COURSE SYLLABUS
PHYSICS 252: PHYSICS III

Description:
A third course in physics covering geometrical optics, interference, diffraction, quantum theory, waves and particles, atomic physics, special relativity, radioactivity, and nuclear physics. Prerequisite: PHYS 251.

Optional Text:
No specific textbook is required but any calculus-based, introductory physics textbook is a good resource for supplemental readings and practice problems. One recommendation is the free on-line textbook *University Physics* by OpenStax (Volumes 1 and 2). Access at *openstax.org/details/books/university-physics-volume-1* and *openstax.org/details/books/university-physics-volume-2*

Instructor: Dr. John Varriano

Office: AH 011 E-mail: *jvarrian@cbu.edu*
Phone: 3439 (office) Home Page: *http://www.cbu.edu/~jvarrian*
685-9551 (home)

Office Hours:
I will announce office hours in class. Feel free to check to see if I am in at other times as well.

Goals:
1. To continue your familiarization with the scientific models that we use to describe Nature, particularly those models that deal with light, atomic particles, and nuclear processes. To deepen your appreciation of Nature.
2. To obtain a certain level of mastery in using these models to predict outcomes of physical interactions. (*The determination of your grade is based mostly on how well you achieve this goal*.)
3. To learn about certain applications of optical, atomic, and nuclear phenomena.
4. To learn about the relative sizes of the physical quantities that are used in the models. To learn what is a reasonable size for each of these quantities.
5. To increase your analytic reasoning, mathematical skills, and build your scientific vocabulary so that you can be an active member in today's technical world.

Topic Prerequisites:
- basic algebra, trigonometry, calculus (differentiation & integration)
- Newton's Laws of Motion and Law of Gravity
- Laws of Conservation of Energy & Conservation of Momentum
- electric & magnetic fields

Outline:
Part 1: Light & Geometric Optics
- nature of light
- geometric ray model of light: reflection, refraction, image formation

Part 2: Physical Optics
- wave model of light: interference, diffraction, polarization

Part 3: Quantum Theory
- photon model of light, quantization of energy
- atomic physics, Bohr model of atom
- wave-particle duality, quantum mechanics

Part 4: Special Theory of Relativity
- relativistic motion & energy

Part 5: Nuclear Physics
- nuclear structure, radioactivity, nuclear reactions

Grading:
There will be 4 tests during the semester and a comprehensive final exam. Each test is worth 100 points and the final exam is worth 300 points. There will be 100 points from 10 collected homework problems. There will be 100 points from 11 computer homework problems. If you miss 3 or fewer classes, your lowest test score will be dropped. If the final exam is your lowest test score, then it will be worth 200 points. Your final grade will be determined by dividing your total points by 900 (if you miss more than 3 classes) or 800 (if you miss 3 or fewer classes) and using the following percentage point scale:

0-59.9% → F / 60-69.9% → D / 70-81.9% → C / 82-92.9% → B / 93-100% → A

Tests/Final Exam:
Tests 1-3 will cover only the material discussed in each relevant part of the course. Test 4 will cover Parts 4&5. The final exam will be comprehensive. A single side of an 8.5" x 11" sheet of paper filled with handwritten notes is permitted for each test. Two sides of a sheet are permitted for the final exam. Tentative test dates are:

① Wed. Sep. 11 / ② Wed. Oct. 2 / ③ Wed. Nov. 6 / ④ Wed. Dec. 4

Absences:
Please make an effort to attend every class. You are responsible for the material covered and assignments given in each class. If you cannot make it to a test and have a valid excuse, let me know before the test date so that arrangements can be made to take the test at another time. Make-up tests will be available if you miss a test with no prior warning but you will be penalized 20 points. There will be no make-up final exam.

Homework:

a. Practice Problems:
Practice problems will be assigned from the book and supplemental problem collection at every class (refer to the Problem Outline). These will not be collected or graded but may appear on the tests and final exam.

b. Collected Problems:
Collected problems will usually be due one week after they are assigned. I will try to grade them and get them back to you by the following class. You are provided with most of the answers to the problems.

If you score less than an 8 on a problem, you may redo the problem. I will then regrade the problem, obtain a new point total, and then subtract 2 points. Thus, the maximum score that you can obtain on a resubmitted problem is 8 points. The problem must be resubmitted by two weeks after the original due date or by the last class of the semester (whichever comes first). The purpose of this policy is to give you the opportunity to learn from your mistakes. Come and seek my help if you don't understand how to solve a problem correctly.

Late problems will be treated as resubmitted problems. That is, they are subject to the 2 -week deadline and 2 points will be subtracted from the point score. No problem will be accepted 2 weeks after the original due date.

The collected problems should be done according to the following format. You will be docked points or the problem may not be accepted if the format is not followed, regardless of your final answer.

(1)Describe the problem.
State the problem you are to solve. Use your own words or copy the problem from the book or hand-out. As you write the problem, think about the kind of problem it is and possible useful models you can use to solve it.
(2)Define the givens.
Define a symbol for each given and set the symbol equal to the given value with units included.
(3)Define the objective.
Define a symbol for the unknown that you will be solving for. State the units that you expect for the unknown. Make clear what you are to find or prove.
(4)Draw a diagram.
Include the symbols for the known and unknown quantities on the diagram. (Drawing a diagram is one of the most powerful tools in solving problems. You MUST have a diagram or I will NOT accept the problem.)
(5)Set up the attack.
Write down the laws or basic equations that you will use. Include the names of the laws or describe the equations in words. Use symbols in the equations that you have defined above.
(6)Show the work and solve the problem.
Solve for your unknown. Show the algebra. Include units when you substitute in for a given quantity. Make sure that units cancel to give you the proper units for your answer. Circle or box your answer and include the units!
(*A word of advice:* It is best to solve for the unknown in terms of the symbols first, and then substitute in the known values at the end of the algebra to find the final answer. This avoids carrying around numbers and units in the algebraic steps and reduces the likelihood of error. Also, by solving for the unknown in terms of the symbols, you can easily find how the answer changes if one of the given quantities changes. That is, you can readily see how the unknown quantity depends on the known quantities.)
(7)Check your answers.
State if your answer seems reasonable. State if your answer has the correct units. (You can often catch a mistake by simply double checking your answer.)

c. Computer Problems:

There are 11 computer problems that are to be completed. The computer problems are an excellent way to assist you in your learning. The computer will tell you if your answer is correct to each question of a particular problem and tell you how to go about solving the question. You can redo each problem as often as you like. Your scores are recorded by the computer in a file and can be sent to me via e-mail. I will count only your best score for each problem.

Each problem is worth 10 points as tallied by the computer. I will halve two of the scores as shown below for a possible total of 100 points for all of the problems. If you perform all of the Volume 5 problems **on time** and receive a perfect score, you earn **10 bonus points.** If you perform all of the Volume 6 problems **on time** and receive a perfect score, you earn **10 bonus points.** Late computer problems will be accepted up until the last class of the semester with a 20% penalty.

Computer problems and due dates:

Vol	No.	Title	Pts.	Due Date	Relevant for:
5	1	Snell's Law	10	Aug 30	Part 1
	2	Thin Lenses	10	Sep 9	"
	3	The Double Slit	5	Sep 23	Part 2
	4	Resolution	10	Sep 30	"
	5	Photons	10	Oct 23	Part 3
	6	Hydrogen Atom	10	Oct 30	"
	7	Laser	5	Nov 6	"
6	1	Relativity 1	10	Nov 20	Part 4
	2	Relativity 2	10	Nov 27	"
	4	Half-Life	10	Dec 6	"
	5	Nuclear Decay	10	Dec 6	"

The problems can be downloaded from my home page (*facstaff.cbu.edu/~jvarrian*). From the title page, select "My Courses". Click on the "Download" button and follow the instructions to run the programs and to send me your score file.

And remember: ☺ Physics is fun!

COLLECTED PROBLEM FORMAT: AN EXAMPLE

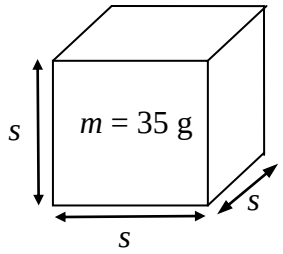
A uniform, solid, copper cube has a mass of 35 grams. How long is one of its sides? Copper has a density of 8.9 grams/cm^3.

① A solid copper cube has a uniform density of 8.9 g/cm^3. Its mass is 35 g. Find the lengths of the sides of the cube.

② density $\rho = 8.9$ g/cm^3
mass $m = 35$ g

③ length of any side $s = ?$ cm

④



⑤ The density of an object is given by

$$\rho = \frac{\text{mass}}{\text{volume}} = \frac{m}{V} \ . \qquad (1)$$

The volume of a cube is

$$V = s^3 \qquad (2)$$

I will solve for the length *s* by combining Equs. (1) & (2). I can substitute Eq. (2) into *V* in Eq. (1). This will give me one equation with the one unknown *s*. I can then solve that equation for *s*.

⑥ Substituting (2) into (1) gives

$$\rho = \frac{m}{s^3} \qquad (3)$$

Solving for *s* gives $s^3 = \frac{m}{\rho}$

$$s = \left[\frac{m}{\rho}\right]^{1/3} \qquad (4)$$

$$= \left[\frac{35\ \text{g}}{8.9\ \text{g/cm}^3}\right]^{1/3} \qquad \text{units: } \left[\frac{\text{g}}{\text{g/cm}^3}\right]^{1/3} = \left[\text{cm}^3\right]^{1/3} = \text{cm}$$

$$\boxed{s = 1.58\ \text{cm}}$$

Since each side of a cube has the same length, all sides are 1.58 cm long.

⑦ The units check. I do get units of cm for the length of a side as expected. The length of 1.58 cm seems reasonable. The cube measures approximately 5/8 of an inch on each side. Its mass of 35 grams corresponds to a weight of about 1.2 ounces. This seems consistent with my experience in handling copper objects.