Wave Motion and Optics (PHYS 2202) Course Outline - Winter 2021

Professor: **Sangeeta Murugkar** (smurugkar@physics.carleton.ca)
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Office Hours: Posted on cuLearn, or by appointment

Lectures: Monday and Wednesday 1:05 pm - 2:25 pm
Online: Big Blue Button

Labs: Instructor: **Maria Paula Rozo Martinez**
e-mail: prmartin@physics.carleton.ca

A4 - Monday, 11:35 am – 2:25 pm
A5 - Thursday, 8:35 am – 11:25 am
A3 - Thursday, 2:35 pm – 5:25 pm
A1 - Friday, 8:35 am –11:25 am

An *at-home lab kit* will be shipped to students for remote experimentation activities in the course. Lab sessions will be delivered synchronously on Big Blue Button on cuLearn.

Please consult the lab website for a list of experiments. Schedule and other details of the lab will be given out during the first lab session starting in the week of January 11th. All changes (lab exemptions, etc.) must be done with the lab instructor.

Course Modality: Synchronous Course

This course is a real-time, online course where the instructor and students meet via web conferencing tools, at scheduled days and times. Instructors and students share information, ideas and learning experiences in a virtual course environment. Participation in synchronous courses requires students to have reliable, high-speed internet access, a computer (ideally with a webcam), and a headset with a microphone.

Course Description

This is an introductory course in wave motion and optics. Optics is the science of light. It has captured human imagination since ancient times and has important implications in both fundamental physics and modern applications. The course starts with a review of geometrical or ray optics and then introduces a description of light in terms of the wave equation, and uses it to interpret the phenomena of polarization, interference and diffraction. Modern applications are introduced in terms of fiber optics and lasers.

Course WebSite: cuLearn PHYS 2202 site

Prerequisites

PHYS 1001 and PHYS 1002, or PHYS 1003 and PHYS 1004 (PHYS 1007 and PHYS 1008 are also acceptable provided a minimum average grade of B- is presented); plus MATH 1004 and MATH 1104, or MATH 1002 and MATH 1102

Students who do not have these prerequisites must check with the course instructor and obtain permission of the Physics Department to remain in the course.

Text Books

Required: Pedrotti, Pedrotti and Pedrotti, **Introduction to Optics**, Third Edition.

References: E. Hecht, **Optics**, Fourth edition, Addison Wesley Longman Inc., Toronto, 2002.

Learning Outcomes:

Upon completion of this course,

1. At an introductory level, students will be able to recall and utilize foundational knowledge in calculus-based wave motion and optics, including geometrical optics, description of light in terms of wave equations, and wave-interpretation of phenomena such as interference, diffraction and polarization, as well as practical implementations in the form of lasers, fiber optics, interferometers and diffraction gratings.

2. Students will have developed basic problem-solving skills in wave motion and optics, and be able to use appropriately the tools of physics, calculus, and algebra. In the lab, students will be able to generate justifiable uncertainty estimates for experimental results.

3. Students will have developed basic written communication skills for reporting lab work and their analysis of solved problems.

Syllabus

Below is the detailed list of topics that will be discussed in the course. The list follows the sequence in which the topics will be covered. It is highly recommended that the list be consulted for preparatory reading before each lecture.

	Lectures				HW and Labs	
	Wednesday		Friday		Mon (A4), Thu (A5, A3), Fri (A1)	
January	13	Course intro Chapter 1: Nature of Light	15	Chapter 2.1-2.6: Geometrical Optics Fermat, reflection, refraction, imaging		Post HW #1 (due Jan 22) Introductory Lab
	20	Chapter 2.7-2.9: Spherical surface, lenses	22	Chapter 3.1-3.7: Optical Instrumentation - Prisms, Microscopes, Telescopes		Post HW #2 (due Jan 29) Exp 1
	27	Chapter 4.1-4.4: Wave Equation, harmonic waves, complex representation	29	Chapter 4.5-4.9: Plane waves, spherical waves, EM Waves, Polarization		Post HW #3 (due Feb 5) Exp 1
February	3	Chapter 5.1-5.4: Superposition of waves of same frequency, standing waves	5	Chapter 5.5-5.6: Beats, Phase and Group velocity		Post HW #4 (due Feb 12) Exp 2
	10	Chapter 6.1-6.4: Lasers, Blackbody radiation, EM radiation, Einstein	12	Review (Midterm Preparation)		Post HW #5 (due Feb 26) Exp 2
	Week of February 15-19, 2021 - Winter Break: no lectures or laboratories.					
	24	*Mid-term Test*	26	Chapter 6.5 – 6.8: Laser elements, operation, characteristics		Exp 3
March	3	Chapter 7.1-7.7: Interference Two beam, Young's slits, thin films , Newtons Rings,	5	Chapter 7.8-8.3 Stokes relations, Interferometry: Michelson		Post HW #6 (due March 12) Exp 3
	10	Chapter 8.4-8.10 Fabry Perot and Applications	12	Chapter 9.1-9.5 Coherence, Fourier Analysis, harmonic waves, line width		Post HW #7 (due March 19) Exp 4
	17	Chapter 10.1-10.4 Fibre Optics Communications Bandwidth propagation	19	Chapter 10.5-10.8 Modes, attenuation, distortion, high bit rate transmission		Post HW #8 (due March 26) Exp 4
	24	Chapter 11.1 – 11.3 Fraunhofer Diffraction- single slit, circular aperture	26	Chapter 11.4 – 11.6 Resolution, double slit		Post HW #9 (due April 2) Exp 5
	31	Chapter 12.1 – 12.3: Diffraction Grating Equation, spectral range, dispersion	2	***Holiday*** *(Good Friday)*		Post HW #10 (due April 9) Exp 5
April	7	Chapter 12.4 – 12.8: Resolution, blazed, interference grating	9	Catch-up/ Final Review		
	14	Final Review (Optional)	16			
	Exam period: April 16-27, 2021					

Assessment

Final grade in the course will be based on two major components, theoretical and practical (labs). The former component includes a closed book exam at the end of the winter term, a mid-term exam and assignments.

Grades

Component	Weight
Assignments (10)	20%
Labs	30%
Midterm exam	20%
Final exam	30%

Passing conditions In order to pass the course, students must pass both the lab and non-lab (Theory) parts separately. Students will be given oral and written instructions in the lab on what is required to pass the lab.

Homework Assignments

There will be a total of 10 weekly assignments; a problem set will be assigned every Friday and will be due at the start of the following Friday lecture.

The homework assignments are marked out of 20.

Penalties for late homework assignments: 1 day late - 4 marks deducted
Over 1 day late - not accepted

Assignments that are more than 1 day late will not be accepted without an acceptable reason such as illness.

You are encouraged to discuss the problems on assignments with other students in this course; however, the work you turn in must be your own. Feel free to consult me when you have questions. The assignments are a critical part of the course and working through the problems yourselves is essential to learn the material. Your homework solutions should be thorough, self-contained, and logical, **with all steps explained**. *To submit your homework you will need to take pictures of your solutions and send it as one PDF; use of a scanning app is highly recommended. Alternately, you can submit a pdf of the solutions worked out on your electronic tablet.* Assignments must be deemed legible by the grader.

Exams

Mid-Term Test - There will be an 80-minute mid-term test held during the lecture time on Wednesday, February 24, 2021. You will need a calculator and a single-sided hand-written original (not word-processed, and not photocopied or scanned/printed) aid sheet, 8.5" x 11" for the test. The aid sheet will be submitted along with the midterm exam solutions as a single PDF file.

Final Exam will be held during the final examination period in April and will cover the entire course. You will need a calculator and a two-sided hand-written original (not word-processed, and not photocopied or scanned/printed) aid sheet, 8.5" x 11" for the exam. The aid sheet will be submitted along with the Final exam solutions as a single PDF file.

If you miss the mid-term test or final exam, a valid reason is required with appropriate justification documentation.

Deferred exam: If a deferred exam is necessary for a student, that exam will replace only the Final Exam component of the course mark and will only be granted if adequate term work has been completed. In this context, adequate term work means completing and submitting 75% of the assignments, writing the midterm exam, and fulfilling the lab requirements; the term mark must exceed 15 out of 65.

Course Copyright
Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copyright protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s).

Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).

Policies

Department policies can be found at:
http://www.physics.carleton.ca/current-undergraduate-students/academic-policies
The policies include information regarding the issues of Plagiarism and of Academic Accommodation. It is your responsibility to read and be familiar with these policies.

Plagiarism:
Plagiarism is the passing off of someone else's work as your own and is a serious academic offence. For the details of what constitutes plagiarism, the potential penalties and the procedures refer to the policies on academic integrity
The complete policy is available at:
http://carleton.ca/senate/wp-content/uploads/Academic-Integrity-Policy1.pdf

Academic Accommodations: University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, here:

https://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/

Academic Accommodations for Students with Disabilities:

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation.

If you are already registered with the PMC, contact your PMC coordinator to send your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). See: https://carleton.ca/pmc/

For Religious Obligations:

Students requesting academic accommodations on the basis of religious obligation should make a formal, written request to their instructors for alternate dates and/or means of satisfying academic requirements. Such requests should be made during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist, but no later than two weeks before the compulsory event.

Accommodation is to be worked out directly and on an individual basis between the student and the instructor(s) involved. Instructors will make accommodations in a way that avoids academic disadvantage to the student.

Students or instructors who have questions or want to confirm accommodation eligibility of a religious event or practice may refer to the Equity Services website for a list of holy days and Carleton's Academic Accommodation policies, or may contact an Equity Services Advisor in the Equity Services Department for assistance.

https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

Undergraduate Administrator

Joanne Martin (Room 3302 HP, telephone 520-2600, ext. 1023 or email (joanne.martin@carleton.ca) is the Physics Undergraduate Administrator and can help with information about prerequisites, inquiries about course substitutions and/or equivalencies, understanding your academic audit and remaining requirements for

graduation. She can also refer you to campus resources such as the Student Academic Success Centre (SASC), Science Student Success Centre (SSSC), Writing Tutorial Centre, Registrar's Office, etc.