Title: Intermediate Mechanics I

Code: PHYS 4051

Number of Credits: 3

Prerequisites: PHYS 3012-3014

Co-requisite: PHYS 4031 (Mathematical Physics I)

Description

This is the first part of the Classical Mechanics course for Physics majors. It covers the fundamental principles of Newtonian mechanics: (i) Newton's laws, frames of reference, equations of motion of point particles, and the conservation theorems; (ii) Linear oscillations: the simple harmonic oscillator, damped oscillations, driven oscillations, resonances; (iii) Non-linear oscillations: the simple pendulum, approximate solutions, and subharmonics; (iv) Central force motion: the reduced mass, conservation theorems, Kepler's laws, orbits and stability, two-particle collisions; (v) Motion in non-inertial frames.

Objectives

After completing this course the student will know the fundamental axioms of classical mechanics and will be able to apply these to actual physical problems. The student will have mastered and practiced the application of simple mathematical techniques to solve problems of Classical Mechanics.

Course Content

Topic	Assigned time (hours)
1. Basic mathematical concepts such as vector operations in different coordinate systems.	3
2. Basic mathematical concepts such as vector operations in different coordinate systems.	3
3. Newtonian mechanics of a single mass point in one dimension, friction forces.	3
4. Newtonian mechanics of a single mass point in one dimension, friction forces.	3
5. Two dimensional problems, potential and kinetic energy and energy conservation.	3
6. Two dimensional problems, potential and kinetic energy and energy conservation.	3

7. Oscillating systems, free-, damped-, and forced harmonic oscillation, coupled oscillations, harmonics and resonance.	3
8. Oscillating systems, free-, damped-, and forced harmonic oscillation, coupled oscillations, harmonics and resonance.	3
9. Nonlinear oscillations and introduction to chaos theory.	3
10. Nonlinear oscillations and introduction to chaos theory.	3
11. Momentum conservation and its consequences, the rocket equation, frames of reference, elastic and inelastic collisions.	3
12. Momentum conservation and its consequences, the rocket equation, frames of reference, elastic and inelastic collisions.	3
13. Angular momentum conservation and its consequences, central forces and planetary motion.	3
14. Angular momentum conservation and its consequences, central forces and planetary motion.	3
15. Gravitation, gravitational potential, Newton's theorems, basic applications of gravity ocean tides.	3
Total hours	45 contact hours

Instructional Strategy

The main instructional tool in this class is lecturing. The emphasis in this course is to introduce and train the student in solving mechanics problems using elementary mathematical methods, which are mainly based on solving differential equations arising from Newton's Laws. As such pure theoretical derivations are kept to a minimum and are only used to introduce the basic concepts. Most of the lecturing time is thus dedicated to the demonstration of solving mechanical problems. Weekly homework assignments allow the student to practice problem solving techniques discussed in class and to develop a deeper understanding of the material. Solutions of homework problems are subsequently discussed in class, where a student usually presents his/her solution.

Minimum Require Facilities

Traditional lecture room to accommodate around ten students.

Student Evaluation

Since the emphasis of this course is on problem solving techniques, the grades are mainly based on four exams where the student will work on problems similar to the ones encountered in class and in the homework problems, as well as on the performance in homework assignments.

Grading System

The overall score is determined by calculating the percentage of points obtained by the student. Grades are then assigned according to the standard curve: 100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59-0% = F.

Bibliography

The content of this course is similar and on the level of the standard texts:

1. Classical Mechanics by Barger & Olsson, 1995, McGraw-Hill
2. Classical Dynamics by Marion & Thornton, 1995, Saunders College Publishing
3. Classical Dynamics: A Contemporary Approach by J.V. Jose and E.J. Saletan, 1998, Cambridge University Press

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