PHY 410

Fall 2015

Course Introduction:

Welcome! In this course, we will examine fundamental phenomena associated with light. Focusing on both physical optics as well as geometrical optics, we will strive to obtain a basic understanding of the properties of light and explore how they are applied in modern instrumentation. This course is designed such that you will develop a working knowledge of optics. The goal is for you to be able to read and comprehend journal articles about optics as well as take part in discussions centered on optics.

Topics that will be discussed in this course are: geometrical optics, aberration theory, optical instrumentation, properties of waves, lasers, diffraction, interference, coherence, and polarization. In addition, at the end of the semester, each student will have the option to give a presentation on a topic not covered in the course. The final exam for this course will be challenging and require a working knowledge of optics, not just the ability to recall homework problems. Please prepare accordingly.

Prerequisites: PHY 140 or PHY 180 and MAT 162

Instructor Information:

Dr. Kevin Aptowicz
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Office Hours:

W 1 pm – 2:00 pm
F 9:30 am – 11 am
or by appointment

Text:

Pedrotti[3]. 2007. *Introduction to Optics* (Third Edition). Upper Saddle River, NJ: Pearson Prentice Hall.

Grading: Grade calculations will use the following weightings:

30% - Killer Final Exam
20% - Exam #1
20% - Exam #2
20% - Exam #3
5% - Homework
5% - Participation
10% - BONUS – Optional Presentation

Exams Policy:

There are no make-up exams. If you are going to miss an exam for a university excused absence (this requires a sign note) you must notify me one week before the exam is going to be offered. An alternate time to take the exam will be determined. This time would most likely be the day before the exam.

Problem Set Policy:

Problems at the end of each chapter will be used for the problem set. You are encouraged to attempt to solve the problems after reading the section. Problems will be chosen at random and graded to determine the score for the problem set. Solutions to all problems will handed-out. It is your responsibility to check your work with the solution set.

Note that the problem sets should be viewed as a minimum assignment in the sense that if you encounter a difficulty with a particular idea, you may need additional practice with it by doing a few extra problems in the relevant section of the text.

LGBTQA Ally:

Based on West Chester University's commitment to diversity, I believe that everyone in my classroom should feel safe. I have completed the University's Lesbian, Gay, Bisexual, Transgender, Queer, Questioning Ally training. In becoming an ally I made the commitment to offer a safe space for *all* of my students, not just those who identify as LGBTQA. If you or someone you know would like to know more about this program, or needs to speak confidentially about issues of sexual orientation or gender identity, please feel free to see me during my office hours.

Disability:

We at West Chester wish to make accommodations for persons with disabilities. Please make your needs known by contacting the Office of Services for Students with Disabilities at extension 3217 as well as myself. Sufficient notice is needed in order to make the accommodations possible. The University and I desire to comply with the ADA of 1990.

Public Safety:

The Emergency Communication Committee has made the recommendation that the emergency phone number for WCU's Department of Public Safety be listed on all course syllabi. That number is 610-436-3311. This specific recommendation is made to help the campus be prepared in case of an emergency situation.

Sexual Misconduct:

West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator, Ms. Lynn Klingensmith. 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 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 to the person designated in the University protection of minors policy. Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth at the webpage for the Office of Social Equity at http://www.wcupa.edu/_admin/social.equity/.

Tentative Schedule (might be revised as the semester progresses)

Class Meeting	Date	Day	Reading*
1	8-24	M	• 1-1: A Brief History • 1-2: Particles and Photons • 1-3: The Electromagnetic Spectrum • 1-4: Radiometry
2	8-26	W	• 2-1: Huygens' Principle • 2-2: Fermat's Principle • 2-3: Principle of Reversibility • 2-4: Reflections in Plane Mirrors • 2-5: Refraction Through Plane Surfaces
3	8-28	F	• 2:6: Imaging by an Optical System • 2-7: Reflection at a Spherical Surface • 2-8: Refraction at a Spherical Surface
	8-31	M	• 2-9: Thin Lenses • 2-10: Vergence and Refractive Power • 2-11: Newtonian Equation for the Thin Lens • 2-12: Cylindrical Lenses
4	9-2	W	• 3-1: Stops, Pupils, and Windows
5	9-4	F	• 3-2: A Brief Look at Aberrations • 3-3: Prisms
6	9-7	M	NO CLASS – Labor Day
7	9-9	W	• 3-4: The Camera • 3-5: Simple Magnifiers and Eyepieces
8	9-11	F	• 3-6: Microscopes • 3-7: Telescopes
9	9-14	M	• 20-1: Ray and Wave Aberrations • 20-2: Third-Order Treatment of Refraction at a Spherical Interface • 20-3: Spherical Aberration • 20-4: Coma • 20-5: Astigmatism and Curvature of Field • 20-6: Distortion • 20-7: Chromatic Aberration
10	9-16	W	REVIEW
11	9-18	F	**Exam #1** – Chapters 1, 2, 3, 20

12	9-21	M	• 4-1: One-Dimensional Wave Equation • 4-2: Harmonic Waves • 4-3: Complex Numbers • 4-4: Harmonic Waves as Complex Functions • 4-5: Plane Waves • 4-6: Spherical Waves • 4-7: Other Harmonic Waveforms
13	9-23	W	• 4-8: Electromagnetic Waves • 4-9: Light Polarization • 4-10: Doppler Effect
14	9-25	F	• 5-1: Superposition Principle • 5-2: Superposition of Waves of the Same Frequency • 5-3: Random Coherent Sources • 5-4: Standing Waves
15	9-28	M	• 5-5: The Beat Phenomenon • 5-6: Phase and Group Velocities
16	9-30	W	• 7-1: Two-Beam Interference • 7-2: Young's Double-Slit Experiment • 7-3: Double-Slit Interference with Virtual Sources
17	10-2	F	• 7-4: Interference in Dielectric Films • 7-5: Fringes of Equal Thickness • 7-6: Newton's Rings
	10-5	M	NO CLASS
18	10-7	W	• 7-7: Film-Thickness Measurement by Interference • 7-8: Stokes Relations • 7-9: Multiple-Beam Interference in a Parallel Plate
19	10-9	F	• 8-1: The Michelson Interferometer • 8-2: Applications of the Michelson Interferometer • 8-3: Variations of the Michelson Interferometer
20	10-12	M	• 8-4: The Fabry-Perot Interferometer • 8-5: Fabry-Transmission: The Airy Function
21	10-14	W	• 8-6: Scanning Fabry-Perot Interfometer • 8-7: Variable-Input-Frequency Fabry-Perot Interferometers • 8-9: Fabry Perot Figures of Merit
22	10-16	F	• 6-1: Energy Quantization in Light and Matter • 6-2: Thermal Equilibrium and Blackbody Radiation • 6-3: Nonlaser Sources of Electromagnetic Radiation
23	10-19	M	• 6-4: Einstein's Theory of Light and Matter • 6-5: Essential Elements of a Laser • 6-6: Simplified Description of Laser Operation
24	10-21	W	• 6-7: Characteristics of Laser Light • 6-8: Laser Types and Parameters • 8-8: Lasers and the Fabry-Perot Cavity
25	10-23	F	Review/Buffer
26	10-26	M	Exam #2 – 4,5,6,7, 8
27	10-28	W	• 9-1: Fourier Analysis • 9-2: Fourier Analysis of a Finite Harmonic Wave Train
28	10-30	F	**Decide on Presentation Topic**

			• 9-3: Temporal Coherence and Line Width • 9-4: Partial Coherence
29	11-2	M	• 9-5: Spatial Coherence • 9-6: Spatial Coherence Width
30	11-4	W	• 11-1: Diffraction from a Single Slit • 11-2: Beam Spreading • 11-3: Rectangular and Circular Apertures
31	11-6	F	• 11-4: Resolution • 11-5: Double-Slit Diffraction • 11-6: Diffraction from Many Slits
32	11-9	M	• 13-1: Fresnel-Kirchhoff Diffraction Integral • 13-2: Criterion for Fresnel Diffraction • 13-3: The Obliquity Factor • 13-4: Fresnel Diffraction form Circular Apertures
33	11-11	W	• 16-1:Conventional Versus Holographic Photography • 16-2: Hologram of a Point Source • 16-3: Hologram of an Extended Object
34	11-13	F	• 14-1: Mathematical Representation of Polarized Light: Jones Vectors • 14-2: Mathematical Representation of Polarizers: Jones Matrices
35	11-16	M	• 15-1: Dichroism: Polarization By Selective Absorption • 15-2: Polarization by Reflection from Dielectric Surfaces
36	11-18	W	• 15-3: Polarization By Scattering • 15-4: Birefringence: Polarization with Two Refractive Indices
37	11-20	F	Review/Buffer
38	11-23	M	Exam #3 – 9,11,13,14,15,16
	11-25	W	NO CLASS – Thanksgiving
	11-27	F	NO CLASS – Thanksgiving
39	11-30	M	• Presentations
40	12-2	W	• Presentations
41	12-4	F	• Presentations
42	12-7	M	Practice Exam Review
	12-9	W	Final Exam … 1pm … brace yourself!

***Complete reading before date indicated.**