Welcome to PHYS 112, the second course of a two-course sequence of algebra-based introductory physics for non-physics majors and anyone desiring an introduction to physics concepts and applications. This course covers electric and magnetic phenomena, oscillations and waves, optics and modern physics. This will be done by introducing the language, ideas and concepts of physics in the above topics.

Instructor information
Lecturer: Naresh Sen  Office: Physics 315  Phone: 410-455-2821  Email: nsen@umbc.edu
Lab teaching assistants: Joseph Kotva, Frank Harris.
For lab-related questions, please contact your lab TA first. See physics web page for their contact info.

Office hours: Please see link on Bb

Class meeting times:
Lecture: 1:00 – 1:50 pm Monday, Wednesday, Friday in room Administration building 101.

Laboratory: in Physics building room 109, at the section time for which you are registered.
You also need to enroll for a laboratory section for the course, and pass the lab to pass the course. If you need to miss a lab, please make arrangements for a makeup with your lab TA. Absence due to planned or unforeseen events will require verifiable documentation.

Course objectives and goals
Upon completion of this course, you are in a position to:
- apply the ideas of physics to electric and magnetic fields, forces, potentials, electric circuits, and electromagnetic induction
- analyze behavior of systems containing electrical and magnetic components such as conductors, batteries, resistors, capacitors, magnets, motors, etc.
- solve conceptual and quantitative problems involving such systems, including problems you may not have explicitly seen before but are based on concepts you HAVE seen, worked with in class or outside class, and learned
- recognize parameters that are relevant physical systems
- make predictions based on physical laws using scientific methods and reasoning
- assess validity of mathematical formulations and solutions in terms of physical system behavior

Some of the tools for being able to reach the above goals are:
- Making connections between different physical concepts and relevant mathematics
  - combining knowledge acquired in other/previous courses with new content from this course.
    - E.g. previous skill – drawing free-body diagrams (FBDs); new content – electrical forces
  - applying conservation principles – electric charge, energy, etc. to analyze a problem.
  - applying techniques of vectors, geometry, algebra/arithmetic, etc. to solve problems. For example: FBD for forces, geometry for force components, algebra/arithmetic to obtain numerical solutions.
- Using multiple representations to solve problems
  - visualizing problems by drawing sketches – meaning ‘FBD’ or ‘something like that (SLT)’ – to get the physical picture and determine relevant concepts/ideas for solving the problem
  - setting up the mathematics to connect with the physical picture for a problem
  - obtaining a graphical representation to connect with the physical picture for a problem
Expectations for the course

What you can expect from me
To help you understand concepts of physics and be able to apply them to solve problems, I will endeavor to do the following:

1. To provide as many tools as I can to make the course useful for you.
2. To be available for assistance during office hours or outside office hours, whichever is convenient.
3. To begin and end class on time, and follow as closely as possible (as time allows), the schedule outlined on the course web site.
4. To do my best to promptly respond to your emails.
5. To do my best to have graded assignments and exams returned to you in a timely manner.
6. To make sure exams are fair, and the grading is likewise fair.
7. To listen to comments about my instruction and be open to suggestions.

What I expect from you
While the tools will be provided to help you learn, you still have to do the work and the learning; I cannot do that for you. To give an automotive analogy: Someone can give you a car and show you how to drive, but you still have to do the driving, fill the gas tank, change the oil, check tire pressure to ensure a smooth ride, etc. So you are encouraged to do the following:

1. To make use of the tools provided to you in a manner that is most useful to your way of learning.
2. To ask questions early and often if something is not clear, in class or during office hours. Do not wait till the last minute when there is very little time to address problems and make adjustments to enhance learning the material.
3. To participate in class during discussion of concept questions and in hands-on lab activities.
4. To attend classes regularly, come to class on time and not get up and leave before class ends. This is disruptive to the class in general and your group in particular, especially during clicker questions where you are working with people around you throughout the lecture. If there are reasons for which you need to leave early, you need to let me know in advance.
5. To be willing to make mistakes and have ‘false starts’ and learn from them rather than give up. Thus you bring a can-do, don’t-give-up approach to your learning process.
6. To share your learning and expertise with others in the class, and thereby help to enhance the overall learning experience of the class. Since the grading scheme for the course is on an absolute scale, helping others will not adversely affect your grade.

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The next two pages consist of details of the course material, in-class activities, reading, classroom etiquette, and grading scheme for the course.
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COURSE MATERIAL: Textbook, LON-CAPA and clicker

Textbook: College Physics: A Strategic Approach by Knight, Jones, and Field, 2nd edition. This is also the textbook used for PHYS 111. Reading assignments will specify chapters and sections in the textbook.

LON-CAPA and clickers: Why do we use these?
We generally learn more from our own mistakes than from unqualified successes. Therefore do not be afraid of making mistakes; having a few ‘false starts’ is an integral part of learning. Being actively engaged in the learning process is one of the main reasons for having the online homework and in-class concept questions using clickers. These allow you to understand concepts and practice solving quantitative problems in a low-stakes environment, and thus prepare for the high-stakes assessment environment (exams).

LON – CAPA online HW ($20)
Registration for the online homework can be done at https://portal.courseweaver.com. The course name is ‘umbc-nsen-fall15-phys112’ and the code you will need is D87ZKN. You will need to give a username and password. The username is your official UMBC email address without the ‘@umbc.edu’.

Online homework (HW) for the course is 12% of the course grade, which is comparable to the typical percentage for introductory courses in the physics department. Extensive physics education research (PER) data shows that graded online homework with immediate feedback increases student engagement and learning. Time spent on HW is very effective in learning the material, and the high percentage on HW grade rewards this time and effort. Additionally, the 12% provides a safety net in the event of a lower-than-expected exam performance.

Clickers for in-class concept questions (CQs)
One clicker, an electronic transmitter used for audience feedback during lecture. Purchase your clicker at the bookstore if you don’t already have one from having used it in a previous course, and register your clicker online.

In lectures, conceptual questions (CQs) are meant to lead to discussions with your neighbors (groups of 3-4) followed by individual responses via electronic devices (‘clickers’). After a question is posited, you discuss the concepts involved with their neighbors, and then respond individually, or ‘vote’, using your clickers. If the majority of the class (say, 80%) gives the correct response, the lecture continues. However, if the responses are incorrect or split among several choices, it is immediately clear that more discussion is needed, often followed by a second round of ‘voting’. Thus the focus of the lecture is to help you understand concepts via active participation rather than ‘covering’ material. In this way, the entire class gets to participate throughout the lecture. This is different than a traditional lecture, in which usually the same few students are actively engaged on a regular basis.

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Laboratory (15 % of grade)
Many of the main concepts of the course will be reinforced (and sometimes introduced) in weekly laboratory sessions, where you get your hands dirty with real equipment, build or use the setup needed to make measurements, collect and analyze data, and assess your results. In lab, you will work in pairs. You will need to write and turn in one ‘lab report’ as a group. This means that all members of the group will get the same grade, so you need to make sure that all group members are on the same page before turning in the lab report. The lab is part of the course, so exams can/will have lab-related questions.
Your lab TA is your lab instructor, so for questions related to the labs, please contact your lab TA first.
Reading
Reading is an essential part of this course. You are expected to have completed the reading assignments prior to lecture. The material in this course is too difficult to learn just by listening to lectures. Reading assignments on a roughly weekly basis will be posted on Blackboard or announced in class. They will not be graded, but are intended to let you know what to read and prepare ahead of the lecture. During the lecture, you can then focus on the parts that you have difficulties with during the reading, instead of seeing the material in class for the first time.

Classroom etiquette
Observing etiquette in the classroom is to be considerate to your neighbors and to the class. *Please mute all cell phones when entering any classroom. Cell phone use in class is not acceptable under any circumstances since it distracts your neighbors and disrupts the lecture.* Please do not surf the web on your laptop or text message during lecture. Please do not throw vegetables at the instructor. It is perfectly OK to interrupt the lecture by yelling “Question!” Questions in lecture are always good.

Grading scheme
3 midterm exams: 15% each, total 45%
Final Exam: 25%
Laboratory: 15%
LON-CAPA Homework: 12%
In-class participation (such as clickers): 3%

Final grades will be assigned on an absolute scale according to your final point total:

<table>
<thead>
<tr>
<th>Range</th>
<th>Grade</th>
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<tbody>
<tr>
<td>90.0% and Above</td>
<td>A</td>
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<tr>
<td>80.0% - 89.9%</td>
<td>B</td>
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<tr>
<td>70.0% - 79.9%</td>
<td>C</td>
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<tr>
<td>60.0% - 69.9%</td>
<td>D</td>
</tr>
<tr>
<td>59.9% and Below</td>
<td>F</td>
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</tbody>
</table>

Having an absolute grading scheme means that you will get a grade based on your performance, regardless of how others do in the course. An absolute grading scheme encourages working in groups and helping each other instead of competing with each other. Physics education research shows that learning from others and teaching others in class (‘peer instruction’) improves understanding and retention of concepts (and so is highly encouraged).

Exam schedule
Please see the ‘Exams’ link on Blackboard for the exam days and times, and other exam policies.

Academic integrity
All instances of academic misconduct will be addressed according to the UMBC Policy on Academic Integrity (http://www.umbc.edu/integrity/students.html). Examples include attempting to make use of disallowed materials on exams, attempting to communicate with anyone other than the instructor or TA during an exam, altering graded work and submitting it for regrading, asking someone else to take an exam in your place, copying or paraphrasing another’s work on homework, asking someone else to do homework and representing it as your own, and permitting or assisting another student to carry out any of the above. Penalties range from a grade of zero on a homework or exam to an F in the course (at my discretion), and from denotation of academic misconduct on the transcript to expulsion (as determined by official hearing of the Academic Conduct Committee).
Additional Resources
The Learning Resource Center (LRC) has free walk-in tutoring for Phys 112, Phys 121, Phys 122 and some 200-level courses in the Math Lab, located on the first floor of the library, behind the reference desk. All of the tutors are trained through at least the first Level of CRLA Certification, have experience tutoring, and have been recommended by instructors in the department. You can find more information at http://www.umbc.edu/lrc/

Help is also available in the Physics Tutorial Center in the physics building Room 226.
PHYS 112 CONTENT

**Electricity and Magnetism**
Chapter 20: Electric fields and forces
Electric charges and forces; Electric field of point charges; Uniform electric field; Forces in electric fields.

Chapter 21: Electric potential
Electric potential and electric potential energy; Electric potential of parallel-plate capacitor, point charges, charged sphere; Connecting potential and field; capacitors and capacitance, energy in capacitors, dielectrics and capacitors.

Chapter 22 and 23: Current, Resistance, Circuits
Current, Ohm’s law, simple resistor circuits, energy and power in circuits; Kirchhoff’s loop l and junction law; resistors in parallel and series; Capacitors in parallel and series; RC circuit and applications

Chapter 24: Magnets and magnetic fields ‘B’ and forces
B of a straight current-carrying wire, B of loop, B of solenoid; Magnetic force on moving charges, on currents

**Oscillations and Waves**
Chapter 14: Oscillations
Simple harmonic motion (SHM): properties, (x,v,a) of SHM, energy of SHM, pendulum.

Chapters 15 and 16: Waves
Transverse and longitudinal waves; Properties of traveling waves
Superposition - standing waves on string (transverse waves) and in air (longitudinal waves)
Superposition – interference in 1D and 2D, beats
Energy and intensity and intensity level, loudness of sound – decibel level
Doppler effect and shock waves

**Optics**
Chapter 17: Wave optics
Interference in: Double slit, diffraction grating, single slit, thin films

Chapter 18 and 19: Ray optics and optical instruments
Reflection; Refraction – Snell’s law, total internal reflection (TIR)
Converging and diverging lenses and thin lens equation
Spherical mirrors
Color and dispersion and applications

**Nuclear Physics**
Chapter 30: Nuclear structure and decay, radiation and radioactivity
EXAMS
3 midterm exams: 15% each, total 45%
Final Exam: 25%

Three midterm exams of 50 minutes duration will be held from 8:00 – 8:50 am on the dates shown below (which also appear on the weekly schedule link). Final exam is of 2 hours duration. All exams are comprehensive.

Exam 1: September 21, Monday of week 5, 8:00 – 8:50 am
Exam 2: October 19, Monday of week 9, 8:00 – 8:50 am
Exam 3: November 16, Monday of week 13, 8:00 – 8:50 am

Final exam: December 16, Wednesday of exam week, 1:00 – 3:00 pm

All exams are closed-book but you are allowed (encouraged!) to bring a single formula card of size 3.5”x 5” or smaller to the exams (typical index card works for this). You may write anything on both sides of the card, but everything must be handwritten – no typing or photocopying, and no magnifying glass allowed. You should bring a simple (not graphing) calculator and a number 2 pencil for every exam. There will be no sharing of calculators during exams. Cell phones, iphones, notepads, and other communication devices will not be allowed. Missed midterm exams may be made up as soon as possible after the absence with proper documentation of reason of absence.

There is no make-up for the final exam. There is also no alternate time for the final exam.
# PHY 112 – Fall 2015 Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Lecture Topic</th>
<th>Textbook</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aug 26 (W)</td>
<td>Charges, electrostatics</td>
<td>Ch20: 1-2</td>
<td>Experiment 1 Electric Charges</td>
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<tr>
<td></td>
<td>Aug 28 (F)</td>
<td>Coulomb’s law</td>
<td>Ch20: 3</td>
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<tr>
<td>2</td>
<td>Aug 31 (M)</td>
<td>Coulomb’s law &amp; superposition</td>
<td>Ch20: 4</td>
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<tr>
<td></td>
<td>Sep 02 (W)</td>
<td>Electric fields, E-field lines</td>
<td>Ch20: 5, 6</td>
<td>Experiment 2 Electric fields (PhET)</td>
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<tr>
<td></td>
<td>Sep 04 (F)</td>
<td>Forces in E-fields, electric potential</td>
<td>Ch20: 7</td>
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<tr>
<td>3</td>
<td>Sep 07 (M)</td>
<td><strong>Holiday - Labor Day</strong></td>
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<td></td>
<td>Sep 09 (W)</td>
<td>Potential, energy conservation</td>
<td>Ch21: 2, 3</td>
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<td></td>
<td>Sep 11 (F)</td>
<td>Potential of capacitor, point charge, sphere</td>
<td>Ch21: 4</td>
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<tr>
<td>4</td>
<td>Sep 14 (M)</td>
<td>Potential and field, E-lines and V-lines</td>
<td>Ch21: 5</td>
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<td></td>
<td>Sep 16 (W)</td>
<td>Capacitors – capacitance, dielectrics, energy</td>
<td>Ch21: 7-9</td>
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<td></td>
<td>Sep 18 (F)</td>
<td>Conductors in electrostatic equilibrium</td>
<td>Ch20: 6 ch21:5</td>
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<tr>
<td>5</td>
<td>Sep 21 (M)</td>
<td><strong>Exam 1 (Ch 20,21;  8:00 - 8:50 am)</strong> Electric current</td>
<td>Ch22: 1-3</td>
<td>Experiment 5 Electric current</td>
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<td></td>
<td>Sep 23 (W)</td>
<td>Current and resistance</td>
<td>Ch22: 4</td>
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<tr>
<td></td>
<td>Sep 25 (F)</td>
<td>Current and potential (voltage), Ohm’s law</td>
<td>Ch22: 5</td>
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<tr>
<td>6</td>
<td>Sep 28 (M)</td>
<td>Electric energy and power</td>
<td>Ch22: 6</td>
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<td></td>
<td>Sep 30 (W)</td>
<td>Circuits: resistors</td>
<td>Ch23: 1-5</td>
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<td></td>
<td>Oct 02 (F)</td>
<td>Circuits: resistors</td>
<td>Ch23: 1-5</td>
<td></td>
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<tr>
<td>7</td>
<td>Oct 05 (M)</td>
<td>Circuits: capacitors, RC</td>
<td>Ch23: 6, 7</td>
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<tr>
<td></td>
<td>Oct 07 (W)</td>
<td>Magnetism: B-field lines</td>
<td>Ch24: 1, 2</td>
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<tr>
<td></td>
<td>Oct 09 (F)</td>
<td>Magnetic forces due to B-fields on charges</td>
<td>Ch24: 5, 6</td>
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<tr>
<td>8</td>
<td>Oct 12 (M)</td>
<td>Magnetic forces due to B-fields on currents</td>
<td>Ch24: 5, 6</td>
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<td>Oct 14 (W)</td>
<td>B-fields of currents</td>
<td>Ch24: 3, 4</td>
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<td>Oct 16 (F)</td>
<td>Force between currents</td>
<td>Ch24: 6</td>
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<td>Oct 19 (M)</td>
<td><strong>Exam 2 (Ch 22, 23, 24;  8:00 - 8:50 am)</strong></td>
<td>Ch25: 1, 2</td>
<td>Lab make-up week</td>
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<tr>
<td></td>
<td>Oct 21 (W)</td>
<td>Induced current, motional emf</td>
<td>Ch25: 4, 3</td>
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<td></td>
<td>Oct 23 (F)</td>
<td>Faraday’s law, Lenz’s law</td>
<td>Ch25: 5, 6</td>
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<tr>
<td>10</td>
<td>Oct 26 (M)</td>
<td>EM waves and light</td>
<td>Ch25: 5, 6</td>
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<tr>
<td></td>
<td>Oct 28 (W)</td>
<td>Wave optics: double slit, diffraction grating</td>
<td>Ch17: 1-3</td>
<td>Experiment 7 Modeling the action potential of a neuron</td>
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<td>Oct 30 (F)</td>
<td>Wave optics</td>
<td>Ch17: 1-3</td>
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<tr>
<td>11</td>
<td>Nov 02 (M)</td>
<td>Wave optics: single slit diffraction</td>
<td>Ch17: 5</td>
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<tr>
<td></td>
<td>Nov 04 (W)</td>
<td>Wave optics: thin-film interference</td>
<td>Ch17: 4</td>
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<tr>
<td></td>
<td>Nov 06 (F)</td>
<td>Ray optics: reflection</td>
<td>Ch18: 1-3</td>
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<tr>
<td>12</td>
<td>Nov 09 (M)</td>
<td>Ray optics: refraction, TIR</td>
<td>Ch18: 3, 4</td>
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<td></td>
<td>Nov 11 (W)</td>
<td>Ray optics: refraction, TIR</td>
<td>Ch18: 3, 4</td>
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<td></td>
<td>Nov 13 (F)</td>
<td>Ray optics: color and dispersion</td>
<td>Ch19: 6</td>
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<tr>
<td>13</td>
<td>Nov 16 (M)</td>
<td><strong>Exam 3 (Ch 25, 17, 18;  8:00 – 8:50 am)</strong></td>
<td>Ch18: 5-7</td>
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<tr>
<td></td>
<td>Nov 18 (W)</td>
<td>Lenses</td>
<td>Ch18: 5-7</td>
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<tr>
<td></td>
<td>Nov 20 (F)</td>
<td>Lenses</td>
<td>Ch18: 5-7</td>
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<tr>
<td>14</td>
<td>Nov 23 (M)</td>
<td>Lenses, mirrors</td>
<td>Ch19:</td>
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<td></td>
<td>Nov 25 (W)</td>
<td>Optical instruments</td>
<td>Ch19:</td>
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<td>Nov 27 (F)</td>
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<td>Holiday – Thanksgiving break</td>
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<tr>
<td>15</td>
<td>Nov 30 (M)</td>
<td>Optical instruments</td>
<td>Ch19:</td>
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<tr>
<td></td>
<td>Dec 02 (W)</td>
<td>Optical instruments</td>
<td>Ch19:</td>
<td></td>
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<tr>
<td></td>
<td>Dec 04 (F)</td>
<td>Optical instruments</td>
<td>Ch19:</td>
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<tr>
<td>16</td>
<td>Dec 07 (M)</td>
<td>Semester Summary</td>
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<tr>
<td>Final</td>
<td>Dec 16 (W)</td>
<td><strong>Final Exam (Comprehensive; 1:00 – 3:00 pm)</strong></td>
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</table>
Office hours

• Joe Kotva: (all in Physics room 226)
  Th 4:30 – 6:30 pm, F 11:30 am – 12:30 pm

• Frank Harris: (all in Physics room 226)
  F 2:30 – 3:30 pm

• Naresh Sen:
  MWF immediately after class till 2:15 pm (in our lecture room)
  T 1:15 – 2:15 pm (Physics room 315)
  W 10:00 – 11:00 am (Physics room 315)
  F 2:30 – 4:30 pm (Physics room 226)
Suggestions for doing well in this class.

1. Take this course seriously, starting on the first day. That means scheduling study time everyday, starting today.

2. Read the chapter and/or online notes before the lecture. Read carefully, do not skim.

3. Read with a pen and notebook. Take notes while you read, and work out example problems.

4. Attend every lecture, and participate in lecture: confer with your clicker group, ask questions, pay attention, don't surf the web, don't text.

5. Don't attempt the homework without studying the chapter first. Start your homework assignments EARLY. If you wait till the last day, and you get stuck, you won’t have time to get help.

6. Don’t get isolated: Get in a study group.

7. Don’t fall behind; you’ll have a hard time catching up.

8. Be an aggressive learner, not a passive listener. You must constantly ask yourself: Does this make sense? Do I understand it? How would I explain it to someone else? It it doesn't make sense to you, do something about it.

9. Just reading the text, attending lecture, and doing the homework is not enough. You have to understand the material. Here is the Test of Understanding: If you can explain the material, in words, to someone else, without referring to the text, then you understand. This course is not about memorizing; it’s about understanding.