University of Wisconsin – Stevens Point

Dept. of Physics and Astronomy

Advanced Mechanics – PHYS 335

Spring 2021

Course Information

- **Course title:** Advanced Mechanics
- **Course number:** PHYS 335
- **Pre-requisites:** PHYS 250, Math 213, Math 222.
- **Textbook:** *Classical Mechanics*, John R. Taylor, University Science Books. ISBN-13: 978-1-891389-22-1.
- **Instructor:** Maryam Farzaneh
- **Contact:** B105 Science Building, mfarzane@uwsp.edu
- **Office hours:** My office hours will be held on Zoom. If you need to meet with me outside of class times, please email me and we will arrange for individual Zoom meetings.
- **Zoom link (You can join the meeting through Canvas):**

https://uwsp.zoom.us/j/94728088196?pwd=YnRCWFhVNVlEMlFHV2RFOWhsaWV5UT09

Please use this link for all the meetings related to PHYS250 (times are below), including individual office hours.

- **Class times:**

  - Tuesday and Thursday 10:00 – 10:50 am (on Zoom)

Course Description

In Advanced Mechanics we study classical Newtonian mechanics with more rigor and mathematical sophistication compared to your introductory physics courses. In this course we will study Newton's Laws using vectors and differential equations in both Cartesian and polar coordinates. We will revisit momentum, angular momentum and energy conservation laws and will study oscillations in detail. A new approach to classical mechanics, called Lagrangian Mechanics will be introduced and will be used to study central forces and many more examples. We will also study motion in non-inertial frames and investigate the rotational motion of rigid bodies.

Learning Objectives

By taking this course you should expect the following:

1. Gain an in-depth understanding of Newtonian Mechanics, especially Newton's Laws, and apply these laws in different situations in Cartesian and polar coordinates.

2. Learn to solve differential equations of motion and determine velocity and position of a particle, given initial conditions.

3. Understand damped and driven oscillation of a mass.

4. Learn Lagrangian Mechanics and be able to apply its results in different situations.

5. Learn to work out problems in a non-inertial frame of reference.

6. Understand the rotation of a rigid body.

Required Material

- **Calculator:** Please have a scientific calculator handy.

Lectures

Lectures are in video format. They are usually no longer than 30 minutes. Each week a Canvas Module, consisting of no more than 5 to 6 videos will be posted on the course's Canvas page. **Please watch these videos before attending online sessions.**

- **Online Discussion Sessions (Lecture Review, Discussion and Problem-Solving)**

  Every Tuesday and Thursday (10:00 – 10:50 am), we will meet on Zoom for a discussion and problem-solving session. You will come to these sessions, having already watched the video lectures.

  At the beginning of each class, I will briefly review the relevant topics discussed in lectures and answer any questions. You will then start working in small groups either on an example problem I provide, or on some of the problems from your homework assignment. My role will be to answer any questions and provide any help and guidance you need.

  I strongly encourage you to come to these sessions and take advantage of the interaction with your peers and the help I provide. You might even get a head start on your homework assignments during these classes.

Homework

You will have one homework assignment per week. These will be posted on Canvas along with your video lectures. You typically have one week to finish your homework and submit it on Canvas **as a single pdf file**. The pdf file can be generated either using the OneDrive App on your phones or by taking jpg images and inserting them in a Word document and saving the file as pdf. I will not accept numerous jpg files for the homework.

Your homework grade is based on the completion of the assignment and the score from a few (typically four) randomly graded problems. I will post the solutions to the entire homework assignment on Canvas. *Overall, the homework assignments count for 40% of your grade.*

Exams

There will be *two* midterm exams during the semester, not counting your final exam. These exams will be held **on weeks 5 and 10 (please see the course schedule) and are take-home exams**. I will give you 24 hours to finish each exam and submit it on Canvas. The final exam is non-cumulative and is also take home with 24-hour time limit. The Final exam will be posted on Canvas on **Monday, May 17, at 10:00 am**. *Overall, these three exams count for 60% of your grade (20% for each exam).*

General Course Policies

- **Disability services**

  UWSP is committed to providing reasonable and appropriate accommodations to students with disabilities and temporary impairments. If you have a disability or acquire a condition during the semester where you need assistance, please contact the Disability and Assistive Technology Center on the 6th floor of Albertson Hall (library) as soon as possible. DATC can be reached at 715-346-3365 or DATC@uwsp.edu.

- **Academic misconduct**

  I expect you to be familiar with the UWSP policies regarding student conduct. You can find the relevant documents here: https://www.uwsp.edu/dos/Pages/Student-Conduct.aspx. Simply put, *do not* copy each other's homework, lab reports and exams and pass them off as your own. Any confirmed incidence of academic misconduct, including plagiarism and other forms of cheating will be treated seriously and in accordance with University policy.

- The schedule for the final exam is set by the University. I will not schedule an early final exam for whatever reason.

- **I *do not* assign work for extra credit. There are *no* bonus points that you can earn.**

- Once you hand in your final exam, there is nothing more you can do to change your grade.

Grading and Evaluation

I will calculate your grade based on a weighted percentage of your scores as follows:

Homework	40%
Exams (2 midterms, 1 Final)	60% (20% each exam)

Your final grades will be determined as follows:

90% and above	A	82--85%	B+	70--73%	C+	56--60%	D+
86--89%	A-	78--81%	B	66--69%	C	50--55%	D
		74--77%	B-	61--65%	C-	below 50%	F

Please note that I do *not* grade on a curve. Scores will be rounded up. For example, 85.6% will become an A-, but 85.3 will remain a B+.

Tentative Course Schedule

The tentative course schedule is as follows. This might change, and I will try my best to announce any changes beforehand.

Week	Chapter and Topic	Comments
(1)	(1) Space, time, mass and force, Newton's laws, Inertial frames, Conservation of momentum	HW1
(2)	(1) Newton's 2nd law in Cartesian and polar coordinates	HW2
(3)	(2) Projectile motion with linear drag	HW3
(4)	(3) Conservation of momentum, Rocket motion, Center of mass, Conservation of angular momentum	HW4
(5)	(4) Work, KE, Conservative forces, PE , Conservation of mechanical energy, Non-conservative forces, Force and PE, Gradient and curl, Energy in one dimension, Graphs of PE	**Exam 1**
(6)	(5) Oscillations: SHM, Damped oscillation, Driven damped oscillation, Resonance	HW5
(7)	(6) Calculus of variations, Brachistochrone, Generalized coordinates	HW6
(8)	(7) Lagrange's equations – Projectile motion, Simple pendulum, Pendulum supported on a wheel, Pendulum with oscillatory support, Bead on a rotating hoop	HW7
	SPRING BREAK	
(9)	(8) Central forces, Equation of motion, Effective potential, Equation of the orbit	HW8

(10)	(8) Kepler orbits, Bounded orbits, Period of orbits, Unbounded Kepler orbits	**Exam 2**
(11)	(9) Motion in non-inertial frames, Accelerating frames, Tides, Rotating frames	HW9
(12)	(9) Newton's Laws in rotating frames, Centrifugal force, Free fall, Coriolis force	HW10
(13)	(9) Foucault pendulum (10) Rotational Motion of Rigid Bodies, CM review, Rotation about a fixed axis	HW11
(14)	(10) Moment of inertia, Rotation about any axis, Principal axes	HW12
(15)	Review, Q&A	Review Problems
(16)	**Final Exam: Monday, May 17, 10:00 am**	