

Analytical Mechanics

with an Introduction to Dynamical Systems

Mechanics

Analysis ~ Design !!

Optimization ?

Commercial tool ?

(FEM, BEM, XFEM....)

Generality (Vector mechanics) : Analytical mechanics v

Ordinary D. E. (Time) ->> Partial D. E. (Space, Time)

Nonlinear problem ~ solution method : another problem

~ **Advanced dynamics or Classical dynamics**

(> **Relativity ! : speed of light :**

Modern mechanics, Quantum mechanics ~ Einstein)

o **Newtonian mechanics** (**F**) : **A**

-> **Each particle : vector : Free-body diagram**

o Analytical dynamics (Energy) : B

-> System as a whole : scalar !

(T , V ; Conservative system) : Non-conservative system

% $A > B$ or $A = B$

Merit <~~> Disadvantage ?

Vector ? ~ Scalar ?

- **Mid-term, Final Examinations**
- **6 Home works**

Solid Mechanics ~> **Dynamics** ~ Fluid Mechanics ~ Thermodynamics

O Kinematics of Particles : 3 DOF (x, y, z or r, θ, φ ..)

Rectilinear Motion: Position, Velocity & Acceleration

Motion of Several Particles: Relative Motion

Motion of Several Particles: Dependent Motion

Curvilinear Motion: Position, Velocity & Acceleration

Motion Relative to a Frame in Translation

Tangential and Normal Components

Radial and Transverse Components

○ Kinetics of Particles : Newton's Second Law : 3DOF

Newton's Second Law of Motion

Linear Momentum of a Particle

Equations of Motion

Equations of Motion in Radial & Transverse Components

○ Energy and Momentum Method

Work of a Force

Kinetic Energy of a Particle.Principle of Work & Energy

Conservative Forces

Conservation of Energy

Principle of Impulse and Momentum

Impact

Problems Involving Energy and Momentum

O Systems of Particles

Application of Newton's Laws: Effective Forces

Linear and Angular Momentum

Motion of Mass Center of System of Particles

Angular Momentum About Mass Center

Conservation of Momentum

Kinetic Energy

Work-Energy Principle.-Conservation of Energy

Principle of Impulse and Momentum

O Kinematics of Rigid Body (x, y, z and r, θ, φ ..)

Translation , Rotation About a Fixed Axis

Equations Defining the Rotation of a Rigid Body About a Fixed Axis

General Plane Motion

Absolute and Relative Velocity in Plane Motion

Coriolis Acceleration

Motion About a Fixed Point

Three Dimensional Motion. Coriolis Acceleration

Frame of Reference in General Motion

o Plane Motion of Rigid Bodies : Forces and Acceleration

Equations of Motion of a Rigid Body

Angular Momentum of a Rigid Body in Plane Motion

Plane Motion of a Rigid Body: d'Alembert's Principle

Systems of Rigid Bodies

Constrained Plane Motion

O Plane Motion: Energy and Momentum Methods

Principle of Work and Energy for a Rigid Body

Work of Forces Acting on a Rigid Body

Kinetic Energy of a Rigid Body in Plane Motion

Systems of Rigid Bodies

Conservation of Energy

Principle of Impulse and Momentum

Systems of Rigid Bodies

Conservation of Angular Momentum

Impulsive Motion

Eccentric Impact

O Kinetics of Rigid Bodies in Three Dimensions

Rigid Body Angular Momentum in Three Dimensions

Principle of Impulse and Momentum

Kinetic Energy (T) Practice

Motion of a Rigid Body in Three Dimensions

Motion of a Gyroscope. Eulerian Angles