NORMANDALE COMMUNITY COLLEGE
PHYSICS 1202 - Physics with Biomedical Applications II
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SYLLABUS

This syllabus is divided into two major sections: Course Administrative Policies and Procedures and Course Outline. The hyperlinks in the document should be active if you have a Web connection. You can easily print this document for offline use.

Course Administrative Policies and Procedures

Course Description: Physics with Biomedical Applications II is a laboratory course designed for students intending to enter fields such as medicine, pharmacy, physical therapy, dentistry, as well as Biology. The course will use basic concepts of calculus such as the derivative and simple integration. PHYS 1202 covers waves and sound, electric fields and forces, simple DC circuits, magnetic fields and forces, EM waves, light and optics, atomic and nuclear physics. Special topics include diagnostic and therapeutic ultrasound, human voice and hearing, electric forces between molecules, electricity in the body, human vision and corrective lenses, CT, PET, MRI, and biological effects of radiation.

Course Objectives: Upon completion of this course students should be able to:
1. State and apply the fundamental laws and concepts of classical and modern physics.
2. Demonstrate an ability to solve realistic physics problems particularly relating to human applications.
3. Use the terminology of physics intelligently.
4. Demonstrate the ability to do experiments and give oral lab reports.
5. Recognize the importance of physics to medicine, dentistry, pharmacy, and other health sciences.

Prerequisite: PHYS 1201, MATH 1400 Survey of Calculus, or MATH 1500, Calculus I. (Note: You are responsible for knowing if you have.) Anytime a derivative or an integral is used, students will learn how to apply the tabulated “recipe” for the solution in a particular problem situation. That is, they will learn how to determine limits, identify constants, etc. Calculus will be used primarily to strengthen student understanding of basic concepts including rates of change and exponential growth and decay. In addition to the textbook, handouts will be available on the application of calculus to the physics.

ADA Statement: This course is available in alternate media by request.


Lab Manual: Purchase the course lab manual from the bookstore.

Personal Response System: You will use an iclickerTM personal response system (PRS) in this class. No other PRS will work, even one that uses radio frequency communication instead of IR. Be certain you obtain the correct PRS. If you do not obtain your course materials through the Normandale Bookstore, you are responsible for obtaining the iclicker. Even if you get your iclicker from the Normandale Bookstore, be certain they sell you the correct device. (They have a bad habit of assuming all PRS are alike-- they aren’t!) Use this ISBN number so you obtain the correct one: ISBN 0-7167-7939-0. You will associate your iclicker’s serial number with your name (much like you associate your cell phone serial number with a phone number). A used iclicker is OK.
**Calculator requirement:** Students will need a basic scientific calculator with these specialized functions and their inverses: \([\sin x], [\cos x], [\tan x], [\log x], [10^x], [\ln x], [e^x], [1/x]\) or \([x^{-1}], [y^x]\), and statistical functions. Graphing calculators not required, but may be used and are recommended. Only traditional calculators may be used on exams. You may not use the calculator function of a cell phone, PDA or similar device.


**University of Minnesota Equivalent:** PHYS 1201/1202, *Introductory Physics for Biology and Pre-medicine I & II*. (Note: Normandale’s PHYS 1201/1202 does not satisfy the University of Minnesota’s IT physics requirements. You must take PHYS 1121 and 1122 if you are transferring to an engineering program or planning to be a physics or astronomy major.) Consult the College of Biological Sciences Transfer Guide. PHYS 1201/1202 is the preferred course for biology majors transferring to the University of Minnesota as well as many programs in other colleges such as CFANS.

**Class Participation Points & iClickers:** You will receive class participation points by using your PRS. There are 15 possible points. If you attend class regularly and answer a clicker question, you will receive one point. If you answer correctly you will receive two points. Because there will be a minimum of 15 clicker questions asked during the semester, you could obtain at least 30 points and 15 of these points are essentially bonus points that add to your total point accumulation.

**Cooperative Learning Groups:** A substantial portion of the work this course involves working with other students. You will engage in two basic types of cooperative group activities: Laboratory and problem solving. There will be three graded-group problems. You should be aware of three important rules governing these groups. These rules are necessary to ensure effective groups: 1. If you are more than five (5) minutes late, you may not be allowed to join your group. 2. If you miss the group session immediately preceding a graded group problem, you will not be allowed to work with your group and will receive a “0” for that problem. 3. THERE WILL BE NO MAKE-UP PROBLEMS.

**Evaluation and Exams:** Individual quizzes will consist of a written problem solution and five multiple choice conceptual questions. There will be no make-up or rescheduling opportunities for any lab, quiz, or the final exam. There will be five individual quizzes and your lowest score will be dropped. If you miss an individual quiz, you will receive a “0” for that quiz, and it will become the lowest score and hence dropped. When I grade a problem, the “correct answer” is worth about 20%. Other equally important aspects of your solution include: Showing your work, using reasonable logic, drawing suitable diagrams, having the appropriate units, and, of course, following the problem-solving strategy. In short, you must demonstrate know how to get the answer.

**Important grading policy:** Any request for a reconsideration of the grading of any quiz, problem, lab or any graded assignment or test must be made within two class days of the return of the item in question or prior to the day of the final exam, whichever comes first. A class day is a day on which lecture section of the course meets. For example, if your class meets Tuesday and Thursday, and a quiz is returned on Tuesday, you must submit the request for reconsideration by Thursday before class.

**Exemption from Final Exam:** You will be excused from the Final Exam and your grade (“A”) will be based on all pre-final work if you meet the following criteria: (1) Your predicted final standing, based on all pre-final work must be 92.0% or greater. (Your predicted final grade is based on your work to date and a prediction of your performance on the final exam based on the average of your individual quizzes. This prediction is not your pre-final percent.) (2) You must have NOT missed any individual quizzes, graded group problems, labs, or any other required, graded work.

SPECIAL SUMMER SESSION NOTE: The summer session schedule is set by Normandale Community College over a year in advance and may conflict with the schedule of other schools or your personal plans. You should only take the course if you can be here for *all* labs, quizzes, the final exam, and class meetings. There are only *four* quizzes, *all four count*, and there are NO makeup quizzes or labs. There *may* be only 11 labs instead of 12 depending on the scheduling of the summer sessions and the July 4 holiday. (The total number of points is adjusted for this.) Summer sessions sometimes begin on a Monday when only the labs meet and there is no “lecture” section. Or, you may have a lab on a Tuesday before the first lecture section. You are *required* to attend your first scheduled lab in order to guarantee a seat in the course for yourself and to pick up course materials. Please do not ask to reschedule any quiz, graded problem, or the final exam, because the answer will be “no”. The only exceptions allowed would be for events like your National Guard unit being suddenly activated or you have been commanded to appear before The Pope, The Queen, or The President, and you will need to bring me an autographed photograph of him or her.

Grading Breakdown:

<table>
<thead>
<tr>
<th></th>
<th>Full Semester</th>
<th>Summer Session</th>
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<tbody>
<tr>
<td>Written Assignment</td>
<td>25</td>
<td>7%</td>
</tr>
<tr>
<td>Class PRS Participation Points</td>
<td>15</td>
<td>4%</td>
</tr>
<tr>
<td>Individual Quizzes (4 × 20 + 4 × 5)</td>
<td>100</td>
<td>28%</td>
</tr>
<tr>
<td>Graded Problems (3 × 20)</td>
<td>60</td>
<td>17%</td>
</tr>
<tr>
<td>Lab (12 × 5)</td>
<td>60</td>
<td>17%</td>
</tr>
<tr>
<td>Final Exam (50 multiple-choice questions, 100 points)</td>
<td>100</td>
<td>28%</td>
</tr>
<tr>
<td>Total Points</td>
<td>360</td>
<td>100</td>
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</tbody>
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Grading Scale:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Grade</th>
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<tbody>
<tr>
<td>85-100</td>
<td>A</td>
</tr>
<tr>
<td>72-84</td>
<td>B</td>
</tr>
<tr>
<td>55-71</td>
<td>C</td>
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<tr>
<td>50-54</td>
<td>D</td>
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<tr>
<td>&lt;50</td>
<td>F</td>
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Policy on Incompletes: Generally I will assign an “I” grade when a student has extenuating circumstances that cause him or her to miss significant portions of the course. The “I” is an alternative to a “W” when the student has demonstrated a mastery of the material and only will miss a part of the course. An agreement between me and the student is made as to the nature of the work to be made up and when it will be completed. I use the “I” very rarely and only upon extensive consultation with the student well in advance of the end of the semester. Extenuating circumstances include jury duty, military duty, and extraordinary family situations. Example 1: A student is in the National Guard and her unit is called to active duty for a brief deployment. In the tenth week of the semester she notifies me that she will miss the last quiz and final exam in the course. To date, all her work has been satisfactory. She agrees to take the last quiz and final exam upon her return. Her request is granted. Example 2: A student has missed several labs and two quizzes. His performance on the other quizzes in the course does not demonstrate an understanding of the material. The day before the final exam, he emails me requesting an “I” so he
can better prepare for the final exam and not harm his GPA. His request is denied due to the untimely request and current standing in the course.

**Laboratory:** We will undertake lab experiments each week. Your group will give an oral summary of your work. Each lab is worth 5 points: 1 point for attendance (as determined by your presence for the pre-lab “clicker” question), 1 point for being prepared (determined by your answers to pre-lab “clicker” question), and 3 points for demonstrating an understanding of what you have done. It is important that you do not miss a laboratory session. THERE WILL BE NO MAKE-UP LABS and you cannot successfully complete the course without doing the laboratory work.

**Policy on Missing Labs:**

- Miss one lab: 0 points for that lab
- Miss a second lab: −5 points for that lab
- Miss a third lab: −10 points for that lab
- Miss a fourth lab: Final grade will be “F”

**Problem Assignments:** Problems will be assigned from each chapter. These will not be graded. Answers will be on D2L. You are, of course, urged to work additional problems. It is important to do these problems because we may do some in class and variations on them may appear on quizzes.

**Note regarding electronic devices:** Cell phones and pagers must be turned off during class. Only traditional calculators may be used on exams. You may not use the calculator function of a cell phone, PDA, iPod or similar device.

**How to Get the Most From This Class:** Don’t miss class! Read the book. Don’t get behind in your reading. (Unlike other disciplines, it is IMPOSSIBLE to cram for a physics exam the night before and count on a passing grade.) Start by reading the chapter Summary, then the text. Work on the Problems and Questions at the end of each chapter with other students. Finally, be sure to see me for help. My office hours will be posted on my office door. If you need to see me outside of those times, please arrange an appointment with me in person, via phone or via email. Don’t wait until it is too late if you are having difficulties.

**From the Normandale Community College Catalog:** “Normandale Community College believes that every person’s education is the product of his/her own intellectual efforts. Each student who enrolls and remains at Normandale, therefore, understands that to submit [individual] work which is not their own violates the purpose of the college and of his/her presence here. No intellectual community can maintain its integrity or be faithful to its members if violations of its central purpose are tolerated. In case such violations do occur, the instructor has the prerogative to take appropriate action.”
The learning outcomes and consequently the key concepts, textbook readings, and suggested problems are all subject to change. Preface each learning outcome with the phrase, “Upon successful completion of this course, you should be able to...”


**Waves and Sound**

**Key Concepts:** Simple Harmonic Motion, Transverse and Longitudinal Waves, Reflection and Transmission of Waves, Wavelength, Period, Frequency, Interference Principle of Superposition, Standing Waves; Resonance, Speed of Sound, Intensity and Sound Level, Decibels, The Ear and Its Response, Loudness, Beats, Doppler Effect, Ultrasonic Medical Imaging.

**Learning Objectives:**
1. Define the terms amplitude, period, frequency, angular frequency, phase; and be able to calculate some of these quantities in problems.
2. State the criteria for simple harmonic motion and solve SHM problems.
3. State the definition of a wave.
4. State the difference between transverse and longitudinal waves, and be able to cite examples of each.
5. Explain the concepts of constructive and destructive interference.
6. Observe standing waves on a string and relate them to the principle of superposition and standing waves in a column of air.
7. Define the intensity of a wave.
8. Calculate an unknown frequency using the principle of beats.
9. Describe how the human voice process produces sound waves.
10. Describe how the human ear detects sound waves.
11. Solve problems related to sound level and sound level intensity.
12. Calculate a velocity from the Doppler shift.
13. Calculate the speed of sound for a given temperature.
14. Describe the use of diagnostic ultrasound and explain how the Doppler effect and the principle of beats are used.

**Textbook:** 12:1-3 (Review); 13:1-8; 14:1-7

**Problems:** 12:2,15; 13:2,3,10,13,24,26,28,34,35,38,54,59; 14:14,29,32,40

**Other Learning Resources:**
- NOVA Science Now: Auto-Tune
- How Ultrasound Works
- Ultrasound (Mayo Clinic)
- Hearing loss

**Electric Forces and Fields**


**Learning Objectives:**
1. Describe the similarities and differences between the gravitational force and the electromagnetic force.
2. Define field and give two examples.
3. Calculate the force on a charged object due to another charged object or an electric field.
4. State the properties of electric charge.
5. State Coulomb’s law and the principle of superposition and use Coulomb’s law in problem solving.
6. State the characteristics of conductors and insulators and how charges are distributed.
7. Describe how electric field lines are used to represent the electric field in a region of space.
8. Describe how electric field vectors are oriented with respect to electric field lines.
9. Sketch the electric field lines of a single charge and a dipole charge.

Textbook: 19:1-7
Problems: 19:3,9,13,16,27
Other Learning Resources:
How DNA Evidence Works

Electric Potential and Electric Energy


Learning Objectives:
1. Define the volt.
2. State the properties of conductors in electrostatic equilibrium.
3. State the definition of potential difference (voltage) and its relation to the change in energy when an electric force acts on a charge.
4. Calculate the change in energy and speed as a charged particle moves through a potential difference.
5. Define the characteristics of the electric potential of a charged conductor.
6. Define an equipotential line and how it is oriented with respect to electric field lines.
7. Plot the relationship between equipotential and electric field lines.
8. Describe the basic features of an electrocardiogram (ECG).
10. Calculate the potential difference between parallel capacitor surfaces.
11. Calculate the energy stored in a capacitor.
12. Define and use the electronvolt unit in problems.

Textbook: 20:1-4,6-7,9-10
Problems: 20:1,2,5,20,21,31,36,48,50,56
Other Learning Resources:
Electrocardiogram (Mayo Clinic)

Simple DC Circuits


Learning Objectives:
1. Define current.
2. Define resistance and calculate the resistance of a conductor from its dimensions and resistivity.
3. Use Ohm’s Law to calculate the current, voltage, or resistance.
4. Calculate the power loss in a resistor.
5. Define resistivity and discuss the temperature dependence of resistance.
6. Compare the speed with which electrons travel in a conductor to the speed of propagation of the information.
1. State the convention for direction of current.
2. Recognize simple circuit elements in a schematic diagram.
3. Recognize resistors in parallel or series and calculate the total equivalent resistance, currents, voltages, etc.
4. Calculate or measure the voltage across resistors.
5. Given a circuit and voltage, calculate or measure the current.
6. Describe how the voltage and current in an RC circuit change with time and calculate current, voltage or charge as a function of time.
7. Calculate the time constant for an RC circuit and explain the physical significance of the time constant in an RC circuit.
8. Observe and graph the voltage across a discharging capacitor as a function of time.
9. Calculate the power dissipated in a resistor.
10. Describe one application in medical technology that uses capacitors to store energy.

**Textbook:** 21:1-2,5-7,9
**Problems:** 21:1,6,10,14,15,17,18,21,23,25,28,31,32,41,44,49,53
**Other Learning Resources:**
- Biventricular pacemaker (Mayo Clinic)
- Automated external defibrillators (Mayo Clinic)

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**Magnetic Forces and Fields**


**Learning Objectives:**
1. State and use the magnetic force law for a charged particle.
2. Explain that the magnetic force on a moving charged particle is centripetal.
3. Calculate the magnitude and direction of the force on a charged particle moving in a uniform magnetic field.
4. Calculate the radius of curvature of a charged particle moving in a uniform magnetic field.
5. Calculate the force due to an external magnetic field on a straight current-carrying wire.
6. Calculate the torque due to a magnetic field on a current-carrying loop.
7. Explain the principles involved in building an electric motor.
8. Describe the orientation of magnetic field of the earth.
9. Describe the sources of magnetic fields.
10. Describe how a mass spectrometer works and how these are used in analytical laboratories.

**Textbook:** 22:1-6,8,10
**Problems:** 22:1,5,11,15,19,23,33,45,47,55,60,62
**Other Learning Resources:**
- How strong are the magnets in an MRI machine?
- How MRI Works
- MRI: Viewing the body’s hidden structure (Mayo Clinic)
Magnetic Induction


Learning Objectives:
1. Explain that changing magnetic flux induces an EMF in a closed conduction loop.
2. State the various ways magnetic flux can change.
3. State Faraday’s law and Lenz’s law and determine the direction of current flow due to an induced EMF.
4. Use Faraday’s Law to calculate the EMF induced in a closed loop circuit.
5. Explain how an electric generator works.

Textbook: 23:1-4,7
Problems: 23:1,20,50,58
Other Learning Resources:
Inside a Power-Cube Transformer
How Power Grids Work

EM Waves


Learning Objectives:
1. State that a time varying electric field produces a magnetic field and that a time varying magnetic field produces an electric field.
2. State that electromagnetic radiation is produced whenever charged particles are accelerated.
3. Explain how Maxwell’s equations predict the existence of electromagnetic waves.
4. State the properties of electromagnetic waves.
5. State the regions into which the electromagnetic spectrum is commonly divided.
6. Recognize the order of these regions and the values for visible light.
7. Describe the particle nature of light and calculate the energy of a photon given the frequency or wavelength.
8. Solve problems involving the intensity, power and EM fields of EM waves.
9. State the regions of the electromagnetic spectrum and indicate the imaging technology used to detect the radiation.

Textbook: 24:2-3,5-9
Problems: 24:33,36,49,60

Optics and Optical Instruments


Learning Objectives:
1. Describe the ray nature of light.
2. State and use the law of reflection.
3. State and use the law of refraction.
4. Define what is meant by total internal reflection and give a medical application.
5. Define dispersion and give an example.
6. Describe how a convex lens forms an image and calculate the position of the object or image.
7. Define dispersion and give an example.
8. Describe how a microscope forms an image.
9. Describe how a concave or convex mirror forms an image and calculate the position of the object or image.
10. Describe how the human eye works.
11. Define myopia and hyperopia and calculate corrections for them.
12. Define presbyopia and accommodation.
13. Describe how the eye responds to color.
14. Define and use the diopter unit.

Textbook: 25:1-5,7, 8; 26:1-5
Problems: 25:16 26:12,15,24,41,42

Other Learning Resources:
How Corrective Lenses Work
Nearsightedness
Farsightedness
Astigmatism
Presbyopia

Quantum Theory and the Atom
Learning Objectives:
1. State the Bohr Model of the atom and explain how it was a useful model.
2. Calculate the energy or momentum of a photon from its wavelength or vice versa.
3. Describe an atom and its components.
4. Describe the photoelectric effect and Einstein’s explanation of it.
5. Describe atomic spectra and why you see discrete wavelengths.
6. Define bremsstrahlung and state how x-rays can be produced.
7. Describe the process that causes the emission of light from an atom.
8. State how x-rays are produced.
9. Explain why CT is an advance over conventional x-ray.

Textbook: 28:1-2,4; 29:1-2,6
Problems: 28:1,3,6,19; 29:5,33
Other Learning Resources:
Bohr's Atom
A Planetary Model of the Atom
The Photoelectric Effect
Wave-Particle Duality and the Photoelectric Effect
X-ray Imaging (Mayo Clinic)
CT scan (Mayo Clinic)
**Nuclear Physics and Radiation**


**Learning Objectives:**
1. Define atomic mass, number, nucleon and isotope.
2. Define radioactivity and give examples.
3. Describe how alpha, beta, and gamma decay or positron emission change a nucleus.
4. Describe how ionizing radiation and x-rays can be detected.
5. State what maintains nuclear stability and why decay occurs.
6. Define half-life and activity and use the concepts to calculate activity.
7. State the effect of increasing the distance from a radioactive source on the intensity of the radiation.
8. Describe the effects of absorber materials on radiation and calculate a half-value thickness.
9. Describe the biological effects of ionizing radiation and how to protect humans from the effects.
10. State this units used to measure radioactive decay activity and effective radiation dose.
11. State the most common sources of background radiation.
12. Describe a use of nuclear physics in medicine such as PET and MRI.
13. Define radiopharmaceutical and describe the use of these isotopes.

**Textbook:** 30:1-5

**Problems:** 30:8,12,14,17,19,21,25,46,47,51,61,62,63,64

**Other Learning Resources:**
- Radioactivity and alpha, beta, and gamma decay
- The ABC’s of Nuclear Science
- EPA Radiation Dose Calculator
- Health Physics Society
- Radiation Terms and Definitions
- Positron emission tomography (PET) scan (Mayo Clinic)
- Biological effects of ionizing radiation
- How Nuclear Medicine Works
- How MRI Works
- MRI: Viewing the body’s hidden structure (Mayo Clinic)

**FINAL EXAM**

15 November 2011