PHYSICS 370 – OPTICS

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Web Site: http://course1.winona.edu/fotto/optics/

I. CATALOG DESCRIPTION
This lecture-laboratory course is a study of geometrical optics, the wave theory of light, interference, diffraction, polarization, magneto-and electro-optics, lasers and holography. Prerequisites: PHYS 202 (General Physics II) or PHYS 223 (University Physics III) and MATH 165 (Calculus II). Offered every two years.

II. MAJOR FOCUS
The study of the properties of light can be divided into three areas: Geometric Optics, Wave Optics, and Quantum Optics.

Geometric optics studies reflection, refraction and dispersion. Wave optics includes interference, diffraction, and polarization. We will also study a little of quantum optics, which examines atomic energy levels and emission, lasers, magneto- and electro-optics and applications.

III. OBJECTIVES
1. The student will know and be able to apply the principles of the following topics in explaining common phenomena:
   - Electromagnetic Waves
   - Reflection
   - Refraction
   - Dispersion
   - Lenses
   - Polarization
   - Mirrors
   - Apertures
   - Diffraction
   - Lasers
   - Holography
   - Electro- and magneto-optical effects

2. The student will develop an understanding of the mathematical tools and techniques for analyzing and solving a wide variety of physics problems.

3. The student will develop an understanding of basic error analysis and precision and accuracy in making measurements. The student will be able to clearly and concisely report the results of experimental work.

4. The student will learn experimental techniques in the optics laboratory, including cleaning optics, mounting optical components, aligning optical systems, and use of optical instrumentation.
IV. TEACHING AND LEARNING STYLE

The instructor will announce reading and problem assignments for the following week. Students are strongly encouraged to work together on homework assignments and studying. The student will be expected to have read the assignment before the lecture and to have completed any assigned problems by the due date. The instructor will use class time to (1) demonstrate concepts covered in the reading material, (2) show relevance of the concepts to the contemporary world through specific examples, (3) show the historical context or the subject matter, (4) demonstrate problem solving techniques, and (5) answer questions from class.

V. EVALUATION

The score on three exams, homework, and labs will determine the student’s grade. The exams will be a combination of multiple choice and/or short answer questions and problems, which must be worked out in detail. The last of these tests will be the final exam and will contain material covered during the entire quarter. The weighting of the various scores is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>2 exams @ 20 % each</td>
<td>40 %</td>
</tr>
<tr>
<td>Homework</td>
<td>15 %</td>
</tr>
<tr>
<td>Labs</td>
<td>20 %</td>
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<tr>
<td>Final Exam</td>
<td>25 %</td>
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<tr>
<td>TOTAL:</td>
<td>100 %</td>
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</tbody>
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VI. POLICIES

Students are expected to attend and participate in class. Class exams are announced well in advance and students are obliged to take tests at the scheduled times. The obvious reasons for the exam policy are for fairness to the entire class. A deduction of 10% per day from the test score will be given to those who have an unexcused absence.

Examples of unexcused absences include, but are not limited to: attendance at weddings, convenient rides home, oversleeping, unpreparedness. Examples of excusable absences include verifiable illness, and family emergency. Prior notice may be given by e-mailing the instructor, calling the department at 457-5260, or the instructor at 457-5854. If you are in doubt of the status of a pending absence, discuss the matter with the instructor prior to the test date.
Course Topics:
The Nature of Light:
   Particles and Photons
   Electromagnetic Spectrum
   Radiometry
Geometrical optics
   Huygens’s Principle
   Fermat’s Principle
   Plane Mirrors
   Spherical Mirrors
   Refraction at a Plane Surface
   Refraction at a Spherical Surface
   Thin Lenses
   Vergence and Refractive Power
   Cylindrical Lenses
Optical Instrumentation
   Stops, Pupils and Windows
   Aberrations – brief overview
   Prisms
   The Camera
   Simple Magnifiers and Eyepieces
   Microscopes
   Telescopes
Wave Equations
   The Wave Equation in One Dimension
   Harmonic Waves as Complex Functions
   Plane Waves
   Electromagnetic Waves
   Polarization
   Doppler Effect
Superposition of Waves
   Superposition Principle
   Random and Coherent Sources
Standing Waves
Beats
Phase and Group Velocities

**Interference of Light**
- Two-Beam Interference
- Young’s Double Slit Experiment
- Interference in Dielectric Films
- Newton’s Rings
- Film Thickness Measurement

**Optical Interferometry**
- Michelson Interferometer and Applications
- Fabry-Perot Interferometer

**Fraunhofer Diffraction**
- Diffraction of a Single Slit
- Rectangular and Circular Apertures
- Resolution
- Double-Slit Diffraction

**Diffraction Gratings**
- Grating Equation
- Free Spectral Range
- Resolution of a Grating
- Grating Instruments

**Coherence**
- Temporal Coherence
- Spatial Coherence
- Lasers
  - Einstein’s Theory of Light-Matter Interaction
  - Elements of a Laser
  - Characteristics of Laser Light

**Polarized Light**
- Selective Absorption
- Polarization by Reflection
- Polarization by Scattering
Birefringence
Optical Activity

**Fresnel Equations**
- Internal and External Reflections
- Phase Change on Reflection

**Selected Topics in Modern Optics (as time allows)**
- Laser Systems
- Holography
- Nonlinear Optics