PHY 300 - Waves and Optics - Fall 2020
Syllabus

Course Description: (4 credits). The physics of oscillations and waves, from mechanical waves to light waves to electron waves. Topics include resonance and normal modes of coupled oscillators, the wave equation and wave propagation, interference and diffraction, polarization and imaging, coherence, and lasers. Three lecture hours and one two-hour laboratory per week.

Lecture: Mondays and Wednesdays, 2:40-4:00 PM.
Laboratory Sections: LO1: Thursdays 4:45-6:35 PM. LO2: Thursdays 7:00-8:50 PM. LO3: Wednesdays 10:30 AM - 12:20 PM.
Instructor: Prof. Thomas K. Allison <thomas.allison@stonybrook.edu>
Instructor Office Hours: Tuesdays, 2:30-4:30 via Zoom meeting (Link on blackboard). In person office hours are available by appointment.
Teaching Assistants: TBD and TBD
Teaching Assistant Office Hours: TBD.

Course Objectives: Students will acquire knowledge of coupled oscillators and resonance, wave phenomena, and optics. Students will gain the ability to apply this physics to a variety of contexts, including classical optics and diffraction theory. Students will also gain facility with Fourier analysis methods. Most importantly, through problem solving and laboratory experience, students will gain an intuition for optical and wave phenomena.

Course Website: On Blackboard
Course Textbooks: *Vibrations and Waves* by A. P. French, *Introduction to Modern Optics, 2nd edition* by Grant R. Fowles.

Problem Sets: The problem set for course is available on blackboard. Weekly assignments will be announced on blackboard, and are due at the beginning of your lab section. You can turn in your homework to your TA as a paper submission or submit a scanned copy electronically via blackboard. Solutions will be posted on the course website on Fridays. Late problems will not be accepted except in extraordinary circumstances. You are encouraged to work together with your classmates on the problems, but you must turn in your own work in the end.

Problem sets should be clearly written, including text explaining your methodology whenever equations do not obviously lead from one to the next. For ease of grading, please encircle, box, or otherwise emphasize your final answers. You will find that being clear will also help you catch your mistakes.

Laboratory Work: Since laboratory time is limited, it is important to prepare for the lab before arriving for your lab section by reading the lab writeup, available on the course webpage. Write and bring with you to lab a short (1/3-page) summary of the main ideas of the lab. Brief quizzes may be given at the beginning of the lab session to ensure students have read the lab writeup. Lab reports are due one week (7 days) after doing the experiment and can be turned in to the teaching assistant for your lab section via a printed copy or submitted electronically via blackboard. See the "PHY300 lab rules" on the course webpage for additional information regarding preparing your lab reports.

Attendance/Participation: Attendance and participation in lectures is highly encouraged, but will be neither monitored nor required. However, laboratory attendance is required, and will be recorded by the TAs. There will be 8 laboratory experiments throughout the semester. Students should plan on attending all 8 labs and turning in all 8 reports. However, to help mitigate problems, only your best 7 lab grades will be used in calculating your grade for the laboratory component of the course, with the remaining one dropped. Furthermore, one lab period in November will be

reserved for students to make up one lab in the event they are unable to attend the lab on the designated week due to an unforeseen event.

Hardware and Software Requirements: Lectures will take place online via Zoom. The Zoom client application can be downloaded from https://stonybrook.zoom.us. In order to participate in discussions in synchronous lectures, students should have a camera and microphone on the device they use to participate in lectures.

Lab reports must be typed and figures included and referenced in the text. This can be done with LaTeX or many word processors. Data analysis and figure preparation should also be done using computer software packages, and it is recommended that students use a software package geared towards scientific computing that allows easy plotting, curve fitting, statistical analysis, numerics, and comparison between data and analytic formulae. Occasionally, homework problems may also ask you to plot results. Learning how to do these tasks on a computer is an essential component of being a modern scientist or engineer. Some example commercial packages available from Stony Brook via SoftWeb (https://softweb.cc.stonybrook.edu/) are MATLAB, Mathematica, and Maple. For an open source solution, the powerful suite of scientific computing modules incorporated into the Python programming language (e.g. Numpy, Scipy, Matplotlib, etc.) provides a very wide range of functionality. Students are free to use whatever software they like for data analysis. However your instructor only supports MATLAB or Python.

We will explore the material in lectures using a variety of computer codes. These codes will be written in either MATLAB or Python and available for download after the lectures from the blackboard site for students to experiment with.

Midterm: During your lab section, Oct. 7-8 and Nov. 18-19
Final Exam: No Final Exam.

Approximate Grade Weighting: 30% problem sets, 40% midterm exams, 30% laboratory work

Ambitious Summary of Contents

Simple Harmonic Motion. Free oscillations, driven oscillations, and resonance. Complex numbers automatically keep track of amplitude and phase.

Coupled Oscillators. Normal modes. Symmetry of normal modes. Matrix treatment. The continuous limit. Traveling waves and standing waves.

Electromagnetic Waves. Maxwell's equations. Wave equation for light. Helmholtz equation. Polarization, reflection, and refraction. Coherence and interference. Waveguides.

Fourier Analysis. Fourier series and Fourier transforms. Uncertainty relations. Fourier analysis of discretely sampled data. The sampling theorem.

Fundamentals of Optics. Fermat's principle of least time. Ray Optics. Refraction and reflection at curved surfaces. Diffraction. The paraxial approximation and paraxial wave equation. Fiber optics.

Nonlinear Optics. Expansion of the polarization. Wave mixing. Phase matching.

Student Accessibility and Support Center (SASC): If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility and Support Center https://www.stonybrook.edu/sasc/. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and SASC. For procedures and information go to the following website: http://www.sunysb.edu/ehs/fire/disabilities.shtml

Academic Integrity: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong.

Faculty are required to report any suspected instance of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at https://www.stonybrook.edu/commcms/academic_integrity/

Critical Incident Management: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, and/or inhibits students' ability to learn

Electronic Communication Email to your University email account is an important way of communicating with you for this course. For most students the email address is firstname.lastname@stonybrook.edu, and the account can be accessed here: http://www.stonybrook.edu/mycloud. *It is your responsibility to read your email received at this account.* For instructions about how to verify your University email address see this: http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo . You can set up email forwarding using instructions here: http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail . If you choose to forward your University email to another account, we are not responsible for any undeliverable messages.

Religious Observances: See the policy statement regarding religious holidays at

http://www.stonybrook.edu/commcms/provost/resources/rel.html

Students are expected to notify the course professor by email of their intention to take time out for religious observance. This should be done as soon as possible but definitely before the end of the add/drop period. At that time they can discuss with the instructor(s) how they will be able to make up the work covered.