Engineering mechanics

statics

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Introduction.

objectives of Engineering Mechanics.

The main objective of a first course in mechanics should be to develop in the engineering student the ability to analyse any problem in a simple and logical manner and to apply to its solution a few, well understood, basic principles.

what is mechanics?! mechanics can be defined as that science which describes and predicts the condition of rest or motion of bodies under the action of forces. It is divided into: ① mechanic of rigid bodies ② mechanic of deformable bodies.

③ mechanic of fluids.

⇒ The mechanic of rigid body is subdivided into statics and dynamics.

⇒ mechanic of deformable body (strength of materials) deformation of bodies can be elastic & plastic deformation.

⇒ mechanic of fluids → incompressible fluids or hydraulics
→ Compressible fluids.

mechanics is a physical science since it deals with the study of physical phenomena.

The basic concepts in mechanics are ① space, ② time, ③ mass and ④ force.

space is a position of a point which is defined by three lengths measured from Certain refrence point (origin) in three given direction.

force is the action of one body on another
It have a magnitude and direction. It is a vector.

In Newtonian mechanics, space, time and mass are absolute concepts independent of each other. This is Not true in relativistic mechanics where the time of an event depends upon its position and the mass of a body vary with its velocity.

* whereas force is not independent of other three. where the resultant force acting on the body is related to the mass of the body and to the manner in which its velocity vary with time.

⇒ the study of elementary mechanics rests on six fundamental principles based on experimental evidence.

* The parallelogram Law for the addition of forces:

This states that two forces acting on

a particle may be replaced by a single force called their resultant obtained by drawing the diagonal of the parallelogram which has sides equal to the given forces.

The principle of Transmissibility:- This states that the conditions of equilibrium or of motion of a rigid body will remain unchange if the force acting at a given point of the rigid body is replaced by a force of the same magnitude and same direction but acting at a different point, provided that the two forces have the same line of action.

Newton's three fundamental Laws:- formulated by Sir Isaac Newton in the latter part of seventeenth century. These laws can be stated as follows:-

1st law:- if the resultant force acting on a particle is zero, the particle will remain at rest or will move

with constant speed in a straight line.

Second law: If the resultant force acting on a particle is not zero, the particle will have an acceleration proportional to the magnitude of resultant and in the direction of this resultant force.

$$F = m \cdot a$$

f- resultant force, m = mass, a = acceleration.

Third law: The forces of action and reaction between bodies in contact have the same magnitude same line of action and opposite sense.

Newton law of Gravitation: This states that two particles of mass M and m are mutually attracted with equal and opposite force f and -f. The magnitude f is given by formula.

$$F = G \cdot \frac{M \cdot m}{r^2}$$

r- distance between the two particles
G- universal constant of gravitation.

$W = m \cdot g$

$g = 9.81\ m/s^2$ or $32.2\ ft/s^2$.

* System of Units

tera	(T)	10^{12}
giga	(G)	10^{9}
mega	(M)	10^{6}
Kilo	(k)	10^{3}
hecto	(h)	10^{2}
deka	(da)	10^{1}
deci	(d)	10^{-1}
centi	(c)	10^{-2}
milli	(m)	10^{-3}
micro	(μ)	10^{-6}
nano	(n)	10^{-9}
pico	(p)	10^{-12}
femto	(f)	10^{-15}
atto	(a)	10^{-18}

example ① $3.82\ km = 3.82 * 10^3\ m$
$= 3820\ m$

② $47.2\ mm = 0.0472\ m$

Conversion from one system to another. Units

Units of length

1 ft = 0.3048 m

1 mil = 1.609 km , 1 mil/s = 0.001 inch.

1 inch = $\frac{1}{12}$ ft = $\frac{1}{12}$(0.3048) = 0.0254 m

= 25.4 mm

Units of force 1 lb = 4.448 N

1 lb = (0.4536 kg)

Units of mass 1 slug = 1 lb · s^2/ft

= $\frac{1\ lb}{1\ ft/s^2}$ = $\frac{4.448\ N}{0.3048\ m/s^2}$ = 14.59 N · s^2/m

or 1 slug = 14.59 kg.

standard pound of mass = 1 lb = 0.4536 kg

Unit of stress or pressure:

lb/ft^2 = 47.88 Pascal - (N/m^2).

lb/in^2 (psi) = 6.895 kPa = 6895 Pa.