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The University of Iowa
The College of Liberal Arts and Sciences
Fall 2026

Title of Course: Introduction to Optics (PHYS:4720)

Course meeting time and place: LR2 Van Allen, MWF 2:30 pm to 3:20 pm

Department of Physics: https://physics.uiowa.edu/

Course ICON site: To access the course site, log into Iowa Courses Online (ICON) using your Hawk ID and password.

Course Home

For Undergraduate Courses: The College of Liberal Arts and Sciences (CLAS) is the home of this course, and CLAS governs the add and drop deadlines, academic misconduct policies, and other undergraduate policies and procedures. Other UI colleges may have different policies.
For Graduate Courses: The College of Liberal Arts and Sciences (CLAS) is the home of this course, and CLAS governs the policies and procedures for its courses. Graduate students, however, must adhere to the academic deadlines set by the Graduate College.

Instructor

Name: Prof. John Prineas

Office location: 406 Iowa Advanced Technology Center

Student drop-in hours: Tue 10:30-12 pm and Wed 11-12:30 pm or by appointment

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DEO: Professor Greg Howes, available for appointment via Meagan Conley, 203 Van Allen, 335-0654

Description of Course

This course examines the fundamental wave properties of light and how light interacts with matter, including reflection, refraction, scattering, dispersion, and propagation through dielectric, metallic, optically active, and birefringent media. We will develop geometrical and wave optics descriptions of optical components and systems, including lenses, mirrors, objectives, beamsplitters, prisms, waveplates, fibers, interferometers, thin films, and optical cavities. Topics will include polarization, superposition and Fourier representations of waves, multi-beam interference, near- and far-field diffraction, diffraction gratings, and Fourier optics. We will also examine temporal and spatial coherence, photon statistics, imaging, Gaussian beam optics, lasers, and introductory nonlinear optics. The course concludes with an introduction to modern nanophotonics, including guided modes and integrated photonics, photonic crystals, plasmonic resonances, optical nanoantennas, metamaterials, and metasurfaces.

Learning Goals

By the end of this course, students should be able to:

- Describe and analyze light as an electromagnetic wave, including propagation, energy flow, dispersion, and interaction with dielectric and metallic media.
- Apply geometrical and wave optics principles to optical systems, including reflection, refraction, lenses, mirrors, fibers, polarization optics, interferometers, thin films, and optical cavities.
- Analyze interference and diffraction phenomena using superposition, Fourier methods, and near- and far-field diffraction, and relate these concepts to optical resolution and imaging.
- Explain coherence and the operation of lasers and other modern optical systems, including temporal and spatial coherence, Gaussian beams, laser cavities, and basic nonlinear-optical phenomena.
- Apply foundational optics concepts to nanophotonic structures, including guided modes and integrated photonics, photonic crystals, plasmonic resonances, nanoantennas, metamaterials, and metasurfaces.

Textbook/Materials

The required textbook for this course is: Hecht, <u>Optics</u>, 5th Ed.

Prerequisites - (PHYS:1512 or PHYS:2703 or PHYS:1612) and (MATH:1560 or MATH:1860)

Assessments: Weekly homework assignments, class participation, a computational project, two in-class midterm examinations, and a comprehensive final examination.

Homework: Homework is primarily intended as preparation for the examinations. Homework problems will closely reflect the concepts and problem solving skills assessed on exams. Because generative AI can readily produce solutions to many homework problems, homework will carry relatively little weight in the course grade. Students who rely on AI generated solutions without developing their own ability to solve the problems should expect this to be reflected in their exam performance.

Where to Get Help: If you need help with homework problems or understanding course material, I encourage you to stop by my office and to work with your classmates. Generative AI tools may also be useful for explaining concepts or providing additional examples.

Class Participation: Class participation will be based on engagement in class discussions and in-class problem solving activities.

Computational Optics Project: Students will complete a short computational project investigating an optical structure or phenomenon related to the course. Possible approaches include:

- ABCD (ray transfer) matrix calculations for geometrical optics systems, imaging systems, optical resonators, or Gaussian beam propagation, using Python, MATLAB, or similar software.
- Transfer matrix calculations for multilayer films, dielectric mirrors, antireflection coatings, or optical cavities, using Python, MATLAB, or available transfer-matrix software.
- Diffraction and Fourier-optics calculations, such as numerical Fresnel or Fraunhofer diffraction from apertures, gratings, or spatial masks, using Python, MATLAB, or similar numerical tools.
- Electromagnetic simulations of waveguides, photonic crystals, resonators, nanoantennas, or related nanophotonic structures using software such as MEEP.

Students may choose from suggested topics or propose their own and may build on existing code or computational tools; programming itself is not the primary objective. A brief project proposal will be due about one week after the project is assigned. The final submission, due about four weeks later, should include a 3–5 page report describing the physical question, computational method, results and figures, interpretation in terms of course concepts, references, and disclosure of any generative-AI use. Code should be submitted separately or as an appendix.

Exams: The two in-class exams will cover material from approximately half of the course, including information presented in lecture and readings; the final exam will be comprehensive. The exams will test students' ability to apply course concepts to solve problems. You will get practice solving problems through weekly homework problems. We will review course material a week before the exam. Suggested study techniques for the exam are to review course material, review homework problems, and do additional practice problems.

Date and Time of the Final Exam

The final examination date and time will be announced by the Registrar generally by the fifth week of classes and it will be announced on the course ICON site once it is known. Do not plan your end of the semester travel plans until the final exam schedule is made public. It is your responsibility to know the date, time, and place of the final exam. According to Registrar's final exam policy, students have a maximum of two weeks after the announced final exam schedule to request a change if an exam conflict exists or if a student has more than two exams in one day (see the policy here).

Grading System and the Use of +/-

Pluses and minuses will be used in the grading for this course

Final grades will be awarded based on the following ranges:

A	**B**	**C**	**D**	**F**
A+ 94-100	B+ 76-81	C+ 58-63	D+ 40-45	F < 28
A 88-93	B 70-75	C 52-57	D 34-39	
A- 82-87	B- 64-69	C- 46-51	D- 28-33	

Course Grades

Final course grades will be based on the following activities: Exam 1: 25% Exam 2: 25% Final: 30% Homework: 5% Class Participation: 5%, Computational Project: 10%. You can check your scores on exams on the course webpage via ICON.

College of Liberal Arts and Sciences (CLAS) Course Policies Attendance and Absences

You are expected to attend all classes unless your absence is excused according to University policy.

Course Calendar of Assignments and Exams

- Homeworks will be assigned Fridays, and will be due the following Fr. These will be problems from the course textbook.
- Computational Project dates:
  - Topic selection: 3-5 sentence project description due Oct. 26
  - Final project: 3-5 page project report due Dec. 2
- There will be two in-class exams and a final. The first in-class exam is scheduled for M Oct 5; the second for W Nov 18.
- There are reading assignments for each class. Refer to the below schedule.

Communication: UI Email

Students are responsible for all official correspondences sent to their UI email address (uiowa.edu) and must use this address for any communication with instructors or staff in the UI community.

Drop Deadline for this Course

You may drop an individual course before the drop deadline; after this deadline you will need collegiate approval. You can look up the drop deadline for this course here**.** When you drop a course, a “W” will appear on your transcript. The mark of “W” is a neutral mark that does not affect your GPA. To discuss how dropping (or staying in) a course might affect your academic goals, please contact your Academic Advisor. Directions for adding or dropping a course and other registration changes can be found on the Registrar's website. Undergraduate students can find policies on dropping CLAS courses here. Graduate students should adhere to the academic deadlines and policies set by the Graduate College.

Academic Honesty and Misconduct

All students in CLAS courses are expected to abide by the CLAS Code of Academic Honesty. Undergraduate academic misconduct must be reported by instructors to CLAS according to these procedures. Graduate academic misconduct must be reported to the Graduate College according to the Graduate College Manual.

Student Complaints

Students with a complaint about a grade or a related matter should first discuss the situation with the instructor, and finally with the Director or Chair of the school, department, or program offering the course.

Undergraduate students should contact CLAS Undergraduate Programs for support when the matter is not resolved at the previous level. Graduate students should contact the CLAS Dean's Office when additional support is needed.

Date-Week of	Reading Assignments	Topics
Aug 24	Review Chapts 2-3	Travelling waves, harmonic waves, complex notation and phasors, plane waves, Maxwell's equations, Poynting vector and intensity, photons, twisted light
Aug 31	Chapt 4 The Propagation of Light	Lorentz oscillator and dispersion, scattering, Snell's Law, Fresnel equations, optical response of metals, evanescent waves
Sept 7	Chapt 5 Geometrical Optics	Geometrical limit, lenses, paraxial approximation, ray diagrams, mirrors, fiber optics, prisms, the eye, objectives and eyepieces
Sept 14	Chapt 7 The Superposition of Waves	Coherent versus incoherent superposition, standing waves, beating, group velocity, Fourier integral, time-bandwidth product, Fourier series (temporal, spatial) and Gaussian
Sept 21	Chapt 8 Polarization	Linear, circular, elliptical polarization, Malus Law, birefringence, beamsplitters, scattering, wave plates, optical activity, Stokes and Jones vectors / Mueller matrices
Sept 28	M: Review WF: Chapt 8 Cont	
Oct 5	M: Midterm Exam 1 WF: Ch 9 Continued	Vector interference between point sources, Michelson interferometer, multiple beam interference, etalons and cavities, free spectral range, finesse, Q factor, resolution, multi-layer films, transfer matrix

Oct 12	Chapt 9 cont. Chapt 10 Diffraction	Huygen-Fresnel picture, Frauenhofer and Fresnel limits, phased array, diffraction from different apertures, diffraction gratings, Fresnel zone plate
Oct 19	Chapt 10 Diffraction	
Oct 26	Chapt 11 Fourier Optics	Fourier integral and Lorentzian, convolution, linear systems, lens as Fourier transform, auto/cross-correlation
Nov 2	Chapt. 11 cont. Chapt 12 Basics of Coherence Theory	Temporal and spatial coherence, partial coherence, visibility, van Cittert-Zernike theorem, mutual coherence, Michelson stellar interferometry, photon statistics
Nov 9	Chapt. 12 cont. Chapt. 13 Modern Optics W: Review	Lasers (Einstein radiation laws, basic elements, threshold, cavity modes, characteristics, speckle), Gaussian beam optics, q-switching, mode locking, nonlinear optics Image analysis: Abbe theory, 4f line, Fourier image
Nov 16	Chapt. 13 cont. W: Midterm Exam 2	
Nov 23	Thanksgiving Break	
Nov 30	Assigned	Introduction to Nanophotonics: guided modes, integrated photonics, photonic crystals, plasmonic resonances, nanoantennas, metamaterials, and metasurfaces
Dec 7	Assigned	

University Policies: Current University of Iowa course policies and student resources are available on the Office of the Provost Student Course Policies page.

Accommodations for Students with Disabilities
Free Speech and Expression
Absences for Religious Holy Days