INTERMEDIATE DYNAMICS

Phys 230 Fall 2013

Instructor:	Professor David Collins
Office:	Wubben 228B
Phone:	248-1787
email:	dacollin@coloradomesa.edu

Office Hours:	TBA
Class Meetings:	MWF 2:00pm-2:50am, Wubben/Science 366
Course Website:	http://www.coloradomesa.edu/~dacollin/teaching/2013Fall/Phys230/index.html
Required Text:	R. D. Knight, *Physics*, Vol 2 (Chs. 16–19), Pearson (2013). G. C. King, *Vibrations and Waves*, Wiley (2009). T. M. Helliwell, Special Relativity, University Science (2010)
Prerequisites:	PHYS 132, 132L and MATH 253

Overview

Phys 230 covers thermodynamics and statistical physics at an introductory level, classical vibrations and waves at an intermediate level and the special theory of relativity.

Thermodynamics and statistical physics describes scenarios in which there are vast number of identical physical systems. By averaging over the microscopic physical properties of individual physical systems, one can arrive at notions of temperature, heat, and entropy which describe collectively to state of the ensemble of physical systems. These basic notions are widely used throughout physics and appear in such diverse areas as bulk magnetism, gas properties, chemistry and atmospheric physics.

Classical waves and vibrations describe physical systems in which there is a repeated basic pattern of motion. These are prevalent in all branches of physics and include springs, simple pendula, electronic circuits, waves on strings, sound waves, light and atoms.

Special relativity describes how different observers can meaningfully make and compare observations and is one of the cornerstones of physics since the early 20^{th} century. The theory of relativity is crucial for a modern understanding of time, space, energy and cosmology.

The course covers:

1. **Thermodynamics:** Fluids.
2. **Thermodynamics:** Temperature, heat, first law of thermodynamics.
3. **Thermodynamics:** Entropy and the second law of thermodynamics.
4. **Thermodynamics:** Kinetic theory of gases.
5. **Special Relativity:** Observers, frames of reference. Principle of relativity.
6. **Special Relativity:** Simultaneity, time dilation, length contraction, Lorentz transformations. Spacetime.
7. **Special Relativity:** Energy and momentum in special relativity.
8. **Vibrations and Waves:** Periodic motion, free damped and forced simple oscillations. Resonance.
9. **Vibrations and Waves:** Classical wave equation. Normal modes. Energy in waves.
10. **Vibrations and Waves:** Interference and diffraction.

Assignments

An undergraduate student should expect to spend on this course a minimum of two hours outside the classroom for every hour in the classroom. The outside hours may vary depending on the number of credit hours or type of course. More details are available from the faculty member or department office and in CMUs Curriculum Policies and Procedures Manual.

1. **Homework:** There will generally be one homework assignment per week. This will be due by 5pm on the date indicated on the assignment. It is in your best interests to work by yourself on the homework problems but collaboration is acceptable. You can discuss the broad outlines of problem solutions with your colleagues but must write your final solutions independently. You are also encouraged to consult me for help with homework problems.

Exams and Quizzes

1. **Class Exams:** There will be two exams during class on the following days:

   Exam 1: 16 September 2013
   Exam 2: 11 October 2013

   Exams will be closed book and closed notes although you will be able to bring a formula sheet. Calculators will be allowed.

2. **Final Exam:** There will be a final exam at **3:00 pm on Monday 9 December 2013**. The final will last one hour and 50 minutes and be comprehensive and closed book although a formula sheet will be allowed. Calculators will be allowed.

Grades

Individual assignments and exams will be graded using suitable scales. In general, to get full credit (100%) for a problem your solution must be correct and well justified. Partial credit will be given for incomplete or partly correct solutions. No credit (0%) will be given for problems not attempted, assignments not turned in or quizzes and exams missed without good reason.

The numerical grades for each component will be totaled and a final numerical grade will be computed according to the following distribution.

Homework	40%
Class Exams	30%
Final Exam	30%

The following final numerical scores will guarantee letter grades:

90%	A
80%	B
70%	C
60%	D

Policies

1. **Helpful Resources:** The Tutorial Learning Center (TLC) is a *free* academic service for all CMU students. Tutors are available in Houston Hall 113 on a walk-in basis for many courses. More information is available at www.coloradomesa.edu/tutoring or 248-1392.

   In coordination with Educational Access Services, reasonable accommodations will be provided for qualified students with disabilities. Please meet with the instructor the first week of class to make arrangements. Nancy Conklin, the Coordinator of Educational Access Services, can be contacted at 248-1826, or in person at Houston Hall 108.

   Helpful advice on student success can be found at:

   http://www.coloradomesa.edu/academics/documents/StudentSuccessatCMU_WCCC.pdf

2. **Withdrawals:** There are several ways to drop this course. The deadline for dropping without penalty is **3 September 2013.** Please consult the MSC academic calendar and catalog for more details about adding and dropping courses.

3. **Attendance:** Attendance policies are described in the CMU catalog. You are expected to attend all the class meetings. In case of illness or other emergencies you must be able to produce the appropriate documentation. There are other circumstances

under which you can be excused but you must discuss these with me in advance. If you miss a class or lab for a valid reason, turn in any assignments due before the start of the next class. Assignments turned in beyond your return to class will not be accepted.

If there is an unavoidable conflict with one of the class exams or the final exam, please discuss it with me as soon as possible. In general I will assume that the final exam will have priority, since you know the dates of the exam.

4. **Academic integrity:** You are expected to present your own work in assignments, exams and quizzes. Fabrication of data, plagiarism, and copying from anyone else, particularly in closed book exams, are serious violation of academic norms. CMU has extensive policies on these matters and penalties for infringement can be severe. For more details, consult the academic integrity policies in the CMU catalog.

Objectives

A student who has taken this course will demonstrate the ability to:

1. Translate between verbal and mathematical descriptions of physical situations. Apply mathematical reasoning, using algebra, trigonometry and calculus, to analyze these situations.
2. Describe physical systems via differential equations and solve these.
3. Use complex number algebra to analyze physical situations.
4. Describe and use fundamental concepts from fluid dynamics such as density, pressure, Archimedes principle, Pascal's principle, the equation of continuity and Bernoulli's equation.
5. Describe and use the zeroth, first and second laws of thermodynamics, particularly for ideal gasses.
6. Describe macroscopic properties of thermodynamic systems and use kinetic theory to relate them to microscopic properties.
7. Relate thermodynamic properties to measurable quantities such as specific heats and use these in calorimetry problems.
8. State Einstein's postulates for special relativity.
9. Relate observations in different frames of reference using time dilation, length contraction, Lorentz transformations, and spacetime diagrams.
10. Describe and use relativistic energy and momentum.
11. Describe and use fundamental concepts associated with oscillations and waves such as period, frequency, wavelength and amplitude.
12. Obtain and solve differential equations of motion for oscillatory systems and use these to extract periods.
13. Describe and solve the classical wave equation and apply these to traveling and standing waves.
14. Describe superposition and interference effects for classical waves.

This course contributes to the fulfillment the following program learning objectives for the BS in Physics degree. A student will have demonstrated the ability to:

1. Show fluency with the major fields of physics (classical mechanics, electromagnetism, statistical physics and quantum theory).
2. Use mathematical representations to analyze physical scenarios. This requires translating back and forth between physical and mathematical problems and using appropriate mathematics to aid in the analysis of the scenario.

Schedule

The following schedule is tentative, except for the dates of the class exams. The text references are: Kn ↔ Knight, *Physics,* Ki ↔ King, *Vibrations and Waves,* and H ↔ Helliwell, *Special Relativity.*

Week	**Dates**	**Topic**
1	8/19 – 8/23	Fluids (Supplementary text).
2	8/26 – 8/30	Temperature, states of matter, ideal gases (Kn Ch 16).
3	9/2 – 9/6	Work, heat and the first law of thermodynamics (Kn Ch 17).
4	9/9 – 9/13	Kinetic theory, entropy, second law (Kn Ch 18).
5	9/16 – 9/20	**Exam I,** Relativity: frames of reference, Einstein's postulates (H Chs 1 – 3).
6	9/23 – 9/27	Time dilation, length contraction, simultaneity (H Chs 4 – 6).
7	9/30 – 10/4	Lorentz transformation, spacetime (H Chs 7 – 9).
8	10/7 – 10/11	Momentum and energy in relativity (H Chs 10 – 13), **Exam II**.
9	10/14– 10/15	Fall break (no classes).
9	10/16 – 10/18	Simple harmonic motion (Ki Ch 1).
10	10/21 – 10/25	Oscillating physical systems, damped oscillators (Ki Ch 1, 2).
11	10/28 – 11/1	Damped and forced oscillators (Ki Ch 2, 3).
12	11/4 – 11/8	Forced oscillators, Complex numbers and oscillations (Ki Ch 3).
13	11/11 – 11/15	Traveling waves (Ki Ch 5).
14	11/18 – 11/22	Traveling and standing waves (Ki Ch 5,6)
15	11/25 – 11/26	Superpositions of waves (Ki Ch 6)
15	11/27 – 11/29	Thanksgiving (no classes).
16	12/2 – 12/6	Interference and diffraction (Ki Ch 7).