

Course Name: Analytical Mechanics  
Instructor: Dr. Ahmed Shakir Mahmood  
Semester: Two  
Second Year / Physics Department  
2016- 2017

**Syllabus:**

**1. Fundamental Concepts: Vectors**

- 1.1 Introduction.
- 1.2 Vectors, Scalar and Vector Products and their applications.
- 1.3 Triple Products
- 1.4 Derivative of a vector
- 1.5 Position Vector of a Particle: Velocity and Acceleration in Rectangular Coordinates.
- 1.6 Velocity and Acceleration in Plane Polar Coordinates
- 1.7 Velocity and Acceleration in Cylindrical and Spherical Coordinates.
- 1.8 Problems

**2. Newtonian Mechanics: Rectilinear Motion of a Particle**

- 2.1 Newton's Law of Motion.
- 2.2 Rectilinear Motion: Uniform Acceleration Under a Constant Force.
- 2.3 Force that Depend on Position: The Concepts of Kinetic and Potential Energy.
- 2.4 Velocity-Dependent Forces: Fluid Resistance and Terminal Velocity.
- 2.5 Problems

**3. Oscillations**

- 3.1 Introduction
- 3.2 Linear Restoring Force: Harmonic Motion
- 3.3 Energy Considerations in Harmonic Motion
- 3.4 Damped Harmonic Motion
- 3.5 Forced Harmonic Motion: Resonance.
- 3.6 Problems

#### **4. General Motion of a Particle in Three Dimensions**

- 4.1 Introduction: General Principle
- 4.2 The Potential Energy Function in Three-Dimensional Motion: The Del Operator.
- 4.3 Forces of the Separable Type: Projectile Motion
- 4.4 The Harmonic Oscillator in Two and Three Dimensions
- 4.5 Motion of Charged Particles in Electric and Magnetic Fields.
- 4.6 Problems.

#### **5. Lagrangian Mechanics**

- 5.1 Hamilton's Variational Principle: An Example
- 5.2 Generalized Coordinates
- 5.3 Calculating Kinetic and Potential Energies in Terms of Generalized Coordinates: An Example
- 5.4 Lagrange's Equations of Motion for Conservative Systems.
- 5.5 Some Applications of Lagrange's Equations
- 5.6 Generalized Momenta: Ignorable Coordinates
- 5.7 The Hamiltonian Function: Hamilton's Equations
- 5.8 Problems

#### **Text Book:**

1. "Analytical Mechanics" by Fowles & Cassidy, 7<sup>th</sup> Edition, 2005, (Thomson Brooks/Cole).