COURSE SYLLABUS **PHY 3110 – Analytical Mechanics** **Spring 2023**

Course Description - PHY 3110, Analytical Mechanics, 4 credit hours
Prerequisite: PHY 2120, MTH 2210 or permission of instructor
This course explores topics from classical physics including linear and nonlinear oscillations, momentum and energy theorems, conservations laws, rigid body dynamics, and central force field motion. The course is intended for of physics, engineering physics, pre-engineering, and other science fields.

Instructor: Dr. Hawley
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Office Hours: MW 3-4pm, WF 2pm-3pm, Thur 2:30-3:20, and by appointment (e.g. Tuesdays, zoom)

Meeting Times and Location: MWF 12:00 – 12:50 pm, AYRS 5003

Course Web Page: https://hedges.belmont.edu/~shawley/PHY3110/ and Blackboard.

Textbook:
Required: Analytical Mechanics, seventh edition, by Fowles and Cassiday
Optional, also recommended:

- Classical Dynamics of Particles and Systems, 5th Edition by S.T. Thornton and J.B. Marion, or other "classical mechanics" texts such by Symon, Taylor or Griffiths (but not Goldstein or Landau).
- Schaum's Outline of Mathematical Handbook of Formulas and Tables, Fifth Edition (Schaum's Outlines) 5th Edition. While you will be allowed to use online math resources such as WolframAlpha and Desmos, having a book that groups useful formulas together that you can flip through is "handy" for learning.

Skill Objectives:

1. Students should be able to demonstrate a functional understanding of the analytical methods of classical physics. As such they will be prepared for future studies in science which build upon this knowledge.
2. Students should be able to successfully employ problem solving techniques such as dimensional analysis, approximation methods, and mathematical expansions.
3. Students will be able to work collaboratively in (some) problem solving experiences.

Course Outline

1. Review of Some Fundamental Concepts
    a. Dimensions in physics
    b. Vectors and scalars
    c. Various coordinate systems
    d. The transformation matrix
    e. Mathematical review: Methods of solving ODEs
2. Newtonian Mechanics
    a. Newton's laws; structure and meaning
    b. Motion in one dimension
    c. Position dependent forces
    d. Time dependent forces
    e. Velocity dependent forces

    f. Consequences of Newton's laws
3. Oscillations
    a. The simple harmonic oscillator
    b. Phase space diagrams
    c. Damped and driven oscillations
    d. Resonance
    e. Applications to physical systems
    f. Nonlinear oscillations
4. Noninertial Frames of Reference
    a. Accelerated coordinate systems
    b. Rotating frames of reference
    c. Dynamics of particles in noninertial reference systems
    d. Effects of rotation
5. Motion in Central Force Fields
    a. The inverse square force
    b. Potential energy in central force fields
    c. Angular momentum
    d. Orbits in central force fields
    e. The gravitational force
    f. Planetary motion; Kepler's laws
    g. Rutherford scattering
6. Systems of Particles
    a. Center of mass concept
    b. Center of mass frame of reference
    c. Linear and angular momentum
    d. Motion with variable mass
    e. Elastic and inelastic collisions
    f. Cross sections
7. Lagrangian & Hamiltonian Dynamics
    a. Hamilton's variational principle
    b. Calculus of variations
    c. Generalized coordinates
    d. Lagrange's equations
    e. Constraints & Lagrange multipliers
    f. Generalized momenta
    g. Hamilton's equations

Grading Schema

Tests (3)	60%
Final Examination (comprehensive)	20%
Homework / Class Assignments	20%

Grading Scale:

Course Average	Letter Grade
90 -100	A
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C

70 - 72	C-
67 - 70	D+
63 - 66	D
60 - 62	D-
Below 60	F

Examination Schedule. (Take-home tests/exams)

Test 1	Assigned Wed Feb 1, Due Mon Feb 6 by 4pm
Test 2	Assigned Wed Mar 1, Due Mon March 13 by 4pm
Test 3	Assigned Wed Mar 29, Due Mon April 3 by 4pm
Final Exam	Due by end of Belmont final exam for this class time (Thurs May 4, 1pm)

For exams, you may ONLY refer to the textbook(s), course notes, Instructor, and limited mathematical guides such as WolframAlpha or Desmos**. Collaborating with other students, consulting any (non-approved) external sources (e.g. solutions guides) is STRICTLY PROHIBITED and will result in referral to the Honor Court for cheating.**

Policy on Class Attendance

Your class attendance will not directly effect on your grade in this course, i.e., your grade will not be automatically raised or lowered because of exceptional class attendance or poor class attendance. Your grade, however, will probably be indirectly affected by your class attendance. The University policy on class attendance, stated on pages 51 and 52 of the current ***Belmont University Bulletin***, will be followed. You must complete all work that you miss because of not being in class.

University Policies

Honor Code: *I will not give or receive aid during examinations; I will not give or receive false or impermissible aid in course work, in the preparation of reports, or in any other type of work that is to be used by the instructor as a basis for my grade; I will not engage in any form of academic fraud. Furthermore, I will uphold my responsibility to see that others abide by the spirit and the letter of the Honor Pledge.*

Accommodation of Disabilities*: In compliance with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act, Belmont University will provide reasonable accommodations of all medically documented disabilities. If you have a disability and would like the university to provide reasonable accommodations of the disability during this course, please notify Tammy Tanksley, Director of Counseling & Developmental Support, in the Office of Student Affairs (460-6407) as soon as possible.*

Disclaimer:
The policies, topics and course organization described in this syllabus are subject to change. Adequate prior notice will be provided to all students in the event of a change.

Statement on Diversity, Equity, and Inclusion (DEI):

"There is neither Jew nor Gentile, neither slave nor free, nor is there male and female, for you are all one in Christ Jesus." – Galatians 3:28

As a Christian institution, we aim to provide a welcoming environment for all people. We acknowledge our debt to the Western tradition of evidence-based science, yet note that the practice of science in that tradition was often only available to wealthy males of European descent. In this course we emphasize that anyone can contribute to science, because the natural world transcends human divisions