**Physics 600 – Classical Mechanics – Fall 2025**

**Instructor:** Prof. S. Martin email: `spmartin@niu.edu` office: LaTourette 214

**Class Meetings:** M,W,F 11:00 – 11:50 in LaTourette 227.

**Office Hours:** M,W,F 11:50 – 2:00 in LaTourette 214, or whenever you can find me. However, before class is not a good time. Office hours can also be by Zoom; just send me an email to schedule one. If I am available, it can happen immediately.

**Course web page:** `http://www.niu.edu/spmartin/phys600`
There will be no Blackboard web page for this course. Everything relevant will be either sent to you by email, or linked to on the web page above, in pdf form.

**Textbook:** *Theoretical Mechanics of Particles and Continua*, A.L. Fetter, J.D. Walecka
Some other optional textbooks at roughly the same level, which you might want to consult:
*Mechanics*, L.D. Landau and E.M. Lifshitz
*Classical Mechanics*, H. Goldstein, C. Poole, J. Safko
*Classical Dynamics*, David Tong's (free!) lectures notes,
http://www.damtp.cam.ac.uk/user/tong/dynamics.html

**Homework policies:** Each homework set should be turned in by email as a single pdf file. NIU's copy machines provides a convenient way to scan your homeworks and have them automatically emailed to you. (The file size and quality will usually be **much** better than if you take a picture on your phone.) Please be neat and legible, and leave enough space for grading notes and corrections. No paper submission of homeworks will be accepted. Show your work! Neatness, organization, and clarity count! Homework should be turned in by midnight on the due date. Late penalty: 10% off for each day late up to 4 days; 100% off for $> 4$ days. You are encouraged to consult with each other, and with me, on the homework. **However, each of you must turn in only your own work. Do not turn in anything that you have copied, or anything that you do not understand. Do not use any form of AI, or Chegg or similar services, or send any materials from this course to such services, or get homework solutions from anyone outside or inside of NIU who may have previously taken this course or its equivalents at other institutions. The homework sets and exams for this class should not be distributed to, or discussed with, anyone other than your peers in this class and your instructor.**

**Exam policies:** Exams will be closed book, but you may bring one page of notes in your own original handwriting, and you will be given a formula sheet for coordinate systems and vector derivatives when necessary. No electronic devices are allowed.

**Midterm 1 Exam:** Monday, October 6, 2025, 11:00-11:59 AM.
**Midterm 2 Exam:** Friday, November 7, 2025, 11:00-11:59 AM.
**Final Exam:** Wednesday, December 10, 2025, 10:00-11:59 AM.

**Grading:** Your numerical score in this class is weighted according to 30% homework, 20% for each midterm exam, 30% final exam. Grades will be assigned according to your numerical score

as a percentage, with the low cutoff for each grade as follows:

| | | |
|---|---|---|
| A 89%, | A– 85%, | B+ 82%, |
| B 77%, | B– 73%, | C+ 66%, |
| C 55%, | D 45%. | |

I reserve the right to amend the above grading scale to be more lenient, but it is guaranteed not be made more strict. To obtain a D or better, you **must also** score at least 50% on the homework portion alone, regardless of your overall score; this requirement will not be changed. No C– or D+ or D– grade will be assigned.

**General Suggestions:** It is very strongly suggested that you do attend class and take notes. Do not suffer in silence; if you are stuck, please arrange for office hours in person or by Zoom. Keep up with the reading and the homework. The best way to prepare for exams is to study homework problems and the concepts that they involve. Stay healthy!

**Accessibility Statement:** If you need an accommodation for this class, please contact the Disability Resource Center as soon as possible. The DRC coordinates accommodations for students with disabilities. It is located on the 4th floor of the Health Services Building, and can be reached at 815-753-1303 or `drc@niu.edu`. Also, please contact me privately as soon as possible so we can discuss your accommodations. Please note that you will not be required to disclose your disability, only your accommodations. The sooner you let me know your needs, the sooner I can assist you in achieving your learning goals in this course.

**Topics to be covered in PHYS 600:**

- Fundamentals of Newtonian mechanics
  - Mechanics of a single particle: momentum, force, work, energy, angular momentum, torque, conservation laws
  - Systems of multiple particles: external and internal forces and torques
  - Center-of-mass frame and relative motion
- Central force motion
  - The two-body problem and its reduction to the one-body equivalent
  - Conserved quantities: energy and angular momentum
  - Effective potentials and classification of orbits
  - Stability of circular orbits
  - Kepler's problem: inverse-square force law
  - Scattering problems, impact parameters and cross-sections
- Lagrangian dynamics
  - What makes a rainbow: intensity enhancement in scattering
  - Classical mechanics as the intensity enhancement limit of the sum-over-paths version of quantum mechanics
  - Hamilton's Principle, Lagrangians, and the Euler-Lagrange equations
  - Configuration space, changes of coordinates, and generalized coordinates

  - Constraints: holonomic and non-holonomic.
  - Lagrange multipliers, forces of constraint, D'Alembert's principle
  - Cyclic coordinates, conservation laws, and Noether's theorem
- Motion in accelerated coordinate systems
  - Inertial and rotating frames
  - Centrifugal and Coriolis forces
  - Motion on the surface of the Earth: falling particle, Foucalt's pendulum, atmospheric and ocean currents, tornadoes and hurricanes
- Small oscillations
  - Linearized equations of motion and stability analysis
  - The complex time dependence trick
  - Matrix notation, eigenvalues and eigenvectors, normal modes
  - Coupled oscillators and the continuum limit
- Motion of rigid bodies
  - Inertial frames, body-fixed frames, and angular velocity
  - Inertia tensor and relation to kinetic energy, angular momentum, and torque
  - Moments of inertia and the parallel axis and perpendicular axis theorems
  - Motion of rigid body with no fixed point or one fixed point
  - Euler's equations for rigid body motion
  - Euler angles
  - Examples: compound pendulum, rolling and sliding ball, symmetric top, asymmetric top
- Hamiltonian dynamics
  - Hamiltonian as Legendre transformation of the Lagrangian
  - Hamilton's equations of motion and phase space
  - Canonical transformations
  - Poisson brackets and Lagrange brackets
  - Liouville's Theorem
  - Virial Theorem
  - Poincaré recurrence
  - Hamilton-Jacobi theory and Hamilton's principal function
  - Action-angle variables
- Topics as time permits
  - Continuous systems (strings, membranes, fluids)
  - Parametric resonance
  - Classical chaos
  - Special relativity