UNIVERSITY OF MARYLAND

Course Information

Course Title: Introduction to Photonics
Course Number: 692
Term: *Spring 2021*
Credits: 3
Course Dates: From Jan 24, 2021 to May 10, 2021
Course Times: MW: 11:00am – 12:15pm

Professor Mario Dagenais
Pronouns: He, him, his
Office Phone: 301-405-3684
Email: dage@umd.edu
Office Hours: MW: 5:00pm – 6:00pm
Classroom: on-line

Course Description

Introduction to photonic concepts and applications. In particular, high quality factor optical resonators, photonic crystals, microresonators, statistical and photon optics, spontaneous and stimulated emission, semiconductor lasers and detectors, modulators and optical switches are discussed. Finally, the concept of photons and the quantum states of light are presented.

Prerequisites

ENEE 380 and ENEE 381, or students who have taken courses with comparable content may contact the department.

Course Objectives

After successfully completing this course you will be able to understand:

- Propagation, interference and coherent properties of optical beams,
- Optical resonators used to enhance the optical field,
- Photon streams and quantum states of light,
- Spontaneous and stimulated emission of light,
- Operation of semiconductor lasers, detectors, modulators and photonic switches.

Required Resources

- Course Website: elms.umd.edu
- Book: Fundamentals of Photonics, 2 Volume Set, B. E. A. Saleh and M.C. Teich, 3rd edition, Wiley 2019, pp. 1520.
- Additional/reference book: "Photonics: Optical Electronics in Modern Optics", A. Yariv and P. Yeh, 6th Edition, Oxford.

Course Structure

This course has two weekly on-line classes. The flexible framework does not require you to be in a specific location to participate; however, you must have access to a full-screen computer or tablet for on-line participation. The online nature of this class will push you to take an active role in the learning process. You will do this by engaging with the instructor and asking questions during the weekly classes, and by working with 1-2 other students on a scholarly presentation at the end of the semester.

Tips for Success in an Online Course

1. **Participate.** Discussions and small group work are a critical part of the course. You can learn a great deal from discussing ideas and perspectives with your peers and professor. Participation can also help you articulate your thoughts and develop critical thinking skills.
2. **Manage your time.** Make time for your online learning and participation in discussions each week. Give yourself plenty of time to complete assignments including extra time to handle any technology related problems.
3. **Login regularly.** Log in to ELMS-Canvas several times a week to view announcements.
4. **Do not fall behind.** This class moves at a quick pace and each week builds on the previous. It will be hard to keep up with the course content if you fall behind in the pre-work or post-work.
5. **Use ELMS-Canvas notification settings.** Canvas ELMS-Canvas can ensure you receive timely notifications in your email or via text. Be sure to enable announcements to be sent instantly or daily.
6. **Ask for help if needed.** If you need help with ELMS-Canvas or other technology, IT Support. If you are struggling with a course concept, reach out to me, and your classmates, for support.

Campus Policies

It is our shared responsibility to know and abide by the University of Maryland's policies that relate to all courses, which include topics like:

- Academic integrity
- Student and instructor conduct
- Accessibility and accommodations
- Attendance and excused absences
- Grades and appeals
- Copyright and intellectual property

Please visit www.ugst.umd.edu/courserelatedpolicies.html for full list of campus-wide policies and follow up with me if you have questions.

Course Guidelines

Academic Integrity

For this class, it is expected that your scholarly paper will be based on your own review of papers accessed via the web and will reflect the integrity of the student work.

Names/Pronouns and Self-Identifications

The University of Maryland recognizes the importance of a diverse student body, and we are committed to fostering inclusive and equitable classroom environments.

Communication with Instructor:

Email: If you need to reach out and communicate with me, please email me at dage@umd.edu. Please DO NOT email me with questions that are easily found in the syllabus or on ELMS (i.e. When is this

assignment due? How much is it worth? etc.) but please DO reach out about personal, academic, and intellectual concerns/questions. I will do my best to respond to emails within 24 hours.

ELMS: I will send IMPORTANT announcements via ELMS messaging. You must make sure that your email & announcement notifications (including changes in assignments and/or due dates) are enabled in ELMS so you do not miss any messages. You are responsible for checking your email and Canvas/ELMS inbox with regular frequency.

Topics covered in this class

1. Wave Optics **(**Saleh & Teich: Chapter 2)

- Monochromatic waves
- Interference
- Polychromatic and pulsed light

2. Gaussian Beam (Saleh & Teich: Chapter 3)
- Gaussian beam
- Transmission through optical components
- Hermite-Gaussian beams
- Laguerre-Gaussian and Bessel beams

3. Photonic Crystal Optics (Saleh & Teich: Chapter 7)
- Optics of dielectric layered media: matrix theory, Fabry-Perot etalon, Bragg grating
- One-dimensional photonic crystals and Bragg modes
- Two- and three-dimensional photonic crystals

4. Resonator Optics (Saleh & Teich: Chapter 10)
- high quality factor resonators, Purcell factor
- Planar-mirror resonators
- Spherical mirror resonators
- Two- and three-dimensional resonators: whispering-gallery modes, micropillar, microdisk and microtoroid microresonators, microsphere microcavities, photonic crystal microcavities.

5. Statistical Optics (Saleh & Teich: Chapter 11)
- Statistical properties of random light: temporal, spatial and longitudinal coherence
- Interference of partially coherent light
- Transmission of partially coherent light through optical systems
- Partial polarization

6. Photon Optics (Saleh & Teich: Chapter 12)
- The photon
- Photon streams: photon-number statistics

• Quantum states of light: coherent light, squeezed-state light, photon antibunching, photons on a beam splitter (Hong-Ou-Mandel)

7. Photons and Atoms (Saleh & Teich: Chapter 13)
• Energy levels
• Interaction of photon with atoms: spontaneous and stimulated emission, absorption, enhanced spontaneous emission and Purcell factor.
• Thermal light
• Luminescence and scattering

8. Semiconductor Lasers and Detectors (Saleh & Teich: Chapters 16, 17,)
• Semiconductors and p-n junctions
• Semiconductor lasers
• Detectors: p-i-n, APDs and single-photon detectors, noise in detection

9. Modulators and Photonic Switches **(**Saleh & Teich: Chapters 20 and 23)
• Principles of electro-optics
• Electroabsorption
• Modulators: phase and intensity modulators using an interferometer, directional modulators
• Liquid crystal modulators and displays
• Optical interconnects: one-to-one, one-to-many, nonreciprocal interconnects
• Active and passive routers: add-drop multiplexers, Mach-Zehnder interferometers, arrayed waveguide gratings
• Optical switches

Major Assignments and Grading

Homework Assignments

- Homework assignments will be posted on Elm every 7-10 days. The purpose of these assignments is to verify your understanding of the class material. You will be given one week to submit your assignments. The assignments will count for 20% of the grade.

Participation & Engagement

- 10% of your grade will be based on your attendance and participation in the class.

Mid-Term Exam

- There will be a mid-term exam to evaluate your understanding of the concepts introduced in class. The mid-term exam will count for 20% of the grade.

Scholarly Team Project

- Toward the end of the semester, you will be asked to make a scholarly team presentation on a topic chosen from a proposed list of topics relevant to the class. The team will be made up of 1 or 2 other classmates. The scholarly paper will count for 20% of the grade

Final Exam

- There will be a final exam to evaluate your understanding of the concepts introduced in class. The final exam will be inclusive and will count for 30% of the grade.

On each exam or assignment you must write out and sign the following pledge:

"I pledge on my honor that I have not given or received any unauthorized assistance on this exam/assignment."

If you are ever unsure about acceptable levels of collaboration, please ask!

Grades

- The final letter grades will be based on your performance compared to your peers. The best students will receive an A grade. If your level of understanding and performance is below, or is average, as compared to your peers, you will receive a B grade. If your performance is way below the performance of your peers, you will receive a C grade or a Fail grade.

All assessment scores will be posted on the course ELMS page.

Late work will not be accepted for course credit so please plan to have it submitted well before the scheduled deadline.

Resources & Accommodations

Accessibility and Disability Services

The University of Maryland is committed to creating and maintaining a welcoming and inclusive educational, working, and living environment for people of all abilities. The University of Maryland is also committed to the principle that no qualified individual with a disability shall, on the basis of disability, be excluded from participation in or be denied the benefits of the services, programs, or activities of the University, or be subjected to discrimination. The **Accessibility & Disability Service (ADS)** provides reasonable accommodations to qualified individuals to provide equal access to services, programs and activities. ADS cannot assist retroactively, so it is generally best to request accommodations several weeks before the semester begins or as soon as a disability becomes known. Any student who needs accommodations should contact me as soon as possible so that I have sufficient time to make arrangements.

For assistance in obtaining an accommodation, contact Accessibility and Disability Service at 301-314-7682, or email them at **adsfrontdesk@umd.edu**. Information about **sharing your accommodations with instructors**, **note taking assistance** and more is available from the **Counseling Center**.

Technology Policy

Please refrain from using cellphones during class sessions.

Participation

- Students with a legitimate reason to miss a live session should communicate in advance with the instructor, except in the case of an emergency.
- Students who miss a live session are responsible for learning what they miss from that session.

- Additionally, students must complete all readings and assignments in a timely manner in order to fully participate in class.

Course Evaluation

Please submit a course evaluation through CourseEvalUM in order to help faculty and administrators improve teaching and learning at Maryland. All information submitted to CourseEvalUM is confidential. Campus will notify you when CourseEvalUM is open for you to complete your evaluations for fall semester courses. Please go directly to the **Course Eval UM website** to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing through Testudo, the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.

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