ECE 754
Modelling and Simulation of Photonic Devices

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR DESCRIPTION

Photonic devices are key components to lightwave generation, amplification, transmission, and detection in many application systems. Photonic devices that utilize primarily photons, in conjunction with electrons can offer a tremendous bandwidth in these applications, especially in broadband communication systems and networks. This course focuses on the modeling of various passive, active, and functional photonic devices through numerical approaches, simulation of device terminal performances through mixed analytical and numerical methods, and extraction of device behavior models.

SCHEDULE And MODE OF DELIVERY

McMaster expects to be fully in-person in the 2023/24 academic year.
Please check with instructor and/or Avenue to Learn for Schedule and Mode of Delivery.

This course has no labs.

INSTRUCTOR

Dr. Xun Li
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Office: ITB-A313
Phone: 905-525-9140 ext. 27698
Office Hours**:** Wednesdays 6:00 PM – 8:00 PM or by appointment

COURSE WEBSITE/S

http://avenue.mcmaster.ca/

COURSE OBJECTIVES

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

1. Gain in-depth understandings on optical waveguides and waveguide-based photonic devices, understand the working principle of and physical processes in photonic devices for optical communication systems.

2. Know how to describe photonic devices by physics based first-principle governing equations and know how to solve these equations through numerical methods.

3. Know how to model photonic devices to obtain their simulated performance.

ASSUMED KNOWLEDGE

Mathematics: Complex variables and functions; Differentiation and integration over multiple variables; Ordinary and partial differential equations; Linear algebra and matrix theory

Physics: Classical electrodynamics, Quantum mechanics, Solid-state physics, Semiconductor physics

Electrical Engineering: Steady-state (DC) and transient (AC) analyses; Time- and frequency-domain analyses, Fourier transforms

COURSE MATERIALS

Textbooks:
Lecture notes will be offered, no textbook

Reference books:
1. Physics of Photonic Devices, 2nd Edition, by S. L. Chuang, Wiley Inter-Science, ISBN9780470293195
2. Optoelectronic Devices - Design, Modeling, and Simulation, by X. Li, Cambridge University Press, ISBN9780521875103

COURSE OVERVIEW

Week	Topic
1	Introduction to photonic device modeling
2	Optical wave propagation
3	Optical wave propagation (continued)
4	Material optical property
5	Material optical property (continued)
6	Numerical solution techniques
7	Numerical solution techniques (continued)
8	Numerical solution techniques (continued)
9	Numerical solution techniques (continued)

10	Selected photonic device modeling and simulation examples: semiconductor lasers
11	Semiconductor optical amplifiers and super-luminescent light emitting diodes
12	Electro-absorption modulators
13	Photodetectors

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, on the course website).

ASSESSMENT

Component	Weight	Due Date
Mid Term Minor Project	50%	
Final Major Project	50%	
Total	100%	

Late submissions of project report are subject to 10% penalty per day (less than one day is counted as one day).

CONDUCT EXPECTATIONS

As a McMaster graduate 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.

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.

ACADEMIC ACCOMMODATIONS 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 to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

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.

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.

RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.

www.eng.mcmaster.ca/ece