COURSE SYLLABUS, FALL 2018

PHYSICS 331

FUNDAMENTALS OF OPTICS

MILLERSVILLE UNIVERSITY

Instructors:
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Office Hours:
Posted in front of my office

Meeting times:
Location: Room 251 Roddy

Introduction: Presents a combination of geometrical optics including lens theory with physical (wave) optics including diffraction, interference, polarization, lasers and coherent light. Four hours per week - 1 hr lecture, 3 hrs laboratory. Prerequisite: Phys 233 or with consent of the instructor.

Texts: ***Optics*****,** 5th Ed., E. Hecht

References:

1. E. Hecht, "Optics", Schaum's Outline Series;
2. Warren J. Smith, "Modern Optical Engineering, The Design of Optical Systems" 2nd Ed.
3. Frank L. Pedrotti, Leno S. Pedrotti, "Introduction to optics", 3nd ed., 2007.
4. Charles S. Williams and Orville A. Becklund, **"**Optics: a short course for engineers & scientists"
5. C. D. O'Shea, W. R. Callen, and W. T. Rhodes, "An Introduction to Lasers and Their Applications", Addison-Wisely Publ. Co., 1978.
6. Orazio Sevelto, "Principles of Lasers", 4th Ed, Translated by David C. Hanna, Plenum Press, 1998.
7. Petter W. Milonni and Joseph H. Eberly, "Lasers", John Wiley & Sons, 1988.

Prerequisites: Phys 233 is prerequisite for this course; however you can still take this course with consent of the instructor if you have a good working knowledge of algebra, trigonometry, differentiation, integration, vector manipulations and Excel.

Goals: To give students a detailed exposure to classical and modern optics, to provide hands-on experience at rapidly growing field of optics. This course will prepare students for graduate programs in optics, or realization as a workforce at high-tech industries.

After completion of this course students will be able to:

1) Become familiar with basic concepts and principles of geometrical, physical and modern optics.
2) Become familiar with basic optics laws and their applications.

3) Discuss the nature of light, its propagation and interaction with matter.
4) Discuss the Maxwell's electromagnetic theory of light.
5) Describe basic phenomena, the principles of lasers and their basic applications.
6) Handle the optical elements and set-ups basic optical experiments.
7) Operate basic optical devices and equipments.

Course Policies:

- Attendance: Class attendance is required.
- Participation: Course projects/assignments and the information presented in class are intended to benefit the students and are expected to actively participate in class discussions relating to these assignments.
- Academic Honesty: Students are expected to complete all course work in an ethical manner without plagiarizing.
- Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment, comply with Title IX of the Education Amendments of 1972, 20 U.S.C. §1681, et seq., and act in accordance with guidance from the Office for Civil Rights, the University requires faculty members to report to the University's Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report to the person designated in the University Protection of Minors policy incidents of sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred. Information regarding the reporting of sexual violence, and the resources that are available to victims of sexual violence, is available at *http://www.millersville.edu/socialeq/title-ix-sexual-misconduct/index.php*.

Homework will be assigned and collected in class. All work (i.e., sentences, equations, derivations, calculations, appropriate sketches neatly done with a ruler and protractor, etc.) must be included with each problem. The homework must be done neatly and completely. Only write on one side of the paper. Clearly indicate the problem being solved, and put a box around your final answer. Typically, homework will be assigned at the beginning of each chapter, and due dates will be announced in class. Homework assignments must be handed in at the beginning of the class session, and late homework assignments will not be accepted.

Exams There will be two midterm exams (tentative dates: and) and a comprehensive final exam. There will be no make-up exams. If you have a scheduling conflict during the final examination period, you must discuss the problem with me at least one week before the end of regularly scheduled classes.

Project The project(s) will be discussed in class at the appropriate time.

Lab notebook, etc. You will need a lab notebook, a good scientific calculator that can perform trigonometric and logarithmic functions. Sharing of calculators during exams is not allowed. Programmable/graphing calculators may not be used during exams. You will also need a ruler and a protractor to construct neat diagrams for homework problems, laboratory reports and exams.

You are required to keep and maintain a laboratory notebook. The notebooks will be collected periodically and graded. See "Laboratory Information" for more details.

You are strongly encouraged to consult the optics books to supplement the class text. They are good references for homework problems and laboratory experiments. (I am still trying to get hold these books by asking the librarian to order these books or via inter-library loans)

Contents: This course will be divided into three main sections:

i) **Geometrical Optics:** (Ch 5, 6) Reflection, Refraction, Mirrors, Lenses, Prisms, Optical systems, Aberrations.

ii) **Physical Optics:** (Ch 2, 3, 4, 7, 8, 9, 10) Wave Motion, Electromagnetic waves Theory, Propagation of light, Superposition of waves, Polarization, Interference, Diffraction.

iii) **Modern Optics:** (Ch 11, 12, 13) Laser theory, types of lasers, laser resonators, properties of laser beams, laser applications, holography.

Grades:

Home work 10%, Quizzes 20%, Labs & lab notebook 20%, Project 10%, Midterms 20%, Final 20%

Final Grades

A: 93-100%, A^-: 90-92.9%, B^+: 86-89.9%, B: 80-85.9%, B^-: 76-79.9%, C^+: 70-75.9%, C: 66-69.9%, C^-: 60-65.9%, D^+: 56-59.9%, D: 50-55.9%, F: below 50%. Final grades are not negotiable.

Tentative Topics

Geometrical Optics: Lenses, Mirrors, Prisms, Optical systems, Aberrations (Ch. 5, 6).

Wave motion: One dimensional waves, plane waves, Differential wave equation, Complex notation (Ch. 2).

Electromagnetic Wave Theory: Basic Laws, Light in Bulk matter, Quantum Field Theory, Photons (Ch. 3).

The Propagation of Light: Interaction of light with matter (Ch. 4).

The Superposition of Waves: Superposition Principle, Periodic waves, Non-periodic waves, Stationary waves (Ch. 7).

Interference: General considerations, Conditions for interference, Interferometers, Applications of interferometry (Ch. 9).

Diffraction: Preliminary considerations, Fraunhofer and Fresnel diffractions (Ch. 10).

Coherence: Temporal and Spatial Coherence (Ch. 7, 9, 13).

Polarization: Nature of polarized light, Mathematical description (Ch. 8).

Birefringence and Retarders: Ch. 8.

Imaging: Abbe Theory of Imaging (Ch. 7, 11 and 13).

Lasers: Photons and lights, Principles of Lasers, Basic applications (Ch. 3 and 13).

Mini Projects: Projects will be decided in the class.

Tentative Lab Schedule for Lab

Lab# 1	Introduction: Handling and cleaning the optics, mechanical assembly.
Lab# 2	Laws of geometrical optics (Reflection and Refraction), Introduction to optical system, handling the optics.
Lab# 3	Thin Lens Equation.
Lab# 4	Imaging, Lenses, Combination of lenses
Lab# 5	Microscopes, Telescope, Expansion of Laser beams.
Lab# 6	Microscopes, electron microscope, Atomic Force Microscope
Lab# 7	Diffraction of Circular Apertures
Lab# 8	Interference, single slit and double slits
Lab# 9	Michelson Interferometer
Lab# 10	Coherence
Lab# 11	Polarization
Lab# 12	Birefringence of Material

Mini Projects

Experiments in optics and modern physics, including techniques for recording, graphically and statistically analyzing, and reporting data. 4 Physics (PHYS). Offered by Physics & Astronomy (http://catalog.gmu.edu/colleges-schools/science/physics-astronomy/).Â PHYS 331: Fundamentals of Renewable Energy. 3 credits. Introduces the physical principles for a range of renewable energies, including solar, wind, hydropower and geothermal. FUNDAMENTALS OF OPTICS FourthEdition Francis A. Jenkins Late Professor of Physics University of California, Berkeley Harvey E. White Professor of Physics, Emeritus Director of the Lawrence Hall of Science, Emeritus University of California, Berkeley W. McGraw-Hili Prlmls WfiJIiI Custom Publishing New York Stl.oois SmFrarrisco Auck1and Bogota CaraaIs lisbon London Madrid Mexia:> Milan Montreal New Delhi Pari5.Â FUNDAMENTALS OF OPTICS Fourth Edition Copyright @ 2001 by The McGraw-Hill Companies, Inc. All rights reserved. Printed in the United States of America. Fundamentals of Nonlinear Optics. ECED 6400 Lecture Notes. c 2016 Sergey A. Ponomarenko.Â In many practical situations in nonlinear optics one deals with pulse or beam elds with their carriers oscillating at optical frequencies. Such fast oscillations can never be detected by even the fastest modern detectors whose response time is much larger. 3Yu. A. Illinskii, L. V. Keldysh, Electromagnetic response of material media (Plenum Press, New York, NY, 1994). 4S. A. Maier, Plasmonics, Fundamentals and Applications (Springer, Berlin, 2007). 6. that an optical period.