

**ENG PHYS 3E04/Physics 3N04**  
**Fundamentals of Physical Optics**  
Fall 2023  
Course Outline

**CALENDAR/COURSE DESCRIPTION**

Geometrical optics, electromagnetic waves, interference of light, Fraunhofer and Fresnel diffraction, polarized light, Fresnel equations, optical properties of materials, introduction to optical systems and precision optics experiments, selected topics in modern optics

**PRE-REQUISITES AND ANTI-REQUISITES**

Requisites: Registration in an Engineering program; ENGPHYS 2A04, PHYSICS 2B03 or equivalent, as approved by the course instructor

Anti-requisites: PHYSICS 3N03, ENGPHYS 3E03

**INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION**

**Dr. Chang-qing Xu**  
JHE A417  
cqxu@mcmaster.ca

**Office Hours:**  
By email appointment

**TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION**

**TBD**

**Office Hours:**  
By email appointment

**COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION**

<http://avenue.mcmaster.ca/>

Avenue to Learn, Email and Microsoft Team will be used in communications between students, McMaster email addresses will be used in the communications.

**COURSE OBJECTIVES**

By the end of this course, students should be able to:

- Solve a range of problems in the domain of geometrical optics
- Demonstrate a good understanding of the wave nature of light

- Demonstrate a good understanding of the principle of superposition – leading to the interference of light in a wide range of situations, including diffraction phenomena.
- Be able to solve problems connected with the operation of optical instruments which directly exploit light wave interference.
- Explain the relation of the optical properties of materials and selected mechanisms for the generation of polarized light.
- Solve problems involving simple waveguides and the propagation of light in modulated media
- Understand the application of boundary conditions in electromagnetic problems, and in particular the development and implications of Fresnel's equations
- Be capable of solving problems connected with the domain of light-matter interactions

## MATERIALS AND FEES

### Required Textbook:

- "Introduction to Optics", 3<sup>rd</sup> edition, by Pedrotti, Pedrotti, Pedrotti (Cambridge 2017).

Please visit the link below to the textbook:

[https://campusstore.mcmaster.ca/cgi-mcm/ws/txsub.pl?wsTERMG1=234&wsDEPTG1=ENGPHY&wsCOURSEG1=3E04&wsSECTIONG1=DAY%20C01&crit\\_cnt=1](https://campusstore.mcmaster.ca/cgi-mcm/ws/txsub.pl?wsTERMG1=234&wsDEPTG1=ENGPHY&wsCOURSEG1=3E04&wsSECTIONG1=DAY%20C01&crit_cnt=1)

### Lecture notes:

- To be posted on Avenue to Learn

### Lab manuals:

- To be posted on Avenue to Learn

### Recommended Additional Textbooks:

- "Optical Physics", 4<sup>th</sup> Edition, Ariel Lipson, Stephen Lipson, and Henry Lipson (Cambridge University Press, 2010)
- "Optics", 5<sup>th</sup> Edition, Eugene Hecht (Pearson, 2016)
- "Introduction to Modern Optics", 2<sup>nd</sup> edition {Paperback}, Grant Fowles (Dover, 1989)

### Calculator:

- Only the McMaster Standard Calculator will be permitted in tests and examinations. This is available at the Campus Store.

### Other Materials:

- The course will make significant use of ZEMAX.

## COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 4 classes (3 lectures and 1 tutorial) per week
- 3 in-person labs
  - Labs will be done in-person (lab schedule will be posted on Avenue to Learn)
  - Submission deadline of lab report will be posted on Avenue to Learn
  - Late submission of lab reports will not be marked and a grade of ZERO will be assigned.
- 2 Zemax assignments

- Submit your assignment reports to Avenue to learn (submission deadline will be posted on Avenue to Learn)
- A grade of ZERO will be assigned for late submission.
- Practice questions (for each Chapter)
  - Self-marking (answers to the practice questions can be found at the end of the textbook, solutions of the selected questions will be provided at tutorials)
- Presentations (optional)
  - This option weights 10% of the total mark (for preparing and presenting solutions of the selected practice questions and/or important concepts/phenomena learnt in the course)
  - Need to inform Dr. Xu on the first day of the class if you decide to take this option (number for this option is limited. First come, first take)
  - Presentation schedule will be posted to Avenue to Learn
- 5 Quizzes (in-class)
  - Submit your quiz solutions to Avenue to learn at the end of each quiz session.
  - A grade of ZERO will be assigned for late submission.
- Final exam (in-person)

#### COURSE OVERVIEW

| Date/Week      | Topic                             | Readings (textbook) |
|----------------|-----------------------------------|---------------------|
| <b>Week 1</b>  | Overview and nature of light      | Chapter 1           |
| <b>Week 2</b>  | Geometrical Optics and ZEMAX      | Chapter 2           |
| <b>Week 3</b>  | Wave Equations                    | Chapter 4           |
| <b>Week 4</b>  | Superposition of Waves            | Chapter 5           |
| <b>Week 5</b>  | Interference of Light             | Chapter 7           |
| <b>Week 6</b>  | No class                          |                     |
| <b>Week 7</b>  | Interference of Light             | Chapter 7           |
| <b>Week 8</b>  | Optical Interferometry, Coherence | Chapters 8, 9       |
| <b>Week 9</b>  | Matrix Treatment of Polarization  | Chapter 14          |
| <b>Week 10</b> | Production of Polarized Light     | Chapter 15          |
| <b>Week 11</b> | Fresnel Equations                 | Chapter 23          |
| <b>Week 12</b> | Fraunhofer Diffraction            | Chapter 11          |
| <b>Week 13</b> | Fresnel Diffraction               | Chapter 13          |
| <b>Week 14</b> | Fresnel Diffraction               | Chapter 13          |

#### ASSESSMENT

| Component     | Weight (option 1*) | Weight (option 2**) |
|---------------|--------------------|---------------------|
| Quizzes       | 20%                | 20%                 |
| Labs          | 30%                | 30%                 |
| Assignments   | 10%                | 10%                 |
| Presentations | 10%                |                     |
| Final Exam    | 30%                | 40%                 |
| <b>Total</b>  | <b>100%</b>        | <b>100%</b>         |

\* Option 1: prepare and give presentations (assigned by Dr. Xu) to explain solutions of practice questions and/or important concepts/phenomena learnt in the course (number for this option is limited. First come, first take)

\*\* Option 2: no presentation to the class.

### ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only, and will not be directly taken into consideration in determining a student's actual grade in the course.

| Outcomes  | Indicators |
|---|------------|
| Be able to solve a range of problems in the domain of geometrical optics  | 1.2, 1.4   |
| Demonstrates a good understanding of the wave nature of light   | 1.2, 1.3   |
| Demonstrates a good understanding of the principle of superposition – leading to the interference of light in a wide range of situations, including diffraction phenomena | 1.2, 1.3   |
| Be able to solve problems connected with the operation of optical instruments which directly exploit light wave interference  | 1.4        |
| Be able to explain the relation of the optical properties of materials and selected mechanisms for the generation of polarized light                                      | 1.2, 1.4   |
| Be able to solve problems involving simple waveguides and the propagation of light in modulated media   | 1.3        |
| Understands the application of boundary conditions in electromagnetic problems, and in particular the development and implications of Fresnel's equations                 | 1.2, 1.4   |
| Be capable of solving problems connected with the domain of light-matter interactions   | 1.2        |

For more information on Accreditation, please visit: <https://www.engineerscanada.ca>

### EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Engineering Physics is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

### PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

#### ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

1. plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. improper collaboration in group work.
3. copying or using unauthorized aids in tests and examinations.

#### AUTHENTICITY / PLAGIARISM DETECTION

**Some courses may** use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to [www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity).

#### COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

**Some courses may** use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

#### CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in

the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

#### ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or [sas@mcmaster.ca](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [Academic Accommodation of Students with Disabilities](#) policy.

#### COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students’ responsibility to regularly check the course webpage (i.e. Avenue to Learn) for updates and announcements.
2. Late submission of homework, lab reports and assignments will not be marked/recorded, and a grade of ZERO will be assigned.

#### SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

1. **Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:**
  - Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
  - Students may submit requests for relief using the MSAF once per term.
  - An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.
  - The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
  - The MSAF cannot be used for academic work that has already been completed attempted.
  - An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
  - The MSAF cannot be used to apply for relief for any final examination or its equivalent. See *Petitions for Special Consideration* above.
2. **For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has been used previously in that term:**
  - Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
  - If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

#### ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

#### COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

#### EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.