MODERN OPTICS

PHYS 4208/ PHYS 5318

Course Instructor: Sangeeta Murugkar

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

How to address me: Professor Murugkar

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, visit me during student hours (see below), or approach me after lecture.

Office Location: Brightspace (Big Blue Button)

Class Location: Brightspace (Big Blue Button)

Class Times: Monday & Wednesday, 11:35am-12:55pm

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

Student Hours: **To be posted on** Brightspace

What are 'Student Hours'?

Student hours are dedicated times through the week for the course instructor and TAs to meet with YOU. Pop in to introduce yourself, ask questions about the course, or discuss content from the course.

Note: If these If these times don't work for you, email me and we can arrange an alternate time to meet.

Course TAs:

Teaching Assistant 1 (he/him/his) 

(teaching.assistant.name1@carleton.ca)

Teaching Assistant 2 (he/him/his) 

(teaching.assistant.name2@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.

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.

Land Acknowledgement

Here at Carleton University, it is important that we acknowledge that the land on which we gather is the traditional and unceded territory of the Algonquin nation.

Community Guidelines

The following values are fundamental to academic integrity and are adapted from the International Center for Academic Integrity*. In our course, we will seek to behave with these values in mind:

	As students, we will…	As a teaching team, we will…
Honesty	• Honestly demonstrate our knowledge and abilities on assignments and exams • Communicate openly without using deception, including citing appropriate sources	• Give you honest feedback on your demonstration of knowledge and abilities on assignments and exams • Communicate openly and honestly about the expectations and standards of the course through the syllabus, and with respect to assignments and exams
Responsibility	• Complete assignments on time and in full preparation for class • Show up to class on time, and be mentally/physically present • Participate fully and contribute to team learning and activities	• Give you timely feedback on your assignments and exams • Show up to class on time, and be mentally & physically present • Create relevant assessments and class activities
Respect	• Speak openly with one another, while respecting diverse viewpoints and perspectives • Provide sufficient space for others to voice their ideas	• Respect your perspectives even while we challenge you to think more deeply and critically • Help facilitate respectful exchange of ideas

Fairness	• Contribute fully and equally to collaborative work, so that we are not freeloading off of others • Not seek unfair advantage over fellow students in the course	• Create fair assignments and exams, and grade them in a fair, and timely manner • Treat all students equitably
Trust	• Not engage in personal affairs while on class time • Be open and transparent about what we are doing in class • Not distribute course materials to others without authorization	• Be available to all students when we say we will be • Follow through on our promises • Not modify the expectations or standards without communicating with everyone in the course
Courage	• Say or do something when we see actions that undermine any of the above values • Accept a lower or failing grade or other consequences of upholding and protecting the above values	• Say or do something when we see actions that undermine any of the above values • Accept the consequences (e.g., lower teaching evaluations) of upholding and protecting the above values

[2] This class statement of values is adapted from Tricia Bertram Gallant, Ph.D.

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)

Reference Textbook:

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

Technology Checklist:

- ☐ An internet-enabled computer (laptop/desktop)
- ☐ Access to reliable internet
- ☐ Webcam
- ☐ Headset with microphone

Assessment in this Course

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
ASSIGNMENTS	30% (10 assignments, worth 3% each)
MIDTERM	25%
FINAL EXAM	45%

Assignments

Ten weekly assignments will be set in a Wednesday lecture. They will typically consist of two or three problems from the text or from the reference textbook. 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. Submission is required before the start of the Monday Lecture. Solutions will be discussed in the following Wednesday lecture. Late assignments will be pro-rated 50% per day.

The top 8 assignments will be used to tabulate your total assignment mark in the course.

Midterm Exam

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The Mid Term grade will be assessed on the basis of a midterm exam due on the first Monday (November 1st) after the mid-term break.

Details will be provided by mid-October.

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The Mid Term grade will be assessed on the submission of a midterm evaluation in the form of a project 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 (5) for a total of 25.

Final Exam

The final exam will take place during the final exam period. The 3 hour online exam will combine elements of both design projects and regular questions.

Exam Proctoring

Please note that all examinations in this course will use a remote proctoring service provided by Scheduling and Examination Services. You can find more information at https://carleton.ca/ses/e-proctoring/.

Special Information Regarding COVID-19

All members of the Carleton community are required to follow COVID-19 prevention measures and all mandatory public health requirements (e.g., wearing a mask, physical distancing, hand hygiene, respiratory and cough etiquette) and mandatory self-screening prior to coming to campus daily.

If you feel ill or exhibit COVID-19 symptoms while on campus or in class, please leave campus immediately, self-isolate, and complete the mandatory symptom reporting tool. For purposes of contact tracing, attendance will be taken in all classes and labs. Participants can check in using posted QR codes through the cuScreen platform where provided. Students who do not have a smartphone will be required to complete a paper process as indicated on the COVID-19 website.

All members of the Carleton community are required to follow guidelines regarding safe movement and seating on campus (e.g., directional arrows, designated entrances and exits, designated seats that maintain physical distancing). In order to avoid congestion, allow all previous occupants to fully vacate a classroom before entering. No food or drinks are permitted in any classrooms or labs.

For the most recent information about Carleton's COVID-19 response and required measures, please see the University's COVID-19 webpage and review the Frequently Asked Questions (FAQs). Should you have additional questions after reviewing, please contact covidinfo@carleton.ca.

Please note that failure to comply with University policies and mandatory public health requirements, and endangering the safety of others are considered misconduct under the Student Rights and Responsibilities Policy. Failure to comply with Carleton's COVID-19 procedures may lead to supplementary action involving Campus Safety and/or Student Affairs.

Note About COVID-19 & Mental Health

The global pandemic has led to extra stress and uncertainty for everyone, and while we may all be experiencing the same storm, this does not mean that we are all in the same boat! If you are struggling, please do not hesitate to reach out. I am happy to listen, and/or direct you to resources that might help. Remember that Carleton also offers an array of mental health and well-being resources, which can be found here.

Children & video sessions

You are welcome to have children with you during video sessions as I fully understand that childcare situations may be complicated for many of us at this time. Do your best to participate and engage, but also please get in touch with me if you have any questions or concerns.

University Policies

In accordance with the Carleton University Undergraduate Calendar Regulations, the letter grades assigned in this course will have the following percentage equivalents:

A+ = 90-100	B+ = 77-79	C+ = 67-69	D+ = 57-59
A = 85-89	B = 73-76	C = 63-66	D = 53-56
A- = 80-84	B- = 70-72	C- = 60-62	D- = 50-52

F = <50
WDN = Withdrawn from the course
ABS = Student absent from final exam
DEF = Deferred
FND = (Failed, no Deferred) = student could not pass even with 100% on final exam

Academic Accommodations, Regulations, Plagiarism, Etc.

Carleton University is committed to providing access to the educational experience in order to promote academic accessibility for all individuals.

Academic accommodation refers to educational practices, systems and support mechanisms designed to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University. More information can be found at: https://students.carleton.ca/course-outline/

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

If you have a documented disability requiring academic accommodations in this course, please contact the Paul Menton Centre for Students with Disabilities (PMC) at 613-520-6608 or pmc@carleton.ca for a formal evaluation or contact your PMC coordinator to send your instructor your Letter of Accommodation at the beginning of the term. You must also contact the PMC no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with your instructor as soon as possible to ensure accommodation arrangements are made. For more details, visit the Paul Menton Centre website.

Addressing Human Rights Concerns

The University and all members of the University community share responsibility for ensuring that the University's educational, work and living environments are free from discrimination and harassment. Should you have concerns about harassment or discrimination relating to your age, ancestry, citizenship, colour, creed (religion), disability, ethnic origin, family status, gender expression, gender identity, marital status, place of origin, race, sex (including pregnancy), or sexual orientation, please contact the Department of Equity and Inclusive Communities at equity@carleton.ca.

Religious Obligations

Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF, 2.1 MB).

Survivors of Sexual Violence

As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/

Accommodations for Missed Work

Carleton recognizes that these are unprecedented times during the COVID-19 pandemic, and that students may be experiencing greater stress and other life factors that are not in their control. As a result, Carleton has put into place a protocol for students to apply for accommodations using a self-declaration form in the event of missed work. The form can be found at: https://carleton.ca/registrar/wp-content/uploads/self-declaration.pdf

For Pregnancy

Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, please review the Student Guide to Academic Accommodation (PDF, 2.1 MB).

Accommodation for Student Activities

Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details, see the Senate Policy on Accommodation for Student Activities (PDF, 25KB).

Academic Integrity

Academic misconduct undermines the values of honesty, trust, respect, fairness, and responsibility that we expect in this class. Carleton University provides supports such as academic integrity workshops to ensure, as far as possible, that all students understand the

norms and standards of academic integrity that we expect you to uphold. Your teaching team has a responsibility to ensure that their application of the Academic Integrity Policy upholds the university's collective commitments to fairness, equity, and integrity. (adapted from Carleton University's Academic Integrity Policy, 2021).

Examples of actions that do not adhere to Carleton's Academic Integrity Policy include:

- Plagiarism
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exams

Sanctions for not abiding by Carleton's Academic Integrity Policy

A student who has not adhered to Carleton's Academic Integrity Policy may be subject to one of several sanctions:

1. If you take full responsibility for your actions, and it is the first time you have violated the policy, you will receive zero on the assessment. If you are found to have violated the policy but do not take responsibility, an additional grade deduction will be applied (e.g. an A- will become a B+)
2. Subsequent violations of the policy may result in more severe sanctions such as failing the course, suspension from all studies and/or expulsion.

Process of an Academic Misconduct Investigation

Step 1: The instructor believes misconduct has occurred and submits documentation to the Dean of the Faculty of Science.

Step 2: The Dean reviews documentation and can proceed with or dismiss the allegation.

Step 3: If sufficient evidence, the student receives an allegation statement by email. Ombuds services is copied on the email.

Step 4: The student provides a written response to the evidence provided.

Step 5: Either party may request a meeting between student, dean, and the ombudsperson.

Step 6: Dean informs the student of the decision.

Appeal: Student has the right to appeal the decision.

Additional details about this process can be found on the Faculty of Science Academic Integrity website. Students are expected to familiarize themselves with and follow the

Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students.

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, refer the Faculty of Science Academic Integrity website. To further understand Academic Integrity, consider attending the Learning and Support Academic Integrity Workshop.

What are the Penalties for Plagiarism?

A student found to have plagiarized an assignment may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; and/or a reprimand; a refusal of permission to continue or to register in a specific degree program; academic probation; award of an FNS, Fail, or an ABS.

What are the Procedures?

3. All allegations of plagiarism are reported to the Dean of Faculty of Science. Documentation is prepared by instructors and/or departmental chairs.
4. The Dean writes to the student and the University Ombudsperson about the alleged plagiarism.
5. The Dean reviews the allegation. If it is not resolved at this level then it is referred to a tribunal appointed by the Senate.

Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students.

Assistance for Students

Academic and Career Development Services: http://carleton.ca/sacds/

Writing Services: http://www.carleton.ca/csas/writing-services/

Peer Assisted Study Sessions (PASS): https://carleton.ca/csas/group-support/pass/

Math Tutorial Centre: https://carleton.ca/math/math-tutorial-centre/

Science Student Success Centre: https://sssc.carleton.ca/

Syllabus

Lecture	Date	Topics	Chapter
1	08-Sep	Postulates of Ray Optics, graded index optics, Fermat's principle, the paraxial ray equation	1 (Ray Optics)
2	13-Sep	The eikonal equation, matrix optics, periodic optical systems.	1
3	15-Sep	Monochromatic waves, the Helmholtz equation, elementary waves, paraxial waves	2 (Wave Optics)
4	20-Sep	Relation between ray and wave optics. Interference: interferometers, multiple wave interference, Bragg reflection.	2
5	22-Sep	The Gaussian Beam and parameters required for its characterization, transmission through optical component	3 (Beam Optics)
6	27-Sep	Beam shaping, reflection from a mirror, transmission through an arbitrary optical system, the ABCD law	3
7	29-Sep	Propagation of light in free space, transfer function of free space	4 (Fourier Optics)
8	04-Oct	Impulse response function. Optical Fourier transform, Diffraction	4
9	06-Oct	Image Formation	4
	11-Oct	***Thanksgiving Day***	***Holiday***
10	13-Oct	The wave equation, Maxwell's Eqn., dielectric media,	5 (Electromagnetic Optics)
11	18-Oct	Monochromatic waves, plane, spherical and Gaussian beams	5
12	20-Oct	Jones vector, Jones matrix, wave retarders, rotators.	6 (Polarization Optics)
	Oct 25 - 29	***Fall Break***	
13	01-Nov	Planar Mirror Waveguide, planar dielectric, optical coupling.	9 (Guided Wave Optics)
14	03-Nov	Guided Waves, attenuation, dispersion: material and modal.	10 (Fiber Optics)
15	08-Nov	Planar mirrors, spherical mirrors, Gaussian Modes.	11 (Resonator Optics)
16	10-Nov	Photons and Atoms	14 (Light and Matter)
17	15-Nov	Amplification, bandwidth, phase shift, rate equations, examples: ruby laser, Nd YAG, gain saturation.	15 (Laser Amplifiers)
18	17-Nov	Theory, amplification and feedback, feedback and loss, conditions for lasing. CW and Pulsed lasers,	16 (Lasers)
19	22-Nov	Doped semiconductors, electron and hole concentrations, generation,	17 (Semiconductor Optics)
20	24-Nov	recombination and injection, the pin junction diode, quantum wires and dots, photodetectors	17, 19
21	29-Nov	Non-linear optical media, second order, optical rectification, the electro-optic effect, three wave mixing,	22 (Non-linear optics)
22	01-Dec	optical Kerr effect, Raman and Brillouin scattering.	
23	06-Dec	Pulse shaping and Compression	23 (Ultrafast optics)
24	08-Dec	*Catch-up, 5318 presentations*	24
25	10-Dec	*Catch-up, 5318 presentations*	25