AN-NAJAH NATIONAL UNIVERSITY
PHYSICS DEPARTMENT
FALL SEMESTER , 2012

Course:

Classical Mechanics (22352)

Instructor:

Dr. Mohammed Salameh Abu-Jafar

Office:

Faculty of Graduate Studies, office # 3201

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Office Hours:

Sunday/ Tuesday/ Thursday 10:00- 12:00 am

or by appointment

Textbook:

Grant R. Fowles, George L. Cassiday, "Analytical Mechanics", 7th ed. ,

Thomson Brooks/Cole, 2005 .

Prerequisite:

Physics 22353 Mathematical Physics

or concurrent and DEQ .

COURSE OBJECTIVES:

a. ***To demonstrate knowledge and understanding of the following fundamental concepts in :***
   1. *Newtonian mechanics in one dimension*
   2. *Oscillations*
   3. *General motion of a particle in three dimensions*
   4. *Newton's law of motion in non-inertial frames of reference*
   5. *Particle motion under central forces*
   6. *The dynamics of systems of particles*
   7. *Lagrangian and Hamiltonian formulation of mechanics*

b. ***To apply the familiar techniques, based on Newton's laws, to systems in a variety of coordinate systems and references frames.***

c. ***To develop the Lagrangian and Hamiltonian formulations of mechanics which are important in the study of quantum mechanics.***

d. ***To develop an understanding of Classical Mechanics of particles and to develop your math skills as applied to physics.***

REFERENCES:

1. *M. G. Calkin," Lagrangian and Hamiltonian Mechanics" ,World Scientific,1996.*
2. *J.B. Marion and S.T. Thornton ,"Classical Dynamics of Particles and Systems" 5th ed. ,2003 – standard undergraduate introductory textbook .*
3. *J. V. Jose & E.J. Saletan , "Classical Mechanics: a contemporary approach", Cambridge Univ. Press, 1998 .*
4. *V.I. Arnold , "Mathematical Methods of Classical Mechanics " , 2nd ed. , Springer , 1989 .*
5. *A .L. Fetter & J.D. Walecka, "Theoretical Mechanics of Particles and Continua", McGraw-Hill, 1980 .*
6. *H. Goldstein, C. Poole & J. Safko, "Classical Mechanics", 3rd ed. , Addison-Wesley, 2002*
7. *K. R. Symon, "Mechanics", 3rd ed. , Addison-Wesley, 1971 .*
8. *T. W. B. Kibble, "Classical Mechanics",2nd ed. , McGraw Hill, 1973 .*
9. *V. Barger and M. Olsson, "Classical Mechanics: a Modern Perspective" ,McGraw-Hill, 1995 .*
10. *R. D. Gregory, "Classical Mechanics: an undergraduate text", Cambridge Univ. Press, 2006*
11. *A. P. French & M. G. Ebison, "Introduction to Classical Mechanics",VNR,1986 .*
12. *T. L. Chow, "Classical Mechanics", John Wiley,1995 .*
13. *A. P. Arya , "Introduction to Classical Mechanics , 2nd ed. ,Prentice-Hall , 1997 .*
14. *L.D. Landau & E.M. Lifschitz, "Mechanics", Pergamon, 1976*
15. *S.N. Rasband, "Dynamics", John Wiley, 1983 .*
16. *K.C. Gupta," Classical Mechanics of Particles and Rigid Bodies", Wiley, 1988.*

COURSE OUTLINE:

I. **Fundamental Concepts: Vectors*(Chapter 1)***

Vector properties , Scalar & Vector product, Transformation matrix, Derivative of a vector, Position vector of a particle: velocity & acceleration in rectangular coordinates, Velocity & Acceleration in plane polar ,cylindrical & spherical coordinates .
(Hw# 1: 1.19 , 1.22 , 1.24 , 1.29)

II. **Newtonian Mechanics in One Dimension *(Chapter 2)***

Newton's laws and inertial systems, Simple applications of Newton's laws, Constant applied force, Position-dependent forces(Conservative, Potential energy), Time-dependent forces, Velocity-dependent forces .
(Hw#2: 2.2 , 2.5 , 2.6 , 2.8 , 2.11 , 2.14 , 2.18)

III. **Oscillations*(Chapter 3)***

Linear restoring force: Harmonic motion, Damped harmonic motion (Critical damping, underdamping or overdamping), Forced harmonic motion .
(Hw#3: 3.3 , 3.5 , 3.10 , 3.11 , 3.12 , 3.18 , 3.19)

COURSE OUTLINE:

IV. **General Motion of a Particle in Three Dimensions *(Chapter 4)***

General principles, Potential energy function in three-dimensional motion: The Del operator, Projectile motion, The harmonic oscillator in two and three dimensions, Motion of charged particles electric and magnectic fields, Constrained motion of a particle .
(Hw#4: 4.1 , 4.3 , 4.8 , 4.14 , 4.17 , 4.21 , 4.22)

V. **Noninertial Reference Systems (*Chapter 5)***

Accelerated coordinate systems and inertial forces, Rotating coordinate systems, Dynamics of a particle in a rotating coordinate system, Effect of earth's rotation, The Foucault Pendulum .
(Hw#5: 5.1 , 5.5 , 5.6 , 5.8 , 5.13 , 5.16 , 5.19)

VI. **Lagrangian Mechanics *(Chapter 10)***

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 .
(Hw#6: 10.4 , 10.6 , 10.11 , 10.14 , 10.19 , 10.21 , 10.26 , 10.27 , 10.29)

COURSE OUTLINE:

VII. **Gravitation and Central Forces *(Chapter 6)***

Gravitational force between a uniform sphere and a particle, Kepler's Laws of planetary motion :The law of Ellipses(Kepler's first law),The law of areas (Kepler's second law),The harmonic law(Kepler's third law),Potential energy in a gravitational field and in a general central field, Energy equation of an orbit in a central field, Orbital energies in an inverse-square field, Effective potential, Stability.
(Hw#7: 6.2 , 6.10 , 6.13 , 6.14 , 6.20 , 6.24 , 6.25)

VII. **Dynamics of System of Particles*(Chapter 7)***

Center of mass and linear momentum of a system, Angular momentum and kinetic energy of a system, Motion of two interacting bodies,Collisions, Oblique collision and scattering, Motion of a body with variable mass: rocket motion.
(Hw#8: 7.1 , 7.2 , 7.7 , 7.10 , 7.14 , 7.15 , 7.17 , 7.26)

Students Learning Outcomes:

By the end of this course, students are expected to be able to :

1. *demonstrate knowledge of core principles in mechanics;*
2. *understand the principles of Newtonian mechanics and have a working knowledge of its application.*
3. *understand and answer problems on damped and forced oscillatory systems, and simple coupled systems.*
4. *demonstrate a working knowledge of classical mechanics and its application to standard problems such as central forces.*
5. *understand and apply Lagrange's equations to simple physical systems.*
6. *solve dynamical problems involving classical particles by using the Lagrangian and Hamiltonian formulation.*

GRADING CRITERIA:

Homeworks & Quizzes :	***10%***
First Exam :	***20%***
Second Exam :	***20%***
Final Exam :	***50%***