Syllabus for Calculus-Based Physics-1: Mechanics (PHYS150-01)

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Abstract

The concepts of calculus-based mechanics will be presented within the context of interactive problem-solving. First, the concepts of displacement, velocity, and acceleration in one and two dimensions will be introduced, build- ing up to Newton's Laws of motion. Next, the concepts of friction and rotational motion will be added. More complex problems will be introduced through the conservation of energy and linear momentum, followed by the rotational equivalents. The course work will include interactive computational exercises, analytic textbook problems, and lab-based activities.

***Pre-requisites**: Calculus I (MATH141) (may be concurrent).*
***Course credits, Liberal Arts Categorization**: 4 Credits, COM1*
***Regular course hours**: Monday, Wednesday and Friday from 13:30 - 15:00 in SLC 228*
***Instructor contact information**: jhanson2@whittier.edu, Discord: 918particle#5083*
***Office hours**: Connect with instructor via Discord server: https://discord.gg/MeJVtC9Y*
***Attendance/Absence**: In-class activities will serve as attendance (see **Grading**). Students needing to reschedule midterms and exams should notify the professor a reasonable time beforehand.*
***Late work policy**: Acceptance of late work is left to the discretion of the instructor.*
***Text**: University Physics Volume One - `https://openstax.org/details/books/university-physics-volume-1`*
***Grading**: See Tab. 1 Note that the final project is a good opportunity for the use of Digital Storytelling. For more information, see `https://diglibarts.whittier.edu` and contact Sonia Chaidez: `schaidez@whittier.edu`. .*
***Grade Settings**: $< 60\%$ = F, $\geq 60\%, < 70\%$ = D, $\geq 70\%, < 80\%$ = C, $\geq 80\%, < 90\%$ = B, $\geq 90\%, < 100\%$ = A. Pluses and minuses: 0-3% minus, 3%-6% straight, 6%-10% plus (e.g. 79% = C+, 91% = A-)*

Item	Percentage
Daily exercises	15 %
Homework sets and labs	30 %
Midterms	30 %
Final Project + Presentation	25%

Table 1: These are the grade percentages given the learning activities in the course.

***Homework Sets**: Typically 10 problems per week, assigned on Monday and collected the following Monday. Please follow the link `https://tutor.openstax.org/enroll/354942/Calculus-Based-Physics-1-Fall-2022` to access the online homework system. The system requires $10.00 for access (remember that the textbook is free). The online system will give clues to struggling students and provide the professor with useful class statistics to aid in class management.*
***Student Accessibility Services**: Whittier College is committed to make learning experiences as accessible as possible. If you experience physical or academic barriers due to a disability, you are encouraged to contact Student Accessibility Services (SAS) to discuss options. To learn more about academic accommodations, drop by our center (ground floor of Wardman Library), email sas@whittier.edu, or contact 562-907-4825.*
***Academic Honesty Policy**: `http://www.whittier.edu/academics/academichonesty`*

***Course Objectives**:*

- To practice written expression of quantitative and numerical ideas and arguments.
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- Improvement of numerical analysis and problem solving.
- Improvement of problem solving via computer simulations.
- To practice the analysis of scientific data and results.

Course Outline:

1. Unit 0 - **Chapters 1.1 - 1.7, 2.1 - 2.4**
   (a) Introduction to iClicker, class procedures, reading syllabus.
   (b) *Warm-up activity: gas mileage, speed, calories and energy.*
   (c) Monday warm-up lecture: chapter 2.2
   (d) Wednesday warm-up lecture: chapter 2.3
   (e) Friday: article bonus
   (f) Topics covered:
      i. Unit-analysis, approximation, and coordinate systems.
      ii. Adding and subtracting vectors, displacement and translational motion.
      iii. Vectors and scalars.
      iv. Adding and subtracting vectors.
      v. Multiplying vectors.
2. Unit 1 - **Chapters 3.1 - 3.6**
   (a) Monday warm-up lecture: chapter 3.1
   (b) Wednesday warm-up lecture: chapter 3.2
   (c) Friday: article bonus
   (d) Topics covered:
      i. Displacement, velocity, and acceleration vectors.
      ii. Differentiation and integration of functions of the form $f(x) = ax^n + b$.
      iii. Motion with constant acceleration in 1D.
3. Unit 2 - **Chapters 4.1 - 4.3**
   (a) Monday warm-up lecture: chapter 4.1
   (b) Wednesday warm-up lecture: chapter 4.2
   (c) Friday: article bonus
   (d) Topics covered:
      i. Displacement, velocity, and acceleration in 2D.
      ii. Projectile motion.
4. **First midterm: distributed October 7th, 2022, take-home and open-book.** This exam is worth 15% of the class grade, and will cover Units 0-2. The emphasis is on working with units, vectors, and applying kinematic equations in 1D.
5. Unit 3 - **Chapters 4.4, 5.1 - 5.4**
   (a) Monday warm-up lecture: chapter 4.4
   (b) Wednesday warm-up lecture: chapter 5.3
   (c) Friday: article bonus
   (d) Topics covered:
      i. Uniform rotational motion.
      ii. Newton's First Law.
      iii. Newton's Second Law.
6. Unit 4 - **Chapters 5.5 - 5.7**
   (a) Monday warm-up lecture: chapter 5.5
   (b) Wednesday warm-up lecture: chapter 5.7
   (c) Friday: article bonus
   (d) Topics covered:
      i. Newton's Third Law.
      ii. Common forces: normal and tension forces.
      iii. Incline planes and free-body diagrams.

7. Unit 5 - **Chapters 6.1 - 6.4**
    (a) Monday warm-up lecture: chapter 6.2
    (b) Wednesday warm-up lecture: chapter 6.3
    (c) Friday: article bonus
    (d) Topics covered:
        i. Frictional forces.
        ii. Centripetal force.
        iii. Drag forces.
8. Unit 6 - **Chapters 7.1 - 7.4**
    (a) Monday warm-up lecture: chapter 7.1
    (b) Wednesday warm-up lecture: chapter 7.3
    (c) Friday: article bonus
    (d) Topics covered:
        i. Work and energy.
        ii. Work-Energy theorem.
        iii. Power.
9. **Second midterm: distributed November 18th, 2022, take-home and open-book.** This exam is worth 15% of the class grade, and will cover Units 3-6. The emphasis will be on Newton's Second Law, free-body diagrams and friction, and the definition of work.
10. **Final project proposal due: November 18th, 2022.** The final project proposal is a 1-2 page report describing the hypothesis, data to me collected, experimental procedures, and parts required. Submit one document per group, and include all names and student IDs.
11. Unit 7 - **Chapters 8.1 - 8.5**
    (a) Monday warm-up lecture: chapter 8.1
    (b) Wednesday warm-up lecture: chapter 8.3
    (c) Topics covered:
        i. Potential energy.
        ii. Conservative forces.
        iii. Conservation of energy.
12. Unit 8 - **Chapters 9.1, 9.3, and 9.4.** *Time-permitting, also 9.5.*
    (a) Monday warm-up lecture: chapter 9.1
    (b) Wednesday warm-up lecture: chapter 9.3
    (c) Friday: article bonus
    (d) Topics covered:
        i. Linear momentum
        ii. Collisions: elastic and inelastic
13. Unit 9 - **Chapters 10.1 - 10.4, 10.6**
    (a) Monday warm-up lecture: chapter 10.1
    (b) Wednesday warm-up lecture: chapter 10.4
    (c) Friday: article bonus
    (d) Topics covered:
        i. Kinematics of rotating systems.
        ii. Rotational kinetic energy.
        iii. Torque.
14. Unit 10 - **Chapters 11.2 - 11.3, 13.1-13.5**
    (a) Monday warm-up lecture: chapter 11.2
    (b) Wednesday warm-up lecture: chapter 13.1
    (c) Topics covered:

i. Angular momentum and conservation of angular momentum.
ii. Newton's Law of Gravity, *Time permitting.*

15. Unit 11 - **Class presentations and Final Review**

(a) No warm-up lectures

(b) Group presentations:

i. Worth 25% of the course grade.
ii. Given as a group.
iii. 15 minute presentation with slides or digital storytelling format.
iv. **Option A:** standard presentation with PDF, LibreOffice, or PowerPoint presentation slides. Presenters speak in person demonstrating their results, practicing technical communication.
v. **Option B:** creation of a pre-recorded video that uses tools from digital storytelling. Whittier College uses WeVideo for such projects: `https://www.wevideo.com/`. The video illustrates the scientific results such that the audience can understand them.