PS 303 – Modern Physics
Embry-Riddle University
Spring 2008

Instructor: M. Anthony Reynolds
email: reynodb2@erau.edu
web: http://faculty.erau.edu/reynolds/ps303 (or Blackboard)
phone: (386) 226-7752
office: Lehman 313
office hours: 8:00-9:00 and 10:30-11:30 MWF (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

Point system:

1 final exam	200 points	200
3 tests	200 points each	600
120 problems	1 point each	120
30 quizzes	2 points each	60
3 group problems	10 points each	30
3 reports	10 points each	30
13 challenge problems	4 points each	52

Grading scale:

A	900 –
B	750 – 899
C	600 – 749
D	500 – 599

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.

RULES

1. Arrive on time; depart on time.
2. Take notes, and bring calculator to each class.
3. No eating, no cell phones.

Final Exam

Comprehensive; two-hour; closed book; closed notes.
Tools: pen or pencil, scientific calculator, 3x5 card (both sides) for equations.
Date: Monday, 29 April, 2:45 pm – 4:45 pm.

Tests

One-hour; closed book; closed notes.
Tools: pen or pencil, scientific calculator.
Dates: Wed 6 February, Wed 5 March, Wed 9 April.
Final exam will count for one missed test.

Problems

Ten sets; 12 problems each; must be neat and stapled.
Due Dates: approximately one per week.
Graded on correctness and effort.

Quizzes

First 5 minutes of each class.
Tools: pen or pencil, scientific calculator.

Group Problems

Three experiments; groups of 3-4.
Due Dates: 23 January, 20 February, 24 March.
Group report: one page, single-spaced; answer assigned questions.

Reports

Three reports on assigned articles.
Due Dates: 30 January, 27 February, 31 March.
One page, single-spaced, minimum 500 words; answer assigned questions.

Grading:		
	<500 words	-1 point
	<400 words	-2 points
	1-4 grammatical errors	-1 point
	5 or more errors	-2 points
	Each question not answered	-1 point

Challenge Problems

Due Dates: each Friday (18 January – 18 April).

All assignments are due at the *beginning* of class on the due date, after which they will be considered late and the score will be reduced by 50%. After the beginning of the *next* class period, they will not be accepted.

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!).

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.

Problem Solving

Solving problems is **critical** to your success in this course. 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. Solve problems 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.

Study Groups

"For most individuals, learning is most effectively carried out via social interactions." (Ed Redish) I strongly suggest that you form study groups.