Fall 2025

MODERN OPTICS

PHYS 4208/ PHYS 5318

Course Instructor: Sangeeta Murugkar

Hear my name: **https://www.name-coach.com/sangeeta-murugkar**

How to address me: Sangeeta

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 (include 'PHYS 4208/5318' in the subject line), visit me during student hours (see below), or approach me after lecture.

Student Hours: To be posted on Brightspace

Office Location: 2414 HP (Herzberg Building)

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

Class Times: Monday and Wednesday, 1:00 – 2:30 pm

Prerequisites: PHYS 2202, PHYS 3606 (or PHYS 3608), and PHYS 3308 or Permission of the Department.

Department/Unit: Physics

Course TA:
Teaching Assistant: Yasaman Shafaee (she/her)
(YasamanShafaee@cmail.carleton.ca)

Welcome to PHYS 4208/ PHYS 5318 !

Optics has ancient roots but remains a very active area of research and development. For example, there are at least 6 Optics related Nobel prizes in the past decade. In this advanced course in Optics, we will consider the theory and applications of free-space and guided-wave propagation including topics such as interference, diffraction and imaging. We will also consider the theory and applications related to topics in Photonics which forms the basis of all modern technologies – from smartphones to laptops to the internet.

Topics to be Covered

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.

Syllabus

	Lecture	Date	Topics	Chapter	
Week 1	1	03-Sep	Postulates of Ray Optics, the paraxial ray equation and application in graded-index optics	1 (Ray Optics)	Post HW1
Week 2	2	08-Sep	Matrix optics: ray transfer matrix, applications to simple components and periodic optical systems.	1	
	3	10-Sep	Wave optics: the Helmholtz equation, reflection, refraction and transmission of paraxial waves	2 (Wave Optics)	Post HW2
Week 3	4	15-Sep	Wave optics: Application to a diffraction grating, interference and interferometers	2	
	5	17-Sep	The Gaussian wavefunction, transmission through optical components	3 (Beam Optics)	Post HW3
Week 4	6	22-Sep	Properties of the Gaussian beam, Beam shaping	3	
	7	24-Sep	Fourier optics: wave function and harmonic function, transfer function of free space	4 (Fourier Optics)	Post HW4
Week 5	8	29-Sep	Impulse response function, optical Fourier transform, Fraunhofer diffraction	4	
	9	01-Oct	4-f imaging system; EM optics: Maxwell's equations	4 & 5	Post HW5
Week 6	10	06-Oct	The wave equation, Maxwell's equations in dielectric media, absorption and dispersion	5 (Electromagnetic Optics)	
	11	08-Oct	Solutions to Maxwell's equations: plane, spherical waves; pulse propagation in dispersive media	5	
Week 7		13-Oct	*Thanksgiving Holiday*		
	12	15-Oct	Polarization optics: Poincare sphere, Stokes parameters, Jones vector, Jones matrix	6 (Polarization Optics)	
			Oct 20 - 24_Fall Break		

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Week 8		**27-Oct**	**Midterm Exam**		
	13	29-Oct	Rotation of polarizers, TE & TM polarization, reflection and transmission matrices	6 (Polarization Optics)	Post HW6
Week 9	14	03-Nov	Planar Mirror Waveguide, planar dielectric, optical coupling.	9 (Guided Wave Optics)	
	15	05-Nov	Fiber optics: Guided Waves, attenuation, dispersion: material and modal.	10 (Fiber Optics)	Post HW7
Week 10	16	10-Nov	Planar and spherical mirror resonators, Gaussian Modes and resonance frequencies	11 (Resonator Optics)	
	17	12-Nov	Interaction of Photons with Atoms, Spontaneous, stimulated emission and absorption	14 (Light and Matter)	Post HW8
Week 11	18	17-Nov	Rate equations, Laser amplifier, gain and phase shift	14 & 15	
	19	19-Nov	Amplifier pumping, examples of amplifiers (ruby, Nd YAG)	15 (Laser Amplifiers)	Post HW9
Week 12	20	24-Nov	Laser Theory, amplification and feedback, feedback and loss, CW and Pulsed lasers	16 (Lasers)	
	21	26-Nov	Laser operation and properties, CW and Pulsed lasers	16 (Lasers)	Post HW10
Week 13	22	01-Dec	Phys 5318 presentations		
	23	03-Dec	Phys 5318 presentations		
	24	08-Dec	*Review*		

Important dates and deadlines can be found here: https://carleton.ca/registrar/registration/dates/academic-dates/, including class suspension for fall, winter breaks, and statutory holidays.

Assessments

Research about learning strongly suggests that the most important factor in learning is doing the work of reading, writing, recalling, practicing, synthesizing, and analyzing. Learning happens best when people actively engage material on a consistent basis, and that is why we have high standards in this course. We are confident that, with appropriate effort, you **all** can meet those standards.

We also make an effort to reduce unintentional bias in grading by, for example and when possible, grading assignments one question at a time (grading all of question 1 before grading any of question 2), grading anonymously, and using rubrics.

Grade Breakdown

COMPONENT	GRADE VALUE	
	PHYS 4208	PHYS 5318
READING REFLECTIONS	15%	15%
ASSIGNMENTS	20%	18%
MIDTERM	25%	20%
FINAL EXAM	40%	37%
PROJECT	NA	10%

Reading Reflections

Attendance at the lectures is highly recommended. As a way of self-learning and keeping up with the course material and readings, a 'reading reflections' mark will be awarded in the following way. A brief concept question will be posed during the Monday lecture and students will submit their answer on Brightspace by the end of the day on Monday.

There will be 'Reading Reflections' for each of the active weeks of class with grading as follows: correct and complete response (100%); partially correct and/or partially complete response (50%); incorrect and/or incomplete response (0%).

Assignments

There will be a total of 10 weekly assignments; a problem set will be assigned every Wednesday and will be due by midnight on the Wednesday of the following week. However, if you need an extension on this deadline, please email me (include 'PHYS 4208/5318' in the subject line) and ask for one. You should include an estimate of when you can get the homework done by. The 'Late and Missed Work policy' will apply for homework submitted late without notifying the instructor.

Assignments should be submitted electronically in a '.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.

Midterm Exam

All students will need to write the midterm exam. The Midterm grade will be assessed on the basis of a midterm exam that will take place in person on October 27th (same time and location as the usual lecture).

Details will be provided by mid-October.

Final Exam

The 3 hour final exam will take place in person during the final exam period.

Project (PHYS 5318 only)

The project only applies to PHYS 5318 students. The project will be based on applications arising from the material in the course. The project topic title needs to be discussed with and approved by Prof. Murugkar. More information on the structure of the report will be provided. Marks will be given based on a written report (20) and a 20-minute seminar (10) for a total of 30.

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.

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:

B.E.A. Saleh and M.C. Teich, (2019). *Fundamentals of Photonics*

Third Edition, John Wiley and Sons, 2019 (Note: Second edition will do as well)

Available from the Carleton Bookstore or elsewhere

$187.99 for e-book

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

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.