

Carleton University
Department of Electronics
Engineering ELEC4702 - Fiber Optic Communications

Course Outline ----- Winter 2022

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.

Instructor

Steven McGarry Room: 5158 ME
 Lab: 5190 ME
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 Course web page: Brightspace

Textbook

The textbook (recommended to purchase) is “Optoelectronics & Photonics: Principles & Practices (2nd Edition)” (Prentice-Hall, 2012) by S.O. Kasap. Class notes and lab materials will be available in Brightspace and updated over the term.

Lecture Outline (Monday and Wednesday 8:35AM-9:55AM, although the intention is to switch to in-person, these will be initially in Brightspace until further notice.)

The prerequisites for this course are basic semiconductor physics as covered in ELEC3908 and basic electromagnetic waves as covered in ELEC3909. The student is expected to have a good knowledge of these subjects. It is also beneficial to have some knowledge of communication systems as would be obtained in SYSC3501. 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. The planned lecture outline is as follows.

<u>Lecture</u>	<u>Topic</u>
1	Introduction
2-5	Basic Optics: ray optics, beam optics, wave optics, EM optics
6-7	Optical Waveguides: dielectric slab waveguides, optical fibers: step-index, graded-index, multimode, single-mode, attenuation, dispersion, coupling, etc.
8	Optical resonators
9	Basic semiconductor theory: energy band model, review of PN junctions, heterostructures
10-12	Optical Sources: LEDs, light amplification, laser diodes, Peltier coolers
13-14	Optical Detectors and Receivers: PIN diode, APD, noise, response time, receiver design
15	Photonic Components: DWDM, VCSELs, MZ modulators, EDFAs, VOAs, PLCs, couplers, optical fibre Bragg gratings

Laboratory (3 hours per lab, alternate weeks, recorded in-lab demonstrations initially and hopefully later in-person in Photonics Lab, MC 6040)

There are five lab experiments.

There is a prelab on laser safety that includes a quiz in Brightspace, which must be completed satisfactorily by each student. Hopefully there will be any in-person lab access later this term, and in any case 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, recorded or 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 if in-person. 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 (if groups are allowed), 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.

Student Responsibilities in the Laboratory (in the event of in-person labs, if possible)

1) 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.

2) 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.

3) Food or drink is not permitted in any lab, especially the Photonics Lab where cleanliness is critically important.

Problems

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.

Course Grade

The final grade will be determined using the following weighting.

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

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. 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, these are planned to be in-person if circumstances permit but they may be on-line if not. 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

For in-person examinations programmable calculators will not be allowed in the midterm or 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.

In the event of on-line examinations, as the access to calculating facilities is difficult to control the exams will be set such that having access to advanced features should not provide any advantage.

In either case you will be required to calculate numerical results during the examinations so it is recommended that you have access to a tool that you can use to efficiently perform such calculations.

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 time, 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.

Academic Integrity

Plagiarism is a serious instructional offense that will not be tolerated. It involves passing off someone else’s original work as your own. Most cases of plagiarism can be avoided by carefully citing sources for any ideas, statements, results etc. that are not your own. Please refer to the section on instructional offenses in the Undergraduate Calendar for additional information. The Universities academic integrity policy webpage can be found at: <https://carleton.ca/registrar/academic-integrity/>

Academic Accommodation

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

Pregnancy obligation: write to 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 visit the Equity Services website: <http://www.carleton.ca/equity/>

Religious obligation: write to 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 visit the Equity Services website: <http://www.carleton.ca/equity/>

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 me 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, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (*if applicable*) at <https://carleton.ca/pmc/>. You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://www.carleton.ca/equity/>

Use of Course Materials

Classroom teaching and learning activities, including lectures, discussions, presentations, etc., by both instructors and students, are copy protected and remain the intellectual property of their respective author(s). All course materials, including PowerPoint presentations, outlines, and other materials, are also protected by copyright and remain the intellectual property of their respective author(s). Students registered in the course may take notes and make copies of course materials for their own educational use only. Students are not permitted to reproduce or distribute lecture notes and course materials publicly for commercial or non-commercial purposes without express written consent from the copyright holder(s).