West Chester University

Physics 300-01: Mechanics
Fall 2014

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 which will receive considerable attention include kinematics and dynamics, energy, conservation laws, oscillations, central force motion, and non-inertial reference frames. During 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, ordinary linear 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 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)

Optional Supplemental 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, such as *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: Mondays and Wednesdays from 1:00—3:00PM
Tuesdays from 3:00—4:00PM
Fridays from 1:00—2:00PM
… 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: Upon successful completion of 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 intermediate and 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, energy, 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, ordinary linear differential equations, matrices, and variational calculus.
- develop and exercise problem-solving skills, especially in cases where problems have not previously been encountered
- develop and advance analytical and critical reasoning skills
- develop and advance those specific critical reading skills needed to succeed in the study of advanced physics topics

Activities such as in-class practice problems, homework assignments, and in-class exams will help contribute to students' achievement of these Course Goals.

General Course Expectations: If you attend graduate school in physics, a solid 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 pop up AGAIN and AGAIN and AGAIN in advanced (300/400 level) physics classes at West Chester. Some of these tools may be unfamiliar to you, and the level of mathematical abstraction that we engage in 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 text, studying provided examples, preparing homework assignments, and (likely) attempting non-assigned, supplemental problems. ***PLEASE BE FORWARNED*** that this class will require a non-trivial amount of work, 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 highest exams at 20% each)
Cumulative Final Exam: 25%
Homework: 15%

I reserve the right to introduce different forms of assessment as needed, and/or 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 (and again after class, even!). The skills you'll gain by learning how to read a physics textbook now will pay big dividends in future 300/400 level 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. I cannot encourage you enough to engage in a careful reading of the assigned textbook sections before class. Doing so will not only increase your overall understanding of the material, it will also allow you to formulate questions about the material 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 in taking lecture time to do practice problems is to provide you with consequence-free (i.e., ungraded) practice with the material, so that you can get immediate feedback on your understanding and technique. I hope these activities will help you boost your skills before you need to perform for a grade, i.e. on tests and homeworks.

Homework: I have planned a total of 11 homework assignments this semester. A tentative schedule of days on which homeworks will be assigned, as well as days on which homeworks will be due, 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. On days that homeworks are assigned, they will be posted to our course's D2L webpage as well as announced in class. 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. Homeworks are due **IN MY OFFICE by 5:00PM** on the indicated due dates. Please note that I reserve the right to modify homework due dates and times, the dates that homeworks are assigned, and the total number of assigned homeworks 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 12 problems, mostly 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. The full text of, and any needed supplemental figures for, problems not coming from the required text will be provided on the homework assignment document.
Submitted homework will be graded based on completion (INCLUDING, as necessary, diagrams, statements of assumptions, and explanations of your approach) on a 3-point scale (3,2,1). Please make sure submitted homework assignments adhere to the following guidelines to avoid losing credit unnecessarily:

1. **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. **Make your methodology 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. **Make sure your math is correct and "legal."** 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. **Organize your work logically.** Your work should start with the most general principles applicable to the problem, and work toward the final result in a logical manner. Note that I need to be able to read your writing and tell what your equations say, not only here but on the exams as well.
5. **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. Ideally, you should include enough expository text for

someone who doesn't know how to solve the problem to be able to follow your work. Your final result should be boxed to make clear to the reader that the problem has been finished and the solution has been determined.

6. Cite collaborators and outside resources used. Explicitly cite any ideas, hints, derivations, or problem-solving steps that you got from other people, books, the internet, or other resources, in your homework. If you worked with classmates on a particular problem, mention them explicitly at the end of your solution. If you do a problem completely out of your own head, state so explicitly.

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. Look for it on the D2L webpage associated with this course.
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 a classmate turn in your homework for you). 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. (See the Academic Integrity statement on page 5 of this syllabus.) It is likely that your work will look *similar* to that of classmates with whom you worked, but if you prepare your own answers for submission there will be differences in how you express your results. Please understand that the purpose of homework is to learn how to do problems and to increase your skills with the mathematical techniques involved in doing so. A thorough understanding of the assigned homework problems will help you answer exam questions correctly. 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. You are always welcome to bring your solutions to my office hours; I'm happy to tell you if you're on the right track or not.
Shortly after the homeworks are due, skeleton solutions (with some steps, calculations, or logic pieces missing) will be posted online to D2L. 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 me.

Exams: There will be four in-class exams over the course of the semester. They will focus on the most recently covered lecture and class material (according to the schedule at the end of this syllabus), but they should be considered cumulative in the sense that we will be building upon what we have already learned throughout the semester. In-class exams have been scheduled for the following dates:

September 22
October 15
November 5
December 1

I reserve the right to modify test dates due to unforeseen circumstances.
At the end of the semester, I will drop your lowest in-class exam grade. Thus only your three highest in-class exam grades will be counted. Note carefully that except for University sanctioned events, there are no excused absences for in-class 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 an in-class exam, you receive a score of zero on it, regardless of the reason for your missing it. I drop your lowest exam score, so you can miss one in-class 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 10 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 this 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. Thus, I am assuming that lecture time will have your full attention and that any personal electronic devices you own will not. 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).

Email Policy: It is expected that faculty, staff, and students activate and maintain regular access to University provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.

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: If you have a disability that requires accommodations under the Americans with Disabilities Act (ADA), please present your letter of accommodations and meet with me as soon as possible so that I can support your success in an informed manner. Accommodations cannot be granted retroactively. If you would like to know more about West Chester University's Services for Students with Disabilities(OSSD), please contact the OSSD which is located at 223 Lawrence Center. The OSSD hours of Operation are Monday – Friday 8:30 a.m. – 4:30 p.m. Their phone number is 610-436-2564, their fax number is 610-436-2600, their email address is ossd@wcupa.edu, and their website is at www.wcupa.edu/ussss/ossd.

Withdrawal Notice: A syllabus constitutes a contract between student and instructor. Your continued enrollment after the **September 2nd 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, or 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 24th 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, though I DO reserve the right to adjust it as necessary during the semester to ensure a satisfactory learning experience. 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]	HW out/due
1	25-Aug	Introduction / Kinematics Review / Math Review	—	HW #1 OUT 08/25
	27-Aug	Newton I,II,III, Newton II in Cartesian Coords	sections 1.1 – 1.6	
	29-Aug	Newton II in Cartesian Coords, Newton II in Polar Coords	sections 1.6 – 1.7	
2	*1-Sep*	NO CLASS—LABOUR DAY		HW #1 DUE 09/03
	3-Sep	Newton II in Polar Coords, Air resistance	sections 1.7, 2.1	HW #2 OUT 09/03
	5-Sep	Linear Air Resistance	section 2.2	
3	8-Sep	Linear Air Resistance in 2D, Projectile Range	section 2.3	HW #2 DUE 09/12
	10-Sep	Quadratic Air Resistance	section 2.4	HW#3 OUT 09/12
	12-Sep	Momentum and Rockets	sections 3.1 – 3.2	
4	15-Sep	Centre of Mass	section 3.3	HW #3 DUE 09/19
	17-Sep	Angular Momentum of a Particle and of a System of Particles	sections 3.4 – 3.5	
	19-Sep	Work and Line integrals	section 4.1	
5	**22-Sep**	**EXAM I: CHAPTERS 1, 2, 3**		HW #4 OUT 09/24
	24-Sep	PE, Conditions for a Force to be Conservative	sections 4.1 – 4.3	
	26-Sep	F from PE, Gradients	section 4.3	
6	29-Sep	More Conservative F Conditions	section 4.4 – 4.5	HW #4 DUE 10/01
	1-Oct	Time Dependent Potentials, Energy for 1D systems	sections 4.5 – 4.6	HW #5 OUT 10/01
	3-Oct	Energy for 1D Systems, Curvilinear Coords	sections 4.6 – 4.7	
7	*6-Oct*	NO CLASS—FALL BREAK		HW #5 DUE 10/08
	8-Oct	Energy for 1D curvilinear coords, Central Forces & Spherical Coords	sections 4.7 – 4.8	HW #6 OUT 10/08
	10-Oct	Energy and More than One Particle	Sections 4.9 – 4.10	
8	13-Oct	Simple Harmonic Motion	Sections 5.1 – 5.2	HW #6 DUE 10/14
	15-Oct	**EXAM II: CHAPTER 4**		HW #7 OUT 10/17
	17-Oct	Simple Harmonic Motion and Complex Numbers	sections 2.5 – 2.7, 5.2	
9	20-Oct	Damped Harmonic Motion	section 5.4	
	22-Oct	Damped, Driven Oscillations	section 5.5	
	24-Oct	Damped, Driven Oscillations & The Calc of Variations	sections 5.6, 6.1	
10	27-Oct	The Calc of Variations & The Euler-Lagrange Equation	section 6.2	HW #7 DUE 10/27
	29-Oct	The Calc of Variations & The Euler-Lagrange Equation + applications	sections 6.2 – 6.3	HW #8 OUT 10/27
	31-Oct	Applications of the Euler-Lagrange Equation, >1 dependent var.	sections 6.3 – 6.4	
11	3-Nov	Lagrange's Equations	section 7.1	HW #8 DUE 11/04
	5-Nov	**EXAM III: CHAPTERS 5 AND 6**		HW #9 OUT 11/07
	7-Nov	Lagrange's Equations for Constrained Systems	sections 7.1 – 7.4	
12	10-Nov	Lagrangian Method & Examples	section 7.5	
	12-Nov	Lagrangian Method & Examples, Ignorable Coordinates	sections 7.5 – 7.7	
	14-Nov	Lagrange Multipliers	sections 7.6, 7.7, 7.10	
13	17-Nov	Lagrange Multipliers, a brief intro to Hamiltonians	sections 7.10, 7.8	HW #9 DUE 11/17
	19-Nov	Relative Coords and Reduced Mass	sections 8.1 – 8.3	HW #10 OUT 11/17
	21-Nov	The "equivalent" 1D Two-Body Problem	sections 8.3 – 8.4	
14	24-Nov	Orbits	sections 8.5 – 8.6	HW #10 DUE 11/25
	26-Nov	NO CLASS—THANKSGIVING BREAK		
	28-Nov	NO CLASS—THANKSGIVING BREAK		
15	**1-Dec**	**EXAM IV: CHAPTERS 7 AND 8**		HW #11 OUT 12/03
	3-Dec	Rotating Reference Frames	sections 9.3 – 9.4	
	5-Dec	Newton's Laws in Rotating Reference Frames, the Coriolis Force	sections 9.5 – 9.6	
16	8-Dec	The Coriolis Force and the Centrifugal Force	sections 9.6 – 9.7	HW #11 DUE 12/08
	10-Dec	**Final Exam**	**10:30AM – 12:30PM**	

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