NORTH CAROLINA STATE UNIVERSITY
Department of Mechanical & Aerospace Engineering

MAE 589-004
Optical Engineering

Spring Semester 2014
Schedule: MW 11:05-12:20 pm
Classroom: EBIII 02232
Website: Moodle
TA: TBD, **Email**: ta@ncsu.edu

Chih-Hao Chang
Office: EBIII 3240
Office Hours: TBD
Email: chichang@ncsu.edu

COURSE DESCRIPTION

This course provides an introduction to optics, with a focus on engineering applications. The course will cover topics in geometrical optics: ray-tracing, reflection, refraction, lens design, imaging optical systems, as well as topics in wave optics: basic electrodynamics, scalar wave theory, interference, Fresnel and Fraunhofer diffraction, image formation, Fourier optics, and 4F systems. Commonly observed optical systems, such as the human eye, microscopes/telescopes, and solar concentrators will be examined. The role of optics in advanced nano/microscale manufacturing will be highlighted, as well as applications in more efficient solar energy systems, engineered materials, and nanotechnology.

COURSE OBJECTIVES

- Analyzing optical systems using the ray properties of light. Designing lenses for compound optical systems using matrix ray tracing. Examine reflection, refraction, and diffraction using geometric principles.
- Analyzing optical systems using wave properties of light and scalar diffraction theory. Applying Fourier optics and linear systems principle to describe coherent optical systems.
- Designing optical instruments and devices for sensing, metrology, lithography, and other engineering applications in the fields of renewable energy and advanced manufacturing.

PREREQUISITES

- None.

PRIMARY TEXT

E. Hecht, ***Optics***, Addison-Wesley, 4th Ed., 2001.

J. Goodman, ***Introduction to Fourier Optics***, Roberts and Company Publishers, 3rd Ed, 2004.

GRADING	OPTION 1	OPTION 2
Homework	15%	5%
Exams (2)	15%, 20%	15%, 20%
Group Project	20%	20%
Final Exam	30%	40%

GROUP PROJECT

- Students will work in groups of 2 to study an active research topic in optics. The project can consist of a thorough literature review and detailed analysis of the current state of the subject, or a design of an improved existing or novel optical system. The students will present the project in a 15 minute presentation in groups during the last week of the course.

GRADING SCALE (W/ GRAY AREA)

Score	>97	93-96.9	90-92.9	87-89.9	83-86.9	80-82.9	77-79.9	73-76.9	70-72.9	67-69.9	63-66.9	60-62.9	<60
Grade	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F

TENTATIVE SCHEDULE

Week	**Topics**	**Reading**
	I. Introduction	
Jan 6	Photons, electromagnetic spectrum, reflection & refraction.	H1, H3
	II. Geometric Optics	
Jan 8, 13	Snell's Law, total internal reflection, waveguides, prisms.	H4.1-7, H5.6
Jan 15, 22	Thin lenses, Huygens principle, matrix ray tracing. Thick lenses, effective focal planes. Reflective optics.	H5.2, H6.1-2
	III. Optical Systems	
Jan 27, 29	Human eye, microscopes/telescopes, wavefront shaping,	H5.7-8
Feb 3	Microlithography and IC chip manufacturing.	
Feb 5	**Exam #1**	
	IV. Wave Optics	
Feb 10	Properties of electromagnetic waves, spherical/plane waves.	H2.1-9, 3.1-2
Feb 12, 17	Light interference, Fabry-Perot interferometer.	H9.1-H9.8
Feb 19	Laser and temporal/spatial coherence.	H13.1
	V. Fourier Optics	
Feb 24, 26	Spatial Fourier transforms; spatial frequency domain.	G2.1-2.3
Mar 3, 5	Fresnel and Fraunhofer diffraction.	G4.1-4.4
Mar 17, 19	Wave description and Fourier properties of lenses.	G5.1-5.2
March 24, 26	Coherent imaging, 4F systems, spatial filtering.	G5.3, 6.2
March 31	**Exam #2**	
April 2	Incoherent imaging systems.	G6.1-6.3
April 7, 9	Resolution of imaging systems. Diffraction-limited microscopy/lithography, Moore's law for IC manufacturing.	G6.5-6.6
	VI. Emerging Fields in Optics	
April 14, 16	Nano Optics: photonic crystal, bio-inspired nanostructures.	Handouts
April 21, 23	Project Presentation. Final Review	
April 28	**Final Exam 8:00-11:00 am**	

OTHERS

- **Class attendance/participation and attention to homework are highly recommended.**
- Homework is due at the beginning of class. Late homework will not be accepted.
- Students are encouraged to work in small groups for homework assignments. **However copying and submitting work of others is a violation of the NCSU Code of Student Conduct, and will be treated as such.**
- Copying figures, equations, or text from other sources without referencing is **plagiarism: a violation of the NCSU Code of Student Conduct.**
- Any student with a disability who is registered with the University Office of Student Disability Services should schedule an appointment with Dr. Chang at the beginning of the semester to discuss academic accommodations.
- There will be no makeup examinations except for valid excuse.
- It is responsibility of each student to be familiar with the NCSU Code of Student Conduct, and in particular with those portions pertaining to academic dishonesty.
- Online class evaluation will be available for students to complete last week of class.