Physics 434: Optics
Fall 2022

Instructor: Prof. David Cooke

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- Office hours: Monday 3-4pm

Teaching assistants:

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Course summary:
Optics is the study of light. Nowadays, optics it is as ubiquitous as electronics and is integral to nearly every scientific endeavour from biology to astrophysics. Knowing some basic optical theory gives you a toolbox to use light in new ways. There are almost no topics in physics that has not been influenced by optics in one way or another. In this course you will gain a basic knowledge of optics and optical components, and get some hands-on experience using optics in the lab.

Class schedule: This course has both a lecture (2 hrs/week) and a laboratory component (3 hrs/week). Currently there is one lab section on a M/W but labs will be on Wednesdays only. That said, if you want to come on Mondays the equipment will be available. The lab schedule will be posted on MyCourses. You will be doing the labs individually and have your own experimental setup. Some labs are multiple sessions however your setup will remain untouched so you can pick up where you left off week to week.

- Lectures are Tuesdays and Thursdays in Wong 1050 from 8:55 am - 9:55 am. Your schedule says a 8:35am start, but we only use one hour of lecture. In the case I need to make up a lecture, we will start at 8:35am (but I will warn you ahead of time specifically). This reduction in lecture hours is to keep the total course hours in line with a 3 credit course now that there is a lab component.
- Laboratory: 3 hours per week (14:35 - 17:25, Wong 0120) on Wednesdays according to the lab schedule posted on MyCourses.

Book:
We will be following text by Saleh and Teich - Fundamentals of Photonics. The text is available online as an ebook. We will only be using the first half of the book in this course but the advanced topics might wet your appetite to learn more about photonics. There will be assigned readings before the lecture and you will need to read them before you arrive in class.

Course outline

The course is organized as follows:

- How to handle and align optical components

  Laboratory 0 – Mounting and aligning optical components (1 session)

- Geometric (Ray) optics – Fermat's principle, Paraxial approximation, matrix optics and linear optical elements.

  Laboratory 1 – Geometric optics and imaging (2 sessions)

- Wave optics – Plane waves, interference and superposition, interferometry

  Laboratory 2 – Interference: Build your own LIGO (3 sessions)

- Beam optics – Gaussian beams and propagation, ABCD matrices

  Laboratory 3 – Gaussian beam optics (2 sessions)

- Fourier optics – Wave propagation and decomposition Fraunhofer diffraction and transformation optics

  Laboratory 4 – Apertures and diffracted light (1 session)

- E&M waves – Polarization, Jones matrices, Fresnel relations

  Laboratory 5 – Optical properties of materials: Maple syrup (2 sessions)

- Photonic crystal optics – Periodic dielectric media, transfer matrix calculations, photonic band structure

  Laboratory 6 – Build your own THz photonic crystal (1 session)

Communication:
Please contact me via email; I will try to respond to all emails within one weekday (24 hours). The teaching assistant responsible for grading will vary week to week, as described on each problem set - please contact the appropriate TA. Course announcements will be sent to registered students at their `mcgill.ca` email address.

- Please let me know if you are not registered and would like to receive announcements.
- Problem sets, lab schedule, exam review, and supplementary materials will be posted to the MyCourses website. We will use Crowdmark for the distribution and grading of assignments, exam and lab exercises.

Assessment:
All assessment, including the final exam, will be online via Crowdmark.
Your grade will be determined by:

- 35% - 5 problem sets
- 30% - 6 laboratory exercises (Labs 1-6)
- 35% Final exam (administered online)

Exams will be open book and administered over a 24 - 72 hour period.

Rules

- McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offenses under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ for more information).
- In accord with McGill University's Charter of Students Rights, students in this course have the right to submit in English or in French any written work that is to be graded.
- Additional policies governing academic issues which affect students can be found in the McGill Charter of Students' Rights.
- Text-matching software may be used to authenticate originality of submitted written work.

Corequisites:
Physics 342 Majors Electromagnetic Waves or Physics 352 Honours Electromagnetic Waves. You should also be comfortable with mathematical techniques used to describe waves, including the wave equation (especially as it pertains to electromagnetic waves), complex numbers, multivariate calculus, and Fourier methods. Please ask if you have any questions or concerns – it is your responsibility to make sure you are properly equipped to take on this class.

Note: In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.