Master Course Description – EE 487/587

Title: Introduction to Photonics

Credits: 4

UW Course Catalog Description

Introduction to optical principles and phenomena. Topics include electromagnetic theory of light, optical interference, diffraction, polarization, optical waveguides, and optical fibers.

Coordinator: Lih Y. Lin, Professor of Electrical and Computer Engineering

Potential Instructors for this course: Prof. Lih Y. Lin, Prof. Mo Li, Prof. Arka Majumdar

Goals: To acquaint students with vocabulary, major principles, and phenomena of modern optics and photonics. To prepare students for advanced courses in the field of photonics.

Learning Objectives:

At the end of this course, students will be able to:

1. Explain concepts in electromagnetic theory that are relevant to the behavior of light.
2. Apply major concepts of electromagnetic theory to the behavior of light.
3. Describe basic light propagation in free space and materials.
4. Apply polarization to the treatment of light.
5. Formulate and derive equations for interference and diffraction of light.
6. Explain phenomena of interference and diffraction.
7. Analyze optical waveguide structures.
8. Design an optical waveguide structure or other photonic system.

Textbook:


Reference Texts:


Prerequisites by Topic:
1. Basic principles of electromagnetism (PHYS 123, EE 361, or Equivalent)
2. Complex numbers and functions
3. Introductory differential and integral calculus, linear differential equations

**Prerequisites by Course:**

E E 361; either MATH 207 or MATH 307; either MATH 208 or MATH 308; either PHYS 123 or PHYS 143

**Topics:**

1. **Electromagnetic theory of light:** Optical wave functions, wave equations, Maxwell’s equations in media, optical power and energy.
2. **Polarization:** Jones vectors and Jones matrices, reflection and refraction at dielectric interfaces, polarization devices.
3. **Interference:** Principle of superposition and interference, two-beam interference and interferometry, multi-wave interference, Fabry-Perot interferometer, group/phase velocity and dispersion.
4. **Diffraction:** Fraunhofer diffraction, diffraction grating, Fresnel diffraction.
5. **Optical waveguides:** Total internal reflection, different waveguide structures, modes in optical waveguides, effective index, modal dispersion, applications in optical fibers.

**Course Structure:** Class meets for two lectures a week, each consisting of a 100 minute session with 10 minute break in between. Homework is assigned for each topic. There is a midterm exam and a final project.

**Grading:** Homework (40%), midterm exam (30%), final project (30%).

**Distinguishing Graduate and Undergraduate Components:** All students are asked to design and model an optical waveguide. The design goals for undergraduate students include determining the effective index and electric-field mode profile of a one-dimensional waveguides. The design goals for graduate students include determining the effective index and electric-field mode profile of a two-dimensional waveguides. Additional homework problems with higher difficulty will be assigned for graduate students.

**Computer Resources:** Mathematical programming software such as Matlab, Mathcad, or Mathematica will be useful for some of the homework problems and the final project.

**Laboratory Resources:** Not required.

**Outcome Coverage:**

(1) **Problems:** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. The course applies knowledge of
physics and mathematics to description and analysis of optical phenomena, devices and systems. Electromagnetic theory and optics formalisms are used throughout the course. Relevance: High.

(7) Learning: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies. To solve problems in photonics requires the ability to acquire and apply new knowledge, tools and learning strategies in engineering, physics and math. Relevance: Medium.

Preparers: Lih Y. Lin