PHY 410

Fall 2016

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, students will have to opportunity to display their new found optics expertise by contributing to group presentations. These will occur at the end of the semester. 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
227 Schmucker Science South
phone: 610.436.3010
kaptowicz@wcupa.edu

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:

20% - Final Exam
20% - Exam #1
20% - Exam #2
20% - Exam #3
5% - Homework
5% - Participation
10% - Group 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.

Tentative Schedule (might be revised as the semester progresses)

Class Meeting	Date	Day	Reading*
1	8-29	M	• 1-1: A Brief History • 1-2: Particles and Photons • 1-3: The Electromagnetic Spectrum • 1-4: Radiometry
2	8-31	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	9-2	F	• 2:6: Imaging by an Optical System • 2-7: Reflection at a Spherical Surface • 2-8: Refraction at a Spherical Surface
	9-5	M	NO CLASS - Labor Day
4	9-7	W	• 2-9: Thin Lenses • 2-10: Vergence and Refractive Power • 2-11: Newtonian Equation for the Thin Lens • 2-12: Cylindrical Lenses
5	9-9	F	• 3-1: Stops, Pupils, and Windows
6	9-12	M	• 3-2: A Brief Look at Aberrations • 3-3: Prisms
7	9-14	W	• 3-4: The Camera • 3-5: Simple Magnifiers and Eyepieces
8	9-16	F	• 3-6: Microscopes • 3-7: Telescopes
9	9-19	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	9-21	W	• REVIEW
11	9-23	F	**Exam #1** – Chapters 1, 2, 3, 20
12	9-26	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 Wave • 4-7: Other Harmonic Waveforms
13	9-28	W	• 4-8: Electromagnetic Waves • 4-9: Light Polarization • 4-10: Doppler Effect
14	9-30	F	• 5-1: Superposition Principle • 5-2: Superposition of Waves of the Same Frequency • 5-3: Random Coherent Sources • 5-4: Standing Waves
15	10-3	M	• 5-5: The Beat Phenomenon • 5-6: Phase and Group Velocities
16	10-5	W	• 7-1: Two-Beam Interference • 7-2: Young's Double-Slit Experiment • 7-3: Double-Slit Interference with Virtual Sources
17	10-7	F	• 7-4: Interference in Dielectric Films • 7-5: Fringes of Equal Thickness • 7-6: Newton's Rings
	10-10	M	NO CLASS – Fall Break
18	10-12	W	• 7-7: Film-Thickness Measurement by Interference • 7-8: Stokes Relations • 7-9: Multiple-Beam Interference in a Parallel Plate
19	10-14	F	• 8-1: The Michelson Interferometer • 8-2: Applications of the Michelson Interferometer • 8-3: Variations of the Michelson Interferometer
20	10-17	M	• 8-4: The Fabry-Perot Interferometer • 8-5: Fabry-Transmission: The Airy Function
21	10-19	W	• 8-6: Scanning Fabry-Perot Interfometer • 8-7: Variable-Input-Frequency Fabry-Perot Interferometers • 8-9: Fabry Perot Figures of Merit
22	10-21	F	NO CLASS – Dr. Aptowicz @ Conference
23	10-24	M	• 6-1: Energy Quantization in Light and Matter • 6-2: Thermal Equilibrium and Blackbody Radiation • 6-3: Nonlaser Sources of Electromagnetic Radiation
24	10-26	W	• 6-4: Einstein's Theory of Light and Matter • 6-5: Essential Elements of a Laser • 6-6: Simplified Description of Laser Operation
25	10-28	F	• 6-7: Characteristics of Laser Light • 6-8: Laser Types and Parameters • 8-8: Lasers and the Fabry-Perot Cavity
26	10-31	M	Review/Buffer
27	11-2	W	Exam #2 – 4,5,6,7, 8

28	11-4	F	**Group Presentation - Topics & Groups Determined** • 9-1: Fourier Analysis • 9-2: Fourier Analysis of a Finite Harmonic Wave Train
29	11-7	M	• 9-3: Temporal Coherence and Line Width • 9-4: Partial Coherence
30	11-9	W	• 9-5: Spatial Coherence • 9-6: Spatial Coherence Width
31	11-11	F	• 11-1: Diffraction from a Single Slit • 11-2: Beam Spreading • 11-3: Rectangular and Circular Apertures
32	11-14	M	• 11-4: Resolution • 11-5: Double-Slit Diffraction • 11-6: Diffraction from Many Slits
33	11-16	W	• 13-1: Fresnel-Kirchhoff Diffraction Integral • 13-2: Criterion for Fresnel Diffraction • 13-3: The Obliquity Factor • 13-4: Fresnel Diffraction form Circular Apertures
34	11-18	F	• 14-1: Mathematical Representation of Polarized Light: Jones Vectors • 14-2: Mathematical Representation of Polarizers: Jones Matrices
35	11-21	M	• 15-1: Dichroism: Polarization By Selective Absorption • 15-2: Polarization by Reflection from Dielectric Surfaces
	11-23	W	NO CLASS - Thanksgiving
	11-25	F	NO CLASS - Thanksgiving
36	11-28	M	• 15-3: Polarization By Scattering • 15-4: Birefringence: Polarization with Two Refractive Indices
37	11-30	W	Review/Buffer
38	12-2	F	Exam #3 – 9,11,13,14,15
39	12-5	M	• Group Presentations
40	12-7	W	• Group Presentations
41	12-9	F	• Group Presentations
42	12-12	M	Review
	12-14	W	Final Exam … 1 pm to 3 pm

***Complete reading before date indicated.**

ACADEMIC & PERSONAL INTEGRITY
It is the responsibility of each student to adhere to the university's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to the Department Undergraduate Handbook, the Undergraduate Catalog, the *Ram's Eye View*, and the University website at www.wcupa.edu.

STUDENTS WITH DISABILITIES
If you have a disability that requires accommodations under the Americans with Disabilities Act (ADA), please present your letter of accommodations and meet with me as soon as possible so that I can support your success in an informed manner. Accommodations cannot be granted retroactively. If you would like to know more about West Chester University's Services for Students with Disabilities (OSSD), please visit them at 223 Lawrence Center. The OSSD hours of Operation are Monday – Friday, 8:30 a.m. – 4:30 p.m. Their phone number is 610-436-2564, their fax number is 610-436-2600, their email address is ossd@wcupa.edu, and their website is at www.wcupa.edu/ussss/ossd.

EXCUSED ABSENCES POLICY FOR UNIVERSITY-SANCTIONED EVENTS
Students are advised to carefully read and comply with the excused absences policy for university-sanctioned events contained in the WCU Undergraduate Catalog. In particular, please note that the "responsibility for meeting academic requirements rests with the student," that this policy does not excuse students from completing required academic work, and that professors can require a "fair alternative" to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

REPORTING INCIDENTS OF SEXUAL VIOLENCE
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/.

EMERGENCY PREPAREDNESS
All students are encouraged to sign up for the University's free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information, visit www.wcupa.edu/wcualert. To report an emergency, call the Department of Public Safety at 610-436-3311.

ELECTRONIC MAIL POLICY
It is expected that faculty, staff, and students activate and maintain regular access to University provided e-mail accounts. Official university communications, including those from your instructor, will be sent

through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.

STRIKE POLICY

Because of contract negotiations between State System Administrators and APSCUF, the class schedule for this course is tentative, and is subject to revision in the case of a strike. Your professor will not be teaching the course during a strike, giving lectures, meeting with students, assigning or grading your work, or submitting mid-term or final grades. During a strike, faculty will not be able to receive email through the university server.

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.