PHYS 531.01W Classical Mechanics for Educators

COURSE SYLLABUS: Fall 2024

INSTRUCTOR INFORMATION

Instructor: Dr. William Newton
Office Location: STC 236
Office Hours: TBA (We'll arrange by poll). They will be held on Zoom once a week for one hour.
Office Phone: 903-366-9331

University Email Address: william.newton@tamuc.edu

Preferred Form of Communication: Email
Communication Response Time: Within 48 hours on weekdays and weekends

Full transparency: the courses in this Master's program were developed by myself, Dr. Robynne Lock and Dr. Bahar Modir (3 classes, 3 classes and 1 class respectively.) We all created video lectures for the classes we developed. However, it is an unavoidable consequence of a department trying to prepare schedules of classes under a number of different constraints that we will often have to teach each other's classes.

This class was developed by Dr. Robynne Lock, with some additional work from Dr. Bahar Modir. The video lectures were created by Dr. Robynne Lock, and so it is her voice you will here. I have added some additional material and made some logistical changes.

You will interact with me live during office hours, and asynchronously in the discussion threads, which we'll try to schedule to best fit everyone's schedule so you should get the chance to discuss the material directly with me!

COURSE INFORMATION

Readings List

I. Newton, "Axioms, or Laws of Motion," in the *Principia: The Mathematical Principles of Natural Philosophy* (1846).

I. Newton, “Definitions,” in the *Principia: The Mathematical Principles of Natural Philosophy* (1846).
E. Du Chatelet *“Foundations of Physics”* Chapters 20 and 21
I. Lovatt and B. Innes, “Resistance is not futile: Air resistance in an algebra based course,” The Physics Teacher 43, 544 (2005).
U. Besson, L. Borghi, A. D. Ambrosis, and P. Mascheretti, “How to teach friction: Experiments and models,” American Journal of Physics 75, 1106 (2007).
M. Schirber, “Focus: Dragging nanoparticles reveals extra-low friction,” Physics 6, 130 (2013).
D. Mackenzie, “Focus: Friction of molecules,” Physics 3, 9 (1999).
M. Sincell, “Focus: Surface grime explains friction,” Physics 7, 6 (2001).
J.R. Minkel, “Focus: Reducing friction without oil,” Physics 13, 14 (2004).
F.J. Giessibl, “AFM’s path to atomic resolution,” Materials Today (May 2005).
S.W. Hla, “Viewpoint: Tuning in to the Smallest (Man-Made) Mechanical Resonator,” Physics 7, 26 (2014).
R.A. Lawson and L.C. McDermott, “Student understanding of the work energy and impulse-momentum theorems,” American Journal of Physics 55, 811 (1987).
L.C. McDermott, P.S. Schaffer and the PEG, “Work and the work-energy theorem” in Tutorials in Introductory Physics, Upper Saddle River, NJ: Pearson (2002).
J.L. Docktor, N.E. Strand, J.P. Mestre, and B.H. Ross, “Conceptual problem solving in high school physics,” Phys. Rev. ST – PER 11, 020106 (2015).
K. Daniels, “Viewpoint: Pushing on a nonlinear material,” Physics 7, 113 (2014).
S. Chasteen, “Focus: Cracking the story of fracture,” Phys. Rev. Focus 25, 5 (2010).
J.R. Minkel, “Focus: Making waves in crack theory,” Phys. Rev. Focus 9, 1 (2002).
M. Rini, “Synopsis: Transiently chaotic,” Physics, November 7, 2013.
M.L. DeJong, “Chaos and the simple pendulum,” Phys. Teach. 30, 115 (1992).

Required Textbook – Fowles & Cassiday, *Analytical Mechanics, 7th Edition* (2005) preferable, 6th edition if 7th is hard to find at a reasonable price.

Recommended book – Tallarida, *Pocket book of Integrals and Mathematical Formulas* Any edition will work. This book is a useful reference containing trigonometric identities, integral tables, etc. You may use it on exams.

The *syllabus/schedule are subject to change.*

Course Description

This course covers classical mechanics from a variety of perspectives. While the course will include traditional advanced mechanics content, history of the subject, current events in physics, and physics education research relevant to mechanics will be discussed.

Note that the traditional advanced mechanics content requires calculus, differential equations, and vector calculus.

University Catalogue Description

Basic topics in motion, forces, properties of matter, energy, and related topics will be explored in the framework of Hamiltonian and Lagrangian mechanics. The elegant derivation of basic conservation laws will be demonstrated using Noether's theorem. Modern topics such as Chaotic systems and special relativity will be introduced. Emphasis will be placed on conceptual understanding.

Student Learning Outcomes

1. Students will be able to apply Newton's laws.
2. Students will be able to use Lagrangians and Hamiltonians.
3. Students will be able to calculate the motion of objects and physically interpret the results of their calculations.
4. Students will be able to discuss the application of findings of physics education research to their own classrooms.
5. Students will be able to incorporate history and current events in physics into their own teaching.

COURSE REQUIREMENTS

Minimal Technical Skills Needed

Students should be able to use myLeo Online, view videos on YouTube, and use scanners and pdf combiners.

Instructional Methods

Each week, a video will be uploaded about the week's advanced classical mechanics content. There will be points during each video during which you should pause and work the sample problems before continuing to watch the video. A discussion board can be found under each week for you to discuss working these problems and your homework problems. A document will be uploaded introducing each reading assignment and containing prompts for your reading reflection. A discussion board can be found under

each week for you to discuss the reading assignment. Problem set homework and reading reflection homework will be due approximately every other week.

- Problem sets and will be due midnight, Wednesdays

- The first discussion post on a problem set will be due the Wednesday before the problem set is due. The rest of the discussion posts are due the same day as the problem set.

- Reading reflections/exams and associated discussion posts will be due by midnight on Sundays.

- The first discussion post on a reading reflection will be due the Sunday before the reading reflection is due. The rest of the discussion posts are due the same day as the reading reflection.

There will be 1 midterm and a final covering the advanced classical mechanics content. The final is not cumulative.

See the schedule at the end of the syllabus for a complete list of due dates.

Student Responsibilities or Tips for Success in the Course

Students are expected to watch the videos, participate in all discussions, complete all homework assignments, and complete all exams. Students are to be aware of all deadlines and ask questions when directions are unclear.

GRADING

Final grades in this course will be based on the following scale:

A = 90%-100%
B = 80%-89%
C = 70%-79%
D = 60%-69%
F = 59% or Below

Assessments

Grades will be based on 5/6 components:

35% Exams
25% Problem set homework
20% Reading reflection homework

The *syllabus/schedule are subject to change.*

10% Problem discussion
10% Reading discussion

Exams: There will be 1 midterm and a final. They will be weighted equally, so each exam is worth 17.5% your overall grade depending. See exam due dates at the end of the syllabus. The exams will be made available one week before the due date. The exams have a 4 hour time limit. It is your responsibility to set aside a time when you can complete the exam and follow the time limit. Exams will be open book. You are free to use Chat GPT, but if you do so you MUST cite it (like you would any other tool used), *and* you must supply the prompt/responses progression that formed you interaction with Chat GPT. Some parts of assignments will *require* the use of Chat GPT. You may also use the pocket book of integrals or similar printouts from the internet of integral tables, the unit circle, and series tables. A document will be uploaded containing suggestions for such references. You will complete exams on your own paper and then scan them and submit them to myLeo Online as a single pdf document with the pages in order and properly oriented.

One of these exams might be changed to a computational project in the latter third of the semester; I'll keep you posted about that.

Problem set homework: Problem sets will be assigned approximately every other week. See the schedule at the end of the syllabus. Problem sets will be made available no later than one week before the due date. Assignments will be graded 50% for effort and 50% for correctness. Note that "effort" is not a nebulous criterion here: For example, *if you fully attempted each problem, with a complete description of every step you took including an explanation of why you are doing it, what mathematical tools you figured out you had to use and how you figured that out* - but every answer was incorrect, you would receive a grade of 50% on that homework. You will complete problem sets on your own paper and then scan them and submit them to myLeo Online as a single pdf document with the pages in order and properly oriented. Problem Sets should be submitted as a SINGLE file. Do NOT upload several jpg files. **Do NOT upload a PDF file larger than 10 MB in size.** If you use a camera phone to take pictures of your work, a useful app is CamScanner (https://www.camscanner.com), which compiles multiple pictures into one document for ease of uploading. There is a free version that I encourage you to check out; other similar apps are available.

You are strongly encouraged to discuss your problem set homework with fellow classmates on the class discussion boards. Problem set solutions will be made available less than 72 hours after the deadline.

Reading reflection homework: Reading assignments will be due approximately every other week. See the schedule at the end of the syllabus. Each reading assignment will be an article about history, current events, or physics education research. You will write a reading reflection based on the assigned prompts. A document will be made available containing the rubric for how reading reflection homework will be graded. You should submit your reading reflection as either a Word document or a pdf document through

the myLeo Online.

Problem discussion: You are expected to participate in the problem discussions either to discuss the sample problems or to discuss the problem set homework. A document called Problem Discussion Rubric will be made available so that you understand how you will be graded for your participation in this discussion. You must make **your first** post in the problem discussion forum no later than the due date shown in the discussion forum. You must make all other posts by the due date of the assignment.

For example: the first problem set is due Sept 13th. Therefore your first discussion post on the problem set is due by Sept 6th, and that is the due date listed in the discussion. The rest of the discussion posts are then due by Sept 13th.

Reading discussion: You are expected to participate in discussions about the reading assignments. A document called Reading Discussion Rubric will be made available so that you understand how you will be graded for your participation in this discussion. Reading discussions will open on the Wednesdays when reading reflection homeworks are due and will close on the following Wednesday. You must make your first post in the reading discussion forum no later than the Monday listed as the due date in myLeo Online at noon, and you must write at least three posts total. At least two of these posts should be responses to other students' posts.

TECHNOLOGY REQUIREMENTS

LMS

All course sections offered by Texas A&M University-Commerce have a corresponding course shell in the myLeo Online Learning Management System (LMS). Below are technical requirements

LMS Requirements:
https://community.brightspace.com/s/article/Brightspace-Platform-Requirements

LMS Browser Support:
https://documentation.brightspace.com/EN/brightspace/requirements/all/browser_support.htm

YouSeeU Virtual Classroom Requirements:
https://support.youseeu.com/hc/en-us/articles/115007031107-Basic-System-Requirements

ACCESS AND NAVIGATION

You will need your campus-wide ID (CWID) and password to log into the course. If you do not know your CWID or have forgotten your password, contact the Center for IT Excellence (CITE) at 903.468.6000 or helpdesk@tamuc.edu**.**

Note: Personal computer and internet connection problems do not excuse the requirement to complete all course work in a timely and satisfactory manner. Each student needs to have a backup method to deal with these inevitable problems. These methods might include the availability of a backup PC at home or work, the temporary use of a computer at a friend's home, the local library, office service companies, Starbucks, a TAMUC campus open computer lab, etc.

COMMUNICATION AND SUPPORT

If you have any questions or are having difficulties with the course material, please contact your Instructor.

Technical Support

If you are having technical difficulty with any part of Brightspace, please contact Brightspace Technical Support at 1-877-325-7778. Other support options can be found here:

https://community.brightspace.com/support/s/contactsupport

Interaction with Instructor Statement

The best method to reach the instructor is through email. You can send an email to bahar.modir@tamuc.edu with PHYS 531 in the subject line.

The instructor will also be available through the virtual office for general questions.

The instructor will hold office hours on YouSeeU-Virtual Classroom or Zoom. When office hours are held through YouSeeU-Virtual Classroom or Zoom the URL(s) will be posted in class announcements. The method for office hours will be posted in class announcements a week in advance.

The instructor will participate on class discussion boards. Please restrict these discussion boards to their labeled topics.

COURSE AND UNIVERSITY PROCEDURES/POLICIES

Course Specific Procedures/Policies

1. You are responsible for knowing when all deadlines are.
2. You are responsible for asking for clarification whenever directions are unclear to you.

The *syllabus/schedule are subject to change.*

3. When emailing the instructor, include the course number in the subject line.
4. You are expected to check D2L for class announcements at least once a day.
5. You are expected to check your email at least once every 48 hours for messages from the instructor. Emails will be sent to the email addresses you provided to MyLeo. Notify the instructor if you would prefer to receive emails at a different address.
6. Homework and exams are due by 11:59 pm on the specified due dates. Late homework will be accepted up to a week late at 50% off. Late exams will not be accepted except in extenuating circumstances.
7. Students are expected to be professional and respectful and follow netiquette.

Syllabus Change Policy

The syllabus is a guide. Circumstances and events, such as student progress, may make it necessary for the instructor to modify the syllabus during the semester. Any changes made to the syllabus will be announced in advance.

University Specific Procedures

Student Conduct

All students enrolled at the University shall follow the tenets of common decency and acceptable behavior conducive to a positive learning environment. The Code of Student Conduct is described in detail in the Student Guidebook.
http://www.tamuc.edu/Admissions/oneStopShop/undergraduateAdmissions/studentGuidebook.aspx

Students should also consult the Rules of Netiquette for more information regarding how to interact with students in an online forum:
https://www.britannica.com/topic/netiquette

TAMUC Attendance

For more information about the attendance policy please visit the Attendance webpage and Procedure 13.99.99.R0.01.
http://www.tamuc.edu/admissions/registrar/generalInformation/attendance.aspx

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/academic/13.99.99.R0.01.pdf

Academic Integrity

Students at Texas A&M University-Commerce are expected to maintain high standards of integrity and honesty in all of their scholastic work. For more details and the definition of academic dishonesty see the following procedures:

Undergraduate Academic Dishonesty 13.99.99.R0.03

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/undergraduates/13.99.99.R0.03UndergraduateAcademicDishonesty.pdf

Graduate Student Academic Dishonesty 13.99.99.R0.10

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/graduate/13.99.99.R0.10GraduateStudentAcademicDishonesty.pdf

Use of AI

Texas A&M University-Commerce acknowledges that there are legitimate uses of Artificial Intelligence, ChatBots, or other software that has the capacity to generate text, or suggest replacements for text beyond individual words, as determined by the instructor of the course.

Any use of such software must be documented. Any undocumented use of such software constitutes an instance of academic dishonesty (plagiarism).

Individual instructors may disallow entirely the use of such software for individual assignments or for the entire course. Students should be aware of such requirements and follow their instructors 'guidelines. If no instructions are provided the student should assume that the use of such software is disallowed.

In any case, students are fully responsible for the content of any assignment they submit, regardless of whether they used an AI, in any way. This specifically includes cases in which the AI plagiarized another text or misrepresented sources.

13.99.99.R0.03 Undergraduate Academic Dishonesty
13.99.99.R0.10 Graduate Student Academic Dishonesty

Students with Disabilities-- ADA Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you have a disability requiring an accommodation, please contact:

Office of Student Disability Resources and Services
Texas A&M University-Commerce
Gee Library- Room 162
Phone (903) 886-5150 or (903) 886-5835
Fax (903) 468-8148

The *syllabus/schedule are subject to change.*

Email: studentdisabilityservices@tamuc.edu

Website: Office of Student Disability Resources and Services

http://www.tamuc.edu/campusLife/campusServices/studentDisabilityResourcesAndServices/

Nondiscrimination Notice

Texas A&M University-Commerce will comply in the classroom, and in online courses, with all federal and state laws prohibiting discrimination and related retaliation on the basis of race, color, religion, sex, national origin, disability, age, genetic information or veteran status. Further, an environment free from discrimination on the basis of sexual orientation, gender identity, or gender expression will be maintained.

Campus Concealed Carry Statement

Texas Senate Bill - 11 (Government Code 411.2031, et al.) authorizes the carrying of a concealed handgun in Texas A&M University-Commerce buildings only by persons who have been issued and are in possession of a Texas License to Carry a Handgun. Qualified law enforcement officers or those who are otherwise authorized to carry a concealed handgun in the State of Texas are also permitted to do so. Pursuant to Penal Code (PC) 46.035 and A&M-Commerce Rule 34.06.02.R1, license holders may not carry a concealed handgun in restricted locations.

For a list of locations, please refer to the Carrying Concealed Handguns On Campus document and/or consult your event organizer.

Web url:
http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/34SafetyOfEmployeesAndStudents/34.06.02.R1.pdf

Pursuant to PC 46.035, the open carrying of handguns is prohibited on all A&M-Commerce campuses. Report violations to the University Police Department at 903-886-5868 or 9-1-1.

COURSE OUTLINE / CALENDAR

Classical Mechanics Content Schedule
Weeks are labeled by the Monday of each week. Math content videos will be uploaded by Wednesday at noon of each week.

8/26 Week 1: Review and drag
9/3 Week 2: Review and drag
9/9 Week 3: Conservative forces and energy
9/16 Week 4: Conservative forces and energy
9/23 Week 5: Oscillations
9/30 Week 6: Oscillations
10/7 Week 7: Three dimensional motion
10/14 Week 8: Three dimensional motion
10/21 Week 9: Three dimensional motion
10/28 Week 10: Noninertial reference systems and rotational motion
11/4 Week 11: Noninertial reference systems and rotational motion
11/11 Week 12: Noninertial reference systems and rotational motion
11/18 Week 13: Thanksgiving
11/25 Week 14: Lagrangians and Hamiltonians
12/2 Week 15: Lagrangians and Hamiltonians

Problem Set Homework Deadlines:
Problem sets will be made available at least one week before the due date.

Homework 1: Review and drag	9/11
Homework 2: Conservative forces and energy	9/25
Homework 3: Oscillations	10/9
Homework 4: Three dimensional motion	10/30
Homework 5: Non-inertial reference systems and rotational motion	11/20
Homework 6: Lagrangians and Hamiltonians	12/4

Problem set discussion deadlines
Homework 1: First post by 9/4; all others by 9/11
Homework 2: First post by 9/18; all others by 9/25
Homework 3: First post by 10/2; all others by 10/9
Homework 4: First post by 10/23; all others by 10/30
Homework 5: First post by 11/13; all others by 11/20
Homework 6: First post by 11/27; all others by 12/4

The *syllabus/schedule are subject to change.*

Reading Assignments:

Reading reflection homework prompts will be will be based on the following readings. You will not be required to read all of the articles listed. For many assignments, you will be asked to select a subset of articles from the list.

Homework 1: History

I. Newton, “Axioms, or Laws of Motion,” in the *Principia: The Mathematical Principles of Natural Philosophy* (1846).

I. Newton, “Definitions,” in the *Principia: The Mathematical Principles of Natural Philosophy* (1846).

E. Du Chatelet *“Foundations of Physics”* Chapters 20 and 21

Homework 2: Physics Education

I. Lovatt and B. Innes, “Resistance is not futile: Air resistance in an algebra based course,” The Physics Teacher 43, 544 (2005).

U. Besson, L. Borghi, A. D. Ambrosis, and P. Mascheretti, “How to teach friction: Experiments and models,” American Journal of Physics 75, 1106 (2007).

Homework 3: Current events and real-world applications

M. Schirber, “Focus: Dragging nanoparticles reveals extra-low friction,” Physics 6, 130 (2013).

D. Mackenzie, “Focus: Friction of molecules,” Physics 3, 9 (1999).

M. Sincell, “Focus: Surface grime explains friction,” Physics 7, 6 (2001).

J.R. Minkel, “Focus: Reducing friction without oil,” Physics 13, 14 (2004).

F.J. Giessibl, “AFM’s path to atomic resolution,” Materials Today (May 2005).

S.W. Hla, “Viewpoint: Tuning in to the Smallest (Man-Made) Mechanical Resonator,” Physics 7, 26 (2014).

Homework 4: Physics Education Research

R.A. Lawson and L.C. McDermott, “Student understanding of the work energy and impulse-momentum theorems,” American Journal of Physics 55, 811 (1987).

L.C. McDermott, P.S. Schaffer and the PEG, “Work and the work-energy theorem” in Tutorials in Introductory Physics, Upper Saddle River, NJ: Pearson (2002).

Homework 5: Physics Education Research

J.L. Docktor, N.E. Strand, J.P. Mestre, and B.H. Ross, “Conceptual problem solving in high school physics,” Phys. Rev. ST – PER 11, 020106 (2015).

Homework 6: Current events and real-world applications

K. Daniels, “Viewpoint: Pushing on a nonlinear material,” Physics 7, 113 (2014).

S. Chasteen, “Focus: Cracking the story of fracture,” Phys. Rev. Focus 25, 5 (2010).

The *syllabus/schedule are subject to change.*

J.R. Minkel, “Focus: Making waves in crack theory,” Phys. Rev. Focus 9, 1 (2002).
M. Rini, “Synopsis: Transiently chaotic,” Physics, November 7, 2013.
M.L. DeJong, “Chaos and the simple pendulum,” Phys. Teach. 30, 115 (1992).

Reading Reflection Homework Deadlines:

Homework 1	9/8
Homework 2	9/25
Homework 3	10/6
Homework 4	10/20
Homework 5	11/10
Homework 6	12/1

Reading Reflection Discussion Deadlines:

Homework 1	First post by 9/1; all posts by 9/8
Homework 2	First post by 9/15; all posts by 9/23
Homework 3	First post by 9/29; all posts by 10/6
Homework 4	First post by 10/13; all posts by 10/20
Homework 5	First post by 11/3; all posts by 11/10
Homework 6	First post by 11/24; all posts by 12/1

Exam due dates: Exams will be made available 1 week before the deadline.

Midterm	10/25
Final	12/13