OE - OPTICAL ENGINEERING (OE)

OE 171 - Photography & Holography 2 Credits

Hours: 2R-0L-2C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

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 2 Credits

Hours: 2R-0L-2C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

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 199 - Professional Experience 1 Credit

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

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

OE 280 - Geometrical Optics 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: W
Graduate Studies Eligible: No
Prerequisites: PH 113

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 280L - Paraxial Optics Lab 0 Credits

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

OE 290 - Directed Research 1-4 Credits

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

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 and Systems 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: PH 113 and (MA 211 or MA 221)

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 295L - Photonic Devices and Syst Lab 0 Credits

Hours: 0R-3L-0C
Graduate Studies Eligible: No
Prerequisites: None

OE 360 - Optical Materials 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: PH 255 and PH 316

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 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: No
Prerequisites: PH 292 and (MA 222 or MA 212)

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 and Applications 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: OE 295 and (PH 316 or ECE 340)

Step-index and graded-index fibers; single-mode and multi-mode fibers; numerical aperture; attenuation and dispersion; fabrication of optical fibers and cables; fiber measurements; source coupling, splices and connectors; point-to-point links; selected applications such as fiber optic sensors and fiber optic system components. Slab and cylindrical dielectric waveguides, silicon waveguides, mode cutoff conditions; effective index of propagating mode, examples of silicon passive and active devices. Relevant laboratory experiments.

OE 393L - Fiber Optics Lab 0 Credits

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

OE 395 - Optomechanics & Optical Engineering Lab 4 Credits

Hours: 2R-6L-4C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: OE 280 and PH 292 and OE 295

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 4 Credits

Hours: 2R-6L-4C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: (RH 330 (may be taken concurrently) or ENGL H290 (may be taken concurrently)) and (OE 280 or EP 280)

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

OE 416 - Optical Engineering Design II 4 Credits

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

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

OE 417 - Optical Engineering Design III 4 Credits

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

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

OE 417L - Optical Eng Design III Lab 0 Credits

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

OE 434 - Non-Imaging Optics 4 Credits

Hours: 4R-0L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: OE 295

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 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: PH 113 and (MA 212 or MA 222)

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 4 Credits

Hours: 3R-3L-4C
Term Available: W,S
Graduate Studies Eligible: Yes
Prerequisites: MA 222

This course explores fundamental image processing techniques including intensity transformations, spatial and frequency-domain filtering, restoration, reconstruction, geometric transformations, segmentation, and morphological processing. Through the projects, students build practical engineering and computer science expertise, focusing on real world implementation and application while discussing foundational mathematical concepts. Cross-listed with ECE480.

OE 450 - Laser Systems & Applications 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: PH 292 and (MA 222 or MA 212)

Ray transfer matrix methods, Gaussian beam propagation, and beam quality. Optical resonators and stability, longitudinal and transverse modes. Stimulated emission, population inversion, rate equations, gain and threshold. Q-switching and mode-locking. Applications and types of lasers. Laser safety and relevant laboratory experiments.

OE 450L - Laser Systems & Apps Lab 0 Credits

Hours: 0R-3L-0C
Graduate Studies Eligible: Yes
Prerequisites: None

OE 460 - Silicon Photonic Devices and Applications 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: PH 292

Energy bands in semiconductors, minority and majority carriers and n/p-type doping. PN-junction in semiconductors, free-carrier absorption and recombination, forward and reverse bias pn-junction diodes. Thermo-optic effect, Franz-Keldysh effect, and plasma dispersion effect in semiconductors. TE/TM-mode propagation in semiconductor waveguides. Modeling passive and active silicon photonic (SiPh) devices. Examples of photonic integrated circuits (PICs) and applications. Fabrication of passive and active SiPh devices and PICs. Laboratory experiments will cover performance characterization of passive and active SiPh devices and PIC systems.

OE 470 - Special Topics in Optical Engineering 2-4 Credits

Hours: 0R-0L-(2 - 4)C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: None

Lectures on special topics in optics.

OE 480 - Optical System Design 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: OE 280

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 485L - Electro Optics Lab 0 Credits

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

OE 490 - Directed Research 1-8 Credits

Hours: 0R-0L-(1 - 8)C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

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 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: OE 393

Analysis and design of common fiber optic communication systems and optical networks. Transmission penalties: dispersion, attenuation. Optical transmitters and receivers: fundamental operation and noise. Intensity and phase modulation. Optical amplification: types of amplifiers, noise and system integration. Point-to-point links: power budget and rise-time analysis. Performance analysis: BER and eye diagrams. WDM concepts and components: multiplexers, filters, common network topologies. Non-linear effects in fibers. Relevant laboratory experiments.

OE 495 - Optical Metrology 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: OE 280 and PH 292

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 495L - Optical Metrology Lab 0 Credits

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

OE 497 - Senior Thesis 2 Credits

Hours: 0R-0L-2C
Term Available: F
Graduate Studies Eligible: No
Prerequisites: None

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 2 Credits

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

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 2 Credits

Hours: 0R-0L-2C
Term Available: S
Graduate Studies Eligible: No
Prerequisites: None

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 2 Credits

Hours: 2R-0L-2C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: None

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 4 Credits

Hours: 4R-0L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: PH 113 and MA 212

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 4 Credits

Hours: 3R-3L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: CSSE 120 or ME 123

Introduction to image segmentation and recognition. Use of neural networks, fuzzy logic and morphological methods for feature extraction.Advanced segmentation, detection, recognition and interpretation. Relevant laboratory experiments and required project.Cross-listed with ECE 582.

OE 570 - Special Topics 1-4 Credits

Hours: (1 - 4)R-0L-(1 - 4)C
Term Available: F,W,S
Graduate Studies Eligible: Yes
Prerequisites: None

Lectures on contemporary topics in optical science, optical engineering, and photonics.

OE 580 - Optical System Design 4 Credits

Hours: 4R-0L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: OE 280

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 584 - Medical Imaging Systems 4 Credits

Hours: 4R-0L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: OE 392 or BE 321 or ECE 300

Engineering principles of major imaging techniques/modalities for biomedical applications and health care including diagnostic x-ray, computed tomography, nuclear techniques, ultrasound, and magnetic resonance imaging. Topics include general characteristics of medical images; physical principles, signal processing to generate an image, and instrumentation of imaging modalities. Clinical applications of these technologies are also discussed. Cross-listed with ECE 584 and BE 541.

OE 585 - Electro Optics & Applications 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: F
Graduate Studies Eligible: Yes
Prerequisites: PH 292 and PH 316

Optical wave propagation in anisotropic media. Normal surface and the index ellipsoid. Double refraction. Optical activity and Faraday rotation. Pockels and Kerr effects. Electrooptic modulators. Acousto-optic effect. Modulators and scanners. Introduction to nonlinear optics. Second-harmonic generation and frequency doubling. Relevant laboratory experiments.

OE 592 - Fourier Optics & Applications 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: S
Graduate Studies Eligible: Yes
Prerequisites: OE 392

Two-dimensional linear systems. Scalar diffraction theory, Fresnel & Fraunhofer diffraction. Coherent optical systems analysis. Frequency analysis of optical imaging systems. Spatial filtering and analog optical information processing. Wavefront reconstruction and holography. Relevant laboratory experiments.

OE 592L - Fourier Optics Lab 0 Credits

Hours: 0R-3L-0C
Graduate Studies Eligible: Yes
Prerequisites: None

OE 593 - Fundamentals of Optical Fiber Communications 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: See Department
Graduate Studies Eligible: Yes
Prerequisites: OE 393

Analysis and design of common fiber optic communication systems and optical networks.Transmission penalties, dispersion, attenuation. Optical transmitters and receivers: fundamental operation and noise. Intensity and phase modulation. Optical amplification: types of amplifiers, noise and system integration. Point-to-point links: power budget and rise-time analysis. Performance analysis: BER and eye diagrams. WDM concepts and components: multiplexers, filters, common network topologies. Non-linear effects in fibers. Relevant laboratory experiments. Students must do additional project work on a topic selected by the instructor. Students may not receive credit for both OE 493 and OE 593.

OE 594 - Integrated Silicon Photonics 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: OE 393

Dispersion properties of silicon waveguides, coupled-mode theory, mode propagation and confinement, effective index of TE and TM modes. Modeling silicon passive devices: directional coupler, Y-branch, Mach-Zehnder interferometer, ring resonators, I/O grating couplers. Modeling silicon active devices: thermo-optic phase-shifters, pn-junction modulators, electro-absorption modulators, and photodetectors. Modeling and simulation of integrated silicon photonics circuits and applications.Laboratory experiments: Fabrication and characterization of a silicon passivedevice.

OE 595 - Optical Metrology 4 Credits

Hours: 3.5R-1.5L-4C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: OE 280 and OE 392

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 595L - Optical Metrology Lab 0 Credits

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

OE 599 - Thesis Research 1-12 Credits

Hours: 0R-0L-(1 - 12)C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: None

Graduate students only. Credits as arranged; however not more than 12 credits will be applied toward the requirements for the MS (OE) degree.

OE 699 - Professional Experience 1 Credit

Hours: 1R-0L-1C
Term Available: W
Graduate Studies Eligible: Yes
Prerequisites: None

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