King Saud University **EE411-Optoelectronic Devices and Systems**
College of Engineering **2nd Semester 1425-1426**
Elect. Eng. Dept.

Instructors: Dr. Ibrahim Elshafiey
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Lectures Schedule: Saturday: 1-1:50 pm, and Sunday: 8-9:50 pm

Text Book:

S.O. Kasap, Optoelectronics and Photonics Principles and Practices, Prentice Hall, 2001.

References:

Gerd Keiser, *Optical Fiber Communications*, 3rd ed., McGraw-Hill, Boston, 2000.

Course Goals:

1. Be familiar with theory and behavior of basic constituents of optical communication system.
2. Be acquainted with wave theory of light.
3. Learn basic design principles of optical fiber links.
4. Be familiar with attenuation and dispersion in optical fibers.
5. Be familiar with light sources.
6. Be familiar with photodetectors.
7. Be aware of polarization and modulation of light.
8. Be acquainted with photovoltaic devices.
9. Learn operating principles of wavelength-division multiplexing (WDM).
10. Recognize architectures and performance characteristics of complex optical networks.

Measurable Objectives:

Upon successful completion of this course, the participant with be able to:

1. illustrate various aspects of wave nature of light.
2. categorize optical fiber types.
3. illustrate optical fiber modes.
4. devise techniques for attenuation and dispersion measurements.
5. analyze signal degradation in optical fibers.
6. compare optical source types.
7. categorize photodetectors.
8. calculate link power budget.
9. analyze system rise-time.
10. categorize photovoltaic devices.
11. illustrate techniques for light polarization and modulation.
12. identify principles of WDM.
13. categorize WDM devices.
14. categorize optical network topologies.
15. describe advances optical networks.

Course Content:

Topic I: INTRODUCTION
Communication Systems; Baseband versus Passband; Analog versus Digital; Coherent versus Incoherent; Modulation and Line Coding; Advantages of Optical Communications; Components in Optical Communications; Advances in Optoelectronic Devices and Systems.

Topic II: WAVENATURE OF LIGHT
Light Waves in a Homogeneous Medium; Refractive Index Group Velocity and Group Index ; Magnetic Field, Irradiance and Poynting Vector; Snell's Law and Total Internal Reflection; Fresnel's Equations; Multiple Interference and Optical Resonators; Goos-Hänchen Shift and Optical Tunneling; Temporal and Spatial Coherence; Diffraction Principles.

Topic III: DIELECTRICWAVEGUIDES AND OPTICAL FIBERS
Symmetric Planar Dielectric Slab Waveguide; Modal and Waveguide Dispersion in the Planar Waveguide; Step Index Fiber ; Numerical Aperture; Dispersion in Single Mode Fibers; Electrical and Optical Bandwidth ; The Graded Index Optical Fiber; Light Absorption and Scattering; Attenuation in Optical Fibers; Fiber Manufacture.

TOPIC IV: SEMICONDUCTOR SCIENCE AND LIGHT EMITTING DIODES
Semiconductor Concepts and Energy Bands; Direct and Indirect Bandgap Semiconductors: E-k Diagrams; pn Junction Principles; The pn Junction Band Diagram; Light Emitting Diodes; LED Materials; Heterojunction High Intensity LEDs; LED Characteristics; LEDs for Optical Fiber Communications

TOPIC V: STIMULATED EMISSION DEVICES LASERS
Stimulated Emission and Photon Amplification; Stimulated Emission Rate and Einstein Coefficients; LASER Oscillation Conditions; Principle of the Laser Diode; Heterostructure Laser Diodes; Elementary Laser Diode Characteristics; Steady State Semiconductor Rate Equation; Light Emitters for Optical Fiber Communications; Single Frequency Solid State Lasers; Quantum Well Devices; Vertical Cavity Surface Emitting Lasers (VCSELs).

TOPIC VI: PHOTODETECTORS
Principle of the pn Junction Photodiode; Photodiode Materials; Quantum Efficiency and Responsivity; The pin Photodiode; Avalanche Photodiode; Heterojunction Photodiodes; Phototransistors.

TOPIC VII: PHOTOVOLTAIC DEVICES
Solar Energy Spectrum; Photovoltaic Device Principles; pn Junction Photovoltaic I-V Characteristics; Series Resistance and Equivalent Circuit.

TOPIC VIII: POLARIZATION AND MODULATION OF LIGHT
Polarization; Light Propagation in an Anisotropic Medium: Birefringence; Birefringent Optical Devices; Optical Activity and Circular Birefringence ; Electro-Optic Effects; Integrated Optical Modulators; Acousto-Optic Modulator; Magneto-Optic Effects.

TOPIC IX: WDM CONCEPTS AND COMPONENTS
Principles of WDM; Passive Components; Tunable Sources; Tunable Filters

TOPIC X: OPTICAL NETWORKS

Basic Networks; SONET/SDH; Ultrahigh Capacity Networks.

Class Project:

Each student will choose a project on a subject related to optoelectronic devices and systems. He is required to submit a report reflecting his understanding of the topic and the ability to identify new features of chosen topic. Students will also give oral presentation illustrating the main points of the presented report. Each report should have a unique title and students are urged to register the title they choose for their project as early as possible with the instructors.

Grading:

10% Homework
15% Class Project Report
5 % Class Project Presentation
30 % Two Mid-Term Exams
40 % Final Exam

Attendance:

Attendance is mandatory in lectures and tutorials. A student who misses more than 25% of classes will not be allowed to take the final exam.