



**COURSE OUTLINE**

1. **Course:** PHYS 375, Introduction to Optics and Waves - Fall 2021

Lecture 01: TR 12:30 - 13:45 in EDC 179

Instructor	Email	Phone	Office	Hours
Dr Paul Barclay	pbarclay@ucalgary.ca	403 220-8517	SB 319	Wednesday 1:30 - 2:30 or by appointment

**In Person Delivery Details:**

Labs are an important component of this course and will be conducted in person roughly every second week, as per the posted lab schedule.

Lectures will mainly be delivered in person. The first class will be delivered online. Information about online zoom meeting codes can be found on the class D2L site.

If possible, portions of in-person lectures delivered using a digital whiteboard will be recorded and posted online.

**Re-Entry Protocol for Labs and Classrooms:**

To limit the spread of COVID-19 on campus, the University of Calgary has implemented safety measures to ensure the campus is a safe and welcoming space for students, faculty and staff. The most current safety information for campus can be found [here](#). **Online Delivery Details:**

This course is being offered online in real-time via scheduled meeting times, you are required to be online at the same time.

To help ensure Zoom sessions are private, do not share the Zoom link or password with others, or on any social media platforms. Zoom links and passwords are only intended for students registered in the course. Zoom recordings and materials presented in Zoom, including any teaching materials, must not be shared, distributed or published without the instructor’s permission.

Online lectures will be given during the scheduled class time using Zoom. Links to recordings of the lectures will be made available to all students via D2L.

**Course Site:**

D2L: PHYS 375 L01-(Fall 2021)-Introduction to Optics and Waves

**Note:** Students must use their U of C account for all course correspondence.

2. **Requisites:**

See section [3.5.C](#) in the Faculty of Science section of the online Calendar.

**Prerequisite(s):**

3 units from Physics 211, 221 or 227; and Mathematics 267 or 277.

3. **Grading:**

The University policy on grading and related matters is described in [F.1](#) and [F.2](#) of the online University Calendar.

In determining the overall grade in the course the following weights will be used:

Component(s)	Weighting %	Date
Homework (7-8)	20	Spread out over the semester - more info on D2L
Midterm exams (2)	20	Oct. 19 and Nov. 18, subject to change
Labs	25	
Final exam	35	To be scheduled by the Registrar

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
<b>Minimum % Required</b>	95 %	90 %	85 %	80%	75%	70 %	65 %	60%	55%	50 %	45 %

This course will have a final exam that will be scheduled by the Registrar. [The Final Examination Schedule](#) will be published by the Registrar's Office approximately one month after the start of the term. The final exam for this course will be designed to be completed within 2 hours.

The University of Calgary offers a [flexible grade option](#), Credit Granted (CG) to support student's breadth of learning and student wellness. Faculty units may have additional requirements or restrictions for the use of the CG grade at the faculty, degree or program level. To see the full list of Faculty of Science courses where CG is not eligible, please visit the following website: <https://science.ucalgary.ca/current-students/undergraduate/program-advising/flexible-grading-option-cg-grade>

**4. Missed Components Of Term Work:**

The university has suspended the requirement for students to provide evidence for absences. Please do not attend medical clinics for medical notes or Commissioners for Oaths for statutory declarations.

In the event that a student legitimately fails to submit any online assessment on time (e.g. due to illness etc...), please contact the course coordinator, or the course instructor if this course does not have a coordinator to arrange for a re-adjustment of a submission date. Absences not reported within 48 hours will not be accommodated. If an excused absence is approved, one possible arrangement is that the percentage weight of the legitimately missed assignment could also be pro-rated among the components of the course. This option is at the discretion of the coordinator and may not be a viable option based on the design of this course.

**5. Scheduled Out-of-Class Activities:**

There are no scheduled out of class activities for this course.

**6. Course Materials:**

Required Textbook(s):

Frank L Pedrotti, Leno M Pedrotti, and Leno S Pedrotti, *Introduction to Optics*: Pearson.

In order to successfully engage in their learning experiences at the University of Calgary, students taking online, remote and blended courses are required to have reliable access to the following technology:

- A computer with a supported operating system, as well as the latest security, and malware updates;
- A current and updated web browser;
- Webcam/Camera (built-in or external);
- Microphone and speaker (built-in or external), or headset with microphone;
- Current antivirus and/or firewall software enabled;
- Stable internet connection.

For more information please refer to the UofC [ELearning](#) online website.

**7. Examination Policy:**

Calculator and one page (double sided) formula sheet allowed.

Students should also read the Calendar, [Section G](#), on Examinations.

**8. Approved Mandatory And Optional Course Supplemental Fees:**

There are no mandatory or optional course supplemental fees for this course.

**9. Writing Across The Curriculum Statement:**

For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section [E.2](#) of the University Calendar.

## 10. Human Studies Statement:

Students will not participate as subjects or researchers in human studies.

See also [Section E.5](#) of the University Calendar.

## 11. Reappraisal Of Grades:

A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See [Section I.3](#) of the University Calendar.

- a. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **ten business days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall submit the Reappraisal of Graded Term work form to the department in which the course is offered within 2 business days of receiving the decision from the instructor. The Department will arrange for a reappraisal of the work within the next ten business days. The reappraisal will only be considered if the student provides a detailed rationale that outlines where and for what reason an error is suspected. See sections [I.1](#) and [I.2](#) of the University Calendar
- b. **Final Exam:** The student shall submit the request to Enrolment Services. See [Section I.3](#) of the University Calendar.

## 12. Other Important Information For Students:

- a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370, MacEwan Student Centre, [Mental Health Services Website](#)) and the Campus Mental Health Strategy website ([Mental Health](#)).
- b. **SU Wellness Services:** For more information, see [www.ucalgary.ca/wellnesscentre](http://www.ucalgary.ca/wellnesscentre) or call [403-210-9355](tel:403-210-9355).
- c. **Sexual Violence:** The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email ([svasa@ucalgary.ca](mailto:svasa@ucalgary.ca)) or phone at [403-220-2208](tel:403-220-2208). The complete University of Calgary policy on sexual violence can be viewed at (<https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Sexual-and-Gender-Based-Violence-Policy.pdf>)
- d. **Misconduct:** Academic integrity is the foundation of the development and acquisition of knowledge and is based on values of honesty, trust, responsibility, and respect. We expect members of our community to act with integrity. Research integrity, ethics, and principles of conduct are key to academic integrity. Members of our campus community are required to abide by our institutional [Code of Conduct](#) and promote academic integrity in upholding the University of Calgary's reputation of excellence. Some examples of academic misconduct include but are not limited to: posting course material to online platforms or file sharing without the course instructor's consent; submitting or presenting work as if it were the student's own work; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; borrowing experimental values from others without the instructor's approval; falsification/fabrication of experimental values in a report. Please read the following to inform yourself more on academic integrity:

[Student Handbook on Academic Integrity](#)  
Student Academic Misconduct [Policy](#) and [Procedure](#)  
[Research Integrity Policy](#)

Additional information is available on the [Student Success Centre Academic Integrity page](#)

### e. Academic Accommodation Policy:

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation->

[for-Students-with-Disabilities-Procedure.pdf](#).

Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, by filling out the [Request for Academic Accommodation Form](#) and sending it to Dr. David Feder by email [phas.ahugrd@ucalgary.ca](mailto:phas.ahugrd@ucalgary.ca) preferably 10 business days before the due date of an assessment or scheduled absence.

- f. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see [Legal Services](#) website.
- g. **Student Union Information:** [VP Academic](#), Phone: [403-220-3911](tel:403-220-3911) Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca). SU Faculty Rep., Phone: [403-220-3913](tel:403-220-3913) Email: [sciencerep@su.ucalgary.ca](mailto:sciencerep@su.ucalgary.ca). [Student Ombudsman](#), Email: [ombuds@ucalgary.ca](mailto:ombuds@ucalgary.ca).
- h. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction ([USRI](#)) survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.
- i. **Copyright of Course Materials:** All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of student academic or [non-academic misconduct](#), in addition to any other remedies available at law.

**Expected knowledge and skills of students entering the course:**

Trigonometry, geometry, algebra, basic calculus, and high-school-level physics, basic understanding of data analysis, significant figures, error analysis.

Familiarity with complex analysis, complex numbers, plotting numbers on complex plane.

Basic data plotting tools.

**Course notes**

Notes will be shared using OneNote. All students will receive an invitation to join a shared OneNote notebook, which will be automatically updated with the instructor's material.

**Homework policy**

All homework must be handed in via D2L.

A student's worst homework score will not be counted towards their final grade.

Late homework will not be accepted.

**Midterm information**

The midterms will be conducted during scheduled class time on October 16 and November 18. Should this not be possible due to COVID-19 concerns, an alternative arrangement (online D2L or take-home exam) will be provided.

**Lab schedule**

The laboratory website can be found at <http://www.pjl.ucalgary.ca/> - it includes general information about labs.

Five labs will be conducted in total, following a detailed schedule on the PJJ website. They will be conducted on the following weeks:

Sept. 13 - 17

Oct. 11 - 15

Oct. 25 – 29

Nov. 15 – 19

Nov. 29 – Dec. 3

Note: In observance of the new statutory holiday on Thursday, September 30, labs will not occur on this week.

A student's worst lab score will not be discarded while calculate their final grade.

No make up labs will be accommodated.

## Detailed syllabus

### Week 1

Sept. 7: Why optics, why now? 1-1 – 1-3  
Introduction to light  
Smart phone cameras and LIGO

Sept. 9: Beginning of geometric optics: Fermat's Principle of Least Time.  
Refraction and reflection from a planar surface. Feynman 26-1 – 26-4  
Derivation of refraction using Fermat's Principle.

**Fundamental concepts: optical rays follow a path from A to B which minimizes the optical path length (equivalent to time).**

### Week 2

Sept. 14, 16: Brief introduction to imaging with rays. 2-3 – 2-8  
Basic principle of imaging systems 2-9 – 2-12  
Perfect imaging with a cartesian oval.  
Refraction from a spherical surface via. Fermat's principle  
Paraxial approximation.

**Operational concepts: small angle / paraxial approx /  $\cos(\phi) = 1$**

**Fundamental concepts: imaged rays follow paths of equal optical length, imaged diverging waves have wavefronts delayed by lens thickness, and are converted into converging waves.**

### Week 3:

Sep. 21, 23: Imaging systems.  
Thin lenses. Focal length. Lens maker formula.

**Fundamental concepts: a thin lens images all horizontal rays to the focal point, independent of their lateral height.**

More thin lenses.

Ray diagrams and image formation.

Magnification.

### Week 4:

Sept. 28 Practical aspects of imaging systems. 3-1 – 3-6  
Chromatic and spherical aberrations.  
Microscopes.

**Fundamental concepts: in "real life" a lens images different colors of light slightly differently, and do not behave like perfect thin lenses.**

Matrix methods and paraxial optic 18-1 – 18-11

Matrix basics.

Thick lens.

System ray transfer matrices.

Location of cardinal points.

**Operational concepts: matrix optics is a convenient way of solving thin lenses equations for multi-lens systems.**

Sept. 30: National Day for Truth and Reconciliation (no class)

**Week 5:**

Oct. 5, 7: Introduction to wave optics. Feynman 28 and 29

**Fundamental concepts: Radiation from an oscillating charge, phase, interference and radiation patterns.**

**Week 6:**

Oct. 14: Review of complex numbers.

Oct. 16: Midterm exam #1

**Week 7:**

Oct. 19, 21: Wave equation. Harmonic waves. Travelling waves. 4-1 - 4-9

Plane and spherical waves. Electromagnetic waves revisited.

Irradiance. Power flux.

Superposition of waves 5-1 - 5-6

Superposition of plane waves of same frequency.

Constructive vs. destructive interference.

Superposition of waves of different frequencies.

**Fundamental concepts: constructive vs. destructive interference, amplitude vs. intensity.**

**Operational concept: manipulating complex numbers, representing phase with complex numbers.**

**Week 8:**

Oct. 26, 28: More interference. 7-1 - 7-9

Young's double slit experiment.

Interference in films. Thickness measurement by interference.

Reflection coefficients. Multiple/infinite reflection interference.

**Week 9:**

Nov. 2, 4: Interferometers. 8-1 - 8-7

Michelson, Sagnac and Fabry Perot interferometers.

**Fundamental concepts: wavelength dependence of constructive interference. Intensity build up in cavities.**

**Week 10:**

Nov. 9 - 11: Reading break

**Week 11:**

Nov. 16: Diffraction. 11-1 - 11-4

Diffraction from a single slit. Diffraction from a rectangular aperture.

**Fundamental concepts: scattering from shapes as interference from N waves.**

Nov. 18: Midterm #2

**Week 12:**

Nov. 23, 25: More diffraction. 11-5 - 11-6, 12-1 -12-3

Diffraction from multiple slits.

**Fundamental concepts: diffraction envelope (from single objects) and orders (from multiple identical objects.)**

**Week 13 and 14:**

Nov. 30, Dec. 2, 7: Gratings, lasers, review.

**Course Outcomes:**

- Describe the laws that determine how an optical ray propagates through media of varying refractive index.
- Analyze examples of image formation using ray optics and thin lens theory
- Describe how interference of waves results in variations in optical intensity
- Analyze diffraction a thin slit and other objects using the concept of wave interference

Electronically Approved - Sep 06 2021 08:54

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**Department Approval**

Electronically Approved - Sep 08 2021 08:53

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**Associate Dean's Approval**