ECE 565
Optical Communication Components and Sub-Systems
Spring 2018

Course objective: To develop a practical understanding of the components and techniques used in current optical communication systems and to have an analytical understanding of their capabilities and limitations.

Course Description: Optical waveguides, Optical Fiber attenuation and dispersion, Power Launching and Coupling of light, Mechanical and fiber lifetime issues, Photoreceivers, Digital On-Off Keying, modulation methods, SNR and BER, QAM and M-QAM, modulation methods, SNR, and BER, Intersymbol Interference (impact on SNR), Clock and Data recovery issues, Point-to-Point Digital Links, Optical Amplifiers Theory and Design (SOA, EDFA, and SRA), Simple WDM system concepts, WDM components.

Prerequisites: Approval of instructor.

Instructors:
Dr. Majeed M. Hayat
hayat@unm.edu; Tel: 272-7095, CHTM 118B; www.professorhayat.com

Classroom & time: CHTM 103; T, Th 3:30PM - 4:45PM

Text: G.P. Agrawal, *Fiber-Optic Communication Systems, 4th Edition, Wiley, 2010.*

Office hours:
TBD

Topics:

1. Introduction to the course and basic concepts in communication (Ch. 1)

2. Optical fiber review (Ch. 2):
    a. Types of fibers
    b. Modes and polarization
    c. Coupling of light
    d. Dispersion
    e. Losses
    f. Propagation computations
    g. Bit rate limitations
    h. Nonlinear effects
    i. Manufacturing issues

3. Review of optical transmitters (Ch. 3)
    a. Types of transmitters: LEDs, Semiconductor lasers.
    b. Bandwidth.
    c. Laser noise (RIN).
    d. Examples of transmitter design.

4. Optical receivers (Ch. 4):
    a. Types of photodetectors: *p-n*, *p-i-n* photodiodes, APDs, MSMs.
    b. Detector noise characterization.
    c. Signal-to-noise ratio and receiver sensitivity.
    d. Bit error-rate (BER) calculations for ON-OFF keying modulation.
    e. Receiver design and performance
    f. Other performance degradation issues (e.g., jitter, intensity noise, extinction ratio).

5. System design and performance (Ch. 5):
    a. Power budget: interplay between loss, dispersion, noise, power, and specified performance.
    b. BER revisited, power penalty: intersymbol interference (ISI).
    c. QAM and M-QAM modulation (notes)
    d. System design.

6. Multi-channel systems (Ch.6):
    a. Wavelength-division multiplexing (WDM): systems and components.
    b. Time-division multiplexing (TDM).
    c. Code-division multiplexing: spread-spectrum techniques; optical orthogonal codes, optical code-division multiple access (OCDMA).
    d. Performance issues: cross talk, bandwidth efficiency, security.

7. Optical amplifiers (Ch. 7):
    a. Semiconductor amplifiers.
    b. Erbium-doped fiber amplifiers.
    c. Raman amplifiers.
    d. Applications.

8. Introduction to dispersion compensation (Ch. 8):
    a. Dispersive devices
    b. Dispersion maps

9. Advanced lightwave systems (Ch.10):
    a. Homodyne and heterodyne detection: SNR improvement.
    b. Modulation and demodulation schemes.
    c. BER comparison of various coherent modulation systems.
    d. Performance limitations: phase noise, intensity noise.
    e. Pulse-amplitude (PAM) systems

Course requirements:

Homework (approx. 6 sets): problems, computer assignments and reading	20 %
Midterm Exam: March 8	30 %
Final Examination: Thursday, May 10, 3:00-5:00	30 %
Project: Due May 3, topic to be announced *	20 %

Computing skills:
Students are expected to be familiar with and have access to one of available general computing tools such as Matlab, MathCad, Mathematica, or equivalent. These will be used in the homework assignments as well as the project.

Tentative grading policy:
A: 90-100; B: 80-89; C: 60-79; F: 59 or below.

Further Reading and References

Palais, *Fiber Optic Communications*, 5th Edn. 2005, Prentice Hall
Pollock, *Fundamentals of Optoelectronics*, 1995
Irwin Connelly, *Semiconductor Optical Amplifiers*, 2002, Kluwer.
Derickson, *Fiber Optic Test and Measurement*, 1998, Prentice Hall
P. Bhattacharya, *Semiconductor Optoelectronic Devices*, Second Ed., Prentice-Hall, 1997.
B. E. A. Saleh & M. C. Teich *Fundamentals of Photonics*, Second Edition, Wiley, 2007.
B. Sklar, *Digital Communications*, Fundamentals and Applications. Prentice Hall.
Digital Communications, 5th Edition, John Proakis and Masoud Salehi, McGraw-Hill Education.