PHYS 4101: Theoretical Mechanics I

Instructor: W. M. Dennis, Room 204D

Reading List:


Text 3 – *Classical Dynamics of Particles and Systems*, Jerry B. Marion and Stephen T. Thornton (Harcourt Brace, 1995)

Office Hours: Will arrange in class after you know your schedules.

Exams: Test I, Test II, Final (All Closed Book and Cumulative)

Excused Absences: An excused absence for any test will cause the final exam grade to be substituted for that test grade.

Homework: Selected Problems will be graded. Homework sets are due at 4:00 on the due days specified. Homework 1 day late will be penalized by 15%, 2 days late by 30%, and 3 or more days late will not be accepted. Your lowest homework score will be dropped from your course average. No other allowances will be made for late or missed homework. Your homework average constitutes 30% of your course grade. Homework study groups are strongly encouraged, but you must hand in your own work. Plagiarism is forbidden by the Academic Honesty Policy of UGA and will be dealt with accordingly. Some problem sets will include a computer problem, which you must complete using Python.

Grade: PHYS 4101 Grade = (0.25 × Homework + 0.25 × Test I + 0.25 × Test II + 0.25 × Final)

PHYS 6101 Grade = (0.9 × PHYS 4101 Grade + 0.1 × Honors Problems)

Incompletes: Rules concerning withdrawals and incompletes We will follow the rules of the UGA Bulletin concerning withdrawals and incompletes.

Grading Scheme: Use of the plus/minus system is a requirement – it is the only grading system approved for the University of Georgia.

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\begin{align*}
A & \equiv [85, 100] & A- & \equiv [82.5, 85) \\
B+ & \equiv [80, 82.5) & B & \equiv [70, 80) & B- & \equiv [67.5, 70) \\
C+ & \equiv [65, 67.5) & C & \equiv [55, 65) & C- & \equiv [52.5, 55) \\
D & \equiv [40, 52.5) & F & \equiv [0, 40)
\end{align*}
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Academic Honesty: All academic work must meet the standards contained in "A Culture of Honesty." Students are responsible for informing themselves about those standards before performing any academic work. More detailed information about academic honesty can be found at the website given above. As a UGA student, you are responsible for knowing and understanding this policy. If you have any questions about the propriety of actions relating to this course, you are obligated to ask me for clarification. See also the UGA website: http://www.uga.edu/honesty/.
Topics:

1. The Lagrangian Method
   (a) The Euler Lagrange Equations
   (b) The Principle of Stationary Action
   (c) Forces of Constraint
   (d) Change of Coordinates
   (e) Conservation Laws
   (f) Noether’s Theorem
   (g) Small Oscillations

2. Central Forces
   (a) Conservation of Angular Momentum
   (b) The Effective Potential
   (c) Solving the Equations of Motion
   (d) Gravity, Kepler’s Laws

3. Oscillations
   (a) Simple Harmonic Motion
   (b) Damped Harmonic Motion
   (c) Damped, Driven Harmonic Motion
   (d) Coupled Oscillators
   (e) Fourier Techniques and Green Functions

   (a) Linearity and Nonlinearity
   (b) The Damped Driven Pendulum
   (c) Chaos and the Sensitivity to Initial Conditions
   (d) Bifurcation Diagrams
   (e) State-Space Orbits
   (f) Poincaré Sections
   (g) The Logistic Map

5. Hamiltonian Mechanics - Optional Topic
   (a) Energy
   (b) Hamilton’s Equations
   (c) Legendre Transforms
   (d) Phase space, Liouville’s theorem