General Physics II

PHY 162.002 --- Spring 2017 Syllabus
Physics Department --- Mercer University

Text (eBook): Fundamentals of Physics, 9th edition, by Halliday, Resnick and Walker
Class Lecture Meetings: MWF 12:00-12:50pm in SEB 144
Lab Meetings: R 9:25-12:05pm in SEB 214
Instructor (including labs): Dr. Jose L. Balduz Jr.
email: balduz_jl@mercer.edu**, office:** SEB 205, **phone:** 478-301-2229
(tentative) office hours: T 10am-12, R 4-6pm, or by appointment (try email)...
Course web page: http://physics.mercer.edu/Balduz/GenPhys/phy162home.htm
Please also see Physics Department home page at http://physics.mercer.edu.
WebAssign enrollment key: mercer 1107 4208

Pre-requisite (C or better): **MAT 191 Calculus I**, **PHY 161 General Physics I**.
Co-requisite or pre-requisite: **MAT 192 Calculus II**.

This course is the second in the two-semester sequence **PHY 161/162 General Physics I/II**, a calculus-based introduction to physics. The main themes in this course are electricity and magnetism, oscillations and waves. The course contains both lecture and lab components that will help students learn to think scientifically about the physical world. Following a brief introduction we will consider a series of topics: **Electric Charges and Fields, Gauss' Law, Electric Potentials, Capacitance, Current and Resistance, Circuits, Magnetic Fields, Induction, Oscillations and Waves,.** This course is intended primarily for physics, chemistry, math, and engineering majors, but is also recommended for others with good mathematical aptitude, including pre-med students and life sciences majors. Students should have a working knowledge of geometry, algebra, trigonometry and calculus. The courses **MAT 191 Calculus I** and **PHY 161** are pre-requisites: Students must have prior academic credit with a grade of C or better. The course **MAT 192 Calculus II** is co-requisite: Students must be concurrently enrolled or have equivalent prior academic credit.

Nature behaves in predictable ways which scientists, over hundreds of years, have formulated into a set of basic physical laws. In the lecture portion of this course, students will learn some of these laws and use them to analyze systems mathematically, reach qualitative conclusions, and compute accurately numerical answers to specific questions. Although we will cover a number of topics and physical systems, the students' goal should be to learn to think about nature broadly, and solve problems by specific application of general principles, as physicists do.

The ultimate validity of these natural laws always rests on experimental evidence. In the lab portion of this course we will illustrate, by experiment, a portion of those laws describing the behavior of simple mechanical, optical, and electromagnetic systems. In the process, students will gain basic concepts and procedures of physics laboratory work. They will become familiar with simple experimental apparatus and construct simple devices; measure quantities such as length, frequency, current, voltage, capacitance; compute derived quantities from the data, and perform basic statistical analysis of the data and the derived quantities; and reason from this analysis to answer questions and arrive at logically sound conclusions about the physical world. This process will help them to master the concepts introduced in the lectures, by showing them in action in the laboratory setting. Although we will investigate a number of specific physical systems, students' goal should be to learn to think about nature and perform experiments as physicists do.

The following topics will be studied in this course:

Oscillations, Waves and Optics

Textbook chapters

- 15 Oscillations
- 16 Waves I
- 17 Waves II

Potential lab exercises

- Periodic Motion: Pendulum
- Periodic Motion: Mass/Spring System
- Standing Waves 1 & 2
- Standing Waves in Air
- Reflection and Refraction
- Geometric Optics 1 & 2

Electricity and Magnetism

Textbook chapters

- 21 Electric Charge
- 22 Electric Fields
- 23 Gauss' Law
- 24 Electric Potential
- 25 Capacitance
- 26 Current and Resistance
- 27 Circuits
- 28 Magnetic Fields
- 29 Magnetic Fields due to Currents
- 30 Induction and Inductance

Potential lab exercises

- *Coulomb's Law: Electroscope*
- Electric Fields and Equipotentials
- Capacitance
- Resistance and Resistivity
- Series and Parallel Resistive Circuits
- Kirchhoff's Laws
- RC Circuits and the Oscilloscope
- Magnetic Fields
- Electric Motors
- *Faraday's Law and Joule Heating*
- *LRC Circuits and Resonance*

Pre-requisite mathematical skills needed to master the course material:

- Familiarity with basic arithmetic and the functions of a scientific calculator;
- Ability to use basic geometrical concepts, including length, area and volume; and relations between lines, polygons and angles;
- Ability to analyze triangles by use of trigonometry;
- Ability to use symbolic manipulation of variables, to solve linear, quadratic, and other simple algebraic equations, and to solve simultaneous equations in multiple variables;
- Familiarity with special functions: exponentials, logarithms, trig functions and their inverses;
- Familiarity with the concepts of differential and integral calculus;
- Ability to apply the rules of differential calculus.

Pre-requisite physics knowledge and skills gained in previous coursework (e.g. PHY 161 or PHY 141), needed to master the course material:

- Conversion of units of physical quantities by using conversion factors and dimensional analysis
- Understanding of the concepts of position, velocity and acceleration;
- Ability to use equations of linear kinematics to describe the motion of point objects;
- Understanding of the concepts of mass and force;
- Ability to analyze and predict the motion of point objects using Newton's Laws;
- Ability to distinguish between vector and scalar quantities and use the rules for their manipulation;
- Ability to use vectors to describe physical observations in two or three dimensions and analyze motion;
- Understanding of the concepts of center of mass, momentum and energy, and the ability to use conservation principles to constrain and predict motion of point objects;
- Understanding of the concepts of angular position, angular velocity and angular acceleration;
- Ability to use equations of rotational kinematics to describe rotating objects;
- Understanding of the concepts of moment of inertia and torque;
- Ability to analyze and predict rotational motion using Newton's Laws;

Students will improve their abilities in the following general areas during successful completion of this course:

- **Conceptual understanding:** Ability to describe and explain the physics concepts relevant to physical systems of interest.
- **Problem solving:** Ability to analyze a complex problem by setting up the mathematical description of the relevant physical system, and planning and carrying out the calculation of numerical predictions for measurable properties of the system, using basic logic and critical thinking, as well as basic mathematical tools (algebra, trigonometry, calculus).
- **Practical laboratory skills:** Experience working in groups on a laboratory experiment, setting up laboratory equipment safely and efficiently, collaborating on lab reports. Ability to creatively plan and carry out experimental procedures; to collect, analyze and interpret experimental data; to identify possible sources of error and implement techniques that enhance precision; to report the experimental data, results, and assessment of reliability in clear and concise manner.

Students will gain the following specific conceptual understanding and practical abilities during successful completion of this course:

Oscillations, Waves and Optics

- Describe the relations among displacement, velocity, and acceleration for an oscillatory system.
- Use the kinematic equations for simple harmonic motion.
- Use force, momentum and energy to predict the dynamics of simple harmonic motion.
- Predict the period of oscillations for a mass on a spring, and for a simple pendulum.
- Relate simple harmonic motion to circular motion.
- Describe wave motion in terms of oscillations, including superposition and interference.
- Analyze wave motion using basic kinematic parameters including period, frequency, wavelength and speed.

- Describe and analyze the nature of standing waves.
- Describe qualitative the nature of sound waves.
- Relate the speed of sound waves to basic mechanical properties of the medium.
- Define and relate sound intensity and sound level.
- Describe and analyze sound phenomena: beats and the Doppler Effect.
- Describe the electric and magnetic fields involved in the propagation of light.
- Describe and analyze the polarization of light.
- Use the reflection law and Snell's law to analyze light reflection and refraction.
- Predict image formation by mirrors and thin lenses using ray optics.

<u>Electricity and Magnetism</u>

- Explain the nature of electric charge, including its quantization and conservation.
- Explain the difference between conductors and insulators, and the role of the dielectric constant.
- Apply the concepts of electric fields, electric flux, electric potential, and electric potential energy to relevant problems.
- Describe the shape of electric field lines for simple arrangements of static charges.
- Use Coulomb's Law to analyze electric forces acting on point charges and electric dipoles, for simple arrangements of static charges.
- Apply Gauss' Law to analyze electric fields in situations with spherical, planar or cylindrical symmetry.
- Calculate electric potential for simple arrangements of static charges.
- Calculate the electric field from the electric potential, and vice versa.
- Analyze capacitors, including the role of dielectrics.
- Explain concepts relevant to electric circuits, like current, potential difference, resistance, resistivity, power and emf.
- Analyze resistive circuits using Ohm's Law, combination rules, and Kirchhoff's Rules.
- Explain and predict the behavior of simple RC electric circuits.
- Explain the nature of magnets and magnetic forces.
- Apply the concepts of magnetic fields and magnetic flux to relevant problems.
- Describe the shape of magnetic field lines for simple arrangements of static magnets.
- Apply Ampere's Law to analyze magnetic fields in situations with cylindrical or toroidal symmetry.
- Predict the magnetic forces and torques acting on static currents and magnetic dipoles.
- Use Ampere's Law to analyze magnetic fields generated by simple circuits, including coils, solenoids and toroids.
- Use Faraday's Law and Lentz's Law to describe induced emf.
- Explain how an electric motor works.
- Explain how an electric generator works.

COURSE MECHANICS

<u>WebAssign and the eBook</u>: Each student in the course must obtain an online account with WebAssign that will cost $90.70, due on or before Janaurry 23. It will provide access to (a) the online homework assignments and other problems, and (b) the HRW9 eBook. Relevant links will be provided on the course webpage. A regular hardcover textbook is also available at the campus bookstore and elsewhere. Homework and exam solutions will be posted here after these are graded.

<u>Course web page</u>: During lecture class meetings the instructor will use both a projector and the whiteboard. Most material presented on the projector in class will be available on the course homepage: basic conceptual material, examples and solutions to textbook problems. In addition, other materials which cannot be presented in class due to time constraints will be posted on the web page: additional textbook problems, old quizzes and exams, and additional practice exam problems. Former students have said that the course web page was very helpful to them, so every student should make good use of this resource.

<u>Lecture sessions</u>: During scheduled "lecture" class periods we will have reading quizzes, lectures on the reading assignments, group work and exams. During lectures, the instructor will give a conceptual and theoretical overview of the course material, present examples, go over solutions to textbook problems, answer questions and ask questions to stimulate thinking and discussion. We will often access and use an online version of the text.

<u>Office hours</u>: Please come see me! If you're doing well in the course, we can talk about physics concepts and the big picture; or about your life after Mercer; or other things... If you're not doing so well in this class, I can try to help you one-on-one, before you get too far behind. Typically that means talking about the material with you, but also having you work problems with me right in my office. There's no substitute for working through a problem yourself, with someone by your side that knows the way...

<u>Lab sessions</u>: Each student will be a member of a lab group. Students may form groups as they wish for each lab exercise. All data collection will be performed by the group. After that, each group must work to complete all data analysis, i.e. data tables and required graphs, before leaving the lab. Often, students will have enough time to complete the entire lab procedure and the analysis during one session. Other times, there will not be enough time during the session, and it will be necessary to finish the analysis later. During each lab session, each student is obligated to a) attend the entire session, b) work successfully with the group to collect the data, and c) help the group carry out the required analysis during the session. Typically, students will not be able to leave the lab session early: Any student who arrives late, fails to contribute to the group work, acts in a disruptive manner, or leaves early without instructor permission will suffer a penalty to their grade for that lab.

<u>Assessment tests</u>: Each student is required to participate in testing for assessment purposes, which may lead to a course grade bonus. At the beginning of the course, students will be asked to individually complete a conceptual test on electricity and magnetism, the **pre-test**. The pre-test score itself will not form part of any student's grade. At the end of the course, students will be asked to individually complete another conceptual test, the **post-test**. The overall pre-test and post-test results will be used by the physics department in the assessment of our program success. If a student completes both tests, the post-test result will be used to grant them a bonus on their course grade of up to +1%: a score of 50% or better will yield +0.25% bonus, 60% or better will yield +0.50% bonus, 70% or better will yield +0.75% bonus, and 80% or better will yield +1.00% (Bonuses are non-cumulative.). <u>Note</u>: In order to receive any course grade bonus, a student must take both the pre-test and the post-test, unless that student was excused from the pre-test: For each test, they must complete it to the best of their ability, and completely and accurately enter their name, student ID and other information on the answer sheet.

Reading assignments / Reading quizzes (10% of total grade): Before discussing a topic in class, it is vital that each student be at least somewhat familiar with the content. To this end, students will receive a series of reading assignments, to be completed before a specific day of class. Before we begin to cover the relevant material in class, we will have an individual reading quiz. This will be brief, and will consist of a few conceptual questions, with no numerical calculations. The reading quizzes will be *closed-book:* I.e., students are not allowed use of a textbook, notes or devices.

Classwork (15% of total grade): After a topic has been introduced via the reading assignment, reading quiz, lecture, and examples, students will be given a set of problems to solve in class. Students may work independently, but group work is *encouraged*. Nevertheless, each student must turn in a separate sheet(s) with their own work and their own name and signature. Classwork will be *open-book*. In most instances, work that is not successfully completed in class may be taken home, completed, and turned into the instructor at the start of the following lecture session.

Homework (one per chapter, for 10% of total grade): Each student will use WebAssign to complete a homework assignment for each chapter. Students may work individually or in groups, and they may use the textbook or any other resources except for the Instructor's Solutions Manual, which is considered off-limits. Although you are encouraged to work together, each student must submit their own answers, by the due date, electronically in their own account to receive credit.

Lab work (15% of total grade):

Lab reports: For most labs, students must submit reports containing data tables, graphs, conclusions, and answers to additional questions: For details please see "*Lab Report Guidelines.*" In most cases, reports will be prepared after the lab session and will be due on the day of the next lab session. The students in each group must either submit individual reports or a group report as they wish. For any report, each student who helped to prepare it must sign it, and everybody who signs it will receive the same grade. Depending on the amount of work involved, each report will be worth a variable number of points ranging from 50 to 100. In cases where all report elements are required, the number of points will be close to 100: data tables and graphs will account for about 20% of the grade, with the introduction, answers to questions and conclusions accounting for the remaining 80%. In cases where there are no questions to be answered and/or no formal conclusions to be drawn, the number of points will be reduced. In some cases students will hand in their work at the end of the lab session; these short reports will also be worth close to 50 points.

Pre-exam practice problem sessions: During the lab session before each exam (A, B, and C), students will do classwork in groups, instead of a lab exercise. This will consist of textbook problems, and is intended to help prepare them for the upcoming exam, especially as it reveals areas that still need work. These will be *open-book* sessions, so notes, textbooks, and mobile devices will be allowed. For grading, they will be counted as lab exercises.

Exams (three, for 20% of the total grade): The three exams (A, B, and C) will consist entirely of numerical problems. The exams will be *closed-book* tests: no notes, textbooks, or mobile devices will be allowed, but the instructor will supply a formula sheet. The topics and *tentative* dates for the exams are as follows:

- Exam A (M 2/6): Electric Forces and Fields [Ch.21-23],
- Exam B (W 3/15): Potentials and Circuits [Ch. 24-27],
- Exam C (M 4/10): Magnetic Fields and Induction [Ch. 28-30].

Note: Only the best two scores from the three exams (A, B, and C) will be counted.

<u>Final Exam</u> (Monday, May 1, 2-5pm, for 30% of the total grade): The final exam will be based entirely on the material on electricity and magnetism (Ch. 21-30). It will consist of two parts. The first part will contain numerical problems to be worked out in detail. The second part will contain both qualitative and quantitative multiple choice questions. The final exam will also be a *closed-book* test.

GRADING SCALE: How much weight is given to each activity, in percentages of the total grade, is shown in the left table below. The final letter grade will be determined from the total grade using the scale shown in the right table below.

	#	% each	total %
Reading quizzes	~10	~1	10
Classwork	var	var	15
Homework	~12	~1	10
Lab work	~15	~1	15
Exams (A, B, C)	3(2)	~10	20
Final exam	1	30	30
Total			***100***

	GP	%
A	4.0	90-100+
B+	3.5	85-89
B	3.0	80-84
C+	2.5	75-79
C	2.0	70-74
D	1.0	60-69
F	0.0	0-59

ADDITIONAL NOTES

Syllabus changes: The dates for exams A, B, and C are tentative and subject to revision. If other changes to this syllabus are necessary, they will be implemented after discussion and negotiation with the students.

Missed labs, quizzes and exams: To avoid hurting their grade, when a student misses any in-class activity (quizzes, classwork, exams, labs) they must convince the instructor that their absence was unavoidable or served a very good cause (e.g. when a student represents Mercer as part of a team). If their absence is not excused they will receive no credit for that activity. It is best to speak to the instructor ahead of time, or to present an official excuse from a Dean or team faculty advisor, or a doctor's excuse.

- There are <u>no make-ups</u>. If a class absence is excused by the instructor, the student's grade will be pro-rated for the activities on that day - i.e. their final grade will not suffer. Anybody who did not take part in a lab session should not sign a report for that lab: They cannot receive any credit for that lab.
- Missed exams which are excused by the instructor may be made up. However, if no alternate arrangements were made *beforehand*, this will be allowed only if the student has an official excuse: e.g., a note from a Dean's office, or a detailed doctor's note.

Lab safety: Lab equipment may be hazardous to your health. Always follow the instructions of your lab instructor or their lab assistant, and consider the well-being of your classmates as well as yourself... Think Safety First!

Lab manuals: The lab manuals (instruction sets and data tables) are viewable on computers in SEB 214 during lab sessions, and copies of relevant instructions will be handed out to each lab group. Students may print completed data tables, graphs and lab reports during the lab sessions; please do not print additional copies of the lab instructions.

Dropped grades: There will be <u>no dropped grades</u>. All work done in the course will be counted.
<u>Exception</u>: Only the best two scores from the three exams (A, B, and C) will be counted.

Extra credit: There will be no extra-credit work, except what is associated with the assessment post-test.

Honor Code: The College of Liberal Arts' academic misconduct policy will be followed. All students are bound by the Mercer University Honor Code... In addition, for all graded work completed in this class (except the online homework), each student must write their name on the paper, and they must sign the paper themselves; otherwise they will receive no credit. It is unethical, and a violation of the honor code of this university, for any student to submit work in person or online for credit, knowing that some person who may get credit did not contribute significantly to that piece of work. This applies not only to homework sets but also to quizzes, classwork, exams, term papers, lab reports and any other work you do at this or any other school...

Electronic devices: In order to maximize student engagement and to minimize sources of distraction, no remote devices (laptop computers, tablets, cell phones…) may be used when class is in session. Likewise, no student should communicate electronically with any person inside or outside the classroom by any means while class is in session. During quizzes and exams, no electronic devices of any kind may be used except for a calculator. Exceptions: (a) In lecture sessions while doing classwork, and in pre-exam practice sessions, students may use remotes to access the course web page and the eBook. And (b) in lecture sessions, *laptop or tablet use may be allowed*, for note-taking and access to the course web page and the eBook, if this is not disruptive to other students, and if the laptop user pays attention to and remains engaged in the class; If this is not the case, or if any other use of the device is made, the instructor will ask the student to close the device, on a permanent basis. Nevertheless, it is strongly advised, that students take notes by hand and bring a paper textbook to class. Any violation of these rules may result in the offending student being asked to leave the classroom.

Disability support: Students requiring accommodations for a disability should inform the instructor at the close of the first class meeting or as soon as possible. The instructor will refer you to the Disability Support Services Coordinator to document your disability, determine eligibility for accommodations under the ADAAA/Section 504 and to request a Faculty Accommodation Form. Disability accommodations or status will not be indicated on academic transcripts. In order to receive accommodations in a class, students with sensory, learning, psychological, physical or medical disabilities must provide their instructor with a Faculty Accommodation Form to sign. Students must return the signed form to the Disability Services Coordinator. A new form must be requested each semester. Students with a history of a disability, perceived as having a disability, or with a current disability, who do not wish to use academic accommodations are also strongly encouraged to register with the Disability Services Coordinator and request a Faculty Accommodation Form each semester. For further information, please contact Carole Burrowbridge, Disability Services Coordinator, at 301-2778 or visit the Disability Support Services website at http://www.mercer.edu/studentaffairs/disabilityservices

All requests for reasonable accommodation are welcome also in regard to absence from class for school representation (i.e., athletic or other events) or personal/family problems.