PHYS 2202 for Winter 2025

Wave motion and Optics

We, the people of the Faculty of Science at Carleton University, acknowledge that our campus is located on the traditional, unceded territories of the Algonquin Anishinabeg people. Miigwetch for your hospitality and stewardship of this territory and the teachings that come from it. We are grateful for this land, the air that we breathe, and the water that sustains us all as well as for the animals, plants and other living beings: these enable us to research, teach, mentor, support, study, and learn. We recognize our responsibility to our natural environment and to reconciliation with Indigenous peoples.

Course Instructor: Sangeeta Murugkar

How to address me: Professor M

Gender Pronouns: (she/her/hers)

Email: sangeeta.murugkar@Carleton.ca

Note: If you have or question or would like to talk with me, you can send an email (mention PHYS 2202 in the subject), visit me during student hours (see below), or approach me after lecture.

Best Ways to be in Touch: in class, via email, or during student hours

Student Hours: To be posted on Brightspace

Office Location: Room 2414, Herzberg Building

Class Location: Please check Carleton Central for the room location.

Class Times: Wed, Fri, 2:30 -4 pm

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

Department/Unit: Physics

Course TA:
Dylan Malenfant (he/him/his)
(Dylanmalenfant@cmail.carleton.ca)

Welcome to PHYS 2202 !

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. This introductory course in Wave motion and Optics, 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.

Topics Covered and Learning Outcomes

Inclusive teaching statement:

I am committed to fostering an environment for learning that is inclusive for everyone regardless of gender identity, gender expression, sex, sexual orientation, race, ethnicity, ability, age and class. It is my hope that our class will support diversity of experience, thought, and perspective. I will continually strive to create inclusive learning environments and would therefore appreciate your support and feedback.

Topics to be Covered

	Lectures				HW and Labs	
	Wednesday		Friday		Labs: Tue, Wed, Thurs	
January	08	Course intro Chapter 1: Nature of Light	10	Chapter 2.1-2.6: Geometrical Optics Fermat, reflection, refraction, imaging		Post HW #1 (due Jan 17) Introductory Lab
	15	Chapter 2.7-2.9: Spherical surface, lenses	17	Chapter 3.1-3.7: Optical Instrumentation - Prisms, Microscopes, Telescopes		Post HW #2 (due Jan 24) Exp 1: Geometrical optics (Lenses)
	22	Chapter 4.1-4.4: Wave Equation, harmonic waves, complex representation	24	Chapter 4.5-4.9: Plane waves, spherical waves, EM Waves, Polarization		Post HW #3 (due Jan 31) Exp 1: Geometrical optics (Lenses)
February	29	Chapter 5.1-5.4: Superposition of waves of same frequency, standing waves	31	Chapter 5.5-5.6: Beats, Phase and Group velocity		Post HW #4 (due Feb 7) Exp 2: Refractive index of a prism
	5	Chapter 6.1-6.2: Blackbody radiation, line-shape function	7	Chapter 6.4: Einstein's theory of light-matter interaction, Lasers		Post HW #5 (due Feb 14) Tutorial: Problem solving session
	12	Chapter 6.5 – 6.8: Laser elements, operation, characteristics	14	Review (Midterm Preparation)		Exp 3: Polarization of light

	Week of February 17-21, 2025 - Winter Break: no lectures or laboratories.					
March	**26**	*Mid-term Test*	**28**	Chapter 7.1-7.7: Interference Two beam, Young's slits, thin films , Newtons Rings,		Post HW #6 (due March 7) Exp 4: - Michelson interferometer/ Fiber optics
	5	Chapter 7.8-8.3 Stokes relations, Interferometry: Michelson	**7**	Chapter 8.4-8.10 Fabry Perot and Applications		Post HW #7 (due March 14) Exp 4: Michelson interferometer/ Fiber optics
	12	Chapter 9.1-9.5 Coherence, Fourier Analysis, harmonic waves, line width	**14**	Chapter 10.1-10.4 Fibre Optics Communications Bandwidth propagation		Post HW #8 (due March 21) Exp 5: Fiber optics/ Michelson interferometer
	19	Chapter 10.5-10.8 Modes, attenuation, distortion, high bit rate transmission	**21**	Chapter 11.1 – 11.3 Fraunhofer Diffraction- single slit, circular aperture		Post HW #9 (due March 28) Exp 5: Fiber optics/ Michelson interferometer
	26	Chapter 11.4 – 11.6 Resolution, double slit	**28**	Chapter 12.1 – 12.3: Diffraction Grating Equation, spectral range, dispersion		Post HW #10 (due April 4) Exp 6: Fraunhofer diffraction
April	**2**	Chapter 12.4 – 12.8: Resolution, blazed, interference grating	**4**	Catch-up/ Final Review		Exp 6: Fraunhofer diffraction
	Exam period: April 11-26, 2025					

Course level learning outcomes:

Upon completion of this course,

1. Students will be able to recall and utilize at an introductory level, 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.

Assessments

Grade Breakdown

COMPONENT	GRADE VALUE
TUTORIAL QUIZ (FEB)	5%
ASSIGNMENTS	15% (Top 8 out of 10 assignments)
MIDTERM	20%
FINAL EXAM	30%
BONUS (EXTRA CREDIT)	5 % (in-class engagement)
LAB	30% (details in the 'Lab Policy' page on Brightspace)

Tutorial Quiz
There will be one tutorial held during the lab period in the week of February 3rd before the midterm exam. This session will serve as a review of the material seen in class lectures and homework. Students will solve practice problems and can ask questions in an informal setting where discussion in groups is highly encouraged. The tutorial concludes with a 45-minute quiz evaluation that will consist of a few new problems.

Assignments
There will be a total of 10 weekly assignments; a problem set will be assigned every Friday and will be due by midnight on the following Thursday. However, if you need an extension on this deadline, please email me (include 'PHYS 2202' in the subject line) and ask for one. You should include an estimate of when you can get the homework done by.

Assignment solutions should be submitted electronically in a single '.pdf' document. Note the assignment may be typed up or handwritten and scanned in. Photos taken with a cell phone are not admissible, as the lighting and contrast are usually bad, and resolution poor.

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.

Midterm Exam
There will be an 80-minute mid-term exam held during the lecture time on Wednesday, February 26, 2025. 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.

Final Exam
The final exam will take place during the final exam period in April and will cover the entire course (more details will be provided closer to the date).

Late and Missed Work Policies

Late Work
Penalties for late homework assignments: 1 day late – 10% marks deducted

2 day late - 20% marks deducted

Assignments that are more than 2 days late will not be accepted without an acceptable reason such as illness. The top 8 assignments will be used to tabulate your total assignment mark in the course.

Missed Work

Short-term (5 days or less): Accommodations for missed work due to unexpected, temporary situations such as sickness, injury, or extraordinary circumstances outside of a student's control, must be requested via a written email to me along with an academic considerations form.

Long-term (> 5 days): Students experiencing chronic, ongoing challenges which necessitate a broader solution are encouraged to reach out to the Paul Menton Centre and/or the Care Support team. (More information here: longer-term accommodation) .

Learning Materials

Textbook:

Pedrotti, Pedrotti and Pedrotti. *Introduction to Optics*

Third Edition, Cambridge, 2018 or newer (Note: Third edition published by Pearson prior to 2018 will do as well)

Available from the Carleton Bookstore or elsewhere

$69.50 to $87.00

Reference Textbook:

E. Hecht, Optics, Pearson (Fifth Ed.,) or Addison Wesley Longman Inc., (Fourth Ed.)

Academic Accommodations and Regulations

Carleton is committed to providing academic accessibility for all individuals. You may need special arrangements to meet your academic obligations during the term. The accommodation request processes are outlined on the Academic Accommodations website (https://students.carleton.ca/course-outline/).

Statement on Chat GPT/Generative AI usage (See the *Sample Syllabus Statements for AI use in Courses* document for examples)

As our understanding of the uses of AI and its relationship to student work and academic integrity continue to evolve, students are required to discuss their use of AI in any circumstance not described here with the course instructor to ensure it supports the learning goals for the course.

Statement on Academic Integrity

Students are expected to uphold the values of academic integrity, which include fairness, honesty, trust, and responsibility. Examples of actions that that compromise these values include but are not limited to plagiarism, accessing unauthorized sites for assignments or tests, unauthorized collaboration on assignments or exams, and using artificial intelligence tools such as ChatGPT when your assessment instructions say it is not permitted.

Misconduct in scholarly activity will not be tolerated and will result in consequences as outlined in Carleton University's Academic Integrity Policy. A list of standard sanctions in the Faculty of Science can be found here.

Additional details about this process can be found on the Faculty of Science Academic Integrity website.

Students are expected to familiarize themselves with and abide by Carleton University's Academic Integrity Policy.

Student Rights & Responsibilities

Students are expected to act responsibly and engage respectfully with other students and members of the Carleton and the broader community. See the 7 Rights and Responsibilities Policy for details regarding the expectations of non-academic behaviour of students. Those who participate with another student in the commission of an infraction of this Policy will also be held liable for their actions.

Student Concerns

If a concern arises regarding this course, **your first point of contact is me**: Email or drop in during student hours and I will do my best to address your concern. If I am unable to address your concern, the next points of contact are (in this order):

Note: You can also bring your concerns to Ombuds services.