**COURSE SYLLABUS, Fall 2019**

**Course Description -** PHY 4410. Survey of Advanced Physics (3)
*Prerequisites: MTH 1151, PHY 3110.*
This course will offer an overview of advance physics topics such as Hamiltonian Dynamics, Relativity, Statistical Mechanics, and Computational Physics. Students will demonstrate proficiency with the conceptual issues and mathematical tools which are applied to the analysis of such systems. The goal of the course is to provide undergraduate physics majors with foundations in these areas for which some prior exposure is likely to be assumed when entering graduate school.

**Instructor:** Dr. Hawley
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**Phone**: (615) 460-6206
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**Office Hours:** MWF 1pm-2pm, MW 4-5pm and by appointment.

**Meeting Times and Locations:**

| | | |
|---|---|---|
| 11 a.m. - noon | MWF | McWho 102 |

**Textbooks:** Analytical Mechanics by Fowles & Cassiday
Supplemental class notes & online tutorials, e.g. http://www.learnpython.org

**Skill Objectives:**

1. Students should be able to demonstrate a functional understanding of the analytical methods of "advanced" undergraduate 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 demonstrate proficiency in the use of computer tools such as symbolic computation, data visualization, Unix and computer programming for scientific applications.
4. Students will be able to work collaboratively in (some) problem solving experiences.

**Course Outline**

1. Computational Physics (Using notes in class)
    a. Unix basics
    b. Symbolic Computation
    c. Numerical Analysis
    d. Finding roots & extrema
    e. Solving ODEs
    f. Finite Difference Approximations
    g. Solving PDEs
    h. Also: Writing documents in LaTeX
2. Relativity (Using notes in class, pending student knowledge from prior classes)
    a. Special Relativity
        i. Coordinate systems (frames of reference), vectors, tensors and metrics
        ii. Minkowski space and the Lorentz signature
        iii. Transformation rules
        iv. Invariance of the Interval
        v. "Paradoxes"
        vi. Mechanics in relativity
        vii. E&M in relativity

   b. General Relativity
      i. The Equivalence Principle
      ii. Curvature
      iii. "Weird objects": black holes etc.
3. Hamiltonian Dynamics (Using Thornton & Marion)
   a. The Hamiltonian
   b. Conjugate variables
   c. Phase Space
   d. Applications
      i. Chaos
      ii. Quantum Mechanics
4. Statistical Mechanics / Thermodynamics (Using supplemental notes)
   a. "Systems"
   b. States & Entropy
   c. Probability distributions
   d. Thermodynamics & Heat
   e. Fermi & Bose statistics
   f. Virialization

**Grading Procedures**

| | |
|---|---|
| Tests | 60% |
| Final Examination (comprehensive) | 20% |
| Homework / Class Assignments | 15% |
| Class Participation* | 5% |

*Class participation grade will be based on the student's asking & answering questions during class, contributing (positively) to discussions, working problems (at the board or in groups).

**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 |

**Examinations:** All examinations will be take-home exams, to be completed individually by the student without collaboration of any kind. Receiving outside help will constitute an Honor Code violation (see below).

**Policy on Missed Examinations**

No make-up examinations will be given. Should you have a valid reason for missing an examination, then your score on the final examination will be used in lieu of the examination you missed. If you fail to take an examination without a valid reason, then you will be assigned a zero on that examination. The course instructor determines the validity of your reason for missing an examination.

**Policy on Class Attendance**

Your class attendance will not have any direct 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 as a consequence 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.

**Resources:**

- Machines:
  - Mac users should install XCode, and then use Terminal. Additional functionality can be added via Homebrew & pip, or an extra Python distribution such as Anaconda.
  - Windows users will likely want to install a virtual Linux machine, e.g. via VirtualBox and Ubuntu. (Google something like "install ubuntu on virtualbox windows")
  - An external compute resource will be available at hedges.belmont.edu (this resides in Dr. H's office), accessible from off-campus via "ssh –Y *username*@hedges.belmont.edu"

- UNIX:
  - "UNIX Tutorial for Beginners": http://www.ee.surrey.ac.uk/Teaching/Unix

- Python:
  - http://www.learnpython.org/

- Google:
  - http://www.google.com Google is your friend. For example, searching on "Hamiltonian Dynamics" will turn up a useful Wikipedia page

- Math:
  - http://www.wolframalpha.com
  - Mathematical Handbook of Formulas & Tables, Schaums Outline Series. (Google it)