West Chester University

Physics 300-01: Mechanics
Fall 2016

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, and touch on ideas from the Hamiltonian formalism. This course will build upon students' knowledge of classical mechanics from previous physics courses, delving into more detail and mathematical sophistication as we study topics in greater depth. We will focus a considerable amount of attention on the following topics: kinematics, 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, 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

<u>Required</u> Course Materials:
- *Classical Mechanics* by John. R. Taylor: University Science Books, 2005 (ISBN 9781891389221)

<u>Optional</u> 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
<u>office</u>: Merion Science Center room 135
<u>office hours</u>: Mondays and Wednesdays from 1:00—3:00PM
Fridays from 2:00—4:00PM
... and by appointment
<u>email</u>: mcaler@wcupa.edu
<u>office phone</u>: 610-436-2320
<u>webpage</u>: 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 D2L help desk in Anderson Hall room 3 (610-436-3350, option 1).

Course Student Learning Outcomes:
PHY 300 fulfills the goal that students understand the concepts and principles of physics as outlined in the Physics Department's Program Assessment. Upon successfully completing PHY 300, students will have a mastery of several important topics in classical mechanics, as approached using both the Newtonian formalism and the Lagrangian formalism. In addition, students will build and develop skills working with a wide range of mathematical methods used ubiquitously in intermediate and advanced physics courses. More specifically, by the end of this course, students are expected to obtain the following learning outcomes:

- Students will demonstrate the ability to apply Newtonian mechanics to the study of time- and velocity-dependent forces.
- Students will be able to determine whether or not a force is conservative, and to calculate the potential energy associated with a conservative force.
- Students will be able to solve intermediate-level oscillatory motion problems.
- Students will demonstrate the ability to solve problems in classical mechanics using the Lagrangian formalism.
- Students will demonstrate the ability to properly utilize Newtonian Mechanics in non-inertial reference frames.

Activities such as in-class practice problems and homework assignments will help contribute to students' achievement of these Course Student Learning Outcomes. Outcomes will be assessed via in-class exams.

General Course Expectations:
If you attend graduate school for physics, you will be expected to have a solid mastery of the material covered in this course. Even if you do not plan on attending graduate school for physics, the mathematical methods which we will learn and use in class pop up AGAIN and AGAIN and AGAIN in intermediate (300/400)-level physics classes at West Chester. Some of these methods may be unfamiliar to you, and the level of mathematical abstraction that we shall engage in will go beyond what you've encountered in your previous physics classes. In order to master the material successfully, and gain good training in the mathematical methods 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 unassigned, optional 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 outside of class on course-related activities. Budgeting enough study time will be crucial to your success in Mechanics. 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. Also, I reserve the right to alter the weight of each of the categories of assessment in the event of some unforeseen circumstance.

Attendance:
While I will not grade on attendance, I **DO** expect you to attend all scheduled classes for the entire scheduled time, as attendance in class is crucial to your success in it. Missing lectures will _**NOT**_ excuse you from any material covered, nor will it excuse you from homework or exams. Please email me if you know you will be absent from class, and arrange to get the notes you'll be missing 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 is *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 that 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!). Engaging in a careful reading of the assigned textbook sections before class 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 can assure you that 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 carefully 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 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 concepts and methods of mechanics, especially by working through problems, will be crucial to your success in this course (as is the case for all intermediate-level and advanced physics courses). To aid in this, I may from time to time introduce practice problems to be completed during the course of lecture. I will expect you to work *together* in small groups on practice problems. When work on a problem is complete, I may call on you to ask you for your methodology and/or solution to it. 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 methodology. 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 6:00PM** 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 10 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 homeworks will be graded partly on completion and partly on correctness. Completely solved problems include ALL necessary diagrams, statements of assumptions, and explanations of your approach. No credit will be given to submitted assignments which are less than half complete. Please make sure submitted homework assignments adhere to the following guidelines to avoid losing credit unnecessarily:

1. <u>Set up the problem adequately</u>. This includes diagramming the problem (when appropriate), choosing a coordinate system (when appropriate), and defining any non-standard variables used (with subscripts as appropriate).
2. <u>Make your methodology clear</u>. 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 it must be a physically correct way to solve the problem.
3. <u>Make sure your math is correct and "legal."</u> All derivatives need to be taken correctly, and all integrals must be evaluated correctly (when called for). Your algebra and arithmetic need to be

complete and correct. And finally, your solution cannot contain any "illegal" or undefined mathematical operations.

4. <u>**Organize your work logically.**</u> 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. <u>**Include expository text which guides the reader through the problem.**</u> If you need to make an assumption or approximation, or if you 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. <u>**Cite collaborators and outside resources used.**</u> 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. 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.

<u>LATE HOMEWORK WILL NOT BE GRADED</u>. **NO EXCEPTIONS**. If you will not be in class, find a way to submit homework on time (for example, have a classmate turn it in for you). I do understand that, on occasion, an unexpected emergency which prevents you from turning in homework on time will pop up; for this 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 6 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. Be conscious of the purpose of doing homework, which 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 pieces of logic 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 4 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 23**
> **October 19**
> **November 9**
> **December 7**

I reserve the right to modify test dates due to unforeseen circumstances.
At the end of the semester, <u>I will drop your lowest in-class exam grade</u>. Only your 3 highest in-class exam grades will be counted. If you miss an in-class exam, you will receive a score of zero on it. There will be **NO**

make-up exams. You *cannot* take an exam early or late. Exceptions will be made ONLY for absences due to University-Sanctioned Events as described in the West Chester University Undergraduate Catalog. I **MUST** have official documentation of the University Sanctioned Event before arrangements can be made to take a missed exam. Note carefully that I **DO** drop your lowest in-class exam score, so you can miss ONE in-class exam (for whatever reason) and it will NOT affect your final grade. If you have **ANY** questions 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 Friday, December 16 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. 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.

Excused Absences Policy for University Sanctioned Events:
Students are advised to carefully read and comply with the excused absences policy for university-sanctioned events contained in the WCU Undergraduate Catalog. In particular, please note that: the "responsibility for meeting academic requirements rests with the student;" this policy does not excuse students from completing required academic work; and that professors can require a "fair alternative" to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

Reporting Incidents of Sexual Violence: West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator, Ms. Lynn Klingensmith. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University protection of minors policy. Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth at the webpage for the Office of Social Equity at http://www.wcupa.edu/_admin/social.equity/.

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 West Chester University Undergraduate Catalog, 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. – 4:00 p.m. Their phone number is 610-436-2564, their fax number is 610-436-2600, and their email address is ossd@wcupa.edu. See the following website for more information: http://www.wcupa.edu/ussss/ossd/default.aspx.

Withdrawal Notice: A syllabus constitutes a contract between student and instructor. Your continued enrollment after the **September 6ᵗʰ 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 28ᵗʰ 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.

Emergency Preparedness: 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 class schedule. I will try to follow it as closely as possible. I reserve the right to adjust this schedule as necessary in order to ensure a satisfactory learning experience. I will post any changes to the class 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	29-Aug	Introduction / Coordinate Systems / Math Review	—	HW #1 OUT 08/29
	31-Aug	Newton I,II,III, Newton II in Cartesian Coords	sections 1.1 – 1.6	
	2-Sep	Newton II in Polar Coords	sections 1.6, 1.7	
2	*5-Sep*	*NO CLASS—LABOUR DAY*		HW #1 DUE 09/07
	7-Sep	Newton II in Polar Coords, Linear Air Resistance	sections 1.7, 2.1, 2.2	HW #2 OUT 09/07
	9-Sep	Linear Air Resistance in 1D and in 2D	sections 2.2, 2.3	
3	12-Sep	Projectile Range in a Linear Medium, Quadratic Air Resistance	sections 2.3, 2.4	HW #2 DUE 09/15
	14-Sep	Quadratic Air Resistance, Momentum and Rockets	sections 2.4, 3.1, 3.2	HW#3 OUT 09/15
	16-Sep	Centre of Mass	section 3.3	
4	19-Sep	Angular Momentum of a Particle and of a System of Particles	sections 3.4, 3.5	
	21-Sep	Angular Momentum of a System, Work and Line Integrals	sections 3.5, 4.1	HW #3 DUE 09/21
	23-Sep	**EXAM I: CHAPTERS 1, 2, 3**		
5	26-Sep	Work and Line Integrals, PE, ME	sections 4.1, 4.2	HW #4 OUT 09/26
	28-Sep	Getting F from PE	section 4.3	
	30-Sep	Conditions for F to be Conservative	section 4.4	
6	3-Oct	Energy for 1D Systems	sections 4.5, 4.6	HW #4 DUE 10/03
	5-Oct	Energy for 1D Systems, Curvilinear 1D systems	sections 4.6, 4.7	HW #5 OUT 10/03
	7-Oct	Curvilinear 1D systems, Central Forces	sections 4.7, 4.8	HW #6 OUT 10/07
7	*10-Oct*	*NO CLASS—FALL BREAK*		
	12-Oct	Central Forces, Energy of 2 Particles	sections 4.8, 4.9	HW #5 DUE 10/12
	14-Oct	Energy of More than 1 Particle	sections 4.9, 4.10	
8	17-Oct	Hooke's Law, Simple Harmonic Motion	sections 5.1, 5.2	HW #6 DUE 10/17
	19-Oct	**EXAM II: CHAPTER 4**		
	21-Oct	Simple Harmonic Motion and Complex Numbers	sections 2.5 – 2.7, 5.2	HW #7 OUT 10/20
9	24-Oct	Damped Harmonic Motion	section 5.4	
	26-Oct	Damped, Driven Oscillations	section 5.5	
	28-Oct	Resonance, The Calculus of Variations	sections 5.6, 6.1	
10	31-Oct	The Calculus of Variations & The Euler-Lagrange Equation	section 6.2	HW #7 DUE 10/31
	2-Nov	The Euler-Lagrange Equation + applications	sections 6.2, 6.3	HW #8 OUT 10/31
	4-Nov	The Euler-Lagrange Equation for More than 1 Dependent Variable	sections 6.3, 6.4	
11	7-Nov	Lagrange's Equations for Unconstrained Systems	section 7.1	HW #8 DUE 11/07
	9-Nov	**EXAM III: CHAPTERS 5 AND 6**		
	11-Nov	Lagrange's Equations for Constrained Systems	sections 7.2 – 7.4	HW #9 OUT 11/11
12	14-Nov	Lagrangian Method & Examples	section 7.5	
	16-Nov	Lagrangian Method & Examples	section 7.5	
	18-Nov	Ignorable Coordinates, Lagrange Multipliers	sections 7.6, 7.7, 7.10	
13	21-Nov	Lagrange Multipliers, a brief intro to Hamiltonians	sections 7.10, 7.8	HW #9 DUE 11/21
	23-Nov	*NO CLASS—THANKSGIVING BREAK*		
	25-Nov	*NO CLASS—THANKSGIVING BREAK*		
14	28-Nov	Relative Coords and Reduced Mass	sections 8.1 – 8.3	HW #10 OUT 11/28
	30-Nov	The "Equivalent" 1D Two-Body Problem	sections 8.3, 8.4	
	2-Dec	Orbits	sections 8.5, 8.6	
15	5-Dec	Rotating Reference Frames	sections 9.3, 9.4	HW #10 DUE 12/05
	7-Dec	**EXAM IV: CHAPTERS 7 AND 8**		HW #11 OUT 12/05
	9-Dec	Newton's Laws in Rotating Reference Frames	section 9.5	
16	12-Dec	The Coriolis Force and the Centrifugal Force	sections 9.6, 9.7	HW #11 DUE 12/12
	16-Dec	**FINAL EXAM**	**10:30AM – 12:30PM**	

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