Physics Department

College of Education

Salahalddin University - Hawler

Subject: Analytical Mechanics (first and second semester)

Course Book – (Year 3)

Lecturer's name Asst.Prof. Dr. Mowfaq Jalil

Academic Year: 2022/2023

Course Book

1. Course name	**Analytical Mechanics**
2. Lecturer in charge	**Mowfaq Jalil Ahmed**
3. Department/ College	**Physics / Education**
4. Contact	mowfaq.ahmad@su.edu.krd **Tel: (07714612357)**
5. Time (in hours) per week	**Theory: 3 hours/week (One group)**
6. Office hours	**Sunday 10:30 – 12:30**
7. Course code	
8. Teacher's academic profile	
9. Keywords	

10. Course overview:

It centers on the development and exposition of Newtonian mechanics with the Lagrangian and Hamiltonian formalism and its applications in simple physical systems

The Newtonian mechanics is studied rigorously using advanced mathematical. Topics treated include kinematics, dynamics, harmonic oscillations, central forces, *rigid bodies, Lagrangian, and Hamiltonian's Mechanics.

Students should have completed a calculus-based course in first year physics as well as the corresponding mathematics course. Students should also have already taken a second-year course in differential equations. Analytical mechanics is mathematically intensive and will, at first, appear to be quite different from first year physics. However, if you keep up with the work as scheduled, this should not present any difficulties.

11. Course objective:

Brief Syllabus:

1. To develop fundamental concepts in mechanics more rigorously as needed for further study in physics.
2. To apply advanced mathematical 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.

12. Student's obligation

	Monthly Exams	Quizzes	Homework	Final Exam	Total
First Course	30	4	6	60	100
Second Course	30	4	6	60	100

13. Forms of teaching

lectures will follow a set of Power-point slides and that are clarified or discussed during the lecture.

14. Assessment scheme

Exams: midterm 21 (December), midterm 24 (February) and final exam.
Exams are meant to test your understanding and ability to apply concepts covered in the course. I therefore do not expect you to memorize equations, except for complex formulas which I will provide you with a sheet of relevant equations. Although the main focus of the exams will be problem solving, all exams will likely contain one conceptual question with a written part to verify that you understand and can explain the physical concepts. Exam and homework problems will be from the textbooks or lecture sheets in general.

15. Student learning outcome:

Student Outcome Learning:

1. To develop fundamental concepts in mechanics more rigorously as needed for further study in physics.
2. To apply advanced mathematical 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.

16. Course Reading List and References:

1. **Analytical Mechanics. Grant R. Fowles & George L. Cassiday. Seventh Edition, Thomson, (2005).**
2. **Theory and Problems of Mechanics with an Introduction to Lagrange's equations and Hamiltonian theory, Murray R. Spiegel. McGraw-Hill company, (1980).**

17. The Topics:

Contents

CHAPTER 0NE	
A brief introduction to dimensional analysis vector algebra: concepts of velocity and acceleration. Curvilinear coordinate and its applications (2weeks).	6H
CHAPTER TWO	
Newton's laws of motion; motion in one dimension, the concepts of potential and kinetic energy. (3weeks).	9H
CHAPTER THREE	
Harmonic motion, damped harmonic oscillator. (3weeks).	9H
CHAPTER FOUR	
Motion of a particle in three dimensions. potential energy, conservative forces. (3weeks). constraint motion	9H
CHAPTER FIVE	
Gravitation, central forces, conic sections, Kepler's laws. (3weeks).	9H
CHAPTER SIX	
Dynamics of many particle system, Mechanics of Rigid Bodies, Moment of Inertia(2 weeks).	6H
CHAPTER SEVEN	
Lagrangian Mechanics Applications. (3weeks).	9H
CHAPTER EIGHT	
Hamilton Equations and some applications	9H

18. Practical Topics (If there is any)	
19. Examinations: some examples from previous examination	

Q1// Write Lagrange equation for a single particle in a central force field.Then find the orbit equation and apply that to a planet under the effect of inverse square force.

Q2// On a horizontal turntable that is rotating at a constant speed, a bug is crawling outward on a radial line such that the distance from the center increase quadratically with the time {r=bt^2} and {θ=ωt} where b and ω are constants. Find the acceleration of the bug. Show that radial component of the acceleration becomes negative when t>√2/w

Q3/ Given spherical coordinate system then

a) Draw the coordinate system.
b) x=…… , y=…… , z=……
c) q_1=…… , q_2=…… , q_3=……
d) h_1=……, h_2=……, h_3=……

Q4/

a) Write Lagrange equation for a single particle in a central force field.
b) Find the orbit equation and apply that to a planet under the effect of inverse square force law

Q5 / If a particle moves on a curve of constant radius. Discuss this motion using polar coordinate system when the angular frequency changes with time.

20. Extra notes:

The first course include 29 examples and 7 solved problems . Similarly, the second course contains a large number of solved examples and unsolved problems.

21. Peer review