PS 303 – Modern Physics
Embry-Riddle University
Fall 2007

Instructor:	M. Anthony Reynolds
email:	`reynodb2@erau.edu`
web:	`http://faculty.erau.edu/reynolds/ps303` (or ERAU online, Blackboard)
phone:	(386) 226-7752
office:	Lehman 313
office hours:	3:30-4:30 MWF and 2:00-3:30 TTh (and by appointment)

Required text: *Modern Physics, 2nd edition,* by Krane

Supplementary: *University Physics, 11th edition*, by Young and Freedman
Quantum Physics, by Eisberg and Resnick
Spacetime Physics, by Taylor and Wheeler

Grading:			*Grading scale*:		
	20%	problem sets		A	90 – 100 %
	60%	3 quizzes-10%, 2 exams-15%		B	75 – 90 %
	20%	two-hour final exam		C	60 – 75 %
	~8%	*challenge work*		D	50 – 60 %

Problem Sets: Assigned weekly, and due at the beginning of class. Graded for correctness. Late work (one class period) will be given half credit.

Exams: 3 half-hour quizzes (9/7, 9/26, 10/10); 2 one-hour exams (10/31, 11/30). No make-ups.

Final exam: Mon 10 Dec, 12:30 pm – 2:30 pm. Two-hours. Comprehensive.

Holidays: Mon, 3 Sep (Labor Day); Fri, 9 Oct (University Day); Mon, 12 Oct (Veteran's Day); Wed – Fri, 21-23 Nov (Thanksgiving)

IMPORTANT NOTE

Listening to lectures is not enough (*you retain only 10% of what you hear* …). All processes of learning are somehow connected to active participation, and the learning of physics is no exception. Therefore, it is imperative that you work diligently at your own desk (… *80% of what you practice* …). However, this does not mean that you should only work alone. I encourage you to form study groups and collaborate with your classmates (… *and 90% of what you teach to others!*).

Course Description: Modern concepts in physics. Topics include special relativity, physical optics, wave-particle duality, the uncertainty principle, elementary quantum mechanics, atomic and molecular structure, and nuclear reactions. **Prerequisites**: PS 219 or PS 250; MA 345 recommended

Learning Outcomes:

1. Define: Interference and diffraction, the Born postulates, physical constraints on a wave function and its derivatives, the probability of finding a particle in a given region of space from a known wave function, wave packets and photons, the momentum operator, the energy operator, the Hamiltonian, the normal Zeeman effect, proper time, proper length, nuclear fission and fusion, Einstein's postulates of the special theory.
2. Discuss: The failure of the Galilean transformations, Einstein's two postulates, the photoelectric effect, Compton scattering, the de Broglie hypothesis, the wave-particle duality of light and matter, the Heisenberg indeterminacy principle, the one-dimensional square barrier and its application to tunneling, the Pauli exclusion principle.
3. Solve Problems In: Intensity patterns for a single slit, thin film application, special theory of relativity, relativistic momentum and kinetic energy, the total relativistic energy, wavelengths of material bodies, the expectation values of the Schrodinger equation in one dimension and three dimensions for a particle in a box and for the simple harmonic oscillator, for a free particle, and the normalization of wave functions.
4. Use: Both orbital and spin angular momentum and their magnetic moments, the total angular momentum to study interactions among electrons of the same atom as well as with external electric and magnetic fields.
5. Derive: The Lorentz contraction, time dilation, the energy of the hydrogen atom from the Born postulates, the solutions of the Schrodinger equation in one dimension.
6. Evaluate: Absorption and emission energy using energy level diagrams and employ the selection rules.
7. Calculate: Energy level diagrams of a particle in a potential well, a simple harmonic oscillation and hydrogen-like systems.
8. Demonstrate: Very basic understanding of elementary nuclear physics, lasers, superconductivity, electron spin and nuclear magnetic resonance.

Code of Behavior

In order for learning to take place, we all must act with civility (formal politeness) and respect (polite consideration, courtesy) toward each other. My responsibilities include coming to class prepared and on time, and evaluating you in a fair and impartial manner. Your responsibilities include coming to class prepared and on time, not disrupting the class (for example, talking without being called on, eating, reading newspapers, sleeping, shuffling papers, talking on cell phones, etc.), and treating your fellow students as colleagues (see the Student Handbook). Violations of this code can result in your removal from the class.

Academic Integrity

Issues of academic integrity are discussed on page 24 of the Student Handbook. They include plagiarism, cheating and fraud. Please read this section, and if you do not understand it, come see me. Some important passages are reproduced here:

"Sanctions [for academic dishonesty] may include failure of a test or assignment, failure of a course, suspension, or dismissal from the University."

"Plagiarism is recognized by the University as an act of academic dishonesty. It is defined as taking the ideas, writings, work, and/or words of another and representing them as one's own."

Office hours

I am always in my office during my office hours, and this is your time to speak with me about any aspect of the course. Also, I am generally in my office between 9 am and 5 pm, and available at times other than my office hours. However, I may be teaching or doing research, and may not be available immediately. If you need to speak with me, drop by or call me and set up an appointment.

Attendance

Class attendance is strongly encouraged. If you miss a class you are still responsible for the material presented in lecture. Make friends with your classmates, and know what has been discussed.

Reading

The textbook is your primary source of information – not lecture. If you don't like the assigned text, find one that you do like (they are all essentially equivalent) – check one out of the library or buy one from a used bookstore. Reading the text is mandatory and is to be done *before* each class. It is extremely important that you come to class prepared to think and discuss the day's topic. Not knowing that topic is a serious detriment to learning. The schedule is listed at the end of this syllabus. *How* to read the textbook is suggested below.

Notes

Taking notes during lecture is important – but you must review and re-copy those notes after class (within a few hours) for them to be useful. Notes that are never reviewed are less than worthless: they give you a false sense of security. It is important that you get into the habit studying every day.

General study habits

Repetition is critical for creating long-term memories. A good method for learning is the following sequence: read, listen, write, re-read, re-write, practice, and review. The textbook should be read THREE times: read once before class, read deeply (at least) once after class, and once as a review. In addition, you do not read textbooks as you would the newspaper. You must work through the examples, all mathematical steps should be confirmed, and you should write notes in the margins (it is your book, you can write in it!).

Problem Sets

Several problems will be assigned every week, and are due at the beginning of the class period on the due date. Each solution will be graded on a scale of 0 to 10. These problem sets are **critical** to your success in this course. Not only are they worth 20% of your grade, but also because the exam problems will be very similar to the homework problems, and solving the problems well will boost your exam performance. I suggest that you solve other problems as well, as practice for the exam, and most of the problems in the text are good for this.

In order to obtain full credit for each problem solution, you must solve it according to the following rules of coherence and readability:

- Describe *briefly*, but in clear and complete sentences, the basic principles used to solve the problem and explain the basic equations that are used in the solution [DO NOT simply rewrite the question].
- If a physical situation is discussed in the problem, draw an appropriate diagram.
- Identify in words, or by clear references to the diagram, all the symbols you use.
- Work through the problem symbolically, getting a simplified symbolic answer, and only substitute numbers (if appropriate at all) at the very end.
- If you obtain an explicit numerical solution, comment on whether the value you get is reasonable.
- Put boxes around your final answers.
- Write up the problem sets neatly.

Do not simply copy another student's work (see the statement about plagiarism above), and do not simply copy from the solutions manual, but I recommend that you form study groups and work together. This can help you through difficult sections and problems. I encourage you to discuss, argue, arm-wrestle, and finally master the problems. However, I expect you to write up your solutions individually, showing your own insights.

Finally, the problem set solutions must be neat, stapled, and have your name clearly written. Unstapled solutions will not be graded. Unreadable solutions will not be graded.

Exams

3 half-hour quizzes, 2 one-hour in-class exams, and one two-hour final exam will be given. All exams are closed book and closed notes. An excellent method to prepare for the exams is to attempt problems at home in an exam-type environment. That is, once you have solved a group of problems, put aside the solutions and pretend that they are questions on an exam – attempt to solve them again, but without any help. If you can do this with several problems from each section, you should do fine on the exams.

Challenge Work

Two types of challenge work can be turned in for extra credit.

First, I will hand out a list of challenge problems. You may turn in one solution per week. These problems are more difficult than the problem sets in that they usually require a synthesis of many of the concepts and techniques that you have learned. Each correct challenge problem will count for 25% - 50% of one problem set.

Second, I will assign articles from Scientific American and Physics Today. You are to read the article and write a short (1-2 pages, single spaced, minimum 500 words) report, detailing how the article relates to what you have learned in class. You may hand in one report before each exam, and credit will be equivalent to one problem set.

Grading System

From page 26 of the Student Handbook: "The following grades are used by the faculty to indicate the quality of work performed." (*I have added my own interpretations in italics.*)

A = Superior (*Performance of the student has been of the highest level, showing sustained excellence in meeting course responsibilities*)
B = Above Average (*Performance of the student has been good, though not of the highest level*)
C = Average (*Performance of the student has been adequate, satisfactorily meeting the course requirements*)
D = Below Average (*Performance of the student has been less than adequate*)
F = Failure (*Performance of the student has been such that course requirements have not been met.*)

Your success in this course depends on you alone. You must be self-critical and determine the method by which you study best. Whatever method you use, I believe that success requires a minimum of **six (6)** hours per week **outside** of lecture. Come see me if you desire suggestions on time management, study hints, or anything that will help you succeed in this course.

You also need adequate sleep and exercise. If you don't get these, your body will not be able to function well (even though your mind is willing).

Preliminary schedule

	Krane	Young
Preliminaries		
Historical Preview		
Physics circa 1900	Ch 1	4.1, 32.1
Physics circa 2000	14.1	44.1
Relativity	2.1	37.1, 8
Quantum Mechanics		38.1

Introduction to …

… Particle Physics		
Matter	14.2, 14.3, 14.9	44.4
Antimatter	14.2	
Mass		
Binding Energy	12.3	43.2
Classification according to mass	14.8	
Electric Charge		
Interactions, not Forces		44.3
Spin	7.4, 7.5	41.3
Nuclear constituents	12.1	
Classification according to spin	8.1	
Pauli Exclusion Principle		41.4
[Interlude: Magnetic moment and the Stern-Gerlach experiment]	7.5	27.7
Discovery of the Neutron	12.1	
Color Charge	14.1, 14.8	44.4
Color force		
Strong Interaction	12.4	
Yukawa's meson	14.3	
Heisenberg Uncertainty Principle	4.3	39.3
Weak Interaction	14.4	44.5
… Nuclear Physics	12.1, 12.2	43.1,43.6
Mass	12.3	43.2
Electric Charge		
Spin		43.1
Magnetic moment		43.1
Color		
Size		43.1
Radioactivity	12.5,12.10	43.3
Discovery of radioactivy		
Radioactive Decay	12.6	43.4
gamma	12.9	
beta	12.8	
alpha	12.7	
Models - shell - liquid drop		43.2
Fusion	13.5	43.8
Fission	13.4	43.7
radioisotope power generation	13.2	
… Atomic Physics	Ch 1	41.1
Properties: mass, etc.	6.1, 8.4	
Atomic spectra	6.4	38.1, 38.3
Angstrom		
Balmer		
Rutherford-Bohr model	6.5, 6.8	38.5
Rutherford scattering	6.3	
Scattering Theory	6.3	
Stationary states	6.5	
Angular momentum	6.8	
Helium		41.4
Quantum numbers	7.6	
Fine structure	7.8	
Periodic table	7.6, 8.2, 8.3	41.4
Moseley & X-rays	8.5	41.5