University of Arizona

ECE Department (College of Engineering)
College of Optical Sciences

ECE/OPTI 632: Advanced Optical Communication Systems

Spring 2014 and Spring 2016

Instructors:
Prof. Milorad Cvijetic (Spring 2014)
Prof. Ivan Djordjevic (Spring 2016)

Course Description

Advanced technologies and methods that enhance the overall optical transmission system performance and throughput, and the trade-offs related to the system engineering process. Topics include advanced chromatic dispersion compensation, PMD compensation and the nonlinearity management. The spectral efficiency limits will be described with advanced modulation, coding and multiplexing techniques to achieve it. Advanced modulation formats, such as various multilevel modulations and OFDM will be discussed in details. Further, the spatial-domain based multiplexing and modulation will be studied. The physics behind parametric amplification will be presented as well as its application to all-optical regeneration and wavelength conversion. The course will include homework and project tasks throughout the semester.

Course Syllabus

(i) Noise sources, channel impairments, and optical transmission system design principles

(ii) Advanced modulation formats, OFDM, polarization multiplexing, constrained coding, and coherent detection:
   a. Multilevel modulation schemes,
   b. Orthogonal frequency-division multiplexing (OFDM),
   c. Polarization multiplexing,
   d. Constrained (line or modulation) coding, and
   e. Coherent detection.

(iii) Forward error correction (FEC):
   a. Linear block codes and cyclic codes,
   b. BCH and RS codes,
   c. Concatenated codes,
   d. Turbo- and turbo-product codes, and
   e. LDPC codes.

(iv) Coded modulation schemes:
   a. Multilevel coding,
   b. Bit-interleaved coded modulation, and
   c. Coded OFDM.

(v) Advanced chromatic dispersion compensation:
   a. Signal pre-distortion compensation,
   b. Post-detection compensation: feed-forward equalizer (FFE), decision-feedback equalizer (DFE), maximum-likelihood sequence estimation (MLSE) or Viterbi equalizer (VE), turbo equalization (TE);
   c. Compensation of chromatic dispersion by OFDM.

(vi) Advanced PMD compensation:
   a. Optical compensation techniques,
   b. Electrical compensation techniques

(vii) Nonlinearity management:
   a. Compensation of intrachannel and interchannel nonlinearities,
   b. Compensation of nonlinear phase noise,
   c. Digital back-propagation method, and
   d. Turbo equalization.

(viii) Spatial-Domain-Based Multiplexing and Modulation

(ix) Optical channel capacity:
   a. Channel Capacity Preliminaries
   b. Calculation of information Capacity
   c. Information Capacity of Systems with Direct Detection
   d. Information Capacity of Multilevel Systems with Coherent Detection
   e. Capacity of Optical OFDM Systems
   f. Channel Capacity of Optical MIMO MMF Systems

(x) Parametric processes and applications:
   a. Parametric amplifiers,
   b. All-optical regeneration,
   c. Wavelength conversion

Prerequisites

ECE 430/530 or equivalent

Textbook:

1. M. Cvijetic, I. B. Djordjevic, *Advanced Optical Communication Systems and Networks*. Artech House, Jan. 2013.

Class time and location:

Tuesday-Thursday, 12:30 PM - 1:45 PM; College of Optical Sciences, room 205

Office Hours

2:00 PM – 3:00 PM, Tuesdays and Thursdays, College of Optical Sciences, room 429

Grading: Regular grades will be awarded for this course

Homework/projects	50%
Midterm	20%
Final Exam	30%