FUNDAMENTAL MECHANICS

Phys 131 Fall 2024

Instructor: Professor David Collins

Office: WS 228B

Phone: 248-1787

email: dacollin@coloradomesa.edu

Office Hours: M 3 – 4pm, T 1 – 2pm, W 9 – 10am, Th 11am – 12noon, F 2 – 3pm.

Class Meetings: MTRF 10:00-10:50am (section 001),
MTRF 11:00-11:50am (section 002), H 201

Course Website: Phys 131 Fall 2024 Website

Required Text: R. D. Knight, *Physics for Scientists and Engineers,* Vol 1, 5th ed, Pearson (2022).

Prerequisites: MATH 151 or MATH 135 (either may be taken concurrently).

Overview

Does Earth move? Does the Moon move? If so, how and are there causes or reasons for this motion? Are the basic rules that govern their motion the same as those for other objects such as a flying baseball, or water flowing through a pipe? What keeps an aircraft aloft? Are there limits to the efficiency of its engines? What is the nature of light? Why do some elements but not others conduct electric currents well? Why are we convinced that atoms exist? What are the fundamental particles from which all matter is built? Are there limits to our universe and could we learn them?

Physics addresses such questions by combining observations, results of experiments, and conceptual and mathematical notions into coherent theoretical schemes. The conceptual underpinnings of the physics we use today originated in the 17th century, when Newton and others produced a framework for understanding much of the physical world. Newtonian mechanics, still a cornerstone of physics, successfully explains a great diversity of physical phenomena and enabled the development of much modern technology.

Phys 131 is an introduction to Newtonian mechanics. You will discover the meaning and uses of concepts such as acceleration, force, momentum, and energy and apply them to assess physical situations and describe physical phenomena. You will see that they provide a simple and elegant framework for understanding the physical universe.

The course will cover:

1. Motion: one and two dimensional kinematics.
2. Vector algebra.
3. Newton's system of mechanics and Newton's three laws.
4. Work and energy, energy conservation.
5. Momentum conservation.
6. Rotational kinematics and dynamics, angular energy and momentum.
7. Newtonian gravitation.

Course Structure

The Monday, Wednesday and Friday class meetings will usually be in lecture format. You will be expected to study the relevant sections of the text before class meetings.

Most Tuesday meetings will consist of a discussion/problem session during which you will work in small groups (with the instructor's help) on pre-assigned problems. You will be expected to attempt these **before the discussion/problem session class meeting.** There will be a short quiz covering the material at the end of the discussion/problem session.

Assignments, Quizzes and Exams

The components of the course that count toward the final grade are listed below.

Unless otherwise specified, work turned in will be graded for **completeness and correctness**. For these, to obtain full credit (100%) for any question or problem your solution must be correct with a complete explanation starting with basic physics or mathematics principles and including all steps that lead to final conclusions. Partial credit may be given for incomplete or partly correct solutions. No credit (0%) will be given for problems not attempted, assignments not turned in or quizzes and exams missed without good reason.

Certain work turned in will only be graded for **completeness**. In this case, a good-faith effort to complete the task will be given full credit.

1. **Warm Up Exercises:** Warm up exercises, available on the course D2L shell, are based on readings of the text and must be completed by 9:00am on the day on which they are due. Instructions and grading schemes for each exercise are provided on the D2L shell. Graded for *completeness.*

2. **Group Exercises:** There will be structured group exercises during certain classes. Each group's response will be graded and all members of the group will receive the same grade. You must attend the class meetings in order to receive credit for these. Graded for *completeness and correctness.* Attendance is required to receive credit.

3. **Quizzes:** There will be a short quiz at the end of each discussion/problem session. Graded for *completeness and correctness.* Attendance for the entire class meeting is required to receive credit.

4. **Homework assignments:** Homework assignments will be due **by 5:00pm on the designated day**. Homework turned in after the deadline will be subject to a penalty of a 5% reduction in maximum grade for each half hour increment (rounded up) that the work is late. You can discuss the broad outlines of problem solutions with your colleagues but must write your submitted solutions independently. You are also encouraged to consult me for help with homework problems. You are not allowed to use any services which provide solutions to any assigned problems. Each homework set will be graded out of 14 points. Two problems will be selected at random and graded for correctness and completeness, each out of 3 points. The remaining problems will be checked for completeness and assigned 8 points. Your single lowest homework score will be dropped at the end of the semester.

5. **Class Exams:** There will be three exams during class on the following days:

   Exam 1 September 20, 2024
   Exam 2 October 18, 2024
   Exam 3 November 8, 2024

   Exams will be closed book and closed notes although you can use a formula sheet. Calculators will be allowed. Graded for *completeness and correctness*.

6. **Final Exam:** There will be a final exam at **10:00am on Monday December 9, 2024 (section 001) and 10:00am on Wednesday December 11, 2024 (section 002)**. The final will last one hour and 50 minutes and be comprehensive and closed book although a formula sheet will be allowed. Calculators will be allowed. Graded for *completeness and correctness*.

Aside from the homework assignments, whose late policy is described above, work will not be accepted after the deadline (the end of the particular class meeting time for work done during any particular class). The only exceptions will be for *documented* absences or illness. In this case, the work must be returned within two business days after the end of the documented absence period.

An undergraduate student should expect to spend a minimum of two hours outside the classroom for every hour in the classroom. The outside hours may vary depending on the number of credit hours or type of course. More details are available from the faculty member or department office and in CMU's Curriculum Policies and Procedures Manual.

Grades

Your course grade will be composed as follows:

Component	Number in Semester	Maximum Points for Each	Total
Warm Up Exercises	15	2	30
Group Exercises	7	3	21
Quizzes	12	5	60
Homework Assignments	10 (11 – 1)	14	140
Class Exams	3	70	210
Final Exam	1	139	139
All components			**600**

Your total score out of 600 points will be converted into a percentage. The minimum percentages for which letter grades will be *guaranteed* are as follows:

90%	A
79%	B
67%	C
50%	D

It is possible that letter grades will be attained at lower numerical scores than those above. This depends on the difficulty of exams and assignments during the semester. The only exception is that an F will be given if your numerical score is less than 50%.

Policies

1. The Tutorial Learning Center (TLC) is a *free* academic service for all CMU students. Tutors are available in Library 305 on a walk-in basis for many courses. Check out the Tutoring & Writing Center website or call 970-248-1392 with any questions.

   In coordination with Educational Access Services, reasonable accommodations will be provided for qualified students with disabilities. Students should contact Educational Access Services at 970-248-1856 or Houston Hall, Suite 108 as soon as possible. Please visit Educational Access Services for additional information.

2. **Attendance:** Attendance policies are described in the Maverick Guide. You are expected to attend all the class meetings and attendance will be recorded. In case of illness or other emergencies you must be able to produce the appropriate documentation explaining the reason for your absence. If you miss more than half of the class meetings in the first week of the semester, you will be dropped from the course. There are other circumstances under which you can be excused but you must discuss these with me in advance. If you miss a class or lab for a *documented* valid reason, turn

in any assignments due within two business days after the end of the documented absence period.

The dates of the class exams and final exam are set at the beginning of the semester and it will be assumed that these have priority over any other events (consult me about conflicts known at the start of the semester). If you miss an exam for illness, an emergency or any other reason, you must provide documentation that justifies your absence. If the reason for your absence is satisfactory to the the instructor, he will make an accommodation for the exam that you missed; times for any make-up exams will be decided by the instructor.

3. **Withdrawals:** There are several ways to drop this course. The deadline for dropping without penalty is **September 3, 2024.** Please consult the CMU academic calendar and catalog for more details about adding and dropping courses.

4. **Electronic Equipment Use:** The only electronic equipment that can be used during exams are calculators. During exams you will not be allowed to use any type of electronic equipment that allows you to communicate with other people or to store information which may be useful during the exam. Examples of such equipment include cellphones, smart phones, iPads, iPods and other similar devices that can record information or connect to the internet. The only exceptions are for students who have a documented disability and need a particular device as part of their disability accommodation.

5. **Academic Integrity:** You are expected to present your own work in assignments, exams and quizzes. Fabrication of data, plagiarism, and copying from anyone else, particularly in closed book exams, are serious violation of academic norms. CMU has extensive policies on these matters and penalties for infringement can be severe. For more details, consult the academic integrity policies in the Maverick Guide.

   You are prohibited from using sources which provide solutions to homework assignment or exam problems. Websites which allow students to solicit solutions for homework problems will be monitored regularly for solutions to problems that have been written and produced by the course instructor or any other CMU faculty. Students who are discovered to have submitted any assignment or exam problem to any such service or have used any such service to obtain or view solutions to any assignment or exam problem will receive zero credit for that entire assignment and the instructor will submit a Report of Academic Dishonesty with the Office of Academic Affairs. Additional penalties may be levied in such cases.

Student Learning Outcomes

Upon completion of this course, a student should be able to:

1. Translate between verbal and mathematical descriptions of physical situations. Apply mathematical reasoning, using algebra, trigonometry and calculus, to analyze these situations.
2. Articulate the arguments, verbal and mathematical, used to analyze physical situations.
3. Represent physical processes graphically and describe given graphical representations in physical terms.
4. Use calculus to describe and analyze physical situations.
5. Use the mathematics of vectors, vector algebra, products of vectors and vector components to analyze physical situations.
6. Distinguish between and relate various linear and rotational kinematic quantities.
7. Apply Newton's First, Second and Third Laws to analyze the dynamics of physical situations involving linear and/or rotational motion.
8. Apply the concepts of energy, work, the conservation of energy, and the conservation of motion to analyze the dynamics of physical situations involving linear and/or rotational motion.

This course is a critical component of CMU's Essential Learning Curriculum and a CMU Degree. In addition to knowledge in the course content area, this class will provide specific learning opportunities in the following areas:

1. Demonstrate investigative and analytical thinking skills to solve problems.
2. Select and use appropriate information in an academic project.
3. Demonstrate quantitative literacy.

This course contributes to the fulfillment of the following program learning outcomes for the BS in Physics degree. A student will have demonstrated the ability to:

1. Show fluency with the major fields of physics (classical mechanics, electromagnetism, statistical physics and quantum theory).
2. Use mathematical representations to analyze physical scenarios.

Guaranteed Transfer

The Colorado Commission on Higher Education has approved PHYS 131 for inclusion in the Guaranteed Transfer (GT) Pathways program in the GTSC1 category. For transferring students, successful completion with a minimum C- grade guarantees transfer and application of credit in this GT Pathways category. For more information go to the GT Pathways program. The course addresses the following GT Pathways Student Learning Outcomes:

Content Criteria

This course should provide students with the opportunity to/Students should be able to:

a) Develop foundational knowledge in specific field(s) of science.
b) Develop an understanding of the nature and process of science.
c) Demonstrate the ability to use scientific methodologies.

d) Examine quantitative approaches to study natural phenomena.

The laboratory (either a combined lecture and laboratory, or a separate laboratory tied to a science lecture course) content of a GT Pathways science course (GT-SC1): Students should be able to:

a) Perform hands-on activities with demonstration and simulation components playing a secondary role.
b) Engage in inquiry-based activities.
c) Demonstrate the ability to use the scientific method.
d) Obtain and interpret data, and communicate the results of inquiry.
e) Demonstrate proper technique and safe practices.

Inquiry and Analysis Competency

Students should be able to:

1. Select or Develop a Design Process
    a) Select or develop elements of the methodology or theoretical framework to solve problems in a given discipline.
2. Analyze or Interpret Evidence
    a) Examine evidence to identify patterns, differences, similarities, limitations, and/or implications related to the focus.
    b) Utilize multiple representations to interpret the data.
3. Draw Conclusions
    a) State a conclusion based on findings.

Quantitative Literacy Competency

Students should be able to:

1. Interpret Information
    a) Explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words).
2. Represent information
    a) Convert information into and between various mathematical forms (e.g., equations, graphs, diagrams, tables, words).

Week	Dates	Topic
1	8/19 – 8/23	Course overview, Vectors (1d), Motion (Ch 2.1 – 2.2).
2	8/26 – 8/30	Motion in one dimension (Ch 2.3 – 2.5, 3.1 –3.2).
3	9/2 – 9/6	Vectors, motion in two dimensions (Ch 3.3 – 3.4, 4.1).
4	9/9 – 9/13	Motion in two dimensions, uniform circular motion (Ch 4.2 – 4.5).
5	9/16 – 9/17	Forces, Newton's laws (Ch 5.1 – 5.5).
5	9/18 – 9/20	Exam review, **Class Exam I**.
6	9/23 – 9/27	Free body diagrams, applying Newton's laws (Ch 5.7, 6.1 – 6.4, 6.6).
7	9/30 – 10/4	Newton's third law, interacting objects (Ch 7.1 – 7.5).
8	10/7 – 10/9	Applying Newton's laws to circular motion (Ch 8.1 – 8.4).
9	10/14 – 10/15	Work, kinetic energy (Ch 9.1 – 9.3).
9	10/16 – 10/18	Exam review, **Class Exam II**.
10	10/21 – 10/25	Potential energy, conservation of energy (Ch 9.4, 10.1 – 10.4).
11	10/28 – 11/1	Conservation of energy, momentum (Ch 10.5 – 10.8, 11.1).
12	11/4 – 11/5	Conservation of momentum, center of mass, rotational motion (Ch 11.2 – 11.5).
12	11/6 – 11/8	Exam review, **Class Exam III**.
13	11/11 – 11/15	Rotational motion, torque, equilibrium (Ch 12.1. 12.5, 12.8).
14	11/18 – 11/22	Rotational dynamics, moment of inertia,rotational conservation laws (Ch 12.3, 12.6, 12.7, 12.9 – 12.11).
15	12/2 – 12/6	Gravitation, oscillations, final review (Ch 13.1 – 13.6, 15.1).