PHO 102 Applied Optics
4 credits (5 hours)

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Office: C272
Office Hours: T TH 12-1 and 3:30-4:00
online (TBD) W 7-8

Prerequisites: PHO K105 and PHO K101; or permission of the instructor

This course is the second semester in a sequence to introduce optics and its applications. Building on the foundations of PHO 101 Introduction to Photonics, you will study more involved systems of lenses, including stops, pupils and windows, aberrations, introduction to lens design and design software. Topics from wave optics include coherence, types of interferometers and their applications, thin films, Fresnel and Fraunhofer diffraction, scattering, and production and modification of polarized light.

Classroom demonstrations, internet web sites, in-class mini labs and team projects will be used extensively. You should expect to work in the lab or on projects during one or both of the scheduled classes each week. This means if you miss a class you'll have to contact me to find out if and how the work can be made up.

References:
The course will be taught mainly from instructor notes and hands-on experiments. Some of this will be filed on Blackboard. You need to have a binder and a notebook. A good way of organizing is to get a 3-ring binder and a 3-hole punched notebook so you can keep it all together. We will also use the text from PHO 101, LIGHT-Introduction to Photonics. Other useful books are:

- J.R. Meyer-Arendt, *Introduction to Classical and Modern Optics, Fourth Edition*; Prentice Hall. This book is out of print, copies are available in the lab and from used book sellers such as Alibris.
- Pedrotti and Pedrotti, *Introduction to Optics, Ed 4,* Prentice Hall 1993This is an advanced text, available in the TRCC library and the lab library.
- Hecht, *Optics*, *Ed 4*, Addision Wesley, 2002.
  This is also an advanced text, with beautiful photos of optical phenomena. It is also in the TRCC library and the lab library.

Attendance Policy
Because the course involves ongoing projects and experiments, you must be in class on time and every time. If you need to miss a class for a legitimate reason, please contact me (885-2353) and your teammates beforehand.

Course Topics with Approximate Hours

LENSES and Mirrors	**HOURS**	**Cumulative Week**
Review of basic optics (PHO 101)	2.5	
Review of thin lenses, mirrors and imaging	5	1.5
Mirror Challenge - Penn	**5**	**2.5**
Thick Lenses: principle planes, equivalent power	5	3.5
front and back vertex power		
TEST: (In class/take home)		
interlude: Intro to FRED (mirrors)	5	4.5
Aberrations: description of 3rd order; calculation	5	5.5
of correction for selected aberrations		6.5
Apertures, stops and pupils	5	7.5
Lens design	2.5	8
LAB TEST: telescope design	2.5	8.5
WAVE OPTICS		
Review of interference	2.5	9
Diffraction gratings and interferometers	5	10
Thin films and air wedges	5	11
TEST: (In class/take home)		
interlude: BU Challenge	5	12
Coherence	2.5	12.5
Diffraction	5	13.5
Scattering	2.5	14
Polarization	5	15
FINAL: (in class/take home)		

SOME TENTATIVE LAB EXPERIMENTS and/or PROJECTS

Two thin lenses
Negative lens focal length
Spherical mirrors
Equivalent lenses
Matrix Methods
Lens design software
Interferometer construction

Filter characterization
n for air- Michelson interferometer
single slit diffraction
Malus' law
Identification of polarization state
PBL Challenges: Penn, BU
Intro to FRED softward

<u>Exam Policy</u>

Several exams are scheduled- some in class and some take home. Teamwork is not discouraged on take home tests- in fact, it is encouraged as long as all members of the team are equally involved. In class exams are usually on concepts rather than numerical problem solving. ***Makeup exams will only be given in the case of serious illness or other bona-fide excuse with documentation.***

<u>Reports</u>

Each lab or project will have specific items that need to be handed in. Be sure to find out what is expected of you before leaving the lab for the day. Most labs will be graded on the basis of 10 points, but some may only be checked off that they were completed. Occasionally, you will also be graded by your peers (and yourself) on teamwork.

ALL labs are expected to be neat and complete. Incomplete labs will not be graded.

No lab reports will be accepted more than 2 weeks after the experiment is completed, or after the graded lab is returned to the class.

<u>Grade Determination</u>

The final grade will consist of:

Class participation*	10%
Tests:	40%
Labs and projects/other**:	50%

*Class Participation: The class participation grade will depend first and foremost on attendance, being on time and prepared with completed homework. Occasional assignments such as participation in outreach activities may contribute positively to this category. Unexcused absences will definitely subtract from your total.

**Other includes items like reports on job shadowing if it can be arranged or company tours.

PHO 102 Course Objectives

Upon successful completion of this course you will be able to:

1. Interpret catalog specifications for lenses and mirrors.
2. Sketch a lens system showing the principle planes and applicable focal lengths.
3. Explain the effects of third order and chromatic aberrations on an image, and specify the methods to optimize lens performance.
4. Explain the importance of pupils, stops and windows
5. Explain the operation of a simple camera, the human eye, Newtonian and Galilean telescopes and other optical systems. Use software to design simple optical systems.
6. Distinguish among forms of interferometer (Michelson, Mach Zender, Fabry Perot, others) and explain the salient features and main uses of each. Build and/or use at least two types of interferometers.
7. Explain the importance of spatial and longitudinal coherence to specific experiments or technologies.
8. Explain the operation of thin films and the advantages of thin film over colored filters. Specify filters for given applications using manufacturer's catalogs.
9. Explain the importance of Rayleigh's criterion in imaging systems and its application to art and technology
10. Explain the importance of resolvance and free spectral range to spectroscopy.
11. Explain several forms of light scattering. Use the explanations to answer practical questions such as why is the sky blue and why is the blue sky polarized?
12. Explain the operation of devices employing polarization, such as an LCD display.
13. Feel confident working around and with optical components in an optical laboratory and in teams.
14. Develop critical thinking and problem solving skills and practice the use of the engineering problem solving cycle.