

SYLLABUS

Foundations of Wave Phenomena Phys 3750 Spring 2013

TECHNICAL DETAILS

Instructor: D. Mark Riffe

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Office Hours: M,W,F 3 – 4 p.m. at the **Quadside Café**; otherwise, an appointment can be made – email is the best way to schedule an appointment.

Prerequisites: Phys 2710, Math 2210; Math 2250 (may be taken concurrently)

Texts: (1) *Lecture Notes* (required), (2) *Foundations of Wave Phenomena* by C. G. Torre (optional). Both available on course website.

Credits: 3 semester credit hours

Lecture: M W F, ENGR 206, 10:30 – 11:20 pm

Course Web Site: <http://www.physics.usu.edu/riffe/3750/index.htm>.

COURSE GOALS

I. Improvement of Mathematical Skills

The main goal of the course is to ramp up everyone's mathematical knowledge and skills so that the upper-division physics courses are less daunting than they might otherwise be. Courses that extensively use material discussed in this course include PHYS 4600 (electrodynamics), 4650/4680 (wave optics), and PHYS 4700/4710 (quantum mechanics).

II. Knowledge of Physics

The course should increase your physics knowledge, especially in the area of wave phenomena, which, as we shall see, is ubiquitous in physics.

III. Writing and Presentation Skills

The class should help to develop both writing and presentation skills. Your writing skills should be improved through your homework write-ups. You will have the opportunity to improve your presentation skills through classroom presentation of selected homework problems.

IV. Practice with Computer Mathematics Packages

For some of the homework problems you will be required to utilize a computer mathematics package, such as Mathcad, Maple, or Mathematica in order to make an appropriate graph.

CLASS TIME

Several different activities will take place during the scheduled class periods.

I. Lectures

Most class periods I lecture on material that is presented in the **Lecture Notes**, which are available on the class website, <http://www.physics.usu.edu/riffe/3750/index.htm>. For each lecture there is a self-contained set of notes (31 lectures total). I encourage you to print off the Lecture Notes and refer to them during the lecture, making notes on them as needed.

II. Homework Presentations

We shall spend time going over some of the homework problems during selected lectures. During these class periods students are (randomly) called upon to present their solutions to selected homework problems. **You need to work these problems ahead of time so that you are prepared to present any one of them during the scheduled class time.** As described below, these oral presentations count towards your grade in the class.

III. Exams

There will be three midterm exams during the semester.

HOMEWORK

I. Overview

Simply attending lectures is NOT sufficient for learning physics. This is because your active engagement in any lecture is neither sufficiently high nor sufficiently long for you to assimilate the material and then be able to apply it to a physics problem. Your most active engagement with the material happens as you are doing the homework. Because of this, many experts feel that doing homework is the KEY to learning physics. **YOU WILL PROBABLY LEARN THE MATERIAL MOST EFFICIENTLY IF YOU APPROACH THE HOMEWORK ASSIGNMENTS AS YOUR BEST OPPORTUNITY TO INTERNALIZE THE CONCEPTS AND HOW THEY ARE APPLIED.**

All homework problems for the course appear at the end of the Lecture Notes for each class. **You should do all of these problems.** These problems will be divided into 3 categories: (1) problems that are **turned in** to be graded (written problems), (2) problems that are **presented by the students** (oral problems), (3) any **remaining problems** in the Lecture Notes. You can expect exam problems to be similar to **any** of these problems.

The homework assignments can be found on p. 4 of this syllabus.

II. Written Homework Requirements

There are several requirements pertaining to the written homework problems. Please carefully follow all of these requirements. **Failure to do so may result in rejection of that assignment and a subsequent zero for that assignment.** Here they are:

1. Homework must be **written up by hand** on standard loose-leaf, college ruled, 8.5" × 11" paper.
2. Write on **one side** of the paper only. Staple the pages together with a staple in the upper left-hand corner.

3. The homework must be written up in **complete sentences**, with any equations as part of the sentences. If you are unsure about how this is done, refer to the lecture notes, or any physics textbook. Be careful with grammar and punctuation!
4. I expect to see a **coherent, cogent presentation** of the solution. I do not need to see every last detail of a calculation. For example, you do not need to show me every last algebraic step. You should, however, present **sufficient detail** in your solution so that I am convinced that you actually worked out the problem and know what you are talking about.
5. **Do not cram** everything together as tightly as possible. I do not care to witness how much paper you can save in doing your homework. Make sure that there is sufficient space between text and equations so that your solution can easily be followed. Important and or lengthy equations should occupy their own lines.
6. **Write neatly!!!** I have little patience for trying to interpret either text or equations.
7. At times you may need to insert a graph that you constructed using something like Mathcad. Such graphs should be **printed out, cut out, and inserted in the appropriate place** in your solution.

III. Oral Homework

As detailed in the schedule below we will spend 8 class periods going over the oral part of the homework assignments. The format for this is as follows. (1) Before class the instructor will randomly assign each problem to a particular student (2) At the beginning of class the assignments will be announced. (3) In turn, each student will get up in front of the class and present his/her solution to the problem. If you are randomly selected to present an oral homework problem and you are absent, then you will receive zero credit for that part of your oral homework grade.

In order for these class periods to work well, you should prepare solutions to all of the oral homework problems **ahead of time**. That way you will be prepared when your number comes up (so to speak).

IV. Homework Due Dates

The written part of each homework assignment is due at the **beginning of class** on the same day that we do the oral homework presentations in class (see the schedule on the next page).

LATE HOMEWORK WILL NOT BE ACCEPTED

That is, **you will receive zero credit for an assignment that is not turned in on time.**

V. Return of Homework

The instructor will make his best effort to return the written assignments within 1 or 2 class periods.

HOMEWORK ASSIGNMENTS

HW Set	Date Due	Written	Oral	Other
1	Jan 18	2.4 3.5	2.1, 2.2, 2.6(a)(c), 2.7(b)(c), 2.8 3.1, 3.2, 3.3	2.3, 2.6(b)(d), 2.7(a)(d), 2.9 3.4
2	Feb 1	4.4 6.4 7.4	4.2, 4.5 5.2, 5.5, 5.8 6.1, 6.3 7.1	4.1, 4.3 5.1, 5.3, 5.4, 5.6, 5.7 6.2 7.2, 7.3
3	Feb 19	8.5 10.4 12.4	8.1, 8.2 9.3 10.1, 10.2, 10.3 11.1 12.1	8.3, 8.4 9.1, 9.2 11.2, 11.3, 11.4, 11.5, 11.6, 11.7 12.2, 12.3
4	Mar 1	13.7 14.4 16.3	13.1, 13.3, 13.6 14.2, 14.5 15.2, 15.3 16.1	13.2, 13.4, 13.5 14.1, 14.3 15.1 16.2
5	Mar 22	17.4 19.2	17.1, 17.3 18.2, 18.3 19.1 20.1, 20.2	17.2, 17.5 18.1, 18.4, 18.5
6	Apr 5	22.3 24.2 25.2	21.1, 21.2 22.1 23.2, 23.3, 23.4 24.3	22.2, 22.4 23.1 24.1, 24.4 25.1, 25.3
7	Apr 19	28.5 29.1	26.1, 26.3, 26.7 27.3, 27.4 28.1, 28.3	26.2, 26.4, 26.5, 26.6 27.1, 27.2, 27.5 28.2, 28.4
8	Apr 26	31.5 32.2	30.1, 30.2 31.1, 31.3 32.1, 32.3	30.3 31.2, 31.4

SCHEDULE

The schedule for the class can be found on the next page. The number in the upper right corner of each box is the lecture number. The page numbers at the bottom center of each box refer to Dr. Torre's text *Foundations of Wave Phenomena*. Due dates for homework are indicated, as are the midterm exams.

Week of	Monday	Tuesday	Wednesday	Thursday	Friday
Jan 7	Course / Syllabus Overview 1		Harmonic Oscillations / Complex Numbers (pp. 1-10) 2		Two Coupled Oscillators / Normal Modes (pp. 15-27) 3
Jan 14	Normal Coordinates / IVP (pp. 15-27) 4		Linear Chain / Normal Modes (pp. 27-34) 5		Homework #1
Jan 21	Martin Luther King Day		Traveling Waves, Standing Waves and the Dispersion Relation (pp. 27-34) 6		Long-Wavelength Limit / Normal Modes (pp. 40-45) 7
Jan 28	1D Wave Eqn. - General Solution / Gaussian Function (pp. 46-55) 8		General Solution w/ Boundary Conditions (pp. 46-55) 9		Homework #2
Feb 4	General Solution using Normal Modes (not in text) 10		Introduction to Fourier Series (pp. 59-64) 11		Midterm Exam I (HW 1 & 2)
Feb 11	Complex Fourier Series (not in text) 12		Vector Spaces / Real Space (pp. 170-176) 13		A Vector Space of Functions (p. 64) 14
Feb 18	President's Day	Homework #3	Dirac Delta Function (pp. 68-69) 15		Intro Fourier Transforms (pp. 65-68) 16
Feb 25	Fourier Transforms and the Wave Equation (pp. 70-75) 17		3D Wave Equation and Plane Waves / 3D Differential Operators (pp. 81-87) 18		Homework #4
March 4	Separation of Variables in Cartesian Coordinates (pp. 90-92) 19		The Wave Equation in Cylindrical Coordinates (pp. 92-102) 20		Midterm Exam II (HW 3 & 4)
March 11	Spring Break	Spring Break	Spring Break	Spring Break	Spring Break
March 18	Separation of Variables in Cylindrical Coordinates (pp. 92-102) 21		Separation of Variables in Spherical Coordinates (pp. 103-111) 22		Homework #5
March 25	Spherical Coordinates II / A Boundary Value Problem / Separation of Variables Summary (pp. 103-111) 23		Energy Density / Energy Flux / Total Energy in 1D (pp. 114-120) 24		Energy Density / Energy Flux / Total Energy in 3D (pp. 120-125) 25
April 1	1D Schrödinger Equation for a Free Particle (pp. 128-133) 26		A Propagating Wave Packet - The Group Velocity (not in text) 27		Homework #6
April 8	A Propagating Wave Packet - Group Velocity Dispersion (not in text) 28		The Uncertainty Principle (not in text) 29		Midterm Exam III (HW 5 & 6)
April 15	Divergence and Curl (pp. 139-143) 30		Maxwell's Equations (pp. 144-151) 31		Homework #7
April 22	Energy Density / Poynting Vector (pp. 151-153) 32		Review 33		Homework #8

EXAMS

I. Overview

There will be a total of four exams, three during the semester and one during the final-exam time slot. Each midterm covers material in two homework assignments. The **final exam is comprehensive**. Dates for the midterm exams can be found on the schedule on the next page. The final exam is scheduled for Wednesday, May 1, 2013, 9:30 a.m. – 11:20 p.m.

At each of the midterm exams you may use the following: (1) a pencil and (2) a 3" × 5" card with anything you want handwritten on it. The card may NOT be larger than 3" × 5", and whatever is on the card must be handwritten. At the final you may use four 3" × 5" cards or an 8.5" × 11" sheet of paper.

To give you an idea of the format of the exams, I have placed copies of several previous midterm exams on the class website. Typically there are several short answer questions and a number of quantitative problems.

II. Rescheduling

There are **only** two valid reasons for rescheduling one of the first three exams. Documentation must be provided for both reasons, as described below.

(1) **Medical.** You may reschedule an exam if you are too sick to take the exam. If you are to sick to take the exam, then you are sick enough to visit the infirmary and obtain a note explaining the extent of your illness. **You must provide the instructor with such a note in order to reschedule an exam for medical reasons..**

(2) **University business.** If you are on travel for university business, then you may reschedule an exam. **Again, you must provide written documentation from the sponsoring organization of your participation in said university business.**

The final exam must be taken during the scheduled time, Wednesday, May 1, 2013, 9:30 a.m. – 11:20 p.m.

EXPECTATIONS

I. What to expect from the course

A. Content. This course is essentially a **mathematical methods of physics course**, couched in terms of wave phenomena. We start with harmonic oscillators and then we move onto the wave equation. Towards the end of the course we look at the Schrödinger equation and spend a little bit of time with Maxwell's equations. Along the way we introduce necessary mathematical concepts such as Fourier series, Fourier transforms, the Dirac delta function, separation of variables, and vector spaces. The concept of orthogonal functions is key, as are multivariable differential operators.

B. Level of Difficulty. This will likely be your **hardest physics course** to date. To be successful in this course you must be able to utilize the math that we are currently studying (or have previously studied) to a variety of problems. At times you may find it extremely helpful to review material from prerequisite math courses previously taken.

II. What the instructor expects from you

A. Participation. The instructor expects you to participate in all aspects of the course. This includes preparing for and attending the lecture, reading the lecture notes, and doing the homework.

B. Effort. The instructor expects you to put in the requisite effort to learn the material in the course so that you are prepared to pass the exams. In addition to the items listed under A. Participation, this includes the steps listed below to get additional help, if needed.

C. Ownership of Learning. The instructor expects you, the student, to take ownership of the learning process. You are ultimately responsible for what you learn.

III. What to expect from the instructor

A. Facilitator. Expect the instructor to be prepared for each lecture, which is where you will be introduced to the different topics in this course. Expect the instructor to answer your questions regarding the material, during class, after class, or during office hours.

B. Evaluator. Expect the instructor to prepare exams that will test you on the material. Do not expect the instructor to be a facilitator during these exams.

NEED HELP?

If you find yourself confused or stuck on a particular topic or are spending an inordinate amount of time on any given homework problem you should try one or more of the following.

- (1) Review the relevant Lecture Notes and/or section in Dr. Torre's text.
- (2) Talk with other students in your class. Ask them to explain things to you (rather than solving the problem for you).
- (3) Seek help from the class instructor, preferably during designated office hours (see first page). If you cannot make it to the designated office hours, then stop by the instructor's office (SER 222B) or send an email (mark.riffe@usu.edu).

LEARNING ASSESSMENT / GRADING

Assessment of your learning will be done via performance on homework and exams. The weights for these components are as follows:

Written Homework 20%
Oral Presentations 15% (1/2 is based on attendance and 1/2 on performance)
Midterm Exams 35%
Final Exam 30%

As is typical of upper-division physics classes, there is no set scale for the assignment of grades. Historically, the class GPA is close to 3.1 (slightly greater than a B).

DISABILITY

Students with ADA-documented physical, sensory, emotional or medical impairments may be eligible for reasonable accommodations. Veterans may also be eligible for services. All accommodations must be coordinated through the Disability Resource Center (DRC) in Room 101 of the University Inn, (435)797-2444 voice, (435)797-0740 TTY, (435)797-2444 VP, or toll free at 1-800-259-2966. Please contact the DRC as early in the semester as possible. Alternate format materials (Braille, large print or digital) are available with advance notice.

POSSIBLE ERRORS

The instructor reserves the right to correct any possible errors to this syllabus.