# West Chester University

## Physics 300-01: Mechanics
## Fall 2013

**Course Overview**: PHY 300 is an intermediate (junior/senior) level course in classical mechanics for physics majors and minors. We will study classical mechanics in both the Newtonian and Lagrangian formalisms, touching briefly on the basic ideas of the Hamiltonian formalism. This course will build upon students' knowledge of classical mechanics from previous physics courses, delving into more mathematical detail and sophistication as we study topics in greater depth. Topics receiving considerable attention include kinematics and dynamics, conservation laws, oscillations, central force motion, and non-inertial reference frames. In the course of our studies, we will build a framework of mathematical tools which are utilized in a wide variety of advanced physics topics; these tools include Taylor series expansions, coordinate transformations, multivariable calculus, linear ordinary differential equations, matrices, and variational calculus.

**Course Credit:** This is a 3 credit course.

**Course Pre-requisites**: Satisfactory completion of MAT 162, as well as satisfactory completion of either PHY 140 or PHY 180 (PHY 180 strongly preferred) is **required** to enroll in PHY 300. MAT 311 and MAT 343 are strongly recommended, but are not required to enroll or succeed in this course.

**Meeting Times:** Monday, Wednesday, Friday from 11:00 AM to 11:50 AM
Merion Science Center, room 109

## Required Course Materials:

- *Classical Mechanics* by John. R. Taylor: University Science Books, 2005 (ISBN 9781891389221)

## Recommended/Optional Materials:

- *Classical Dynamics of Particles and Systems, 5th Edition*, by Thornton and Marion: Brooks/Cole, Cengage Learning, 2004 (ISBN: 0-534-40896-6)
- An introductory level physics textbook, e.g., *Fundamentals of Physics 8th Edition* by Halliday, Resneck, and Walker, or *Physics for Scientists and Engineers 8th Edition*, by Serway and Jewett (among others)
- a scientific calculator

## Instructor Information:

Dr. Michelle A. Caler
office: Merion Science Center room 135
office hours: Tuesdays from 11:00AM—12:00PM and from 2:00PM—3:00PM
Wednesdays from 1:00—3:00PM
Fridays from 1:00—3:00PM
… and by appointment
email: mcaler@wcupa.edu
office phone: 610-436-2320
webpage: This course has a D2L website associated with it, where assignments, course documents, and relevant announcements will be posted regularly. Please let me know if you are unable to access it. Report any problems with D2L by emailing d2l@wcupa.edu or visiting the ACC student helpdesk in 20 Anderson Hall (610-436-3350).

**Course Goals**: After completing this course, students will have gained a sound understanding of several important topics in classical mechanics, as approached using both the Newtonian formalism and the Lagrangian formalism. In addition, they will build and develop skills working with a wide range of mathematical tools used ubiquitously in advanced physics courses. More specifically, the primary goals of this course include:

- develop and advance those mental models needed to solve qualitative and quantitative problems in classical mechanics. Emphasis will be placed on problems in the areas of kinematics and dynamics, conservation laws, oscillations, Lagrangian mechanics, central force motion, and non-inertial reference frames.
- develop and advance skills with mathematical tools utilized in advanced physics topics. These tools include Taylor series expansions, coordinate transformations, multivariable calculus, linear ordinary differential equations, matrices, and variational calculus.
- develop and exercise problem-solving skills, especially in cases where the problems have not been previously encountered
- develop and advance language skills
- develop and advance analytical and critical reasoning skills
- develop and advance those specific critical reading skills needed to succeed in studying advanced physics topics

**General Course Expectations:** If you attend graduate school in physics, a sound understanding of the material covered by this course is expected. Even if you do not plan to attend graduate school in physics, the mathematical tools which we will learn and use in class will pop up AGAIN and AGAIN and AGAIN in future advanced (300/400 level) physics classes at West Chester. Some of these tools may be unfamiliar to you, and the level of mathematical abstraction may be new. In order to master the material successfully, and gain good training in the mathematical tools presented, you will have to put in a substantial amount of effort. You will have to spend time outside of class reading the material covered in the text, studying the examples provided, and preparing homework assignments. ***PLEASE BE FORWARNED***, and please do not be surprised if you find yourself spending 10 hours or more per week on course-related activities. Budgeting enough study time will be crucial to your success in this course. I will do everything in my power to help you in class, during office hours, and at other times that we can arrange; however, in the end, the responsibility to set aside enough time to master the material has to be yours.

**Grading**: Exams: 60% (3 exams at 20% each)
Cumulative Final Exam: 25%
Homework: 15%

I reserve the right to introduce different forms of assessment as needed and to alter the weight of each of the categories of assessment in the event of some unforeseen circumstance.

**Attendance**: I expect you to attend all scheduled classes for the entire scheduled time. Missing lectures will ***NOT*** excuse you from any material covered, nor excuse you from homework or exams. Please email me if you know you will be absent from class, and arrange to get the notes from a classmate. In cases of extreme illness or emergency that require prolonged absence, you are responsible for contacting the appropriate Dean whose office will contact your professors and make appropriate recommendations. Making sure that you get class notes if you must be absent from class will be ***your responsibility***.

**Class Preparation:** In the (paraphrased) words of a former professor of mine, "Read the textbook. Read it carefully. Read it with a pencil in hand so you can work the examples as you go. Sometimes in the text steps and logic are omitted: work these things out for yourself as you go along." And in my own words, do your very best to read the text before each class. The skills you will gain by learning how to read a physics text book now will pay big dividends in future 300/400 level (and higher) physics classes.

You should come to lecture having read the material to be covered in class, and, if possible, having read a little bit ahead. A tentative schedule of topics to be covered each day appears at the end of this syllabus. I will post any changes to this schedule to D2L, and announce in class that an updated schedule has been posted. **IT IS YOUR RESPONSIBILITY** to make sure that you have an up-to-date class schedule. Doing the reading before class will not only increase your overall understanding of the material, it will also allow you to formulate questions about it and seek clarification during lecture if a concept or technique is not clear. I may from time to time call on you to answer questions about the material being discussed. I will ***not*** grade you on your responses, but I ***DO*** expect you to give such questions your full, honest thought and effort.
Getting hands-on with the material and working through problems will be crucial to your success in this course, as it is in all advanced physics courses. To aid in this, I may from time to time include practice problems to be completed during the course of lecture. I will expect you to work *together* in small groups on them. When work on these practice problems is complete, I may call on you to ask you for your methodology and/or solution. I expect you to give these questions your full, honest effort; however, I will ***not*** grade you based on your responses. My goal for these practice problems is to provide you with ungraded practice with the material, with immediate feedback, to help boost your skills before you need to perform for a grade on tests and homeworks.

**Homework:** Approximately once per week, problems from the textbook will be assigned for homework. Typically, they will be assigned on Fridays and due the following Friday, although there may be some variation in this pattern. When homework problems are assigned, they will be posted to our course's D2L webpage as well as announced in class; the homework due date will be announced when the problems are assigned. I will try to remind you at least once before a homework is due, but I cannot promise that I will always remember to do this. Please note that I reserve the right to modify homework due dates and times, as well as the dates that homeworks are assigned, due to unforeseen circumstances. Also, some assignments might not be collected for grading, at my discretion.
Homework assignments will consist of anywhere between 4 and 10 problems, all coming from the required text. The exact number of problems per assignment will vary according to the difficulty of the material and the duration of coverage. When assigning homeworks, I will assign a mix of 1-, 2-, and 3-star problems from the text. To get full credit on the homework, you need to work all the way through the problem (diagram and set-up to final, boxed solutions) **AND** your submitted solutions **MUST** meet the following criteria:

1. **You have set up the problem adequately**. This includes diagramming the problem (when appropriate), choosing a coordinate system (when appropriate), and defining all variables (with subscripts as appropriate).

2. **Your methodology must be clear**. If your solution to the problem rests on an assumption that is not stated in the problem, you must state that assumption explicitly. Your strategy for solving the problem should be clear to the reader, and must be a physically correct way to solve the problem.

3. **Your math must be correct.** All derivatives need to be taken correctly, and all integrals must be evaluated correctly (when called for). Your algebra and arithmetic need to be correct. And finally, your solution cannot contain any mathematically illegal operations.

4. **Your work must be logically organized**. Your work should start with the most general principles applicable to the problem, and work toward the result in a logical manner. I need to be able to read your writing and tell what your equations say. And lastly, you should reference any collaborators you worked with. If you work with your classmates on a problem, or ask a professor for help, make a note of it on your solution. Give credit where credit is due. If you didn't work with anyone on the problem, you should make note of that as well.

5. **You should include expository text which guides the reader through the problem**. If you need to make an assumption or take a limit at a certain point in the problem, it should be noted with words. Any major developments in the problem (setting two expressions equal to each other, transitioning between coordinates, etc.) should be noted. The final result should be boxed to make clear to the reader that the problem has been finished and the solution has been determined.

Finally, please staple your homework before you submit it, and cut off any "scruff" from spiral notebooks.
I will provide you with an example of a problem which has been worked out according to the above criteria. Please note that I ***will*** take off points if you submit homework solutions which do not meet them. See the discussion of the homework grading rubric below.
Homeworks will be graded as follows:

- Of the 1-star problems assigned, 1 or 2 will be chosen at random (using a random number generator) for grading.
- Of the 2-star problems assigned, 1 or 2 will be chosen at random (using a random number generator) for grading.
- All 3-star problems assigned will be graded. Under almost all circumstances, there will be only one 3-star problem assigned per homework; sometimes, there might not be any.

The exact number of problems chosen to be graded will vary from problem set to problem set, but at most 5 problems will be chosen for grading. I will let you know when a homework is assigned how many problems will be graded from each category.
Homework problems "chosen" by the random number generator will be graded according to a rubric. The rubric will be exactly the same for all problems selected for grading. This rubric will be given to you the first day of class, and will be posted as a separate document to D2L. The exact number of points each homework is worth will necessarily vary depending on the number of problems designated to be graded and which problems the random number generator "chooses."
***LATE HOMEWORK WILL NOT BE GRADED***. NO EXCEPTIONS. If you will not be in class, find a way to submit homework on schedule (for example, have someone else turn in your homework for you). Absence from class is not an excuse for not turning in your homework. I do understand that on occasion an emergency which prevents you from turning in homework on schedule will unexpectedly pop up, and for that reason ***I will drop your lowest homework grade at the end of the semester***.
Although you should work together to solve assigned problems, the work you turn in **MUST** be your own. (Of course your work will look very similar to that of students with whom you worked, but if you prepare your own answers for submission there will be differences in how you express your results.) Homework is for the purpose of learning to do problems and increasing your skills with the mathematical techniques involved in doing so. If you just copy someone else's homework answers *without having tried to do the problems yourself*, you will learn very little from the homework and you will be at a disadvantage on tests (where you will have to rely on your own understanding). Please see the "Academic Integrity" topic below.
Shortly after the homeworks are due, skeleton solutions (with some steps, calculations, or logic pieces missing) will be posted online to D2L for each problem assigned (whether graded or not). Full solutions will not be posted. Neither I nor other physics professors will always be there to tell you explicitly where you went wrong when solving a problem and what you needed to do instead, so you need to begin learning how to figure that out for yourself. When you have questions about how to complete the skeleton solutions, it is your responsibility to ask.

**Exams**: There will be four (4) regular exams over the course of the semester. Regular exams are those exams that occur in lecture during the course of the semester. They will focus on the most recently covered lecture and class material, but they should be considered cumulative in the sense that we will be building upon what we have already learned throughout the semester. Regular exams have been scheduled for the following dates:

**September 23**
**October 28**
**November 18**
**December 6**

I reserve the right to modify test dates due to unforeseen circumstances.
At the end of the semester, **I will drop your lowest regular exam**. Thus only your three (3) highest regular exam grades will be counted. Note carefully that except for University sanctioned events, there are no excused absences for regular exams, no make-up exams, and you cannot take an exam early or late. I must have documentation of the University sanctioned event **before** a make-up exam can be scheduled. What

this means that if you miss a regular exam, you receive a score of zero on it, regardless of the reason for your missing it. I drop your lowest regular exam score, so you can miss one regular exam and it will not affect your final grade. If you have ANY questions or concerns about this particular policy, please come talk to me and get clarification BEFORE it is too late!

**Final Exam:** The final exam for this course will be given on Wednesday, December 11th from 10:30 AM—12:30 PM. This is the time scheduled by the University registrar for our final exam. The final ***will be cumulative***, ***it is mandatory***, and ***it counts.*** Your final exam grade ***cannot*** be counted as your dropped exam score. Missing the final exam will result in a zero for the exam unless EXTREME circumstances apply.

**Intellectual Property Statement:** The instructor for this course utilizes copyrighted materials under the "Freedom and Innovation Revitalizing United States Entrepreneurship Act of 2007" (Fair Use Act). Apart from such copyrighted materials, all other intellectual property associated with this course is owned and copyright protected by the instructor, including, but not limited to, lectures, course discussions, course notes and supplementary materials posted or provided to students authored by the instructor, assessment instruments such as quizzes and exams, and Power Point presentations. No recording, copying, storage in a retrieval system, or dissemination in any form, whether electronic or other format, by any means of the intellectual property of the instructor, either in whole or in part, is permitted without the prior written permission of the instructor. When such permission is granted, it must specify the utilization of the intellectual property and all such permissions and waivers shall terminate on the last day of finals in the semester in which this course is held.

Links and references to on-line resources provided by the instructor may lead to other sites. The instructor does not sponsor, endorse or otherwise approve of any information appearing in those sites, nor is responsible for the availability of, or the content located on or through, external sites. Apart from materials used in accordance with the Fair Use Act, the instructor takes no responsibility for material that is otherwise offered at web sites and makes no warranty that such material does not infringe any third party rights. However, should any of this type of material be present and this fact is brought to the attention of the instructor, they will remove references to it from course materials.

**Ye Olde Technology Policy:** Please turn off all cell phones, iPods/iPads/iPhones, tablet PCs, Kindles, laptops, etc. before class. If you are expecting an emergency call, change your phone to vibrate mode and answer the call outside of our classroom. The spirit of the rule is that the classroom should be an electronic free zone where we tune out the distractions of the world and focus on learning physics. I am assuming that lecture time will have your full attention and that any personal electronic devices you own will not.

I do not allow the use of laptops in my class. However, I do understand that use of a laptop, or other personal electronic devices, may be required to accommodate certain disabilities. Terms of use in such cases can be discussed with me on an individual basis (please see the topic “disability and special needs” below).

**Academic Integrity:** It is the responsibility of each student to adhere to the University's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in automatic failure and removal from this course.

For questions regarding Academic Dishonesty, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to their major department’s handbook, the Undergraduate Course Catalogue, the Rams Eye View, or the University Web Site. Please understand that improper conduct in any of these areas will not be tolerated and may result in immediate ejection from the class.

**Disability and Special Needs:** We at West Chester wish to make accommodations for persons with disabilities. Please make your needs known by contacting the Office of Services for Students with Disabilities at extension 3217 as well as myself. Sufficient notice is needed in order to make the accommodations possible. The University and I desire to comply with the ADA of 1990.

**Withdrawal Notice**: A syllabus constitutes a contract between student and instructor. Your continued enrollment after the **August 31st drop deadline** indicates that you accept all instructional practices, requirements, and policies. If you find the standards to which you will be held accountable too rigorous, if you are unable to *reliably* access the internet to log on to D2L, or if an ongoing scheduling conflict prevents you from attending class regularly and punctually, you must officially withdraw (grade "W") through the Registrar's Office by the **October 25th course withdrawal deadline**. You are responsible for checking your grades before this withdrawal deadline so you aren't surprised by your standing as the end of the course approaches. You can contact me anytime to get an estimate of your grade as it stands at the moment.

**Public Safety**: All students are encouraged to sign up for the University's free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information and to sign up, visit www.wcupa.edu/wcualert. To report an emergency, call the Department of Public Safety at 610-436-3311.

This is the tentative schedule; I will try to follow it as closely as possible. I will post any changes to this schedule to D2L, and announce in class that an updated schedule has been posted.

***IT IS YOUR RESPONSIBILITY*** to make sure that you have an up-to-date class schedule.

| Week | Date | Topic | Reading Due[1] |
|---|---|---|---|
| 1 | 26-Aug | Introduction / Math Review | – |
| | 28-Aug | Newton I,II,III, Newton II in Cartesian Coords | sections 1.1-1.6 |
| | 30-Aug | Newton II in Cartesian Coords and Polar Coords | sections 1.6-1.7 |
| 2 | *2-Sep* | NO CLASS—LABOUR DAY | |
| | 4-Sep | Newton II in Polar Coords, Air resistance | sections 1.7, 2.1, 2.2 |
| | 6-Sep | Linear Air Resistance | sections 2.2-2.3 |
| 3 | 9-Sep | Quadratic Air Resistance | section 2.4 |
| | 11-Sep | Momentum and Rockets | sections 3.1-3.2 |
| | 13-Sep | Rockets, Centre of Mass | sections 3.2-3.3 |
| 4 | 16-Sep | Angular Momentum and Centre of Mass | sections 3.3-3.5 |
| | 18-Sep | Work, Line integrals, PE, Conservative Forces | sections 4.1-4.2 |
| | 20-Sep | PE and Conservative Forces, F as grad of PE | sections 4.2-4.3 |
| 5 | **23-Sep** | **EXAM I: CHAPTERS 1, 2, 3** | |
| | 25-Sep | Conditions for a Force to be Conservative | sections 4.3-4.4 |
| | 27-Sep | Time Dependent Potentials, Energy for 1D Systems | sections 4.5-4.6 |
| 6 | 30-Sep | Energy for 1D Systems, Curvilinear Coords | sections 4.6-4.7 |
| | 2-Oct | Central Forces and Spherical Coords | sections 4.8 |
| | 4-Oct | Energy and More than One Particle | sections 4.9-4.10 |
| 7 | *7-Oct* | NO CLASS—FALL BREAK | |
| | 9-Oct | Simple Harmonic Motion | sections 5.1-5.2 |
| | 11-Oct | Complex Numbers | sections 2.5-2.7 |
| 8 | 14-Oct | Damped Harmonic Motion | section 5.4 |
| | 16-Oct | Damped, Driven Oscillations | sections 5.5-5.6 |
| | 18-Oct | Damped, Driven Oscillations and Resonance | sections 5.5-5.6 |
| 9 | 21-Oct | The Calculus of Variations | sections 6.1-6.2 |
| | 23-Oct | The Calc of Variations & The Euler-Lagrange Equation | sections 6.2-6.4 |
| | 25-Oct | Applications of the Euler-Lagrange Equation | section 6.3 |
| 10 | **28-Oct** | **EXAM II: CHAPTERS 4 AND 5** | |
| | 30-Oct | Lagrange's Equations | sections 7.1-7.2 |
| | 1-Nov | Lagrange's Equations for Constrained systems | sections 7.2-7.4 |
| 11 | 4-Nov | Lagrangian Method & Examples | section 7.5 |
| | 6-Nov | Lagrangian Method & Examples | section 7.5 |
| | 8-Nov | Lagrangian Method & Examples, generalized momenta | sections 7.5-7.7 |
| 12 | 11-Nov | Lagrange Multipliers | section 7.10 |
| | 13-Nov | Lagrange Multipliers, a brief intro to Hamiltonians | sections 7.10,7.8 |
| | 15-Nov | Relative Coords and Reduced Mass | sections 8.1-8.3 |
| 13 | **18-Nov** | **EXAM III: CHAPTERS 6 AND 7** | |
| | 20-Nov | The 1D two-body problem | sections 8.3-8.4 |
| | 22-Nov | Orbits | sections 8.5-8.6 |
| 14 | 25-Nov | Unbounded orbits | sections 8.6-8.7 |
| | *27-Nov* | NO CLASSES—THANKSGIVING BREAK | |
| | *29-Nov* | NO CLASSES—THANKSGIVING BREAK | |
| 15 | 2-Dec | Newton's Laws in Rotating Reference Frames | sections 9.3-9.5 |
| | 4-Dec | The Coriolis Force | sections 9.5,9.7 |
| | **6-Dec** | **EXAM IV: CHAPTERS 8 AND 9** | |
| 16 | 9-Dec | TBA | |

1: section numbers refer to the sections in Classical Mechanics by John. R. Taylor