Course Outline: OPSE301, Fall 2017

Introduction to Optical Science and Engineering

Prerequisites: Phys 121, Math 112, Data Analysis software such as MATLAB

Instructor: Dr. John Federici, Office: 474T, 596-8482; email: federici@njit.edu

Office Hours: Tuesdays and Thursdays 10-11AM or by appointment

COURSE MATERIAL:

- **Textbook:** *Physics of Light and Optics* by Peatross and Ware (This textbook is available FOR FREE on the web) http://optics.byu.edu/textbook.aspx.
- MATLAB (available for download from NJIT web page) or similar analysis and plotting software. **NOTE: EXCEL is good at making plots for reports, but it is NOT sufficient for fitting data to an arbitrary function.**
- **Note:** The laboratory manual will be distributed in class or via the world wide web. The course webpage can be accessed through the following web address: http://web.njit.edu/~federici/

ATTENDANCE: It is expected that students will attend all lectures, recitations, labs. If you anticipate an absence, please let your lab partner and your instructor know immediately. If you miss a laboratory exercise, it is YOUR responsibility to make arrangements with the instructor to make up the laboratory outside of normal class hours. Absence from class DOES NOT alter the deadlines for turning in labs or assignments.

HELP: Visit or email your instructor if you are having trouble with the course; do not simply hope for a miracle and fall further behind.

GRADING: Your final letter grade in OPSE 301 will be based on a composite score for term's work that includes the mid-term, final exam, homework, and lab reports.

- Homework - Homework assignments are given in the syllabus below and are due weekly. Late homework will NOT be accepted.
- Lab Reports – Over the course of the semester, we will perform roughly 4 laboratory assignments during class time. A lab report will be required for each lab.
- Mid-term Exam - The date and location of the mid-term exam TBA.
- Final Exam - A **Comprehensive Final Exam will be given** during Final Exam Period .

Final Letter Grades : Here are the approximate weights to be used for calculating the composite score:

- **25%** for mid-term exam
- **25%** for the final exam
- **25%** for the homework
- **25%** for lab reports

The cutoff percentages for various letter grades will be in the range of 80% for A, 75 % for B+, 70% for B, 65% for C+, 55% for C, and D or F below 50 %.

HONOR CODE STATEMENT: NJIT has a zero-tolerance policy for cheating of any kind and for student behavior that disrupts learning by others. Violations will be reported to the Dean of Students. The penalties range from a minimum of failure in the course plus disciplinary probation up to expulsion from NJIT. Avoid situations where your own behavior could be misinterpreted as dishonorable. **Students are required to agree to the NJIT Honor Code on each exam, assignment, quiz, etc. for the course.**

Turn off all cellular phones, wireless devices, computers, and messaging devices of all kinds during classes and exams. Please do not eat, drink, or create noise in class that interferes with the work of other students or instructors. Creating noise or otherwise interfering with the work of the class will not be tolerated.

Assignments: You are responsible for all weekly reading and homework assignments listed in this outline. The reading should be completed BEFORE class each week. Homework assignments MUST be turned in ON TIME. For each assignment, you will receive partial credit for a 'reasonable' attempt at each problem. Homework assignments are due just about EVERY WEEK. Check syllabus weekly to see what is due. ALL ASSIGNMENTS not turned in by the assigned date will be scored as a zero. **Each student must turn in individual Homework assignments. No group submissions will be accepted.**

During the course, you will complete several laboratory assignments. The lab reports are due as indicated in the outline (nominally due 2 weeks after each experiment is completed). Late lab reports will not be accepted. **Each student must turn in an individual laboratory report. No group laboratory reports will be accepted.**

EMail/ Alternative Methods of Delivery Policy: If you submit assignments by email, it is **REQUIRED that you put in the subject line "OPSE 301"**. (This helps me identify student submissions from my other emails.) The instructor is not responsible for assignments turned in outside of class time (in my mailbox, under my door) or not delivered by email. If assignments are delivered by email, it must be date stamped BEFORE the due date/ time. I will log them in when I receive them. THE INSTRUCTOR IS NOT RESPONSIBLE FOR LOST EMAILS, COMPUTER CRASHES, ETC.

Groups and Working Together: You will work with one partner for lab assignments. You are encouraged to help each other with homework and laboratory assignments. It is expected (although not required) that lab groups will present the same raw data in their laboratory reports. However, each student must submit an individual laboratory report with their own analysis, graphs, and discussion. DO NOT CUT AND PASTE your laboratory

reports from other students' work. With regards to homework assignments, you are encouraged to work together if that method helps you learn the material. However, remember that you must understand the homework assignment well enough that you can do it BY YOURSELF on the exams.

Accommodations for Disabilities: If you need accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services, Fenster Hall Room 260 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

LEARNING OUTCOMES: For this course, you can expect to be assessed on the following learning outcomes:

1. Recall the definitions and relationships involving frequency, wavelength, wave velocity, group velocity, refractive index, power, intensity, and dispersion.
2. Comprehend basic concepts of light propagation using the concepts of rays, wavefronts, Huygen's principle. Apply these principles to the description of light propagation including reflection and refraction. Apply the equations and concepts governing wave propagation to optical problems for various initial conditions. Calculate unknown quantities based on physical relationships, initial conditions, and known quantities.
3. Apply the concepts of refraction and reflection to understand the operation of mirrors, lenses, prisms, and fiber optic cables.
4. Comprehend the meaning of the equations governing wave propagation as it applies to interference and diffraction. Apply principles of interference and diffraction to analyze these effects in several model systems including thin film interference, interferometry, light propagation through small holes, and spatial resolution. Calculate unknown quantities based on physical relationships, initial conditions, and known quantities.
5. Generalize the concepts underlying light propagation to an electromagnetic treatment of light using Maxwell's equations.
6. Comprehend the meaning and origin of color and its manifestation through various optical means such as scattering, dispersion, interference, diffraction gratings. Understand how to measure and quantify color.
7. Comprehend the meaning and mathematical representation of electromagnetic wave polarization. Explain the difference between linear, circular, and elliptical polarization states, and how the polarization state of light can be manipulated using reflection and birefringent materials.
8. Develop basic laboratory skills in the detection and manipulation of visible light using photodetectors, mirrors, lenses, and beamsplitters. Using these basic skills, assemble and test optical systems which demonstrate interference. Using these basic skills, explore experimental means for detecting color and manipulating the polarization state of light. Quantify the observed optical effects and compare measured results with theoretical predictions.

Week	Topic With Lecture Notes	Text Assignment	HW Problems	Lab assignment	Online Reference Material
1	EM Spectrum, Snell's Law, ABCD Matrices, Total Internal Reflection Lecture Notes PPT Lecture Notes	Ch. 9.2-9.6, 9.A	9.4, 9.7, 9.8, HW set #1	Matlab Assignment Intro_lab_data Matlab Hints	
2	Components: Mirrors, Lens, Prisms Lecture Notes PPT Lecture Notes Animation 1	Ch. 9.2-9.6, 9.A	9.10, 9.11, HW set #2 Problem 9.11 HINTS (PPT)		
3	Electromagnetic Waves, Maxwell's Equations Lecture Notes PPT Lecture Notes Animation 1 Animation 2	Ch. 1	1.2, 1.4, 1.6, HW set #3	Lab 7 - Detection of light	
4	Plane Waves, Complex Refractive Index, Energy Density of Fields Lecture Notes PPT lecture Notes	Ch. 2.1-2.3,2.6, 2,7 2C, 2D	2.10, 2.11, HW set #4		
5	Color, Dispersion Lecture Notes PPT Lecture notes	Ch 2.4, 2.5	HINTS for Prob 2.3 2.3, 2.4, 2.5, 2.6, HW Set #5	Lab 5 - Absorption	
6	Fresnel Equations, Brewster's Angle, Total Internal Reflection Lecture Notes - part 1 Lecture Notes - part 2 PPT lecture notes	Ch 3.1-3.6	3.2, 3.3, 3.5, 3.7, 3.11, 3.13		
7	Interference, Young's experiment, Thin Film interference	Superposition of waves	HW Set #7, 4.1, 4.2		Superposition of waves

	Lecture Notes-part 1 Lecture Notes-part 2 PPT lecture notes	and Ch. 4.1			
	MIDTERM EXAM				
8	Beats. Group Velocity, Phase Velocity, Michelson Interferometer Lecture Notes PPT Lecture Notes	Ch 7.2	7.1, 7.3	Lab 13- Michelson Interferometer	
9	Analyzing Lab 13 Data with Matlab Lecture Notes			Lab 13 (cont.)	
10	Anisotropic Medium, Polarization of Light, Jones Vectors, Waveplates Lecture Notes PPT Notes	Ch. 5.1-5.4, 6.1-6.6	6.1, 6.5, 6.6, 6.10, 6.12, HW set #10		Polarizers Waveplates
11	Polarization of Light, Waveplates, Polarizers	Ch. 5.1-5.4, 6.1-6.6		Lab 3 – Waveplates and polarizers	
12	Diffraction - Fresnel and Fraunhofer Theory Lecture Notes PPT notes	Ch 10	10.6, HW set #12		
13	Diffraction Applications, Resolution of Telescope, Focusing of Laser beam Lecture Notes PPT notes	Ch. 11.1,11.2, 11.6, 11.7	11.3, 11.11, HW set #13	Lab 3 (cont.)	
14	REVIEW for FINAL				

Tuesday Nov 21nd follows a THURSDAY schedule
Thursday Nov. 23th - Thanksgiving Break – no classes
READING DAY – Dec. 14
FINAL EXAM PERIOD – Dec 15th-21st

Lab Number	Topic
3	Polarization-- Wave plates and polarizers
5	Absorption of colored dye
7	Detection of light -- Photodiode detectors
10	Diffraction
13	Michelson Interferometer