Carleton University

Department of Electronics

Winter 2026

ELEC4702: Fiber Optic Communications

Introduction

In this course you will learn about the fundamental components of a fiber optic communications system, and basic optical link/network design. You will also become familiar with important optical measurements through five formal laboratories.

Course Description and Requirements

Course Description: Fundamentals of optoelectronics with application to fiber optic communications. Optical fibre: modes, losses, dispersion, splices and coupling to sources. Optical sources: LEDs and laser diodes. Optical detectors: photoconductor, pin and avalanche photodiodes. Optical receiver design. Fiber optic communications systems: intensity modulation/direct detection; coherent homodyne or heterodyne detection.
Prerequisite(s): ELEC 3908 and ELEC 3909.
Lectures: Tues/Thurs 2:35-3:55 CB 3101
Laboratory and problem analysis: Tues 8:35-11:25 MC 6040

Instructor

Professor: Christopher Smelser
Email: Christopher.Smelser@carleton.ca
Course Webpage: on Brightspace

Textbook: Please include price of required books

1) The textbook (recommended to purchase) is “Optoelectronics & Photonics: Principles & Practices (2nd Edition)” (Prentice-Hall, 2012) by S.O. Kasap.
Price: eBook - $107.99, Print - $90.00 (paperback) $246 (hardcover) (Amazon.ca, Jan. 5, 2026)
2) The lecture material covers most of Chapters 1-5 of the textbook and some additional material on optics and optical networks not in the textbook. Class notes and lab materials will be available in Brightspace and updated over the term.

Lecture Outline

In person, Tues/Thurs 2:35-3:55 CB 3101
The following topics will be covered during the course lectures with an approximate schedule:
Week Topic
1 Introduction
1-3 Basic Optics: ray optics, beam optics, wave optics, EM optics
4-5 Optical Waveguides: dielectric slab waveguides,6-7 Optical Fibres: step-index, graded-index, multimode, single-mode, atenuation, dispersion,
coupling, etc.
8 Optical resonators
9 Basic semiconductor theory: energy band model, review of PN junctions, heterostructures
10-11 Optical Sources: LEDs, light amplification, laser diodes
11-12 Optical Detectors and Receivers: PIN diode, APD, noise, response time, receiver design
13 Photonic Components: MZ modulators, EDFAs, VOAs, PLCs, couplers, optical fibre Bragg gratings

Laboratory and Problem Analysis Sessions

3 hours (alternate weeks with lab 1 starting January 20) in-person in Photonics Lab, MC 6040 as posted on Brightspace

Notes for Labs

- There are five lab experiments.
  There is a prelab on laser safety that includes a quiz in class, which must be completed satisfactorily by each student. This is critical for the in-person lab portion and learning proper safety protocols is a very important part of the course.

  Lab 0 (Prelab) --- Laser Safety
  Lab 1 --- Basic Optics and Properties of a Laser
  Lab 2 --- Optical Fibers
  Lab 3 --- Optical Sources (LEDs and Laser Diodes)
  Lab 4 --- Photodetectors and Optical Receivers
  Lab 5 --- Optical Communication Link

- Be prepared for the lab experiments by reading the lab instructions posted on Brightspace before the beginning of each lab session in the Photonics Lab. Each student must keep his/her own lab notes during the lab and their presence will be checked by the instructor or the TA for the course during the lab period.
- Attend each lab punctually. Absence (without permission of the instructor) means no mark for that lab. If you have a valid reason (medical certificate required) for missing a scheduled lab, the lab must be completed as soon as possible after the scheduled lab period.
- Your eyes will be exposed to potentially harmful laser radiation in the lab. You will be provided with safety goggles. All safety instructions given by the instructor or TA must be observed. Failure to do so will mean

expulsion from the lab and a grade of F in the course.
• Food or drink is not permitted in any lab, especially the Photonics Lab where cleanliness is critically important.
• A lab report in PDF format must be submitted to the Brightspace ELEC4702 lab webpage for each experiment one week after completion of the scheduled lab period. This report should include a cover page including the names of all members of the lab group, the measurement set-up, a clear description of the measurement performed, data, sample calculations, discussion of results, and conclusions. It is not a formal lab report with Purpose, Apparatus, Observations etc., and background theory given in the lab description does not have to be copied over again in the report. A late lab report will be deducted marks at 20% per day up to 3 days. A lab report will not be accepted if it is more than 3 days late.
• ALL LABS MUST BE SUBMITTED TO COMPLETE THE COURSE AND OBTAIN CREDIT. These are individual reports and, except for using common data collected, must be fully prepared by the student submitting the report.

Problem Analysis

Several problems will be assigned every second week on the course Brightspace website to help the student understand the lecture material and prepare for the midterm and final exams. The student's solutions will not be submitted or graded. Solutions will be posted to the Brightspace website.

Self-Declaration form and Deferred Term work

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for submitting a self-declaration form no later than three (3) days after the date/deadline of term work including test/midterm, labs, assignments. Any alternate arrangements made with the instructor for submission of term work should be made as soon as possible but within 3 days of the missed due date. If this is not possible after discussion with the instructor, alternate arrangements must be made before the last day of classes in the term as published in the academic schedule.

Contact the instructor with the completed self-declaration form no later than 3 days after the date/deadline of term work including test/midterm, labs, assignments.

Evaluation and Grading Scheme

The cumulative course grade will be determined as follows:

All 5 lab reports	30%
Midterm examination	20% (in class)
Final examination	50% (officially scheduled during exam period)
Total	100%

To pass the course you need:
Participation in all labs is mandatory. Each student must submit all lab reports.

- A student must receive at least 50% overall and at least 50% on the final exam in order to pass the course.
- The midterm exam is mandatory. If the midterm exam is missed for a medical reason, the midterm weight will be added to the final exam.

Midterm & Final Exams

The midterm exam will be during the lecture period and the final exam will be three hours and officially scheduled in-person. For both exams you will be provided with equation sheets and all other information required for their completion, which will be available on the website prior to the exam.

Calculator Policy

You will require a calculator (programmable calculators will not be allowed) for the midterm and final exam. A "programmable calculator" is defined as a calculator that can store program steps or text at any level of sophistication and the rule applies irrespective of whether or not there appears to be anything stored. If you have any doubts about the eligibility of your calculator, please see me well before the exam.

Website Mark Listings

Marks will be available on the Brightspace course website. Please check your marks online and report any discrepancies immediately. Please note: Near the end of the term, information will be posted on the course website concerning the final opportunity for mark argument/correction. After that □me, the term marks will be closed and there will be no further opportunity for correction or argument. Please monitor the course website for the final deadline.

Final Exam Availability

In keeping with Faculty of Engineering policy, students are not entitled to the results of their final exam, which is considered to serve as an evaluation of performance rather than a pedagogical tool.

Learning Outcomes

Upon successful completion of this course, students will be able to:
1) Identify the main components in an optical communications system.
2) Describe the basic concepts of optical systems and the techniques used to analyse them.
3) Explain the operation and use of optical waveguides.
4) Understand the differences in the various types of fibreoptic waveguides, where they would be used and what properties are important for these uses.
5) Understand the basic operation of semiconductor opto-electronic devices used to convert between optical and electrical signals both from an electrical and optical standpoint.
6) Explain the use of appropriate semiconductor materials for semiconductor opto-electronic components and how such "material engineering" is critical to optimising such devices.

7) Be able to assemble and analyse active and passive components into a point-to-point communications link.
8) Understand the importance of wavelength and coherent multiplexing schemes and in modern fibreoptic communications systems.

Graduate Attributes

The Canadian Engineering Accreditation Board requires graduates of undergraduate engineering programs to possess 12 attributes: Graduate-Attributes.pdf (engineerscanada.ca) or GA's. Courses in all four years of our programs evaluate students' progress towards acquiring these attributes. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate. Accreditation metrics are based on courses common to all students in a program.

This following list provides the GAs that will be measured in this course, along with the indicators that are intended to develop and assess these attributes.

There are no graduate attributes measured for this course.

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity. Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- Any submission prepared in whole or in part, by someone else;
- Using another's data or research findings without appropriate acknowledgment;
- Submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own;
- Failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks; and
- Unless explicitly permitted by the instructor in a specific course, the use of generative AI and similar tools to produce assessed content (such as text, code, equations, images, summaries, videos, etc.).

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: Contact us 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 accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form (click here).

Religious obligation: Contact us 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 click here.

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send us your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, contact us, if needed, to ensure that accommodation arrangements are made.

You should request your academic accommodations in the Ventus Student Portal, for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm.

Please consult the PMC website for the deadline to request accommodations for formally-scheduled exams (if applicable).

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/equity/sexual-assault-support-services

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 will be provided to students who compete or perform at the national or international level. Contact us 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: https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf