University of Toronto at Mississauga

Optics (PHY347H5S)

Winter 2021

Course Specifics

Course Instructor: Prof. Claudiu Gradinaru
Phone: (905) 828-3833
E-mail: claudiu.gradinaru@utoronto.ca

Lectures: Tuesday, 1 – 3 pm

Tutorials: Thursday 2 – 4 pm (alternating with labs)
Labs: Thursday 2- 5 pm (alternating with tutorials)

Virtual Office Hours: Monday, 3 – 4 pm (instructor)
Wednesday, 4 – 4:30 pm (TA1)
Friday, 4 – 4:30 pm (TA2)
(Zoom links will be posted on the course website on Quercus)

Teaching Assistants: Daniel Nino
Email: daniel.nino@mail.utoronto.ca
Virtual Office Hours: TBD
(Zoom link will be posted on the course website on Quercus)

Dennis Fernandes
Email: dennis.fernandes@mail.utoronto.ca
Virtual Office Hours: TBD
(Zoom link will be posted on the course website on Quercus)

Supplementary material: Introduction to Optics, 3rd ed. (2006), Pedrotti et al, Pearson

Course Description

This course focuses mainly on providing a strong foundation of wave optics, while also presenting and an introduction to modern optics and the quantum nature of light. The topics in this course may vary but will include: electromagnetic waves and the propagation of light, basic coherence concepts and the interference of light, Fraunhofer and Fresnel diffraction, polarization, laser principles and the blackbody radiation. The students will have the opportunity to put to practice the optical principles learned during the lectures by performing laboratory experiments.
on various optical devices and systems. Anyone who would like to learn about electromagnetic waves and also have the opportunity to work with lasers and other optical devices will benefit from taking this course. [24L, 15P, 12T]

Prerequisite: PHY241H5, 245H5
Exclusion: PHY385H1 (SCI E)

Learning Outcomes

On successful completion of the course, the students will be able to:

1. Describe the basic concepts of electromagnetic waves and the corpuscular nature of light.
2. Identify and illustrate physical concepts and terminology used in optics and explain them in appropriate detail.
3. Apply equations and laws pertaining to optics and the physics of light to obtain quantitative solutions to problems in optics.
4. Become familiar with optics laboratory experiments and procedures, perform a series of optics experiments and report their findings.
5. Assemble optical components on an optical bench
6. Use measuring methods based on interferometry and spectrometry
7. Analyze and interpret results of lab experiments
8. Understand the basics of coherence theory, and apply concepts such coherence time and length, and partial coherence.
9. Understand the origin of blackbody radiation, the spectrum of the Sun and of other light sources
10. Use lasers and explain their components, operation, properties and applications

Marking Scheme

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Due Date</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>4 problems sets, answered on Crowdmark, each worth 5%</td>
<td>On-going</td>
<td>20%</td>
</tr>
<tr>
<td>Lab Reports</td>
<td>5 lab reports based on experimental data acquired in person or remotely, submitted on Quercus, each worth 6%</td>
<td>On-going</td>
<td>30%</td>
</tr>
<tr>
<td>Term Test</td>
<td>Two-hour test consisting of problem sets, answered on Crowdmark.</td>
<td>Feb. 25</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>Two-hour test consisting of problem sets, answered on Crowdmark.</td>
<td>TBD, Apr. 8-22, 2021</td>
<td>30%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>100%</td>
</tr>
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Course Outline

The following list provides an overview of the topics covered in PHY347 during the 2021 winter term, with corresponding chapters from the textbook (Hecht). A more detailed lecture schedule will be posted on the course website at the beginning of the term. Students are responsible for all topics covered, even if they are unable to attend a lecture or a tutorial session. In such an event, students are encouraged to read through the materials posted on Quercus (lecture notes and recordings, tutorial materials, lab manuals), read the related chapters of the textbook, get in touch with a classmate and/or visit the Course Instructor and the Teaching Assistants during Office Hours to ensure that they are prepared for the assignments and tests that may include the topic in question.

1. **Waves Refresher**: different waves, superposition/summation, phase/group velocity
   - Chapter 2: 2.1 – 2.9
   - Chapter 7: 7.1, 7.2

2. **Basic Electromagnetic Theory**: Maxwell Equations, Energy, Irradiance, Radiation Spectrum
   - Chapter 3: 3.1 – 3.3 (except 3.3.4), 3.5 (up to Scattering), 3.6

3. **Propagation of Light**: Fermat principle, Fresnel equations, Total Internal Reflection
   - Chapter 4: 4.5 – 4.7

4. **Polarization of Light**: birefringence, optical activity, Jones vectors, applications
   - Chapter 8: 8.1(except 8.1.5), 8.2 – 8.7, 8.10, 8.11

5. **Interference of Light**: wavefront- & amplitude-splitting, thin films, multi-beam, Michelson
   - Chapter 9: 9.1 – 9.4, 9.6 (up to 9.6.1)

6. **Basic Coherence Theory**: temporal, spatial, partial/degree of coherence, applications
   - Chapter 12

7. **Diffraction of Light**: Fraunhofer, Fresnel, circular/rectangular apertures, gratings, Cornu spiral
   - Chapter 10: 10.1 – 10.3 (except 10.3.6, 10.3.11)

8. **Photons, Blackbody, Lasers**: Planck/Wien/SB, Einstein coefficients, Laser concepts/operation
   - Chapter 13: 13.1 and Ch. 26 (26.1 – 26.4) from Pedrotti
**Tutorials and Labs**

Regarding tutorials and labs, the course will have two sections, each managed by a different TA. Labs and tutorials will be offered each week except the first week of classes, when a lecture will be offered instead. The two sections will have alternating labs and tutorials each week. Tutorials will be offered on Zoom. The labs will be offered in a hybrid “rotating in-person” scheme. This implies that one student per team of 3 or 4 students will be present in the lab at the designated times and perform an assigned experiment under the supervision of the lab technician and the TA. The other members of the team will be remotely connected via Zoom and participate in the lab execution remotely and synchronously. A detailed schedule of the labs and tutorials will be posted on the course website on Quercus. Team selection and lab assignments will be performed in the first week of classes.

**Midterm Test**

The midterm test will be 60 minutes in length and will take place during regularly scheduled lecture periods, starting at precisely 1:00 pm on Feb. 25, 2021. The test will be administered on Crowdmark.

**Final Exam**

The final exam will be 2 hours in length, cumulative, and scheduled during the final examination period of the winter term. All final exam policies and regulations will be those set by the Office of the Registrar.

**Important Course Dates (Winter 2021)**

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<thead>
<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>First lecture</td>
<td>Tue. Jan. 12, 1 – 3 pm EDT</td>
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<tr>
<td>First lab or tutorial</td>
<td>Thu. Jan. 21 @ 2 pm EDT</td>
</tr>
<tr>
<td>First assignment</td>
<td>Thu. Jan. 28</td>
</tr>
<tr>
<td>Midterm test</td>
<td>Thu. Feb. 25 (tentatively)</td>
</tr>
<tr>
<td>Last lecture</td>
<td>Tue. Apr. 6 1 – 3 pm EDT</td>
</tr>
<tr>
<td>Last lab/tutorial</td>
<td>Thu. Apr. 8 @ 2 pm EDT</td>
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**Additional Dates of Significance (Winter 2021):**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>January 24th, 2021</td>
<td>Last day to drop an S course on ACORN and receive 100% course fee refund, as long as you are still registered in other courses for this session.</td>
</tr>
<tr>
<td>February 16–19, 2021</td>
<td>Reading Week</td>
</tr>
<tr>
<td>March 15, 2021</td>
<td>Last day to drop a S course from your academic record and GPA.</td>
</tr>
<tr>
<td>April 9, 2021</td>
<td>Classes end for Y and S courses. Last day to request Late Withdrawal After the Drop Date (LWD) or to request/cancel Credit/No Credit for Y and S courses.</td>
</tr>
<tr>
<td>April 13-23, 2021</td>
<td>Final exam period.</td>
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