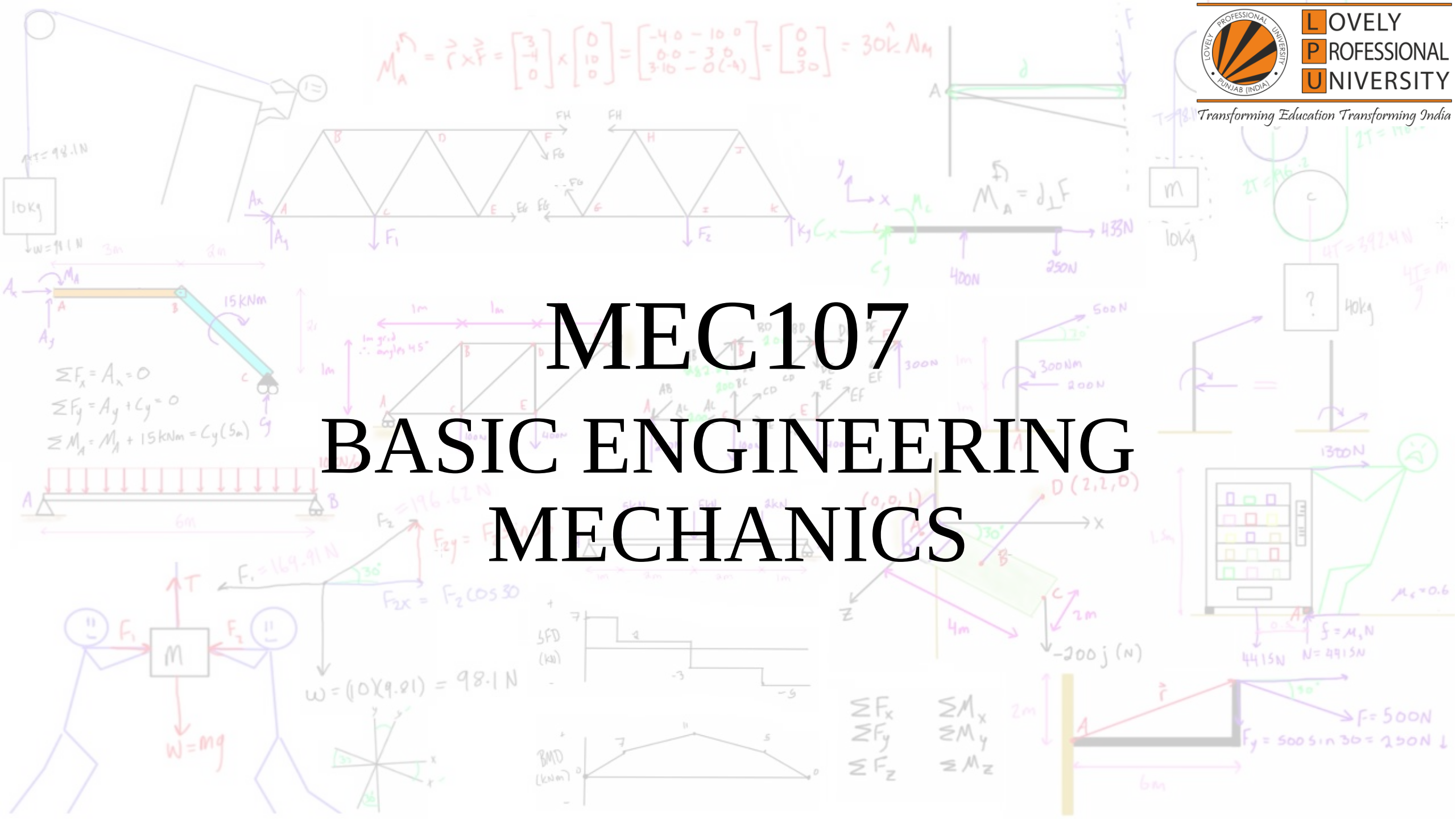
LOVELY PROFESSIONAL UNIVERSITY

Transforming Education Transforming India

MEC107
BASIC ENGINEERING MECHANICS



Course Details

LTP : 3 1 0
(3 LECTURES AND 1 TUTORIAL PER WEEK)

CA category : A0203

There will be Three compulsory tests

- (One Test before MTE and Two test after MTE)

Exam category: 13 (MTE Online Viva Voce)

Course Assessment Model

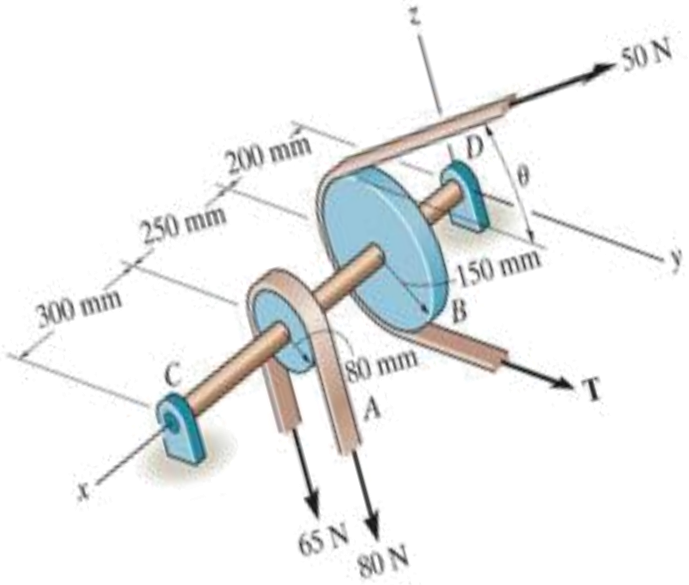
- **Marks break up***

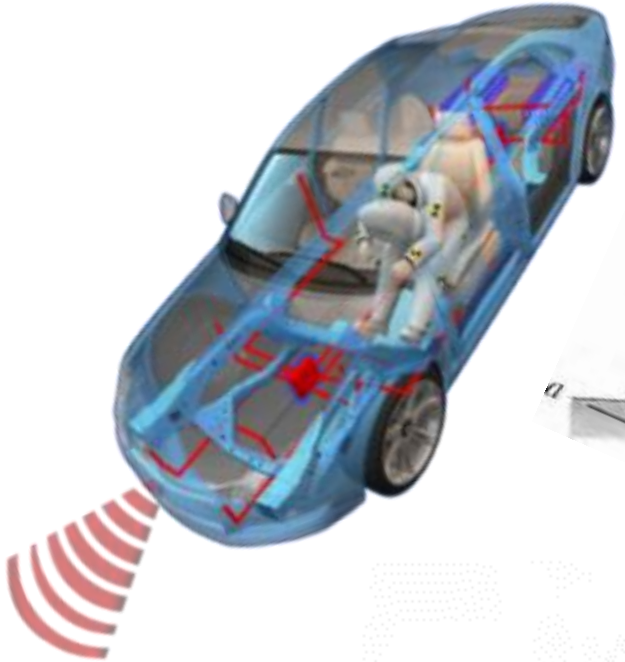
• Attendance	05
• CA (Two best out of three tasks)	30
• MTE	25
• ETE	40
• **Total**	**100**

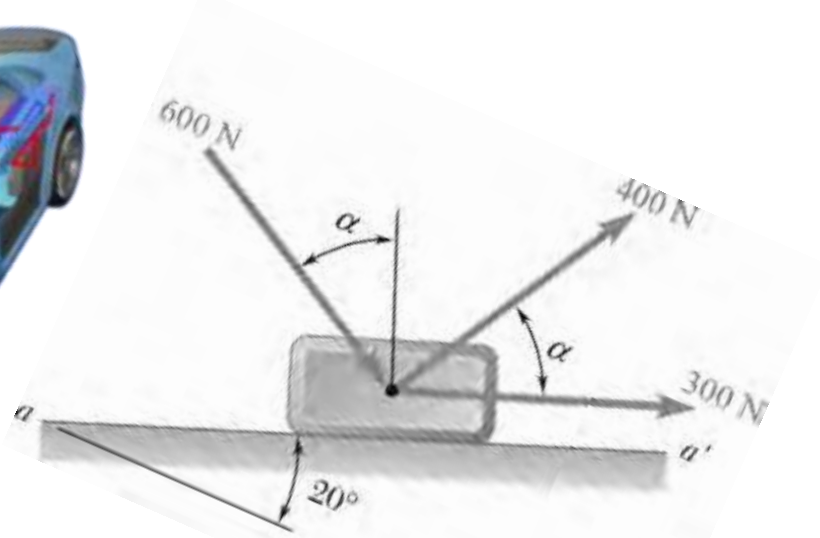
Why Engineering Mechanics?

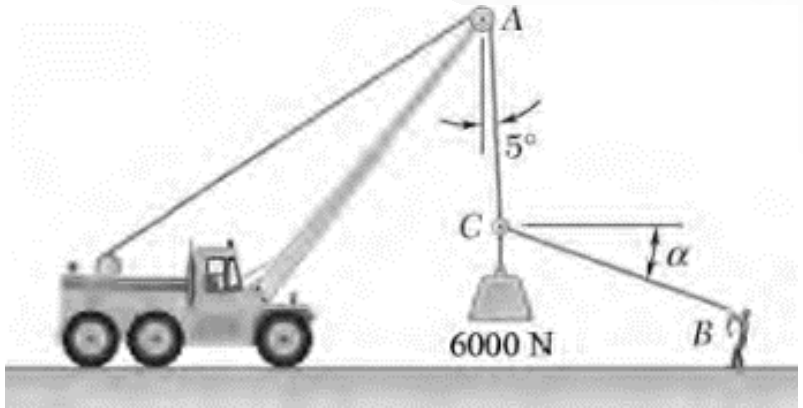
For Mechanical Engineers

✓Basic Course for higher level courses of Mechanical Engineering









Why Engineering Mechanics?

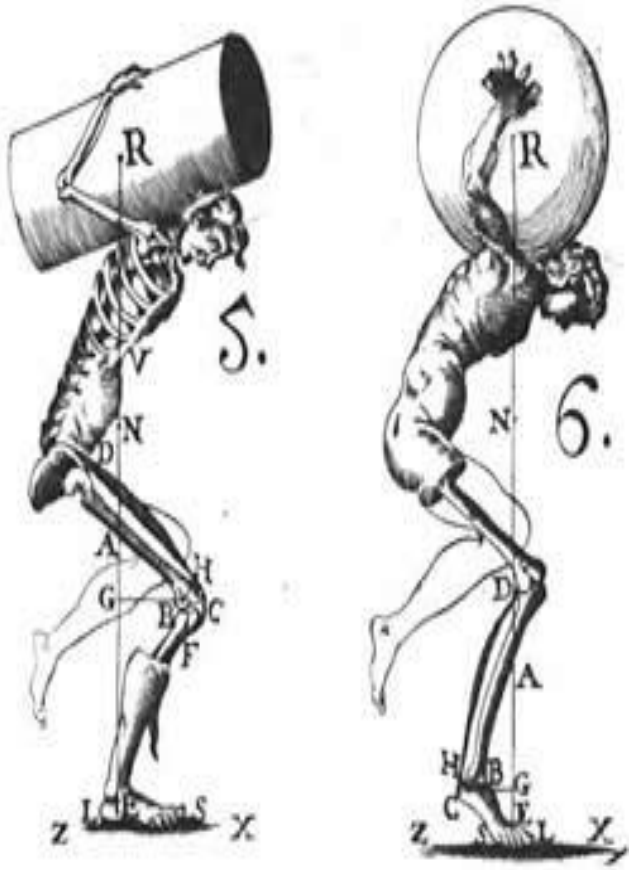
For Civil Engineers:

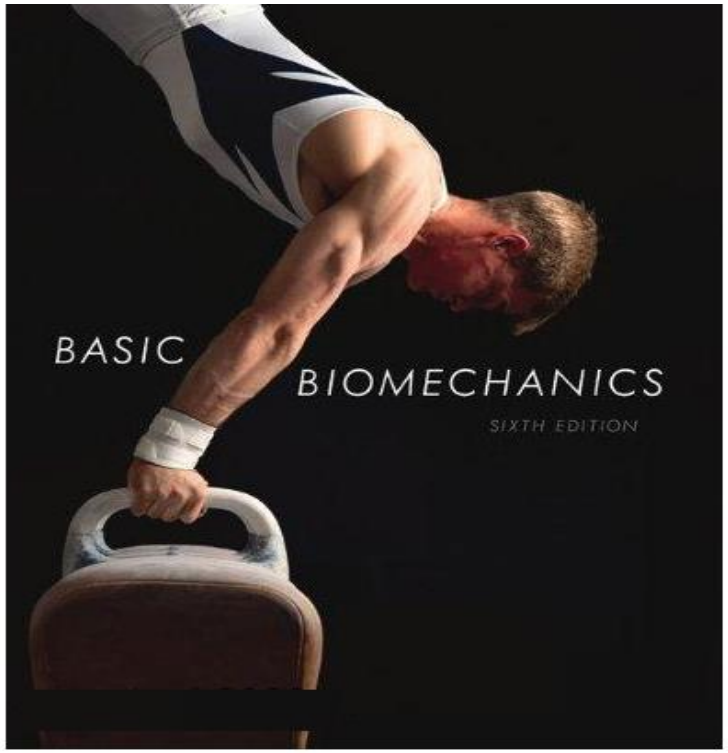
Why Engineering Mechanics?

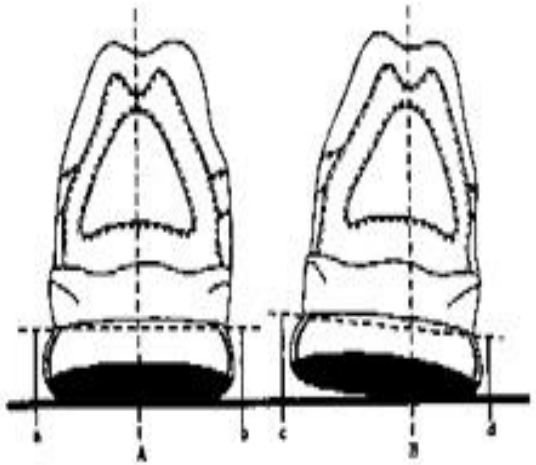
For Electronics Engineers:

Why Engineering Mechanics?

For Biotech Engineers:







Why Engineering Mechanics?

LOVELY PROFESSIONAL UNIVERSITY
Transforming Education Transforming India

For Computer Engineers:

- Software Development

- Design of keys, Screens etc. for computers and laptops

Course Contents

- **Unit I: Introduction to Mechanics** : Basic concepts, System of forces, Coplanar Concurrent Forces, Components in 2-D Plane-Resultant-Moment of Forces and its Applications, Couples and Resultant of Force System, Equilibrium of System of forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems
- **Unit II Friction** : Introduction to friction, Types of friction, Limiting friction, Angle of friction, Laws of Friction, Static and Dynamic friction, Motion of bodies
- **Unit III Centroid and Moment of Inertia** : Centroids of areas and lines, Centroids of composite plates and wires, First moments of areas and lines, Moment of inertia of plane sections, Theorems of moment of inertia, Center of gravity, Moment of inertia of standard and composite sections, Mass moment of inertia of thin plates
- **Unit IV Analysis of structures** : Introduction to trusses, Definition of trusses, Simple trusses, Analysis of truss by method of joint, Analysis of truss by method of section.
- **Unit V Introduction to Dynamics** : Basic terms, general principles in dynamics, Types of motion, General Plane motion, Rectilinear motion, Plane curvilinear motion
- **Unit VI Plane Kinematics and Kinetics of Rigid bodies** : D' Alembert's principle and its applications in plane motion and connected bodies, Work energy principle and its application in plane motion of connected bodies, Kinetics of rigid body rotation

UNIT 1: Introduction to Mechanics

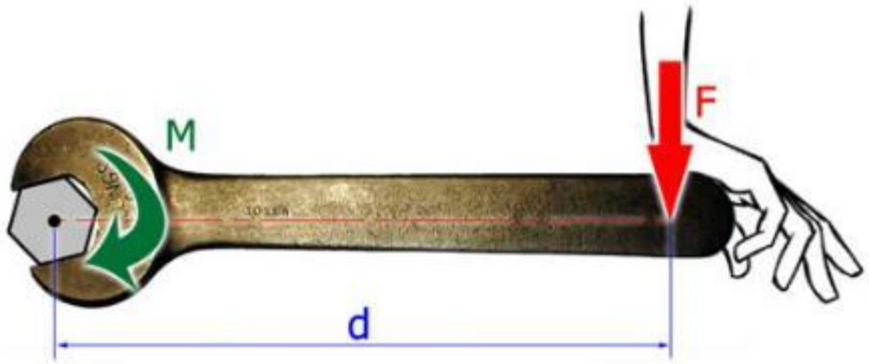
- Concept of Forces
- Moments, Couples and Resultant of Forces
- Equilibrium and Resolution of forces
- Coplanar and Spatial systems

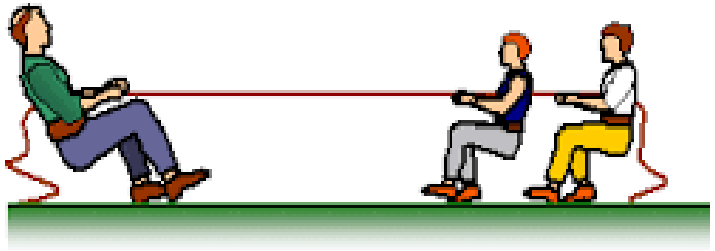
$$\sum F_X = 0$$

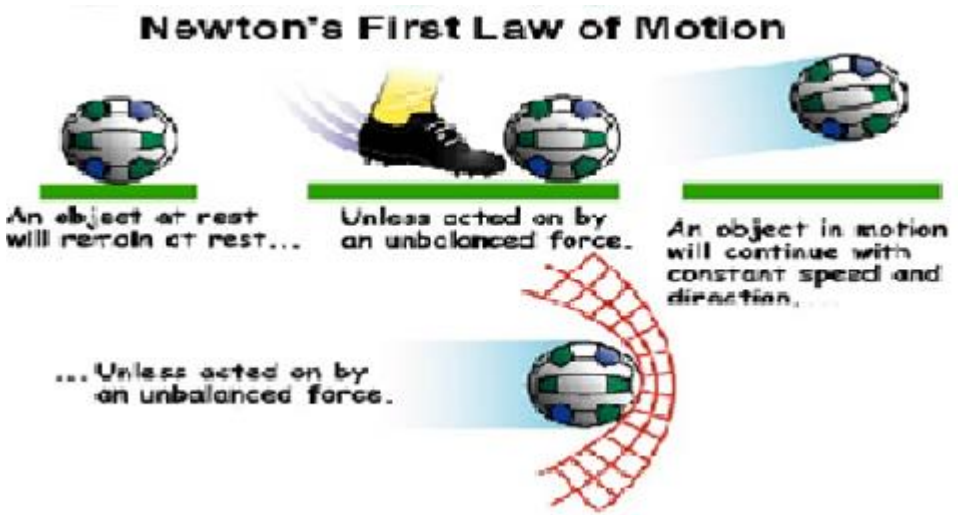
$$\sum F_Y = 0$$

$$\sum F_Z = 0$$

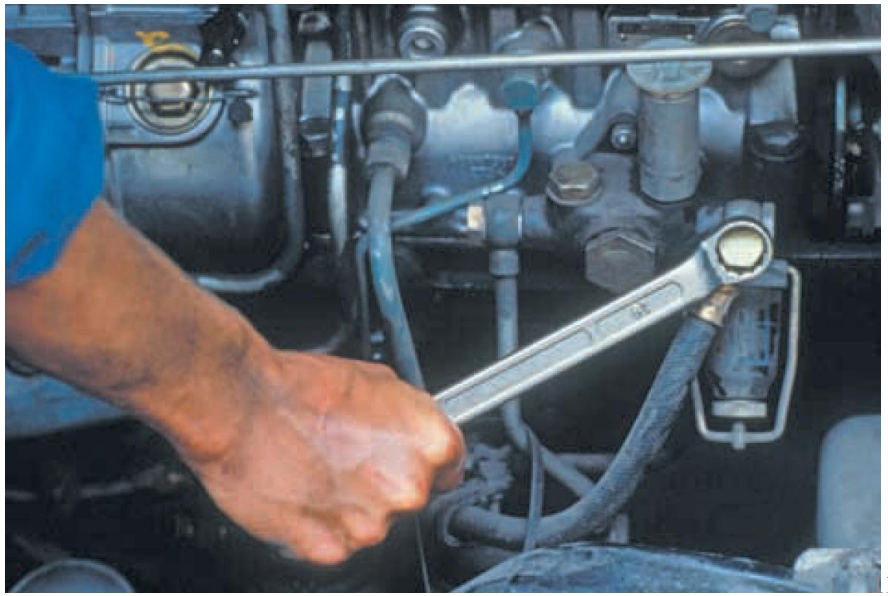
Equilibrium equations







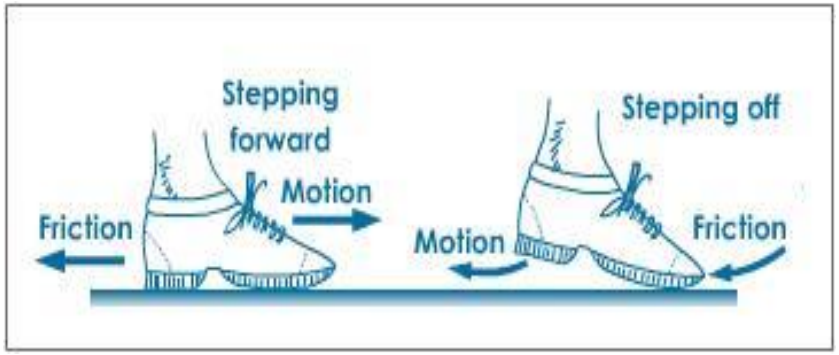
Unit 1:: Introduction to Mechanics

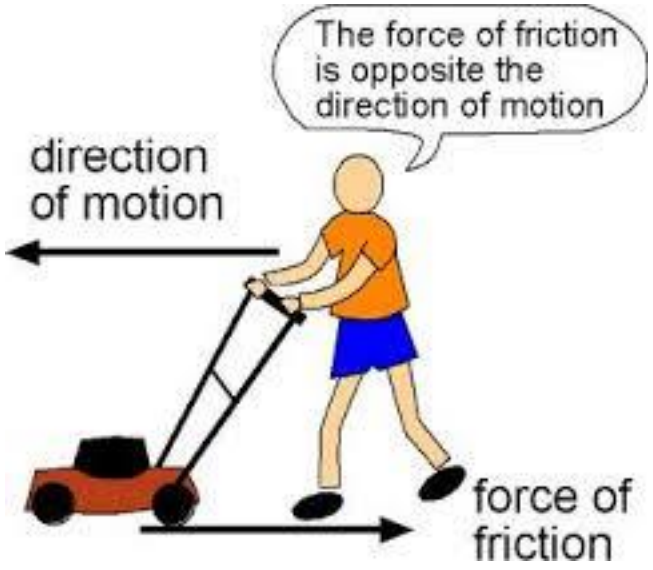


UNIT 2: Friction

You cannot move properly without friction

- Types and Laws of friction
- Limiting Friction and Motion of bodies
- Statics and Dynamics friction
- Wedges and screw jack



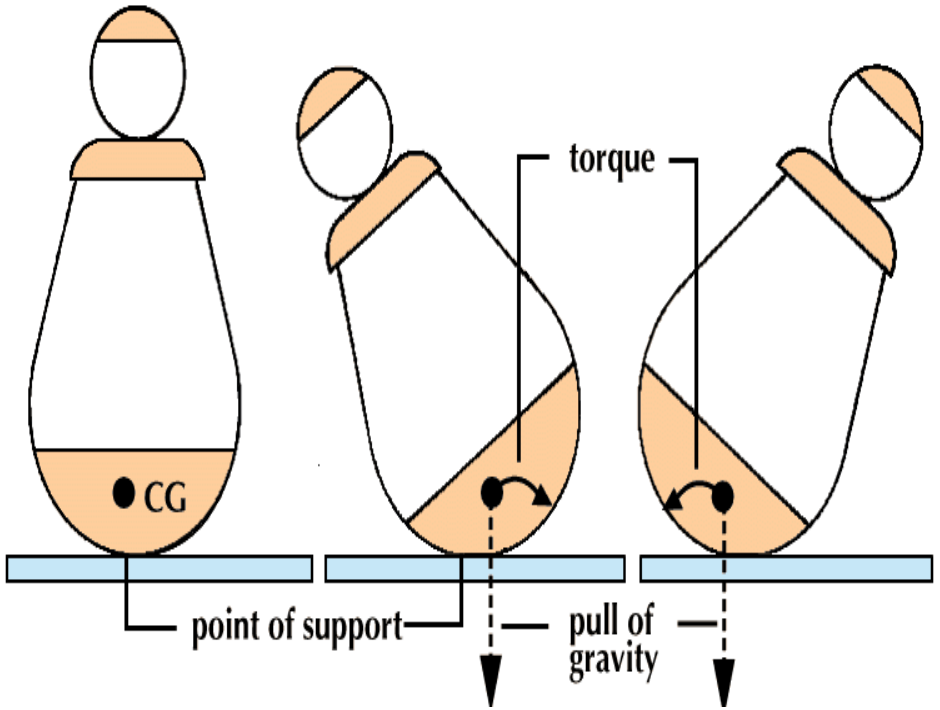


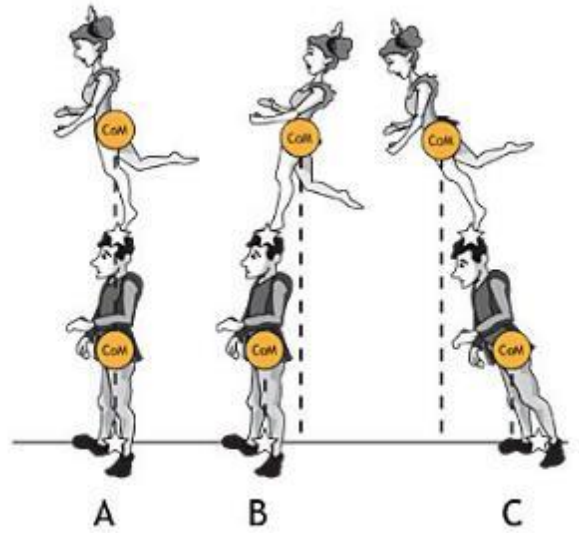
Unit 2:: Friction

UNIT 3: Centroid and Centre of Gravity

Center of gravity is the average location of the weight of an object

- Centroid of simple figures and composite sections
- Centre of gravity and its implications





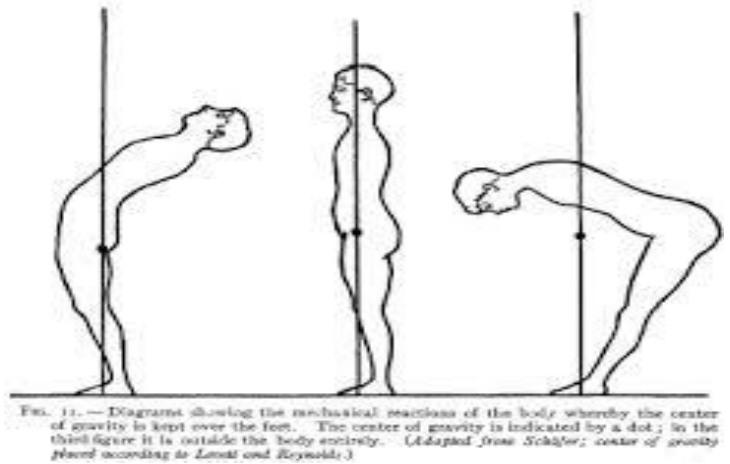
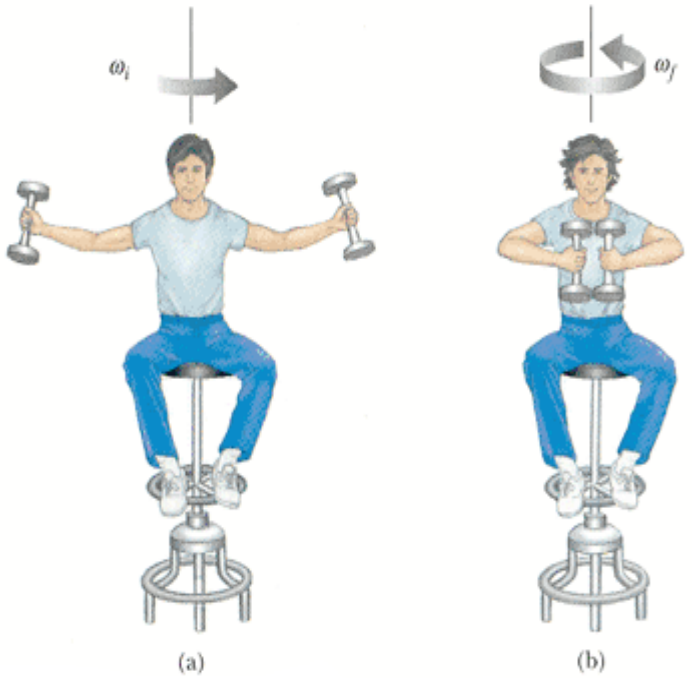


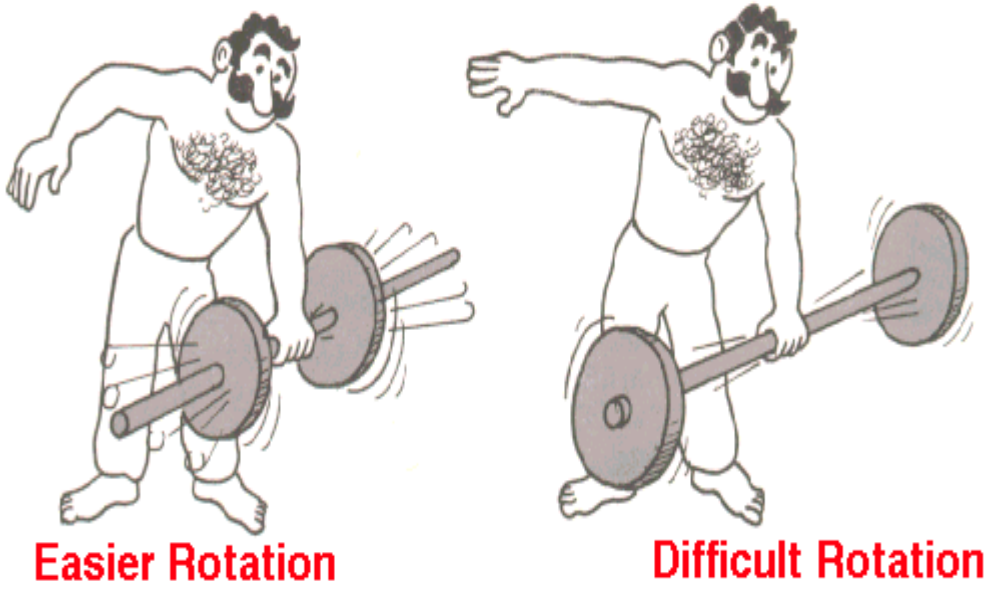
FIG. 11.—Diagrams showing the mechanical reactions of the body whereby the center of gravity is kept over the feet. The center of gravity is indicated by a dot; in the third figure it is outside the body entirely. (*Adapted from Schäfer; center of gravity placed according to Lanz and Reynolds.*)

UNIT 3: Moment of Inertia

Object's resistance to rotation and bending

- Moment of Inertia of area (of plane sections)
- MOI of standard and composite sections
- Mass moment of Inertia of different sections

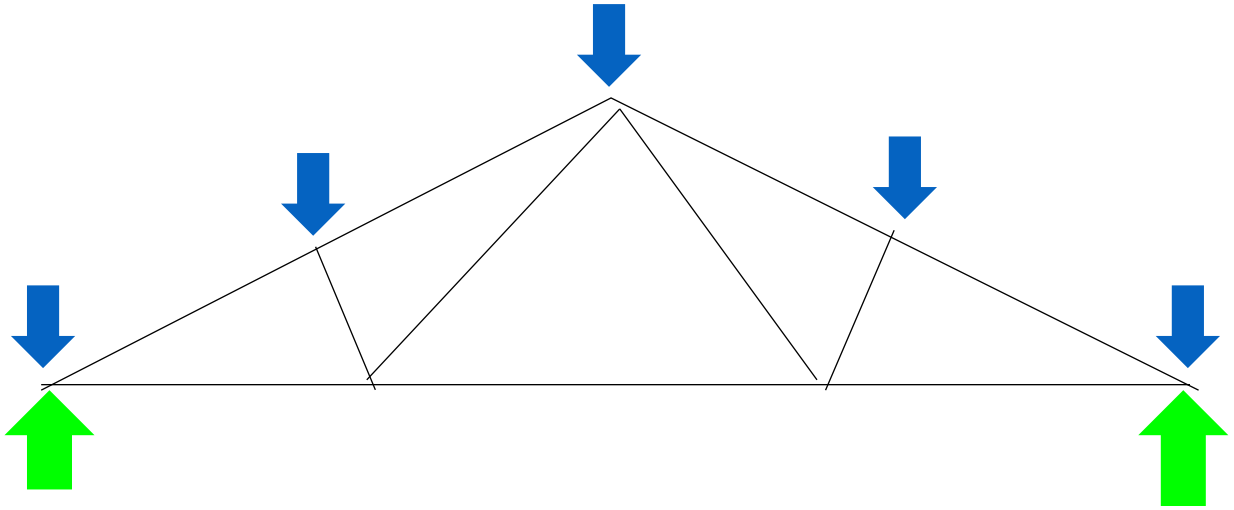




Unit 3:: Centroid and Moment of Inertia

UNIT 4: Analysis of Structures

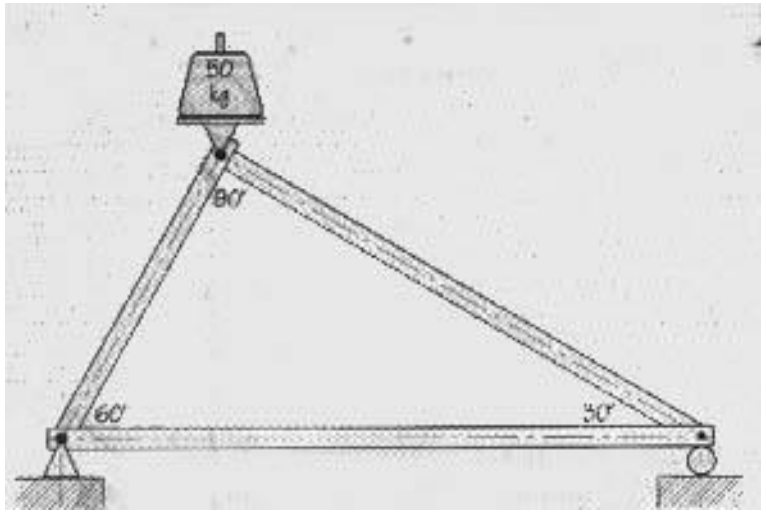
A truss is an assembly of linear members connected together to form a triangle or triangles that convert all external forces into axial compression or tension in its members



Objective is to find:

- Distribution of forces and moments in different members

Simple Truss



Two methods:

1. Method of Joints
2. Method of Sections

Unit 4:: Analysis of structures

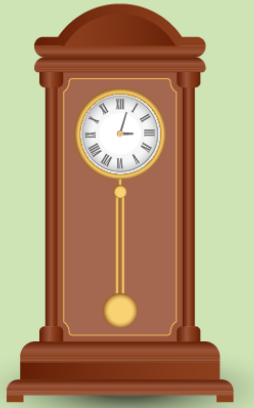
Unit V Introduction to Dynamics

- Rectilinear and Curvilinear motion
- General principles in dynamics

Rectilinear

Circular

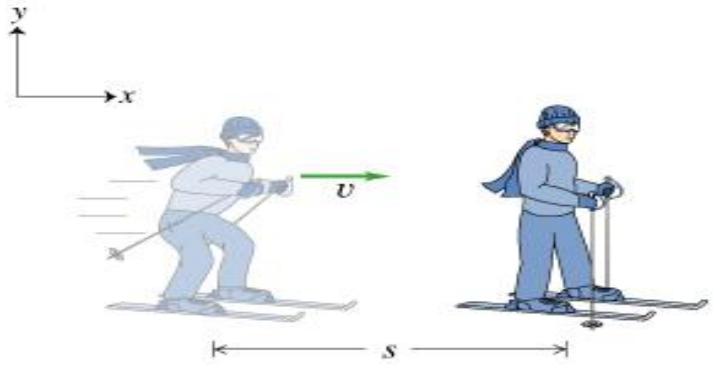
Rotational

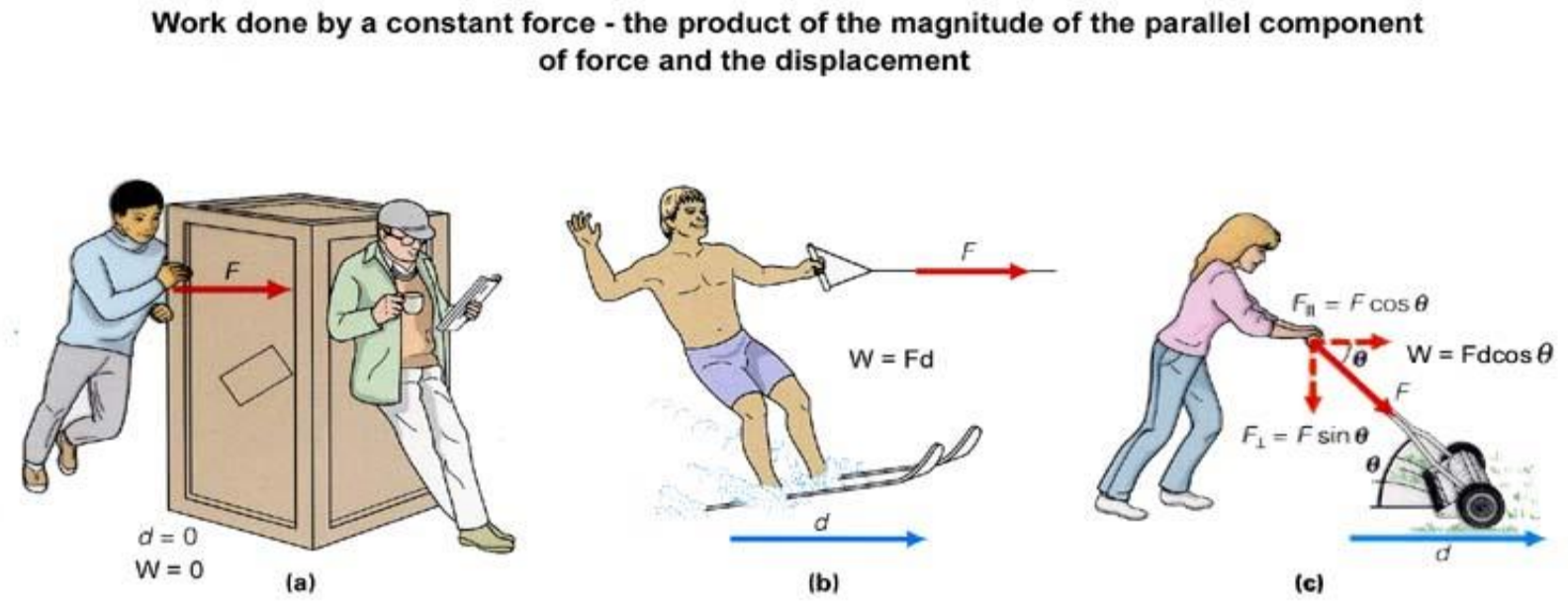


Periodic

UNIT 6: Plane Kinematics and kinetics of rigid bodies

- D'Alemberts Principle
- Work Energy Principle
- Kinetics of Rigid body Rotation

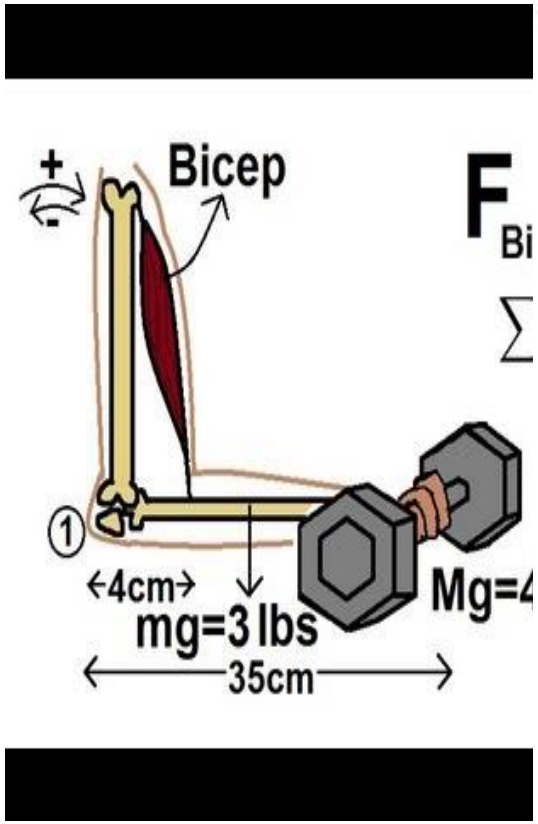


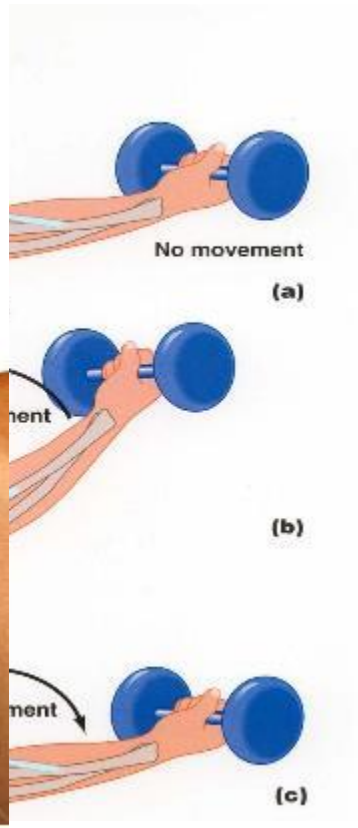


Importance Of Engineering Mechanics

Can you identify the application of Engineering Mechanics behind biceps?

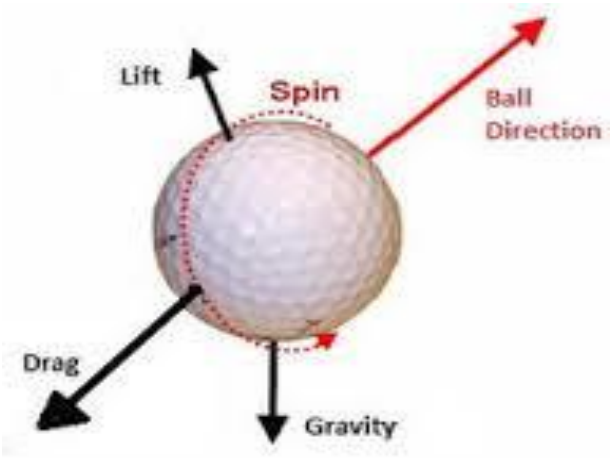
- Concepts of Mechanics are used in body building

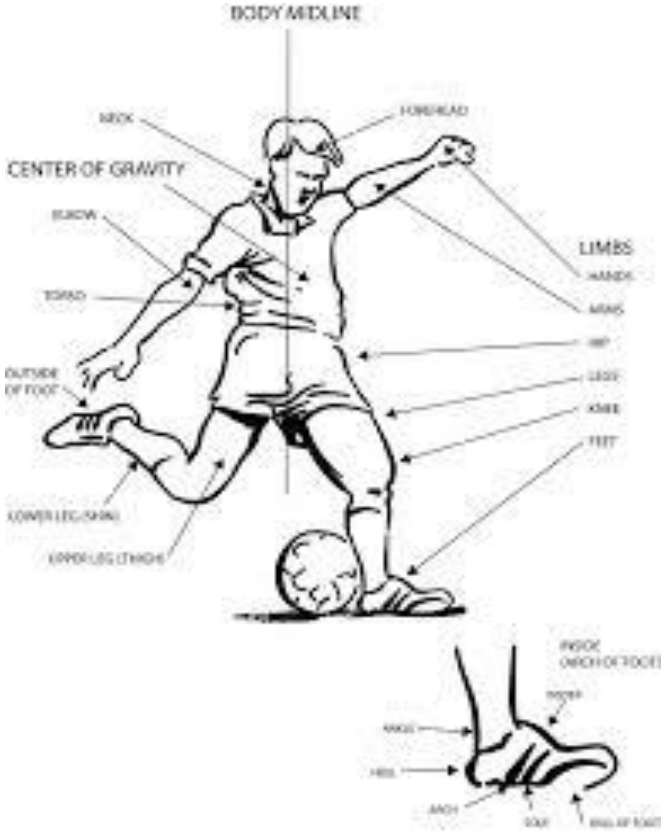




Importance Of Engineering Mechanics

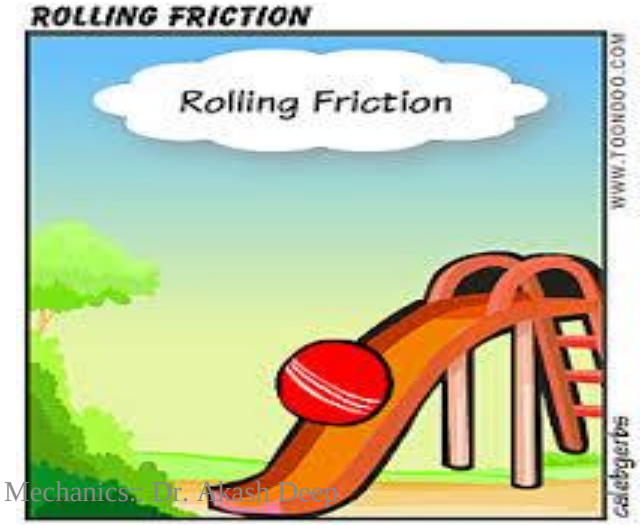
- Spinning of balls depends upon its shapes and sizes whose design is governed by concepts of mechanics

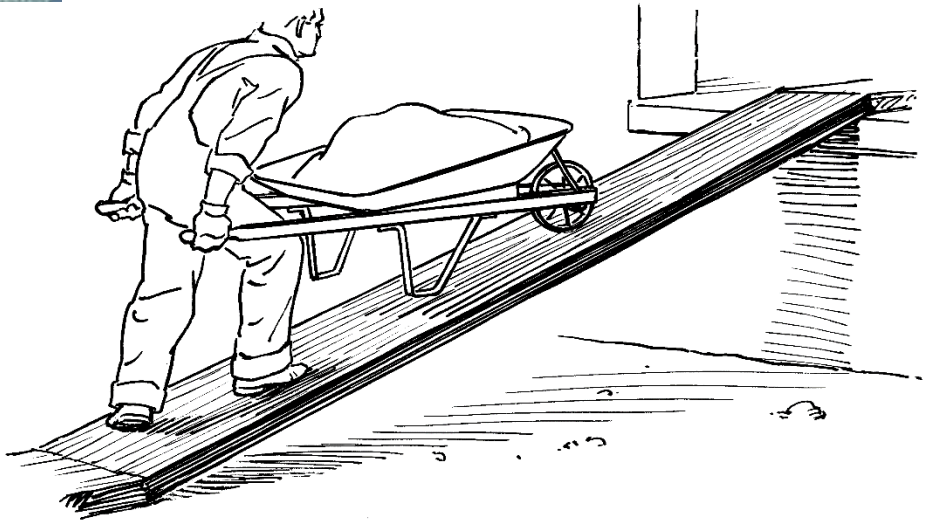




Importance Of Engineering Mechanics

Concepts of mechanics are used in motion of bodies





Importance Of Engineering Mechanics

Concepts of mechanics are used in motion of bodies

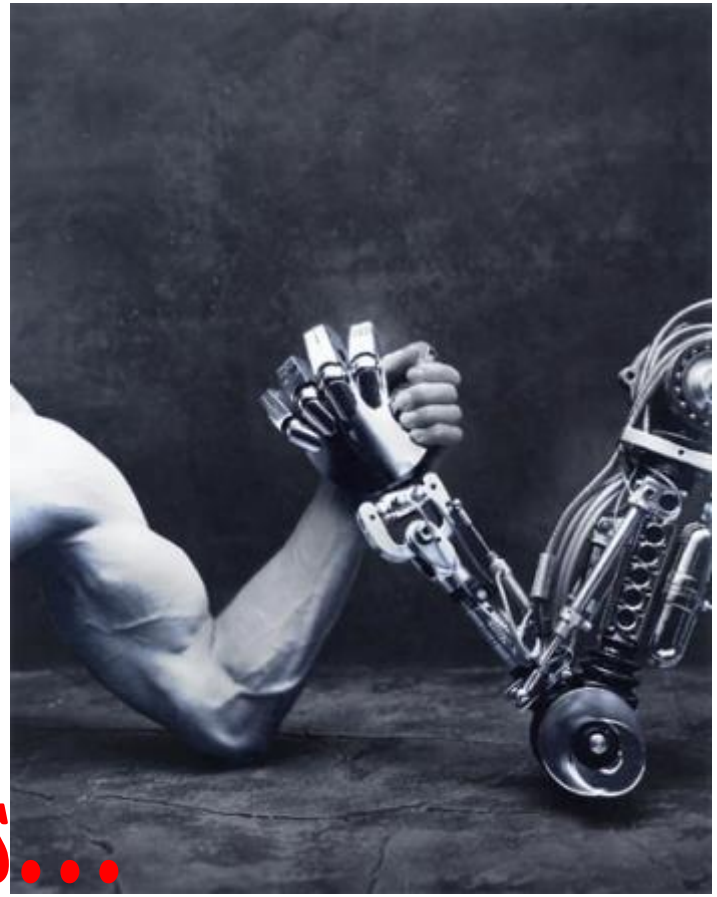
Friction Force plays a major role while walking on road, sand or ice

Get Set Go!!!

Gear up
Fasten your seat belts

Explore your Mechanics abilities

Build futuristic solutions…



Course Outcomes

- Through this course students should be able to:
  - CO1 :: analyze forces, moments and their applications in real life situations.
  - CO2 :: Understand the basic concepts of the laws of friction and moment of inertia and its real life applications.
  - CO3 :: analyze and determine the forces in members of trusses and frames.
  - CO4 :: apply fundamental concepts of kinematics and kinetics of particles and rigid bodies to the analysis of practical problems

Books

- **Text Books:**

1. VECTOR MECHANICS FOR ENGINEERS, STATICS AND DYNAMICS by BEER AND JOHNSTON, MCGRAW HILL EDUCATION

- **References:**

1. ENGINEERING MECHANICS: STATICS by ANDREW PYTEL | JAAN KIUSALAAS, CENGAGE LEARNING

2. ENGINEERING MECHANICS by BASUDDEB BHATTACHARYYA, OXFORD UNIVERSITY PRESS

3. ENGINEERING MECHANICS - STATICS AND DYNAMICS by R. C. HIBBELER, A. GUPTA, PEARSON

4. ENGINEERING MECHANICS - STATICS AND DYNAMICS by S K SINHA, PEARSON

Prerequisites

- FUNDAMENTAL UNITS: Mass, Length, Time
- DERIVED UNITS: area, velocity, acceleration, pressure etc.
- SYSTEMS OF UNITS: 1. C.G.S. units, 2. F.P.S. units, 3. M.K.S. units and 4. S.I. units.
- BASIC ALGEBRA:

1. $a^0 = 1$; $x^0 = 1$
   (*i.e., Anything raised to the power zero is one.*)
2. $x^m \times x^n = x^{m+n}$
   (*i.e., If the bases are same, in multiplication, the powers are added.*)
3. $\frac{x^m}{x^n} = x^{m-n}$
   (*i.e., If the bases are same in division, the powers are subtracted.*)
4. If $ax^2 + bx + c = 0$

   then $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

   where a is the coefficient of x^2, b is the coefficient of x and c is the constant term.

Prerequisites

- TRIGONOMETRY:

In the first quadrant (*i.e.*, 0° to 90°) all the trigonometrical ratios are positive.

In the second quadrant (*i.e.*, 90° to 180°) only sin θ and cosec θ are positive.

In the third quadrant (*i.e.*, 180° to 270°) only tan θ and cot θ are positive.

In the fourth quadrant (*i.e.*, 270° to 360°) only cos θ and sec θ are positive.

In any triangle ABC,

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

where a, b and c are the lengths of the three sides of a triangle. A, B and C are opposite angles of the sides a, b and c respectively.

Prerequisites

- TRIGONOMETRY:

$$\sin(A+B) = \sin A \cos B + \cos A \sin B$$

$$\sin(A-B) = \sin A \cos B - \cos A \sin B$$

$$\cos(A+B) = \cos A \cos B - \sin A \sin B$$

$$\cos(A-B) = \cos A \cos B + \sin A \sin B$$

$$\tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A . \tan B}$$

$$\tan(A-B) = \frac{\tan A - \tan B}{1 + \tan A . \tan B}$$

$$\sin 2A = 2 \sin A \cos A$$

$$\sin^2 \theta + \cos^2 \theta = 1$$

$$1 + \tan^2 \theta = \sec^2 \theta$$

$$1 + \cot^2 \theta = \operatorname{cosec}^2 \theta$$

$$\sin^2 A = \frac{1 - \cos 2A}{2}$$

$$\cos^2 A = \frac{1 + \cos 2A}{2}$$

$$2 \cos A \sin B = \sin(A+B) - \sin(A-B)$$

Prerequisites

- DIFFERENTIAL CALCULUS:

1. $\frac{d}{dx}$ is the sign of differentiation.

2. $\frac{d}{dx}(x)^n = nx^{n-1}; \frac{d}{dx}(x)^8 = 8x^7, \frac{d}{dx}(x) = 1$

   (i.e., to differentiate any power of x, write the power before x and subtract on from the power).

3. $\frac{d}{dx}(C) = 0 ; \frac{d}{dx}(7) = 0$

   (i.e., differential coefficient of a constant is zero).

4. $\frac{d}{dx}(u.v) = u.\frac{dv}{dx} + v.\frac{du}{dx}$

Prerequisites

- DIFFERENTIAL CALCULUS:

5. $$\frac{d}{dx}\left(\frac{u}{v}\right)=\frac{v.\frac{du}{dx}-u.\frac{dv}{dx}}{v^2}$$

$$\left[\begin{array}{l}\textit{i.e., Differential coefficient of}\\ \textit{two functions when one is}\\ \textit{divided by the other}\end{array}\right]=\left[\begin{array}{c}(\textit{Denominator}\times\textit{Differential coefficient of numerator})\\ -(\textit{Numerator}\times\textit{Differential coefficient of denominator})\\ \hline \textit{Square of denominator}\end{array}\right]$$

6. Differential coefficient of trigonometrical functions

$$\frac{d}{dx}(\sin x)=\cos x\,;\frac{d}{dx}(\cos x)=-\sin x$$

$$\frac{d}{dx}(\tan x)=\sec^2 x\,;\frac{d}{dx}(\cot x)=-\operatorname{cosec}^2 x$$

$$\frac{d}{dx}(\sec x)=\sec x\,.\tan x\,;\frac{d}{dx}(\operatorname{cosec} x)=-\operatorname{cosec} x\,.\cot x$$

(i.e., The differential coefficient, whose trigonometrical function begins with co, is negative).

Prerequisites

- INTEGRAL CALCULUS

1. $\int dx$ is the sign of integration.

2. $\int x^n \, dx = \frac{x^{n+1}}{n+1}$; $\int x^6 \, dx = \frac{x^7}{7}$

   (i.e., to integration any power of x, add one to the power and divide by the new power).

3. $\int 7dx = 7x$; $\int C \, dx = Cx$

   (i.e., to integrate any constant, multiply the constant by x).

4. $\int (ax+b)^n \, dx = \frac{(ax+b)^{n+1}}{(n+1)\times a}$

   (i.e., to integrate any bracket with power, add one to the power and divide by the new power and also divide by the coefficient of x within the bracket).

Next Class: Introduction to Engineering Mechanics

Thank You.

Any Queries?