Phys 3750 -- Wave Phenomena Fall 2019

September 13, 2019

1 Overview

Lecture 1 Course / Syllabus Overview

1.1 Physical models, wave and other
1.2 Linear vs. nonlinear
1.3 Superposition
1.4 Course Calendars

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2 Simple harmonic oscillation

1. Mass-spring (see notes)
2. Simple pendulum: Taylor series
3. General potentials
4. Complex representations

Readings:
1. Torre, Introduction
2. Torre: Harmonic Oscillations, Complex numbers ... Ch 1
3. Riffe: Lecture 2

Problems: (due Thursday, Sept. 5)
• Torre, problems 1.2, 1.4, 1.5, 1.6, 1.8, 1.9, 1.11, 1.18

3 Coupled oscillators and normal modes

Readings:
1. Torre:
   • 2. Two Coupled Oscillators
   • 3. How to Find Normal Modes
   • 4. Linear Chain of Coupled Oscillators
2. Riffe:
   • Lecture 3 Two Coupled Oscillators / Normal Modes
   • Lecture 4 Normal Mode Coordinates / Initial Value Problem. Homework 1
   • Lecture 5 Linear Chain / Normal Modes
3. Lecture Notes

Problems: (due Thursday, Sept. 12)
1. Torre, problems 2.1, 2.3, 2.5
2. Riffe, problems 2.6, 2.7, 3.1
3. Study the 3 mass case, including answers to both Torre 2.6 and Riffe 3.5. Verbally describe the motions of the three masses in each of the normal modes.

4 Two approaches to the wave equation

Approach 1: The continuum limit of coupled oscillators
Note that Torre and Riffe give slightly different approaches here. Read:
1. Torre
   • 5. The Continuum Limit and the Wave Equation
   • 6. Elementary Solutions to the Wave Equation
Approach 2: Waves on a string

Read my notes:

- Lecture Notes: Waves on a string

5 Solutions to the wave equation

Read:

1. Torre
   - 6. Elementary Solutions to the Wave Equation
   - 7. General Solution to the One Dimensional Wave Equation

2. Riffe
   - Lecture 6 Traveling Waves, Standing Waves, and the Dispersion Relation
   - Lecture 8 1D Wave Equation - General Solution / Gaussian Function
   - Lecture 9 General Solution with Boundary Conditions.

3. Wheeler
   - Lecture Notes: The continuum limit
   - Lecture Notes: Solutions to the wave equation

Problems: (Due Thursday, September 19)

1. Torre: problems 3.1, 3.2, 3.3, 3.4

2. Riffe:
   (a) Lecture 4: problems 4.1, 4.3
   (b) Lecture 6: problem 6.3
   (c) Lecture 8: problems 8.1,

3. Find the eigenvalues and eigenvectors of the matrix

\[ M = \begin{pmatrix} 3 & 4 \\ 4 & 3 \end{pmatrix} \]

First Midterm Exam, Tuesday, September 24