ECE 5411: Optical Communication Systems

Credits and Contact Hours: 3.0 Credit Hours
15 weeks: Three 50-minute lectures per week + three 3-hour labs

Instructor’s Name: Steve Blair

Text Book(s) and/or Required Material:

Catalog Description: Systematic study of modern optical-fiber communication systems; Loss-limited systems vs. dispersion-limited systems; Point-to-point links, broadcast and distribution systems, and optical networks; Wavelength-division multiplexing (WDM) and sub-carrier multiplexing (SCM); optical amplifiers and dispersion compensation; Emphasis is on system design. Includes hands-on laboratory experience.

Prerequisites:
- C- or better in ECE 3300: Fundamentals of Electromagnetics and Transmission Lines; and
- Full major status in Computer Engineering

Designation: Elective

Contribution of Course to Meeting the Requirements of ABET Criterion 5: This course teaches electrical engineering science and electrical engineering design.

Specific Outcomes of Instruction: In this course, students will be prepared to:
1. Understand the basics of modern communication systems
2. Understand guided wave propagation through optical fibers
3. Differentiate between time-division multiplexing and wavelength-division multiplexing
4. Understand the characteristics of laser diodes, photodetectors, modulators, and optical amplifiers
5. Analyze the noise performance of an optical system
6. Analyze the bit-error-rate of a digital communications system, including implications of system design choices

Relationship of the Course to the Program Outcomes:
(a) An ability to apply knowledge of mathematics, science, and engineering. The course content presents many opportunities for students to apply fundamental concepts learned earlier, including electromagnetic theory for the analysis of optical fiber, basic probability for the analysis of error performance, basic digital communications for analysis and design of modulation and optical and electrical filters. Students apply this knowledge especially in the solution of the homework problems.

(b) An ability to design and conduct experiments, to analyze and interpret data, and to debug and analyze software. All laboratory exercises require that data be collected, interpreted, and presented in a report.
(c) An ability to design a system, component, process or software package to meet desired needs. System design is covered extensively in lectures, homework, and laboratory exercises. Specific emphasis is placed upon optical link design and performance and single- and multiple-channel network design.

(g) An ability to communicate effectively in written and oral form. The results of the labs are submitted in written form. A final project is communicated in oral presentation format.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. All laboratory exercises require the use of state-of-the-art optical instrumentation, such as high-speed bit-error-rate testers, fiber fusion splicers, optical time-domain reflectometer, tunable lasers, optical spectrum analyzer, optical amplifier, and WDM components.

Topics Covered in the Course:

- Fiber optics: Fiber modes; attenuation; modal, chromatic, and polarization mode dispersions; self- and cross-phase modulation; four-way mixing; fiber splicing; connectors
- Transmitters: Lasers, LEDs, spectral linewidth, modulation, noise, transmitter module design, external modulators
- Receivers: Photodetectors, receiver shot and thermal noise, bit-error rate, sources of power penalty
- DWDM Systems: Wavelength multiplexing, WDM networks, WDN components (multiplexors, demultiplexors, tunable filters)
- OTDM Systems: Optical time division multiplexing, OTDM networks, OTDM components
- Amplifiers: Semiconductor amplifiers, erbium-doped fiber amplifiers, systems applications, span design