Physics 621: Classical Mechanics
Syllabus - Fall 2023

CRN: 75527, F01

Lecture: **MWF 9:15-10:15, REIC 207**

Instructor: Ataur R. Chowdhury

Office: REIC 118

Office Hours: M 3:00-4:30
W 3:00-4:30

Contact: Phone (907) 474-6109
Fax (907) 474-6130
Email archowdhury@alaska.edu

Prerequisites: Graduate standing or permission of instructor**.**

Text: **Classical Mechanics** by Goldstein, Poole & Safko, Third Edition, Addison Wesley (ISBN 0-201-65702-3).

Useful Resources: 1. J. Marion and S. Thornton, *Classical Dynamics of Systems and Particles (Thomson-Brooks/Cole, 2004)*. An excellent undergraduate textbook on classical mechanics. If you find Goldstein a little difficult, this will be an excellent resource to bank on.
2. M. Boas, *Mathematical Methods in the Physical Sciences,* Second Edition (Wiley, 1983). A useful mathematical resource for most of the mathematical tools you need for this course. The math course (Phys 611) you have taken or will be taking concurrently with the course will also be very useful.
3. L. Landau and Lifshitz, *Mechanics* (Vol. 1, Theoretical Physics). It is condensed but very insightful text that is the popular equivalent of Goldstein in Russia.

Description: Lagrange's equations, two-body problem, rigid body motion, special relativity, canonical equations, transformation theory, and Hamilton-Jacobi method.

Schedule: Materials covered in this course will be based on chapters 1-10 of Goldstein. Additional material will be provided in class as needed.

Course Objective:

1. To acquire a basic understanding of advanced concepts and formulation of classical mechanics.

2. To learn advanced mathematical methods that are useful trough-out physics.

3. To develop and sharpen high-level problem-solving skills.

Physics 621: Classical Mechanics
Syllabus - Fall 2023

CRN: 75527, F01

4. To be able to apply the knowledge learned in this course to real-world problems in classical mechanics and related fields.

Student Learning Outcomes:

1. Understand the basic formalism of classical mechanics.
2. Apply classical formalism to solving physical problems.
3. Learn the art of Lagrange equation, and its application to simple systems.
4. Apply Lagrange equations to solve problems in mechanics.
4. Exploit the symmetry in classical formalism.
5. Understand the rotational symmetry and its consequences.
6. Learn angular momentum based on symmetry.
7. Understand the physics of particle scattering.
9. Learn rudimentary theory of relativity.

Instructional methods: Interactive lecture based instruction

Mode of Instruction: Face-to face live lectures in class

Credits: 3 credits: 3 hr. of lecture per week.

Course Requirements/ Policies:

Class Attednence/Participation:
For a better understanding of the course material, attendance and participation in classroom activities are very important. For many of you this will be the first graduate physics course that deals with the fundamentals of advanced mechanics and many of you may find this course a little difficult and mathematically intense. However, if you attend classes and work out all the assignments, you will learn and possibly master the material. This is why it is highly expected that the students will commit themselves to attend the class regularly. There will be supplemental materials for this course and the students will be held responsible for all the materials that will be brought in from outside the text. The students will be expected to participate in class activities and take part in meaningful discussions and ask questions to better comprehend the subject material.

Homework:
Homework is the single most important aspect of this course. The best possible way to learn physics, and perhaps any science, is through doing problems. This is a graduate course, and you may find homework challenging. However, if you find your homework difficult, please come and ask me for help. On average, 6-8 problems will be assigned on most Fridays. The

homework will be due back at the beginning of class the following Friday. NO LATE HOMEWORK WILL BE ACCEPTED. NO EXCEPTIONS (barring emergencies and extreme situations). Group work is extremely effective in achieving a greater understanding of the subject material, and it is highly encouraged for solving problems. For additional help with the homework the students are most welcome to consult the instructor during office hours or any other time by prior appointment. Any homework you submit should reflect your own best effort. **Copying homework from your friend or any online sources, especially AI related resources is not acceptable and will result in a grade of zero for the assignment.**

Paper:

For most graduate courses, it is customary that a paper is required to explore the field a little more than it is done in classroom setting. Classical mechanics is well established but it is continuously evolving and is being employed in many other fields outside physics. To explore its contemporary development, you will be required to write a paper that adds something outside the scope of this course. You can delve into some exciting developments of classical mechanics in space exploration, in non-linear dynamics, in chaotic motions, etc., and pick your topic. You could also choose an advanced topic in classical mechanics or any related field. This paper does not have to be an original piece of work but must be part of some work that is ongoing or some work that has been published in reputable scientific journals. The paper should be limited to 5-6 pages (not including references) pages, and the format of this paper should follow the format of any published article in a reputable journal. The paper will be graded mainly on merit of its physics (70%), clarity of its concept (20%), and its style (10%) of presentation. An outline for this paper is due on September 25, 2023, and the written paper is due on November 20, 2023. The presentation of the paper will take place on the 15th week of classes. The outline and paper need to be submitted on the blackboard.

Examinations:

There will be one midterm examination (October 16, Monday 9:15-10:15) and a final comprehensive examination (December 13, Wednesday, 8:00 am-10:00 am) for this course. Examinations will consist of, in the most part, problems like those in the homework and those worked out in class. Midterms will cover the material covered in class and homework prior to the date of test, and the final will be comprehensive and will include material covered during the entire semester.

Grading Policy:

Homework	35%
Participation	5%
Paper	10%
Midterm	20%
Final	30%
Total	100%

Physics 621: Classical Mechanics
Syllabus - Fall 2023

CRN: 75527, F01

The final grading for this course will be based on a curve. For a given score, your letter grade will not be lower than what it would be expected based on standard grading scale (90-100 = A, 80-90 = B, etc.). Allowed grades are limited to letter grades A, B, C, D, F, I, NB, and no plus-minus grades will be given for this course.

Incomplete Grade Policy: "The letter "I" (Incomplete) is a temporary grade used to indicate that the student has satisfactorily completed (C or better) most of the work in a course but for personal reasons beyond the student's control, such as sickness, has not been able to complete the course during the regular semester. Negligence or indifference are not acceptable reasons for an "I" grade."

Academic Honesty

UAF expects and requires academic honesty from all members of the University community, and takes any act of plagiarism and cheating seriously. It is expected that all assignments, including homework and reports, that are turned in for this course must the original work of the individual student. Failure to comply with this policy will result in penalty as stipulated under UAF regulations.

Syllabus Addendum (Revised 8/22/2022)

COVID-19 statement: Students should keep up-to-date on the university's policies, practices, and mandates related to COVID-19 by regularly checking this website:
https://sites.google.com/alaska.edu/coronavirus/uaf?authuser=0
Further, students are expected to adhere to the university's policies, practices, and mandates and are subject to disciplinary actions if they do not comply.

Student protections statement: UAF embraces and grows a culture of respect, diversity, inclusion, and caring. Students at this university are protected against sexual harassment and discrimination (Title IX). Faculty members are designated as responsible employees which means they are required to report sexual misconduct. Graduate teaching assistants do not share the same reporting obligations. For more information on your rights as a student and the resources available to you to resolve problems, please go to the following site: https://catalog.uaf.edu/academics-regulations/students-rights-responsibilities/.

Disability services statement: I will work with the Office of Disability Services to provide reasonable accommodation to students with disabilities.

ASUAF advocacy statement: The Associated Students of the University of Alaska Fairbanks, the student government of UAF, offers advocacy services to students who feel they are facing issues with staff, faculty, and/or other students specifically if these issues are hindering the ability of the student

to succeed in their academics or go about their lives at the university. Students who wish to utilize these services can contact the Student Advocacy Director by visiting the ASUAF office or emailing asuaf.office@alaska.edu.

Student Academic Support:

- Speaking Center (907-474-5470, uaf-speakingcenter@alaska.edu, Gruening 507)
- Writing Center (907-474-5314, uaf-writing-center@alaska.edu, Gruening 8th floor)
- UAF Math Services, uaf-traccloud@alaska.edu, Chapman Building (for math fee paying students only)
- Developmental Math Lab, Gruening 406
- The Debbie Moses Learning Center at CTC (907-455-2860, 604 Barnette St, Room 120, https://www.ctc.uaf.edu/student-services/student-success-center/)
- For more information and resources, please see the Academic Advising Resource List (https://www.uaf.edu/advising/lr/SKM_364e19011717281.pdf)

Student Resources:

- Disability Services (907-474-5655, uaf-disability-services@alaska.edu, Whitaker 208)
- Student Health & Counseling **[6 free counseling sessions]** (907-474-7043, https://www.uaf.edu/chc/appointments.php, Gruening 215)
- Center for Student Rights and Responsibilities (907-474-7317, uaf-studentrights@alaska.edu, Eielson 110)
- Associated Students of the University of Alaska Fairbanks (ASUAF) or ASUAF Student Government (907-474-7355, asuaf.office@alaska.edu, Wood Center 119)

Nondiscrimination statement: The University of Alaska is an affirmative action/equal opportunity employer and educational institution. The University of Alaska does not discriminate on the basis of race, religion, color, national origin, citizenship, age, sex, physical or mental disability, status as a protected veteran, marital status, changes in marital status, pregnancy, childbirth or related medical conditions, parenthood, sexual orientation, gender identity, political affiliation or belief, genetic information, or other legally protected status. The University's commitment to nondiscrimination, including against sex discrimination, applies to students, employees, and applicants for admission and employment. Contact information, applicable laws, and complaint procedures are included on UA's statement of nondiscrimination available at www.alaska.edu/nondiscrimination. For more information, contact:
UAF Department of Equity and Compliance
1692 Tok Lane, 3rd floor, Constitution Hall, Fairbanks, AK 99775
907-474-7300
uaf-deo@alaska.edu

Physics 621: Classical Mechanics
Syllabus - Fall 2023

CRN: 75527, F01

Additional syllabi statement for courses including off-campus programs and research activities:

University Sponsored Off-Campus Programs and Research Activities

We want you to know that:

1. UA is an AA/EO employer and educational institution and prohibits illegal discrimination against any individual: www.alaska.edu/nondiscrimination.
2. Incidents can be reported to your university's Equity and Compliance office (listed below) or online reporting portal. University of Alaska takes immediate, effective, and appropriate action to respond to reported acts of discrimination and harassment.
3. There are supportive measures available to individuals that may have experienced discrimination.
4. University of Alaska's Board of Regents' Policy & University Regulations (UA BoR P&R) 01.02.020 Nondiscrimination and 01.04 Sex and Gender-Based Discrimination Under Title IX, go to: http://alaska.edu/bor/policy-regulations/.
5. UA BoR P&R apply at all university owned or operated sites, university sanctioned events, clinical sites and during all academic or research related travel that are university sponsored.

For further information on your rights and resources click here.

General Remarks

"Physics is just the refinement of everyday thinking," A. Einstein

Physics is the subject that requires you to think and ponder. Physics is not mathematics, but it does require mathematics to make it useful. In order for you to succeed in this course you may pay heed to the following suggestions.

1. Read the chapter before it is discussed in class so that you know the material and know what questions to ask for clarification.
2. Start your homework on day one so that you have ample time to think about the questions and get the help you need.
3. Think the problems through and follow the logical sequence to get the result.
4. Do not hesitate to ask for help. We wish all of you to excel and we are here to help.

Physics 621: Classical Mechanics
Syllabus - Fall 2023

CRN: 75527, F01

Tentative Schedule

Lecture, Reading, Paper and Exam

Week	Date	Topics	Reading Assignment
1	8/28-9/01	review of Newtonian mechanics Principle of virtual work	Goldstein chapter 1 Goldstein chapter 2
2	9/04-9/08	Lagrange's equations and examples	Goldstein chapter 2
	9/04	**Labor Day (no classes)**	
3	9/11-9/15	Lagrange approach in central force problems	Goldstein chapter 3
4	9/18-9/22	planetary motion	Goldstein chapter 3
5	9/25-9/29	rotating frames of motion **Outline for paper due Monday**	Goldstein chapter 4
6	10/02-10/06	kinematics of rotating bodies	Goldstein chapter 4
7	10/09-10/13	rotational motion of rigid bodies	Goldstein chapter 5
8	10/16-10/20	Euler's equations of motion **Midterm Friday (10/16)**	Goldstein chapter 5
9	10/23-10/27	theory of small oscillations	Goldstein chapter 6
10	10/30-11/03	normal modes theory of special relativity	Goldstein chapter 6 Goldstein chapter 7
11	11/06-11/10	relativistic particle dynamics	Goldstein chapter 7
12	11/13-11/17	Hamilton's equations of motion	Goldstein chapter 8
13	11/20-11/24	canonical transformations	Goldstein chapter 9

Physics 621: Classical Mechanics
Syllabus - Fall 2023

CRN: 75527, F01

	11/23-11/24	**Fall Break (no classes)**
11/20		**Paper is due.**

14	11/27-12/01	Poisson's brackets	Goldstein chapter 9
15	12/04-12/08	Hamilton-Jacobi theory	Goldstein chapter 10
16	12/13	**FINAL**: 8:00-10:00 …….All the best…	