University of Central Florida

CREOL
The College of Optics and Photonics

(SPRING 2016)

OSE 6432 – Guided Waves and Optoelectronics

Fall Catalog Data: OSE 6432 (3,0) Guided Waves and Optoelectronics

Pre-requisite: Graduate Standing and OSE 6111 (Optical Wave Propagation) or **equivalent**.

Time & Place: Monday & Wednesday @ 1:30am - 2:45 in CREOL 102

Instructor: Dr. Demetrios Christodoulides {CREOL 210 Tel: 407-882-0074 }

Office Hours: Wednesdays and Fridays 10:00am - 11:00am in CREOL 210 or by appointment

Textbook:

Photonics by Amnon Yariv and Pochi Yeh, Oxford University Press, New York (Sixth Edition).

Additional Reading (Optional):

An introduction to Electro-Optic Devices by Ivan Kaminow, Academic Press, New York and London.

Electrooptics by Fernando Agullo-Lopez, Jose Manuel Cabrera, Fernando Agullo-Rueda, Academic Press. London.

Fundamentals of Photonics by Bahaa E.A. Saleh, Malvin Carl Teich, Wiley, New York.

Course Objectives:
To apply the principles of linear optical wave interaction with isotropic and anisotropic media to the understanding of electro-optic devices (modulators). Bulk and waveguiding devices will be covered. Basic semiconductor photonic devices will also be studied.

Topics to be covered in this course:

Guided Wave Optics

Planar Slab Waveguides
Rectangular Waveguides
Circular Waveguides (Optical Fibers)
Dispersion in Waveguides
Pulse Propagation

Electro-Optics and Acousto-Optics

Linear Electro-Optic Effect
Electro-Optic Modulators
Integrated Optic Modulators
Photoelastic Effect
Acousto-Optic Modulators

Optoelectronics

The Semiconductor p-n Junction
Optical Gain and Absorption
Laser Diodes
Photodetectors

Homework: Assignments will be given approximately bi-weekly and collected one week from the day they are handed out. Students may choose to scan their work and email it to me
Late returns will not be graded.

You may use calculators, *Mathcad* or *Matlab* or *Mathematica* to solve the homework problems but **do not** turn in a printout of these. You need to show your work step by step as if you were taking a test or exam using a calculator. Mathcad or other similar software printouts **will not** be graded.

Website: https://webcourses.ucf.edu/
or access through https://my.ucf.edu/

Grading Scheme: 10% Homework
50% Mid-Term Tests
40% Finals.
± Grades will be used

Final Exam Schedule: April 28, 2016 - May 4, 2016

Integrity: Every student is expected to pledge the following:
"*I will practice and defend academic and personal honesty*".

Anyone caught cheating will automatically earn an "F".

Prepared by: Dr. Demetrios Christodoulides **Date:** Jan 2016.

OSE 6432: Guided Waves and Optoelectronics

Syllabus:

Guided Wave Optics

Planar slab waveguides (Ch3, p110 in Yariv's Book Sixth Edition)
Waveguide modes, field distribution, and group velocity (p110-126)
Rectangular channel (handouts)
Single and multi-mode optical fibers (Ch3, p126-137)
Propagation constants and velocities (Ch1, p13-18)
Waveguide, material and modal dispersion (Ch3, p140-144)
Pulse propagation (Ch7, p313-321)

Electro-optics and Acousto-Optics

Light propagation in anisotropic media (Ch1, p30)
Linear electro-optic effect and the electro-optic tensor (Ch9, p406)
Longitudinal and transverse modulators (Ch9, p424)
Amplitude modulation, phase modulation (Ch9, p420-423)
Mach-Zehnder modulators (Handouts)
Coupled-mode theory (Handouts)
Optical coupling between waveguides (Ch13, p611-615)
Directional Coupler switch (Ch13, p616)
Acousto-optic interaction and Bragg diffraction (Ch9, p440-456)
The photoelastic effect (Ch9, p440)
Acousto-optic modulators, deflectors, and scanners (Handouts) (Ch9, p457-460)

Optoelectronics

Band Theory (Handouts) (Ch15, p673-680)
p-n junctions (Handouts) (Ch11, p517)
Semiconductor laser amplifiers – gain v/s pumping (Ch15, p680)
Semiconductor injection lasers: (Handouts) (Ch15, p686)
    Amplification, feedback, oscillation, power, spectral and spatial distribution, mode selection
Properties of semiconductor photoconductors (Ch11, p511)
    Quantum efficiency, responsivity, response time
Photodiodes
    p-n and p-i-n, hetero structure photodiodes (Ch11, p521)
Photodetector noise
    Thermal and Shot noise (Ch11, p473-475)

Pre-requisite: OSE-5111 Optical Wave Propagation

Description: Optical propagation of light waves as applied to isotropic, anisotropic, periodic media, and Gaussian and pulse beam propagation.

Topics:

Electromagnetic Field Theory

Electromagnetic fields; Time varying and Harmonic Maxwell's equations; Boundary condition; Power Flow.

Wave Equation in Linear Isotropic Homogenous Media

Uniform plane waves in unbounded lossless media; Non-uniform plane waves in lossy media; Phase and group velocity; Polarization, linear, circular, and elliptical; Reflection and refraction at planar boundaries of lossless - Brewster angle, critical angle, total internal reflection and associated phase shifts; Reflection and refraction at planar single and multi-layered lossless and lossy media; Applications: Thin film coatings, etc.

Electromagnetic Propagation in Anisotropic Media

Dielectric tensor classification of anisotropic media; Plane wave propagation in anisotropic media - the dispersion relation; Light propagation in uniaxial and biaxial media; Power flow in anisotropic media;

Refraction and reflection at anisotropic interface; Index ellipsoid; Optical activities, Faraday rotation; Jones's Calculus, retardation plates, polarizers; Applications: anisotropic devices.

Propagation of Optical Pulses

Pulse propagation equation; Group velocity and group velocity dispersion; Time delay and pulse spreading; Gaussian Pulse Propagation; Frequency chirp.