for this course.
Light, optics, image formation, and optical instruments. Introduction to the properties, physics of operation, types, and applications of lasers. Characteristics of optical fibers and optical communication systems. Applications of lasers and fibers in industry, medicine, and consumer products. Laser safety.

OE 280 Geometrical Optics 3.5R-1.5L-4C W
Prerequisites: PH 113 Physics III 3.5R-1.5L-4C S,F,W
Corequisites: There are no corequisites for this course.
First-order optics including graphical ray tracing, Gaussian methods, y-nu ray tracing, cardinal points, apertures, stops, pupils, vignetting, and obscuration. Optical invariant, dispersion, chromatic aberrations, glass selection, exact ray tracing, third-order monochromatic aberrations, introduction to computer-aided design and analysis. Relevant laboratory experiments.

OE 290 Directed Research Arranged
Prerequisites: Consent of instructor
Corequisites: There are no corequisites for this course.
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 Photonic Devices & Systems 3.5R-1.5L-4C S
Prerequisites: PH 113 Physics III 3.5R-1.5L-4C S,F,W, and MA 211 Differential Equations 4R-0L-4C F,W,S
Corequisites: There are no corequisites for this course.
Optical radiation, radiometry, and photometry. Blackbody radiation and thermal sources. Introduction to optoelectronic devices. Light emitting diodes and other optical sources. Optical detectors (thermal, photoemissive, and semiconductor detectors).
Sources/effects of noise and SNR. Flux transfer in optical systems. Relevant laboratory experiments.

**OE 360 Optical Materials 4R-0L-4C W (every other year)**

**Prerequisites:** PH 255 Foundations of Modern Physics 3.5R-1.5L-4C W, and PH 316 Electric & Magnetic Fields 4R-0L-4C F

**Corequisites:** There are no corequisites for this course. Electromagnetic waves in dielectrics/metals and complex refractive index. Optical, thermal, and mechanical properties of materials. Thin film interference, optical coatings, and design of multilayer films. Optical characterization of materials. Electromagnetic waves in anisotropic materials, double refraction, optical activity, and polarization devices.

**OE 392 Linear Optical Systems 4R-0L-4C F**

**Prerequisites:** PH 292 Physical Optics 3.5R-1.5L-4C F, and MA 212 Matrix Algebra & Systems of Differential Equations 4R-0L-4C F,W,S

**Corequisites:** There are no corequisites for this course. Propagation of light and scalar diffraction theory. Fraunhofer and Fresnel diffraction, coherence, Fourier series and transforms, convolution and correlation. Linear system theory, impulse and step response, transfer functions. Coherent and incoherent image formation, optical transfer function (OTF), modulation transfer function (MTF). Image quality assessment methods. Optical information processing applications.

**OE 393 Fiber Optics & Applications 3.5R-1.5L-4C W (every other year)**

**Prerequisites:** OE 295 Photonic Devices & Systems 3.5R-1.5L-4C S, and PH 316 Electric & Magnetic Fields 4R-0L-4C F or ECE 341 Electromagnetic Waves 4R-0L-4C F or consent of instructor

**Corequisites:** There are no corequisites for this course. 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. Relevant laboratory experiments.

**OE 395 Optomechanics & Optical Engineering Lab 2R-6L-4C F**

**Prerequisites:** PH 292 Physical Optics 3.5R-1.5L-4C F, and OE 280 Geometrical Optics 3.5R-1.5L-4C W, and OE 295 Photonic Devices & Systems 3.5R-1.5L-4C S

**Corequisites:** There are no corequisites for this course. Design, assembly, and alignment of bench top optical systems. Introduction to experimental techniques in optics. Data collection and analysis. Relevant lecture topics including principles of opto-mechanical design, fold mirrors and prisms, lens and mirror mounting, kinematic mounts, precision adjustments and control.

**OE 415 Optical Engineering Design I 2R-6L-4C S**

**Prerequisites:** OE 280 Geometrical Optics 3.5R-1.5L-4C W or EP 280 Introduction to Nano-engineering 3.5R-1.5L-4C W and Junior/Senior standing

**Corequisites:** RH 330 Technical & Professional Communication 4R-OL-4C

Principles of design. Codes of ethics appropriate to engineers. Case studies related to optical engineering and engineering physics professional practice, teamwork, contemporary issues, patents and intellectual property. Team-oriented design project work on selected topics in optical engineering and engineering physics. Introduction to
OE 416 Optical Engineering Design II 2R-6L-4C F
**Prerequisites:** OE 415 Optical Engineering Design I 2R-6L-4C S
**Corequisites:** There are no corequisites for this course.
Team-based capstone design project following structured design processes and utilizing knowledge gained from prior coursework. Project planning and budgeting, development of product/process specifications, application of engineering standards, system design and prototyping subject to multiple realistic constraints (cost, schedule, and performance). Formal midterm design review. Deliver initial statement of work and interim technical report. Laboratory activities supporting the formal design process. Cross-listed with EP 416.

OE 417 Optical Engineering Design III 2R-6L-4C W
**Prerequisites:** OE 416 Optical Engineering Design II 2R-6L-4C F
**Corequisites:** There are no corequisites for this course.

OE 434 Non-Imaging Optics 4R-0L-4C S (every other year)
**Prerequisites:** OE 295 Photonic Devices & Systems 3.5R-1.5L-4C S
**Corequisites:** There are no corequisites for this course.
Lighting, illumination, and solar concentration systems. Radiometry and photometry for illumination, etendue, and concentration. Color coordinates, color vision, and color measurements. Sources, light transfer components, and systems evaluation. Introduction to design methods (edge-ray, compound parabolic concentrator, tailored reflector). Design examples and case studies.

OE 435 Biomedical Optics 4R-0L-4C W
**Prerequisites:** PH 113 Physics III 3.5R-1.5L-4C S,F,W, and MA 212 Matrix Algebra & Systems of Differential Equations 4R-0L-4C F,W,S
**Corequisites:** There are no corequisites for this course.
Optical techniques for biomedical applications and health care; imaging modalities; laser fundamentals, laser interaction with biological cells, organelles and nanostructures; laser diagnostics and therapy, laser surgery; microscopes; optics-based clinical applications; imaging and spectroscopy; biophotonics. Cross-listed with BE 435.

OE 437 Introduction to Image Processing 3R-3L-4C W
**Prerequisites:** MA 212 Matrix Algebra & Systems of Differential Equations 4R-0L-4C F,W,S
**Corequisites:** There are no corequisites for this course.
Basic techniques of image processing. Discrete and continuous two dimensional transforms such as Fourier and Hotelling. Image enhancement through filtering and histogram modification. Image restoration through inverse filtering. Image segmentation including edge detection and thresholding. Introduction to image encoding. Relevant laboratory experiments.

OE 450 Laser Systems & Applications 3.5R-1.5L-4C S
Prerequisites: PH 292 Physical Optics 3.5R-1.5L-4C F, and MA 212 Matrix Algebra & Systems of Differential Equations 4R-0L-4C F,W,S
Corequisites: There are no corequisites for this course.

OE 470 Special Topics in Optical Engineering 2-4C
Prerequisites: Consent of instructor
Corequisites: There are no corequisites for this course.
Lectures on special topics in optics.

OE 480 Optical System Design 4R-0L-4C F
Prerequisites: OE 280 Geometrical Optics 3.5R-1.5L-4C W
Corequisites: There are no corequisites for this course.
Review of geometrical optics and exact ray tracing. Chromatic and monochromatic aberrations. Image quality assessment, spot size, point spread function, Strehl ratio, and modulation transfer function. Classical lens design and design of various imaging, non-imaging, and diffractive optical systems. First-order layout, computer-based optimization, tolerancing, and manufacturing considerations.

OE 490 Directed Research Credit arranged
Prerequisites: Consent of instructor
Corequisites: There are no corequisites for this course.
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 3.5R-1.5L-4C S (every other year)
Prerequisites: OE 393 Fiber Optics & Applications 3.5R-1.5L-4C W (every other year)
Corequisites: There are no corequisites for this course.

OE 495 Optical Metrology 3.5R-1.5L-4C W
Prerequisites: OE 280 Geometrical Optics 3.5R-1.5L-4C W, and OE 392 Linear Optical Systems 4R-0L-4C F
Corequisites: There are no corequisites for this course.
Geometrical test methods (refractometers, knife edge, Ronchi, Wire, Hartmann). Review of interference and coherence. Third-order aberrations, Zernike polynomials, and fringe analysis. Interferometers (Newton, Fizeau, Twyman-Green, and shearing),
fringe localization, and phase shifting. Holographic, Moire, photoelastic and speckle interferometry. Applications of optical metrology. Relevant laboratory experiments.

OE 497 Senior Thesis 1-2C F,W,S  
**Prerequisites:** Consent of PHOE faculty  
**Corequisites:** There are no corequisites for this course.  
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.

OE 498 Senior Thesis 1-2C F,W,S  
**Prerequisites:** Consent of PHOE faculty  
**Corequisites:** There are no corequisites for this course.  
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.

OE 499 Senior Thesis 1-2C F,W,S  
**Prerequisites:** Consent of PHOE faculty  
**Corequisites:** There are no corequisites for this course.  
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.

OE 520 Principles of Optics 2R-0L-2C F  
**Prerequisites:** Graduate standing  
**Corequisites:** There are no corequisites for this course.  
Introduction to optics for incoming graduate students. Geometric optics; wave optics; sources and detectors. Students progressing towards or holding a bachelor’s degree in Optical Engineering may not receive credit for OE 520.

OE 535 Biomedical Optics 4R-0L-4C W  
**Prerequisites:** PH 113 Physics III 3.5R-1.5L-4C S,F,W, and MA 212 Matrix Algebra & Systems of Differential Equations 4R-0L-4C F,W,S and Senior or Graduate standing  
**Corequisites:** There are no corequisites for this course.  
Optical techniques for biomedical applications and health care; imaging modalities; laser fundamentals, laser interaction with biological cells, organelles and nanostructures; laser diagnostics and therapy, laser surgery; microscopes; optics-based clinical applications; imaging and spectroscopy; biophotonics. Students must do additional project work on a topic selected by the instructor. Students may not receive credit for both OE 435 and OE 535. Cross-listed with BE 535.

OE 537 Advanced Image Processing 3R-3L-4C S  
**Prerequisites:** CSSE 120 Introduction to Software Development 3R-3L-4C F,W,S or ME 123 Computer Programming 4R-0L-4C F,W,S and Senior or Graduate standing  
**Corequisites:** There are no corequisites for this course.  

OE 570 Special Topics in Optics 2 or 4C F,W,S
Prerequisites: Consent of instructor and Senior or Graduate standing
Corequisites: There are no corequisites for this course.
Lectures on contemporary topics in optical science, optical engineering, and photonics.

OE 580 Optical System Design 4R-0L-4C F
Prerequisites: OE 280 Geometrical Optics 3.5R-1.5L-4C W and Senior or Graduate standing
Corequisites: There are no corequisites for this course.
Review of geometrical optics and exact ray tracing. Chromatic and monochromatic aberrations. Image quality assessment, spot size, point spread function, Strehl ratio, and modulation transfer function. Classical lens design and design of various imaging, non-imaging, and diffractive optical systems. First-order layout, computer-based optimization, tolerancing, and manufacturing considerations. Students must do additional project work on a topic selected by the instructor. Students may not receive credit for both OE 480 and OE 580.

OE 585 Electro-Optics and Applications 3R-3L-4C W
Prerequisites: PH 292 Physical Optics 3.5R-1.5L-4C F, and PH 316 Electric & Magnetic Fields 4R-0L-4C F and Senior or Graduate standing
Corequisites: There are no corequisites for this course.

OE 592 Fourier Optics & Applications 3.5R-1.5L-4C W
Prerequisites: OE 392 Linear Optical Systems 4R-0L-4C F and Senior or Graduate standing
Corequisites: There are no corequisites for this course.

OE 593 Fundamentals of Optical Fiber Communications 3.5R-1.5L-4C S (every other year)
Prerequisites: OE 393 Fiber Optics & Applications 3.5R-1.5L-4C W (every other year) and Senior or Graduate standing
Corequisites: There are no corequisites for this course.

OE 594 Integrated Optics 4R-0L-4C F
Prerequisites: OE 393 Fiber Optics & Applications 3.5R-1.5L-4C W (every other year) and Senior or Graduate standing


OE 595 Optical Metrology 3.5R-1.5L-4C W
Prerequisites: OE 280 Geometrical Optics 3.5R-1.5L-4C W, and OE 392 Linear Optical Systems 4R-0L-4C F or Senior/Graduate standing or consent of instructor
Corequisites: OE 480 Optical System Design 4R-0L-4C F
Geometrical test methods (refractometers, knife edge, Ronchi, Wire, Hartmann). Review of interference and coherence. Third-order aberrations, Zernike polynomials, and fringe analysis. Interferometers (Newton, Fizeau, Twyman-Green, and shearing), fringe localization, and phase shifting. Holographic, Moire, photoelastic and speckle interferometry. Applications of optical metrology. Relevant laboratory experiments. Students must do additional project work on a topic selected by the instructor. Students may not receive credit for both OE 495 and OE 595.

OE 599 Thesis Research As arranged
Prerequisites: There are no prerequisites for this course.
Corequisites: There are no corequisites for this course. Graduate students only. Credits as arranged; however not more than 12 credits will be applied toward the requirements for the MS (OE) degree.

OE CPT Curricular Practical Training 1R-0L-1C
Prerequisites: Consent of department head
Corequisites: There are no corequisites for this course.
Any international student with an F-1 Visa employed by any company in the form of an internship, co-op, or practicum must enroll in a CPT course. The CPT experience is to be complimentary training to the student’s curriculum and should contribute substantially to his/her learning experience. Students must have an offer of employment from a company prior to registering for this course. The CPT must be approved by the Department Head, Director of International Student Services, and the student’s advisor. Students are required to submit a report at the conclusion of the employment to his/her instructor to receive a grade for the CPT experience.

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