Classical and Quantum Waves
Syllabus, Spring 2016
Frank A. Moscatelli
Physics NYU

General 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 and linear algebra. Topics include linear oscillators, damping, resonance, coupled oscillators, normal modes, mechanical waves, light, matter waves in modern physics, Fourier analysis, Fourier optics (diffraction), and an introduction to numerical (computer) methods for solving differential equations.

Instructor

Prof. Frank Moscatelli
E-mail: frank.moscatelli@nyu.edu
Telephone: 610-905-5023
Office Hours: Pretty much anytime Tuesday, by appointment
Office: Meyer TBA

Teaching Assistant

George Wong
E-mail: gnw209@nyu.edu
Office Hours: TBA
Office Meyer Meyer 537

Meeting Times & Places

Lectures:	Monday Wednesday 12:30 – 1:45	Meyer 102
Recitation:	Wednesday 3:30 – 4:45	Meyer 333
Recitation:	Thursday 5:00 – 6:15	Meyer 333

Texts

These three texts are required:

CQW Lecture Notes by D. J. Pine with T. C. Lubensky. [available on NYU Classes website]
Quantum Physics, A Fundamental Approach to Modern Physics by John S. Townsend, University Science, [only in last several weeks of course].
Introduction to Python for Science by D. J. Pine. [available on NYU Classes]

Weekly Problem Sets

Problem sets will be assigned about once a week and posted on NYU Classes. They are Due at the end of class Wednesdays. Please note that doing and turning in the homework assignments is an essential part of this course, both for learning the material and for your grade. See below.

Exams

There will be two midterm exams and a final exam.

Grading

Mid-term exam 1: 20%
Mid-term exam 2: 20%
Final exam: 30%
Homework: 30%

Topics

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
- propagation of waves in material; dispersion & diffusion
- phase & group velocities, wave packet spreading
- transition to continuum, string modes, & the wave equation

Fourier analysis

- Fourier series (brief review)
- Fourier transforms
- Discrete Fourier transform and the FFT

Quantum Waves

- diffraction of “particles”
- quantum phenomenology (Compton scattering, photoelectric effect, Bohr atom)
- de Broglie waves
- time-dependent Schrodinger equation
- electron dispersion relation, particle wave packets & dispersion

1-D quantum problems and two simple 3-D problems

- time-independent Schrodinger equation
- solutions to square-ish wells – energy quantization
- time-dependent solutions – superposition
- scattering from barriers – reflection & transmission