TO: The Faculty of the College of Engineering

FROM: Elmore Family School of Electrical and Computer Engineering

RE: New Graduate Course, ECE 60431 Fiber Optics Communications

The faculty of the School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 60431 Fiber Optics Communications
Sem. 2 Lecture 1, Cr. 1.
Restrictions: Concurrent registration for ECE 60400

Description: This course will aim to introduce students to the fundamentals of fiber optic communications, which constitute the backbone of the internet. The course will start with a refresher on the operation of key components needed for an effective fiber optic communication system, and then show how these components interact at a system level. Finally, the course will conclude with outlook for future research in extending the capabilities of these networks to higher bandwidths and quantum-secured communications.

Reason: This course will provide students with a refresher of the key components of a fiber optic communication network, and show how they integrate together at a system level. As such, it is critical that students complete their full undergraduate degree before taking this course – hence the choice of a 695-level course.

Milind Kulkarni,
Associate Head for Teaching and Learning
Elmore Family School of Electrical and Computer Engineering

Course History: Spring 2020 – 4, Spring 2019 - 2

Syllabus

ECE 695: Fiber Optic Communications

Spring 2019: MWF 11:30-12:20 pm in EE 226

Instructor: Peter Bermel <pbermel@purdue.edu>

Office Hours: In EE 332 when our class meets: 3:20-4:30 pm MWF (or email for another time)

In addition to office hours, students are encouraged to make use of the following online resources:

- ECE 695 – Fiber Optic Communications -- Primary Course Page (this page)
- ECE 695 Blackboard website (for non-public information, such as grades and homework)

The primary course textbook is *Fiber-optic communication systems (4th Edition)* by Govind P. Agrawal.

Course Description:

This course will aim to introduce students to the fundamentals of fiber optic communications, which constitute the backbone of the internet. The course will start with a refresher on the operation of key components needed for an effective fiber optic communication system, and then show how these components interact at a system level. Finally, the course will conclude with outlook for future research in extending the capabilities of these networks to higher bandwidths and quantum-secured communications.

Lecture Format:

Students are expected to read assigned material prior to class. Class periods will be devoted to providing an overview of the assigned reading topics, and providing an opportunity for relevant discussions.

Class Schedule:

We will meet Mondays, Wednesdays, and Fridays at 11:30 am in EE 226. Our first class will be on Monday, January 7, 2019, and our last will be on Friday, February 8, 2019. The only exception will be January 21 (Martin Luther King Day).

Grading:

Your course grade will be based on a total of 300 points from quizzes. Up to 50 extra points can also be earned from attendance and extra credit assignments. Your course grade will be calculated by dividing your total by 400, and assigning letter grades on a 10-point scale.

Each quiz will be worth 100 points, and your lowest grade will be dropped. However, if you miss an quiz without a valid reason, it will be averaged into your final grade as a zero. If your quiz averages are lower than the target average, they will be curved at the discretion of the instructor.

Quiz Schedule:

Quiz 1	Wednesday, January 16, 2019
Quiz 2	Wednesday, January 23, 2019
Quiz 3	Wednesday, January 30, 2019
Quiz 4	Wednesday, February 6, 2019

Quizzes are closed book, but a formula sheet will be provided. You should bring a calculator to each quiz. Following ECE policy, your calculator **must** be a Texas Instruments TI-30X IIS scientific calculator.

Make-up Quiz Policy:

There will be NO written make-up quizzes. If you have a good excuse for missing a quiz, you will either be given an oral quiz, or your missed quiz will be dropped without penalty.

Academic Dishonesty:

Any case of academic dishonesty will result in a grade of F in this course.

Campus Closing/Disruption of Classes:

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or

other circumstances. In such an event, information will be posted on the course webpage or emailed to you by the instructor.

Class Attendance:

Your class attendance is important. If you must miss class, you are responsible for any material, information, handouts, announcements, etc. you missed. If you are not in class and have someone else sign the attendence sheet for you, you will both receive an F for the class. Attending class is the only way to earn extra credit for attendance.

Course Outline

Week	Topics	Agrawal
1	Optical fibers: wave propagation, dispersion, and loss	Chapters 1 & 2
2	Optical transmitters and receivers: materials, sources, modulation, speed limitations	Chapters 3 & 4
3	Fundamental concepts in optical communication networks: power, noise, and speed	Sections 5.1, 5.2, 6.1, 6.4
4	Current optical communication network architectures: TDM, DWDM, QPSK, QAM	Chapter 8, Section 10.2
5	Future optical networks: fiber-to-the-home, data centers, quantum key distribution	Chapter 9

Please come to class on-time!

Class announcements may supersede prior written information

Learning objectives for Fiber Optic Communications.

After completing this course, you will be able to:

Week 1 - Optic Fibers

- Obj 1.1: Calculate the number of optical modes supported by a given fiber
- Obj 1.2: Calculate the field profile associated with the LP_{01} mode
- Obj 1.3: Calculate the photon emission rate of an LED for a given input current

Week 2 - Optical Transmitters and Receivers

- Obj. 2.1: Calculate the threshold power required for a generic 4-level laser to initiate lasing

- Obj. 2.2: List the conditions under which a semiconductor heterojunction can initiate lasing
- Obj. 2.3: Calculate the benefit of quantum confinement in reducing the lasing threshold for semiconductor lasers

Week 3 - Fundamental Concepts in Optical Communication Networks

- Obj. 3.1: Calculate the bandwidth limit for optical telecommunications
- Obj. 3.2: Describe the requirements for an optical amplifier in an optical communications network
- Obj. 3.3: List two physical effects that can provide sufficient amplifications for potential use in an optical communications network

Week 4 - Current Optical Communications Network Architectures

- Obj. 4.1: Describe the difference between wavelength division multiplexing, code division multiplexing, and time division multiplexing
- Obj. 4.2: Calculate the relative information density of phase-shift keying versus frequency-shift keying
- Obj. 4.3: Describe the typical architecture of a hybrid packet and optical communications network

Week 5 - Future Optical Networks

- Obj. 5.1: Describe what a soliton is and how it might benefit optical communications
- Obj. 5.2: Explain the benefits and drawbacks of on-chip optical interconnects compared to electrical interconnects
- Obj. 5.3: Describe the fundamental challenges of building a quantum communications network.