CLASSICAL MECHANICS

PHY 401

Instructor: Dr. Romulo Ochoa
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Text: S.T. Thornton and J.B. Marion, **Classical Dynamics of Particles and Systems,** 5th Edition, Thomson/Brooks Cole, 2004

I. Course Description

Newtonian mechanics is studied rigorously using advanced mathematical and numerical techniques. Topics treated include kinematics, dynamics, harmonic oscillations, central forces, many particle systems, rigid bodies, Lagrangians, and Hamiltonians. Scientific programming is used extensively in problem solving.

II. Course Objectives

1. To develop fundamental concepts in mechanics more rigorously as needed for further study in physics, engineering and technology.

2. To apply advanced mathematical and computational techniques to complex problems.

3. To contribute to the development of the student's thinking process through the understanding of the theory and application of this knowledge to the solution of practical problems.

III. Course Outline

1. Newtonian Mechanics for a Single Particle (Ch. 2)
   Newton's laws and inertial systems. Simple applications of Newton's laws, including constant applied forces, position-dependent forces, time-dependent forces and velocity-dependent forces, conservation theorems.
   Homework 1: 2.3, 2.6, 2.7, 2.9, 2.12, 2.15, 2.23, 2.29, 2.39, 2.52 and additional problems HW 1

2. Oscillations (Ch. 3)
   Linear restoring force: Harmonic motion. Damped harmonic and forced harmonic motion. Resonance. Introduction to chaotic motion.
   Homework 2: 3.6, 3.10, 3.15, 3.20, 3.40, 3.44 and additional problems HW 2.

Test 1 TBA

3. Lagrangian and Hamiltonian Mechanics (Ch. 6 and 7)
   Euler equation and calculus of variations. Hamilton's variational principle. Generalized coordinates. Lagrange's equations of motion for conservative systems. Generalized momenta. Ignorable coordinates. Forces of constraint. Lagrange multipliers. Generalized forces. Hamilton's equations.
   Homework 3: 7.3, 7.4, 7.5, 7.12, 7.14, 7.15, 7.17, 7.22, 7.24, 7.26, 7.28.

4. Gravitation and Central Forces (Ch. 5 and 8)

Gravitational force between a uniform sphere and a particle. Potential energy in a gravitational field. Kepler's laws of planetary motion. Energy equation of an orbit in a central field. Orbital energies in an inverse-square field. Effective potential. Orbital transfers: gravitational boost and braking.
Homework 4: 5.4, 5.7, 5.15, 8.5, 8.10, 8.14, 8.25, 8.28 and additional problems HW 4

Test 2 TBA

5. Dynamics of System of Particles (Ch. 9)
Center of mass and linear momentum of a system. Angular momentum and kinetic energy of a system. Motion of two interacting bodies. Collisions and scattering. Motion of a body with variable mass: rocket motion.
Homework 5: 9.4, 9.6, 9.10, 9.12, 9.21, 9.23, 9.30, 9.37, 9.42, 9.54, and 9.60.

6. Noninertial Reference Systems (Ch. 10)
Accelerated coordinate systems and inertial forces. Rotating coordinate systems. Dynamics of a particle in a rotating coordinate system. Effects of Earth's rotation. The Foucault pendulum.
Homework 6: 10.3, 10.6, 10.9, 10.18, 10.20, and 10.22.

7. Mechanics of Rigid Bodies (Ch. 11)
Center of mass of a rigid body. Rotation about a fixed axis. Calculation of moment of inertia. Angular momentum. The physical pendulum. Laminar motion of a rigid body. Center of percussion. Eulerian angles.
Homework 7: additional problems HW 7

Final Exam

IV. Assessment of Student Performance
1. Tests (35 points)
2. Final exam (35 points)
3. Homework problems (20 points)
Homework problems are due one week after the corresponding chapter has been completed in the lectures unless otherwise noted. Late homework will not be accepted. Homework should be handed in an ordered and neat presentation; points will be deducted for lack of these.
4. Computer program (10 points)
The computer program is due three weeks after it is assigned.

Grading Scale	
Final Score	Letter Grade
92.5 – 100	A
89.5 – 92.4	A-
86.5 – 89.4	B+
82.5 – 86.4	B
79.5 – 82.4	B-
76.5 – 79.4	C+
72.5 – 76.4	C
69.5 – 72.4	C-
66.5 – 69.4	D+
59.5 – 66.4	D
0 – 59.4	F

V. Attendance

Students are expected to attend class. No makeups will be given unless there is an emergency situation. In that case students are expected to contact the instructor no later than 24 hours after the test or exam; otherwise they will be given a zero grade for the missed evaluation.

VI. Bibliography

Arya, A. P., "Introduction to Classical Mechanics," 2nd Ed., Prentice Hall, 1998.
Walker, J. "Halliday and Resnick Fundamentals of Physics," 8th Ed., J. Wiley & Sons, 2007.
Taylor, J. R., "Classical Mechanics," University Science Books, 2005.
Serway, R. A., "Physics for Scientists and Engineers," 7th Ed., Thomson-Brooks/Cole, 2008.
Spiegel, M. R.,"Theoretical Mechanics," Schaum's Outline Series, McGraw Hill, 1992.
Young, H. D. and Freedman, "University Physics," 11th Ed., Pearson/Addison-Wesley, 2004.

VII. Selected TCNJ Policies

Final Examinations

The final exam is not scheduled until the middle of the semester. Therefore do not plan on any travel until after the last day of the exam period. TCNJ's final examination policy is available on the web: http://academicaffairs.pages.tcnj.edu/college-governance/policies/final-examevaluationreading-days-policy/

Attendance

Every student is expected to participate in each of his/her courses through regular attendance at all class sessions. It is further expected that every student will be present, on time, and prepared to participate when scheduled class sessions begin. While attendance itself is not used as a criterion for academic evaluations, grading in this course is based on participation in quizzes to be given at the beginning of several classes. No make-ups or extensions will be given unless a student has a genuine emergency. If a student misses an exam or assignment deadline they must contact the instructor within 36 hours to explain the situation; otherwise the student will earn a zero for that exam or assignment.

Students who must miss classes due to participation in a field trip, athletic event, or other official college function or for a religious holiday should arrange with their instructors for such class absences well in advance. In every instance, however, the student has the responsibility to initiate arrangements for make-up work.

TCNJ's full attendance policy *is available at:*
http://policies.tcnj.edu/policies/digest.php?docId=9134

Academic Integrity Policy

Academic dishonesty is any attempt by the student to gain academic advantage through dishonest means, to submit, as his or her own, work which has not been done by him/her or to give improper aid to another student in the completion of an assignment. Such dishonesty would include, but is not limited to: submitting as his/her own a project, paper, problem set, report, test, or speech copied from, partially copied, or paraphrased from the work of another (whether the source is printed, under copyright, or in manuscript form). Credit must be given for words quoted or paraphrased. The rules apply to any academic dishonesty, whether the work is graded or ungraded, group or individual, written or oral.

TCNJ's academic integrity policy *is available at:*
http://policies.tcnj.edu/**policies**/view**Policy**.php?docId=7642

Americans with Disabilities Act (ADA) Policy

Any student who has a documented disability and is in need of academic accommodations should notify the professor of this course and contact the Office of Differing Abilities Services (609-771-2571).

Accommodations are individualized and in accordance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1992.
TCNJ's Americans with Disabilities Act (ADA) policy is available at: *http://affirm.pages.tcnj.edu/key-documents*