Instructors

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Office hours: Fridays 4-6 p.m. or by appointment
Meyer 601

Teaching Assistant

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Lab Instructor

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Meeting Times & Places

Lectures (V85.0105001): Tuesdays and Thursdays, 12:30-1:45 p.m. Meyer 122
Recitation (V85.0105002): Wednesdays, 2:00-3:15 p.m. Meyer 102
Recitation (V85.0105003): Mondays, 2:00-3:15 p.m. Meyer 102
Laboratory (V85.0107001): Tuesdays, 3:30-6:30 p.m. Meyer 221
Laboratory (V85.0107002): Fridays, 12:00-3:00 p.m. Meyer 221
Final Exam: Thursday, December 12, 12:00-1:50 p.m. Meyer 102

Texts

Lecture Notes by D. J. Pine. [available on Blackboard]

Required Equipment

An electronic transmitter used for student feedback during lecture. We use the “iClicker”, which you may have used in the Physics I-III sequence. If you do not already have one, you can purchase one in the NYU Bookstore.

Course Description

Introduction to the physics of classical and quantum waves for students who have had at least one year of college physics and three semesters of calculus or intensive calculus. Topics include linear and non-linear oscillators, resonance, coupled oscillators, normal modes, mechanical waves, light, matter waves, Fourier analysis, Fourier optics (diffraction), and an introduction to numerical (computer) methods for solving differential equations.

Prerequisites & Co-requisite

Prerequisites: V85.0095 or V85.0012 and V63.0123 or V63.0222. with a grade of C- or better, or permission of the Department.

Blackboard

All course announcements, including homework assignments, solutions, and lecture notes, will be posted on Blackboard. Your homework and exam scores will also be available on Blackboard.
Problem Sets

Problem sets will be assigned about once a week. Copies of the problem sets as well as solutions will be posted on Blackboard.

Exams

There will be two midterm exams and a final exam. The two midterm exams will take place in the evening outside of the normal class time. They will be schedule in the first class meeting.

Grading (approximate guidelines)

mid-term exam 1 (evening) 20%
mid-term exam 2 (evening) 20%
Final exam 25%
Homework 30%
Class participation (clicker) 5%

Laboratory (a separate course: V85.0107)

There is a laboratory component to Classical & Quantum Waves that will consist of 11 different experiments, which are described on the web site http://physics.nyu.edu/~physlab/Modern2/modern2.html. Labs will commence the week of January 31st and go through the end of April. Please note that you must register for Classical & Quantum Waves Lab as a separate course.

Topics to be covered

Interspersed throughout the coverage of the topics below will be an introduction to numerical computational techniques and computer programming. In particular, you will learn how to write simple Python programs that can solve differential equations, solve for roots of non-linear equations, & solve matrix eigenvalue problems.

Small-amplitude oscillations (diatomic molecule, pendulum, mass & spring, RLC circuits)
  • linear oscillator (linear & torsional motion)
  • damping, quality (Q) factor
  • forcing & resonance
  • transients

Coupled oscillators (systems of harmonic springs)
  • coupled linear masses
  • normal modes & coordinates
  • the dynamical matrix, diagonalization, eigenvectors, & eigenvalues
  • transients, superposition, & beats
  • vibrations in a solid – acoustic & optical modes, band gap
  • transition to continuum, string modes, & the wave equation
  • defects & localized modes

Fourier analysis
  • Fourier series (brief review)
  • Fourier transforms
  • Discrete Fourier transform and the FFT
Dispersion (sound waves in a solid)
- sound in solids: dispersion in acoustic & optical branches
- phase & group velocities, wave packet spreading
- Fourier analysis – uncertainty principle

Waves and barriers (E&M)
- reflection & refraction
- impedance & polarization

Diffraction (optics)
- Kirchoff diffraction integral
- Fresnel & Fraunhofer diffraction
- Fourier transforms and Fraunhofer diffraction
- Convolution and image formation

Matter waves (quantum mechanics)
- diffraction of “particles”
- de Broglie waves
- time-dependent Schrödinger equation
- electron dispersion relation, particle wave packets & dispersion
- quantum phenomenology (Compton scattering, photoelectric effect, etc.)

1-d quantum problems
- time-independent Schrödinger equation
- solutions to square-ish wells – energy quantization
- time-dependent solutions – superposition
- scattering from barriers – reflection & transmission
- quantum harmonic oscillator

Quantum states & bra/ket notation
- light polarization (linear, circular, elliptical)
- superposition
- measurements
- interaction-free measurements
- Interpretations of quantum mechanics