

ELEC ENG 4EM4 **Photonic Devices and Systems**

COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

Fundamentals of light. Optical fibers and their propagation characteristics. Lasers and photodiodes. Optical amplifiers and modulators. Photonic networks.

Three lectures, one tutorial and one lab every other week.

PRE-REQUISITES AND ANTI-REQUISITES

Pre-requisite(s): ELECENG 3EJ4; or ENGPHYS 3BA3 and ENGPHYS 3BB3

Anti-requisite(s): ENGPHYS 4K03

SCHEDULE and MODE OF DELIVERY

The material for this course will be delivered through a mixture of in person lectures, tutorials, laboratories, and textbook readings. The platform and schedule for each component is as follows:

Lecture: Mondays and Thursdays, 9:30 am – 10:20 am, and Tuesdays, 10:30 am – 11:20 am.

Tutorial: Mondays 1:30pm – 2:20pm

Lab: (*Every Other Week*): The first lab starts on Monday, January 22, 2024, from the odd groups (i.e., L01, L03, ...).

| | | | |
|----------------|---------------|----------------|---------------|
| L01 Mondays | 14:30 – 17:20 | L02 Mondays | 14:30 – 17:20 |
| L03 Tuesdays | 14:30 – 17:20 | L04 Tuesdays | 14:30 – 17:20 |
| L05 Wednesdays | 14:30 – 17:20 | L06 Wednesdays | 14:30 – 17:20 |
| L07 Thursdays | 14:30 – 17:20 | L08 Thursdays | 14:30 – 17:20 |
| L09 Fridays | 14:30 – 17:20 | L10 Fridays | 14:30 – 17:20 |
| L11 Wednesdays | 18:00 – 21:00 | | |

INSTRUCTOR

Dr. Telex M. N. Ngatchet
 Email: ngatchet@mcmaster.ca
 Office: ITB-110
 Phone: 905-525-9140 ext. 21238
 Office Hours: Tuesdays & Wednesdays 1:30 pm-3:00pm, and by appointment.

TEACHING ASSISTANTS

Names, contact information, and office hours are provided on the course website

COURSE WEBSITE/s

<http://avenue.mcmaster.ca>

COURSE OBJECTIVES

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

- develop knowledge on operating principles of photonic devices and optical fibers,
- design methodologies and analyzing techniques of lightwave communication systems,
- model simple fiber optic communication systems,
- gain hands-on experience on fiber-splicing and fiber optic systems design.

CEAB GRADUATE ATTRIBUTES (GAs)

Note: The CEAB Graduate Attributes (GAs) defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: <http://www.engineerscanada.ca>

| Attributes | Indicators | | Measurement Method(s) |
|--------------------------------|------------|--|--|
| | Number | Description | |
| Knowledge Base for Engineering | 1.4 | Basic understanding of light propagation and interaction in photonic devices | Questions in the lab reports and mid-term exam |
| Use of Engineering tools | 5.1 | Evaluates engineering tools | Questions in the lab 2 report |

| Attributes | Indicators | | Measurement Method(s) |
|------------------|------------|--|--------------------------------|
| | Number | Description | |
| Investigation | 3.2 | Capable of selecting appropriate model and methods to model/design fiber optic systems | Questions in the final exam |
| Problem Analysis | 2.2 | Propose problem solution supported by reasoning | Questions in the mid-term exam |
| Design | 4.1 | Define problems based on constraints | Questions in the final exam |

ASSUMED KNOWLEDGE

Electromagnetics; Signals and systems; Communication systems; Electronic circuits

COURSE MATERIALS

Required Texts:

“Fiber-Optic Communications: Fundamentals and Applications”, S. Kumar and M.J. Deen, John Wiley and Sons, 2014, available at the [Campus Store](#)

Calculator:

Only the McMaster Standard Calculator (Casio fx-991 MS or MS Plus) is permitted in tests and examinations. This is available at the [Campus Store](#)

Other:

Lecture notes and lab manuals

COURSE OVERVIEW

| Week | Topic | Readings |
|------|--|---------------|
| 1 | Review of electromagnetics | Lecture notes |
| 2 | Basics of optics | Lecture notes |
| 3 | Optical Fibers - single-mode and multi-mode fibers | Lecture notes |
| 4 | Optical Fibers – fiber dispersion Uniform Plane wave | |
| 5 | Optical Sources – basic concepts | Lecture notes |

| | | |
|----|--|---------------|
| 6 | Optical Sources – semiconductor lasers Phase speed and group speed | Lecture notes |
| 7 | Optical Receivers – Photodetectors | Lecture notes |
| 8 | Optical Receivers – Receiver Design | Lecture notes |
| 9 | Optical Transmission System Design – modulation formats | Lecture notes |
| 10 | Optical Transmission System Design – performance evaluation | Lecture notes |
| 11 | Wavelength division multiplexing | Lecture notes |
| 12 | Review | Lecture notes |

At certain points in the course, it may make good sense to modify the schedule. The Instructor may modify elements of the course and will notify students accordingly (in class and on the course website).

LABORATORY OVERVIEW

Labs are NOT held during the first week of term.

| Date/Week | Topic | Readings |
|-----------|--|-----------------|
| Week 1 | Lab introduction and familiarization with the labkit | Lab volt manual |
| Week 2 | Optical Fibers | Lab volt manual |
| Week 3 | Optical Transmitters | Lab volt manual |
| Week 4 | Optical Transmission Systems | Lab volt manual |

LABORATORY OPERATION

- Each student in the course is required to pass the lab safety quiz prior to attempting any of the laboratories. The quiz will be available on Avenue to Learn.
- Access to all labs is restricted in the interest of security and safety. Information on accessing and using the lab can be found on the webpage:
<https://www.eng.mcmaster.ca/ece/labs-and-health-safety/#tab-content-labs-access-and-use>
- **Lab Requirements:**
 - Every student conducts the lab work individually; even group discussion is encouraged.
 - Students need to submit their experiment results on Avenue to Learn individually on the due date described in the lab manual. **No late submission will be accepted.**
 - MSAF transfers the weight of missed lab work to that of the final exam.

ASSESSMENT

| Component | Weight |
|-------------------|--------|
| Labs (4) | 20 % |
| Quiz (3) | 20 % |
| Mid-term Exam (1) | 20 % |
| Final Exam (1) | 40 % |
| Total | 100 % |

Grading and Evaluation Policies

- There are four (4) labs -worth 20%, three (3) quizzes conducted during the tutorials - worth 20%, one (1) mid-term exam -worth 20%, and one (1) final exam -worth 40%, to be evaluated in this course. The final exam will test cumulative knowledge.
- All grades are final unless error(s) in marking is proven.
- No make-up/deferred quizzes and mid-term will be granted; Late assignments will be given Zero; Bell curving will not be applied.
- Use of books, notes, other copied materials, computers or cell phones are not allowed during exams.
- Every exam counts. There is no policy for poor mid-term exam marks to be replaced by better final exams (or vice versa).
- MSAF transfers the weight of a missed mid-term exam to that of the final exam.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. The 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, located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained.

- improper collaboration in group work.
- 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., online search, other software, etc.). For more details about McMaster's use of Turnitin.com, please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ONLINE ELEMENT

Some courses may use online elements (e.g., email, 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 email 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 online 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.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

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.

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 ACCOMMODATIONS

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

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.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK

McMaster Student Absence Form (MSAF): 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".

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.

www.eng.mcmaster.ca/ece

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory and online <https://hr.mcmaster.ca/app/uploads/2019/07/2019-McMaster-Lab-Manual.pdf>

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe conditions.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and the sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.
9. Personal ergonomics should be practiced when conducting lab work. <https://bit.ly/3fOE71E>
10. Current University health and safety issues and protocol should be known.
<https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/>

Location of Safety Equipment

| | |
|---|---|
| Fire Extinguisher On walls in halls outside of labs | First Aid Kit ITB A111, or dial "88" after 4:30 p.m. |
| Telephone On the wall of every lab near the door | Fire Alarm Pulls Near all building exit doors on all floors |

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the ECE laboratories, please contact 24103.

In Case of a Fire (On Campus Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In power labs, press the wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol For Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

| | | |
|-----------------------|--|--|
| TA | The first point of contact for lab supervision | |
| ECE Lab Supervisor | Steve Spencer - ITB 147 | steve@mail.ece.mcmaster.ca |
| ECE Chair | Mohamed Bakr - ITB A111 | mbakr@mcmaster.ca |
| ECE Administrator | Shelby Gaudrault - ITB A111 | gaudraus@mcmaster.ca |
| ECE Course Instructor | Telex M. Ngatchet - ITB 110 | ngatchet@mcmaster.ca |