OPSE 301: Introduction to Optical Science and Engineering

General information: 3 credit hours. Tue: 6 PM – 8:50 PM, FMH 403B

Instructor: Tino Hofmann, (973)-596-5456, tino.hofmann@njit.edu

Office Hours: Tuesdays and Thursdays 9-10 AM or by appointment, 454T or via Zoom.

Course Material:

- **Textbook:** *Physics of Light and Optics* by Peatross and Ware ISBN: 1312929278
  (online free of charge: http://optics.byu.edu/textbook.aspx)
- **Data Analysis:** MATLAB or ORIGIN (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.

Course Content: Laboratory and lecture. For applied physics, engineering, computer science, or biology majors. Introduces optics and photonics principles with their elementary applications. Topics include speed at light, reflection, refraction, geometric optics, interference and interferometry, polarization, dispersion, birefringence, fiber optics, diffraction, introduction to spectroscopy, and ray tracing.

Prerequisite: Phys 121, Math 112, Matlab or Python knowledge

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 data analysis and manipulation using MATLAB, the manipulation and detection of light, the attenuation of light by an absorbing medium, interferometry, the manipulation of the polarization state of light. Quantify the observed optical effects and compare measured results with theoretical predictions.

In the table below the weekly topics are shown.

Week	Topic with Lecture Notes
1	EM Spectrum, Snell's Law, ABCD Matrices, Total Internal Reflection
2	Components: Mirrors, Lens, Prisms
3	Electromagnetic Waves, Maxwells Equations
4	Plane Waves, Complex Refractive Index, Energy Density of Fields
5	Color, Dispersion
6	Fresnel Equations, Brewsters Angle, Total Internal Reflection
7	Interference, Young's experiment, Thin Film interference
	MIDTERM EXAM
8	Beats. Group Velocity, Phase Velocity, Michelson Interferometer
9	Intro to Lasers
10	Anisotropic Medium, Polarization of Light, Jones Vectors, Waveplates
11	Polarization of Light, Waveplates, Polarizers
12	Diffraction - Fresnel and Fraunhofer Theory
13	Diffraction Applications, Resolution of Telescope
14	REVIEW for FINAL

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. IMPORTANT: Each week's homework assignments usually include problems from the Online Textbook AND some additional problems provided by the instructor. Please see weekly assignments in the course syllabus

Lab Reports: Over the course of the semester, we will perform roughly 3-4 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 / Academic Integrity: 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. The students are expected to adhere to the University Policy on Academic Integrity.**

Noise and distractions: Mute or turn off 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.

Accommodations for Disabilities: If you need accommodations due to a disability please contact the Office of Accessibility Resources and Services to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.