



## **QUESTION BANK**

### **ME 3351 ENGINEERING MECHANICS**

**(R 2021)**

**Class: II Year – Civil & Mechanical Engineering**

#### **PART A**

## UNIT – I

1. **Two forces 30 N and 40 N act at a point 'O'. The included angle between them is 60°. Find the magnitude and direction of the resultant May / June 2016**

Ans:  $R = 60.82 \text{ N}$ ,  $\alpha = 34.71^\circ$

2. **What are the minimum requirements for equilibrium of a particle in space? May / June 2016**

- Sum of horizontal forces are zero ( $\Sigma H = 0$ )
- Sum of vertical forces are zero ( $\Sigma V = 0$ )
- Sum of moments are zero ( $\Sigma M = 0$ )

3. **State the triangle law of forces. Nov / Dec 2015**

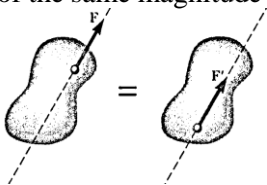
If two forces acting on a body are represented by the sides of a triangle then their resultant is represented by the third side of the triangle taken in the opposite order.

4. **A vector F starts at point (2, -1, 2) and passes through the point (-1, 3, 5) find its unit vector May / June 2015**

Ans:  $\frac{\vec{F}}{|\vec{F}|} = 5.83$ ,  $\lambda = -0.5145\mathbf{i} + 0.6861\mathbf{j} + 0.5145\mathbf{k}$

5. **State the principle of transmissibility May/June 2015, Nov /Dec 2009**

The state of rest or of motion of a rigid body is unaltered if a force acting on the body is replaced by another force of the same magnitude and direction but acting anywhere on the body along the line of action of the replaced force.



6. **Define Lami's theorem Nov / Dec 2014, May / June 2012**

It states "If three coplanar forces acting at a point be in equilibrium, then each force is proportional to the sine angle between the other two"

Mathematically  $\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma}$

Where P, Q and R are three forces and  $\alpha$ ,  $\beta$ , and  $\gamma$  are the included angles between the forces (SKETCH)

7. **Resolve the 100 N force acting 30° to horizontal into two components one along horizontal and another along 102° to horizontal May / June 2014**

Hint: By applying parallelogram law of force concept, Data given is  $R = 100 \text{ N}$  and  $\theta = 30^\circ$

Ans:  $F_1 = 115.47 \text{ N}$  and  $F_2 = 57.76 \text{ N}$

8. **Two forces of 400 N and 600 N act at an angle 60° to each other Determine the resultant in magnitude and direction May / June 2014**

Ans:  $R = 871.77$  and  $\alpha = 36.586^\circ$

9. **Find the length of the line joining origin with a point (2,1, -2) Nov / Dec 2015, May / June 2014**

Ans : 3  $\sqrt{2^2 + 1^2 + (-2)^2}$

10. **What is meant by force-couple system? May / June 2013**

When a number of forces and couples are acting on a body, they combined into a single force and couple having the same effect. This is called force couple system. It is also termed as equivalent systems.

11. **Find the unit vector of a force  $\mathbf{F} = 4\mathbf{i} - 5\mathbf{j} + 8\mathbf{k}$  May / June 2013**

Ans:  $\frac{\vec{F}}{|\vec{F}|} = 10.247$ ,  $\lambda = 0.39\mathbf{i} - 0.49\mathbf{j} + 0.78\mathbf{k}$

12. **Find the angle between the forces A and B given as  $\mathbf{A} = 3\mathbf{i} - 2\mathbf{j} + 4\mathbf{k}$ ,  $\mathbf{B} = 5\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}$  Nov/Dec 2012**

Solution:  $\vec{A} \cdot \vec{B} = 15 - 6 - 16 = -7$   $A = \sqrt{3^2 + (-2)^2 + 4^2} = 5.385$

$$B = \sqrt{5^2 + 3^2 + (-4)^2} = 7.071$$

$$\theta = \cos^{-1} \left[ \frac{\vec{A} \cdot \vec{B}}{A \times B} \right] = \cos^{-1} \left[ \frac{-7}{5.385 \times 7.071} \right]$$

$$\theta = 100.59^\circ$$

13. **How will you find the direction cosine in the Z – direction of the resultant force of a concurrent spatial force system? Nov / Dec 2012**

$$\theta_z = \cos^{-1} \lambda_z$$

14. **What is the difference between a resultant force and equilibration force? May / June 2012, Nov / Dec 2010**

- The resultant of a force system is a single force which produces the same effect as that of the force system. It is equivalent force of all the given forces.
- The single force which brings the force system to equilibrium is called as an equilibrant. The equilibrant is equal and opposite to the resultant of force system.

15. **Define non-coplanar concurrent forces Nov / Dec 2011**

The forces do not lie on the same plane, but their lines of action meet at common point in space

16. **State the necessary and sufficient conditions for the static equilibrium of a particle in two dimension. Nov / Dec 2011, May / June 2010**

- Sum of horizontal forces are zero ( $\Sigma H = 0$ )
- Sum of vertical forces are zero ( $\Sigma V = 0$ )
- Sum of moments are zero ( $\Sigma M = 0$ )

17. **Find the magnitude of the resultant of the two concurrent forces of magnitude 60 kN and 40 kN with an included angle of 70° between them May / June 2011**

Ans: Resultant R = 82.7 kN

18. **A force of magnitude 500 N is passing through the origin and a point A (0,2,1,0)m write the vector form of the force May / June 2011**

Ans:  $F = 98i + 490j$

19. **Define the following terms: (a) Coplaner forces, (b) Concurrent forces. May / June 2010, Nov / Dec 2010**

Coplaner force: If the line of action of all forces lie on same plane, then the forces are said to be coplanar forces

Concurrent forces: If the line action of all the forces meet at a common point, then the forces are said to be concurrent forces.

20. **A force  $F = 9i + 6j - 5k$  acts through the origin. What is the magnitude of the force and the angle it makes with X, Y, and Z axis? Nov / Dec 2009**

(Ans:  $F = 18.49N$ ,  $\theta_x = 60.87^\circ$ ,  $\theta_y = 71.06^\circ$ ,  $\theta_z = 144.2^\circ$ )

21. **What is unit vector? May / June 2009**

A vector of unit magnitude is called Unit vector. The unit vector of a force is obtained by dividing the given force by its magnitude.

## UNIT – II

### 1. How free body diagram constructed? May / June 2016, Nov / Dec 2011

Free body diagram of a body is the diagram drawn by showing all the external forces and reactions on the body by removing the contact surfaces and physical structures.

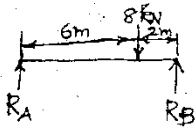
### 2. State Varignon's theorem. May / June 2016, 2016, 2009, Nov / Dec 2014, 2012

It states that "If a number of coplanar forces are acting simultaneously on a particle, the algebraic sum of moments of all forces about any point is equal to the moment of their resultant force about the same point.

### 3. Distinguish between the resultant and equilibrant. Nov / Dec 2015

- The resultant of a force system is a single force which produces the same effect as that of the force system. It is equivalent force of all the given forces.
- The single force which brings the force system to equilibrium is called as an equilibrant. The equilibrant is equal and opposite to the resultant of force system.

### 4. Find $R_A$ and $R_B$ of the beam shown in fig. Nov / Dec 2015



Ans:  $R_A = 2 \text{ kN}$ ,  $R_B = 6 \text{ kN}$

### 5. List the different supports used to support structural components May / June 2015, 2014

1) Roller support 2) Hinged support 3) Fixed support

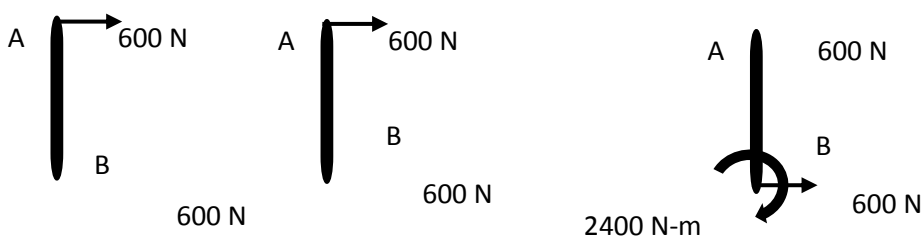
### 6. Find the magnitude and location of the single equivalent force for the beam AB of length 8 m having a point C at 3 m from A subjected to the following forces. May / June 2015

- An upward force of 10 N at A
- A downward force of 10 N at C
- An upward force of 40 N at B

### 7. Define couple. Nov / Dec 2014

A **couple** is a pair of forces, equal in magnitude, oppositely directed, and displaced by perpendicular distance. The simplest kind of **couple** consists of two equal and opposite forces whose lines of action do not coincide.

### 8. Replace the force 600 N from A as shown in fig by equivalent force and couple at B. May/June 2014



### 9. Find the resultant of the force system shown in fig. May / June 2014



Ans:  $R = 0$  But the moment will not zero by taking moments about 'o'  
 $\Sigma M_o = 2300 \text{ N-m}$  (in anticlockwise direction)

### 10. State polygon law of equilibrium May / June 2014

If a number of concurrent forces acting simultaneously on a particle, are represented in magnitude and direction by the sides of polygon taken in order, then the resultant of this system of forces is represented by the closing side of the polygon in the opposite order.

**11. Write the equation of equilibrium of a rigid body in two dimension. May / June 2013**

- Sum of horizontal forces are zero ( $\Sigma H = 0$ )
- Sum of vertical forces are zero ( $\Sigma V = 0$ )
- Sum of moments are zero ( $\Sigma M = 0$ )

**12. Distinguish between a couple and a moment Nov / Dec 2012**

<b>Couple</b>	<b>Moment</b>
Two equal and parallel forces acting in opposite direction constitute a couple	Moment is the turning effect product by a force on the body on which it acts
It does not depend on any point of axis	It depends on point or axis about which moment is taken

**13. What is meant by free body diagram of a rigid body? May / June 2012, Nov / Dec 2009**

Free body diagram of a body is the diagram drawn by showing all the external forces and reactions on the body and by removing the contact surfaces.

**14. Write the conditions of equilibrium of a system of parallel forces acting in a plane May / June 2012, Nov / Dec 2010**

Parallel force system in a plane is a non-concurrent force system. For such a system the equation of equilibrium are

- Sum of horizontal forces are zero ( $\Sigma H = 0$ )
- Sum of vertical forces are zero ( $\Sigma V = 0$ )
- Sum of moments are zero ( $\Sigma M = 0$ )

**15. What are the necessary and sufficient conditions of equilibrium of rigid bodies in two dimensions and in three dimensions? Nov / Dec 2011, May / June 2010**

- Sum of horizontal forces are zero ( $\Sigma H = 0$ )
- Sum of vertical forces are zero ( $\Sigma V = 0$ )
- Sum of moments are zero ( $\Sigma M = 0$ )

**16. Why the couple moment is said to be a free vector? May / June 2010**

The couple is a pure turning effect which may be moved anywhere in its own plane without change its effect on the body. Hence, couple moment is said to be free vector.

## UNIT – III

### 1. State Pappus-Guldinus theorem. May / June 2016

The area of surface of revolution obtained by revolving a line or curve is equal to the length of the generating line or curve multiplied by the distance travelled by the centroid of the generating line / curve when it is being rotated.

### 2. When will the product of inertia of an area become zero? May / June 2016, Nov / Dec 2011, May / June 2010

The product of inertia is zero when either one or both of the  $x - x$  and  $y - y$  axis, happen to be the axes of symmetry.

### 3. A right angled triangle of base 3 m and height 4 m is revolved about its 4 m vertical edge. Compute the volume of the solid generated. Nov / Dec 2015

Ans:  $37.70 \text{ m}^3$

### 4. Write an expression for the radius of gyration of an area. Nov / Dec 2015, 2010, May / June 2012

Radius of gyration  $k = \sqrt{\frac{I}{A}}$   $I$  = Moment of inertia,  $A$  = Area

### 5. Find the radius of gyration of a rectangular area of MI about its base $9 \times 10^4 \text{ cm}^4$ and cross sectional area $300 \text{ cm}^2$ May / June 2015, 2013

Data given:      MI base=       $I = 9 \times 10^4 \text{ cm}^4$   
                         Area              =       $A = 300 \text{ cm}^2$

$$\text{Radius of gyration } k = \sqrt{\frac{I}{A}} = \sqrt{\frac{9 \times 10^4}{300}}$$

Radius of gyration  $k = 17.32 \text{ cm}$

### 6. State perpendicular axis theorem. May / June 2015

This theorem states that the moment of inertia of a planar body about an axis perpendicular to its plane is equal to the sum of its moments of inertia about two perpendicular axes concurrent with the perpendicular axis and lying in the plane of the body. ( $I_{zz} = I_{xx} + I_{yy}$ )

### 7. State parallel axis theorem. Nov / Dec 2014, 2009, Nov / Dec 2010, May / June 2012

Parallel axis theorem states that “ The moment of inertia of a plane area about any axis is the sum of the moment of inertia of the area about the axis, passing through the centroid of the area parallel to the given axis and the product of area of the plane and the square of the perpendicular distance of its centroid from the axis.

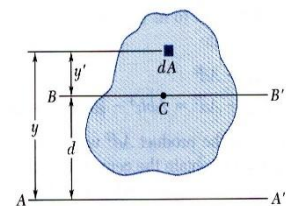
Mathematically  $I_{AB} = I_{GG} + Ah^2$

$I_{AB}$  = Moment of inertia a parallel axis X-X

$I_{GG}$  = Moment of inertia about its centroidal axis G-G

$A$  = Area of the body

$h$  = Distance between the axes GG and AB



### 8. Define principle moment of inertia Nov / Dec 2014, 2012, May / June 2009

The perpendicular axes about which product of inertia is zero are called principal axes and the moment of inertia with respect to these axes are called as principal moment of inertia.

### 9. Define centroid May / June 2014

Centroid is the point in a plane area such that the moment of the area, about any axis, through that point zero

### 10. Define polar moment of inertia. May / June 2014, Nov / Dec 2011

The area moment of inertia for an area relative to an axis perpendicular to the plane of the area is called the polar moment of inertia. It is denoted by  $I_p = I_{xx} + I_{yy}$

### 11. Define first moment of an area about an axes May / June 2014

First moment of an area (or) centroid of a plane figure is defined as the point through which the entire area of the plane figure is assumed to be concentrated.

### 12. What is the radius of gyration of circle of diameter d about its diameter? May / June 2014

$$\text{Radius of gyration } k = \sqrt{\frac{I}{A}} \quad I = \frac{\pi}{64} d^4, A = \frac{\pi}{4} d^2$$

$$K = 0.25 d$$

**13. When will the centroid and centre of mass coincide? May / June 2013**

If the geometry of the body is symmetrical about its axes, then its centroid and centre of mass will coincide

**14. Distinguish between centroid and centre of gravity. Nov / Dec 2012, 2009**

- Centre of gravity applies to the bodies with mass and weight while centroid applies to plane area.
- Centre of gravity of a body is the point through which the entire weight of the body acts for any orientation of the body while centroid is the point in a plane area such that the moment of the area, about any axis, through that point zero.

**15. Write the SI units of the mass moment of inertia and of the area moment of inertia of a lamina May / June 2010**

For mass moment of inertia =  $\text{kg m}^2$

For area moment of inertia =  $\text{m}^4$

**16. What is radius of gyration? May / June 2009**

The radius of gyration is defined as the distance at which the whole area of the body may be assumed to be concentrated with reference to the axis of the reference.

## UNIT – IV

### 1. What is angle of repose? May / June 2016, Apr / May 2015

The maximum angle of inclination of the plane at which the body remains in equilibrium under the action of frictional force only, is called as angle of repose.

### 2. A wheel of radius 50 cm is moving on rails, with a speed of 12 m/s. Find the angular speed of the wheel May / June 2016, Nov / Dec 2012

$$\begin{aligned}\text{Data given:} \quad \text{Wheel radius } R &= 50 \text{ cm} = 0.5 \text{ m} \\ \text{Speed } v &= 12 \text{ m/s} \\ \text{Angular speed } \omega &= v \times R \\ \omega &= 12 \times 0.5 \\ \omega &= 6 \text{ rad/sec}\end{aligned}$$

### 3. What is impulsive force? Nov / Dec 2015

A force acting on a particle during a very short time interval that is large enough to produce a definite change in momentum is called an impulsive force.

### 4. State the principle of work and energy for the general plane motion of the rigid bodies. Nov / Dec 2015

Principle of work and energy states that “The change in kinetic energy is equal to the total work done by the particle”

### 5. A wheel of radius 50 cm subjected to a load of 300 N rolls on a level ground at constant speed. If the wheel is pushed by a tractive force of 60 N applied horizontally at the centre of the wheel, find the coefficient of rolling resistance. Apr / May 2015

$$\begin{aligned}\text{Ans: } 60 \text{ N} \times 50 \text{ cm} &= 300 \text{ N} \times \text{coefficient of rolling resistance} \\ \text{coefficient of rolling resistance} &= \frac{60 \times 50}{300} = 10 \text{ cm}\end{aligned}$$

### 6. Define limiting friction Nov / Dec 2014

If the frictional force reaches its maximum value  $F_{\max}$  (or)  $F_{\lim}$ , When the external force is increased, the body will lose its balance and it will move towards the left side. The maximum amount of friction developed in the contact surface is known as the limiting friction.

### 7. Define instantaneous centre of rotation. Nov / Dec 2014

In rotation of rigid bodies, it is possible to locate a point in the plane which has zero velocity at any instant and hence the plane motion of other points may look as pure rotation about this point. Such a point is called as instantaneous centre of rotation.

### 8. A body is rotating with an initial angular velocity 3 rad/s. Its angular velocity increases to 10 rad/s in 5 seconds. Find the angular acceleration of the body. May / June 2014

$$\begin{aligned}\text{Data given:} \quad \text{Initial angular velocity} &= 3 \text{ rad/sec} \\ \text{Final angular velocity} &= 10 \text{ rad/s} \\ \text{Time} &= 5 \\ \omega &= \omega_0 + \alpha t \\ 10 &= 3 + (\alpha \times 5) \\ \alpha &= 1.4 \text{ rad/s}\end{aligned}$$

### 9. Define angle of friction May / June 2014

Angle between the normal reaction (N) and the resultant (R) is known as angle of friction ( $\theta$ )

### 10. What is general plane motion? May / June 2014, 2013, 2010

The motion of rigid body is said to have general plane motion, when the body undergoes a combination of translation and rotation. In other words any plane motion which is neither a rotation nor a translation is referred to as general plane motion

### 11. Define: Coefficient of static friction. May / June 2014, Nov / Dec 2010

The ratio of limiting friction to the normal reaction is known as co-efficient of static friction it is denoted by the symbol  $\mu$



Mathematically  $\mu = \frac{\text{Limiting friction}}{\text{Normal reaction}} = \frac{F_m}{N_R}$

- 12. A fly wheel has a mass moment of inertia of 11 kg m<sup>2</sup> about the axis of rotation. It runs a constant angular velocity of 94.25rad/s. find the kinetic energy of the fly wheel. May / June 2013**

Data given: Mass moment of inertia  $I_m = 11 \text{ kg m}^2$

Angular velocity  $\omega = 94.25 \text{ rad/sec}$

Kinetic energy KE  $= \frac{1}{2} \times I_m \omega^2$   
 $= \frac{1}{2} \times 11 \times (94.25)^2$

- 13. When do we say that the motion of a body is impending? Nov / Dec 2012, 2011 May / June 2012**

When the applied force over the body is just sufficient to overcome, the friction, then the motion of the body is at impending stage.

- 14. How do at any given instant, the velocity and acceleration of different points of a rigid body vary when it is undergoing translation? May / June 2012**

Let us assume that a rigid body translates with it particle A and B moving to A' and B' respectively in time  $\Delta t$ . Since the motion is translation, A'B' is parallel to AB thus AA'BB' form a parallelogram. Therefore  $\Delta SA$  and  $\Delta SB$ , representing the displacements of the particles A and B respectively, are the same in magnitude and direction (SKETCH)

- 15. A rigid body rotates about a fixed axis. Write the expression for angular velocity when the rotation is uniformly accelerated Nov / Dec 2011**

The expression for angular velocity, when the rotation is uniformly accelerated is given by  $\omega = \frac{2\pi N}{60}$

- 16. State the laws of dry friction May / June 2010**

- The frictional force always acts in a direction opposite to that in which the body tends to move
- The force of friction is equal to force applied to the body as long as the body is at rest
- The magnitude of frictional force (F) bears a constant ratio to the normal reaction (N) between the two surfaces
- The force of friction depends upon the nature of surfaces in contact
- The frictional force does not depend on the shape and area of contact of the bodies

- 17. A body is rotating with an angular velocity of 5rad/sec. After 4 seconds, the angular velocity of the body becomes 13rad/sec. Determine the angular acceleration of the body Nov/Dec2010**

Data given: Initial angular velocity = 5 rad/sec

Final angular velocity = 13 rad/s

Time = 4

$$\omega = \omega_o + \alpha t$$

$$13 = 5 + (\alpha \times 4)$$

$$\alpha = 2 \text{ rad/s}$$

- 18. List out the different types of friction. What is coefficient of static friction? Nov / Dec 2009**

Types of friction

- Dry friction (Coulomb friction)
- Fluid friction

The ratio of limiting friction to the normal reaction is known as co-efficient of static friction it is denoted by the symbol  $\mu$

Mathematically  $\mu = \frac{\text{Limiting friction}}{\text{Normal reaction}} = \frac{F_m}{N_R}$

- 19. A rigid body is acted upon by a force of 100 N, the velocity of body changes from 15 m/s to 25 m/s during the period of 50s. Find the mass of body and the distance moved by the body during the time of interval. Nov / Dec 2009**

Data given: Force  $F = 100 \text{ N}$ , Initial velocity  $u = 15 \text{ m/s}$ , Final velocity  $v = 25 \text{ m/s}$

Time = 50 sec

Solution:

$$v = u + at$$

$$25 = 15 + (a \times 50)$$

$$a = 0.2 \text{ m/s}^2$$

$$F = m \times a$$

$$100 = m \times 0.2$$

$$m = 500 \text{ kg}$$

$$v^2 = u^2 + 2aS$$

$$25^2 = 15^2 + (2 \times 0.2 \times S)$$

$$S = 1000 \text{ m}$$

**20. What is coulomb friction? May / June 2009**

The friction that exists between two unlubricated surfaces is called coulomb friction.

**21. Define coefficient of Kinetic friction. May / June 2009**

When the bodies are in relative motion, the co-efficient of friction is called kinetic. The kinetic co-efficient of friction is always less than static co-efficient of friction

## UNIT – V

### 1. What's D' Alembert's principal May / June 2016, 2013 Nov / Dec 2012

The system of a forces acting on a body in motion is in dynamic equilibrium with the inertia force of the body

### 2. What happens if two perfectly elastics are in impact? May / June 2016

When two elastic bodies collide, they momentarily come to rest immediately after collision, then deform to some extent they move apart and recover because of action restoring elastic forces.

### 3. A train running at 80 km/h is brought to a standing halt after 50 seconds. Find the retardation and the distance travelled by the train before it comes to a halt. Nov / Dec 2015, 2009

Data given: Initial velocity  $u = 80 \text{ km/h} = 22.22 \text{ m/s}$

Final velocity:  $v = 0$

Time: 50 sec

Solution:  $v = u + at$

$$0 = 22.22 + a(50)$$

$$a = -0.44 \text{ m/s}^2$$

$$v^2 = u^2 + 2aS$$

$$0 = (22.22)^2 + (2 \times (-0.44) \times S)$$

$$S = 561 \text{ m}$$

### 4. What is dynamic equilibrium. Nov / Dec 2015

Dynamic equilibrium is an alternative to Newton's second law of motion

$\Sigma F = ma$  (or)  $\Sigma F - ma = 0$  If a vector  $(-ma)$  is added to the forces acting on the particle, we get a system vectors that reduces to zero. The vector  $-ma$  has a magnitude of  $ma$  and direction opposite to that of acceleration. The vector  $-ma$  is called inertia vector. The particle is said to be in dynamic equilibrium under the action of the system of forces acting on it and the inertia vector

### 5. A particle is projected into space at an angle of $30^\circ$ to the horizontal at a velocity of 40 m/s. Find the maximum height reached by the projectile. Apr / May 2015

$$\text{Ans: Max height} = \frac{u^2 \sin^2 \theta}{2 \cdot g}, \quad \frac{40^2 \sin^2 30}{2 \cdot 9.81} = 20.39 \text{ m}$$

### 6. Distinguish between perfectly plastic impact and perfectly elastic impact. Apr / May 2015

**Perfectly plastic impact:** The bodies which does not regain its original shape and size when the external forces are removed are called inelastic bodies, that impact is called perfectly plastic impact

**Perfectly elastic impact:** The bodies regain its original shape and size when the external forces are removed are called elastic bodies, that impact is called perfectly elastic impact.

### 7. Define Newton's law (second law) of motion. Nov / Dec 2014

The rate of change of momentum is directly proportional to the applied force and in the direction of the force  
(ie)  $F = ma$

### 8. Give the equation of work energy for a rectilinear motion Nov / Dec 2014

$$\text{Ans: } \frac{1}{2}mv^2$$

### 9. A motorist is travelling at 90 kmph, when he observes a traffic light 250 m ahead of him turns red. The traffic light is timed to stay red for 12 sec. if the motorist wishes to pass the light without stopping, just as it turns green. Determine: (a) The required uniform deceleration of the motor and (b) the speed of the motor as it passes the traffic light May / June 2014

$$\text{Ans: } a = -0.6944 \text{ m/s}^2$$

$$v = 60 \text{ kmph}$$

### 10. State the principal of work and energy May / June 2014, Nov / Dec 2011

Principal of work and energy states that "The change in kinetic energy is equal to the total work done by the particle"

### 11. A stone is dropped from the top of a tower. It strikes the ground after four seconds. Find the height of the tower May / June 2014, Nov / Dec 2011

$$\text{Ans: Height } h = 78.48 \text{ m}$$

### 12. A car runs with an initial velocity of 30 m/s and uniform acceleration of $3 \text{ m/s}^2$ . Find its velocity after 5 seconds May / June 2013

Data given: Initial velocity  $u = 30 \text{ m/s}$

Final velocity  $v = u + at$

Acceleration  
Time

$$a = 3 \text{ m/s}^2$$
$$t = 5 \text{ sec}$$

$$v = 30 + (3 \times 5)$$
$$v = 45 \text{ m/s}$$

- 13. A car moves on a circular path of radius 25 m, with a uniform speed of 9 m/s. Determine the total acceleration on the car Nov / Dec 2012**

Data given: Radius of the curve  $r = 25 \text{ m}$   
Speed  $u = 9 \text{ m/s}$

Total acceleration

$$a = (u^2/r)$$
$$a = (9^2 / 25)$$
$$a = 3.24 \text{ m/s}^2$$

- 14. A body moves along a straight line so that its displacement from a fixed point on the line is given by  $s = 3t^2 + 2t$ . Find the velocity and acceleration at the end of 3 seconds. May / June 2012, 2010**

Ans: Velocity  $v = 20 \text{ m/s}$ , Acceleration  $a = 6 \text{ m/s}^2$

- 15. A particle of mass 10 kg falls vertically from a height of 100 m from ground. What Is the change in potential energy when it has reached a height of 50 m May / June 2012, 2010**

Ans: PE at height 100 m  $h_1 = 9810 \text{ J}$ , PE at height 50 m  $h_2 = 4905 \text{ J}$

- 16. What is linear momentum? Nov / Dec 2010**

Linear momentum of a particle is defined as the product of mass of a particle and its velocity.

Mathematically Momentum = mass x velocity

SI unit for momentum is kg m/s.

- 17. Explain the difference between kinematics and kinetics Nov / Dec 2009**

- Kinematics is the study of motion of a body or of a particle without considering the forces causing the motion of it
- Kinetics is the study of motion of a body or of a particle by considering the forces causing the motion.

- 18. A train running at 80 km/h is brought to a standing halt after 50 seconds. Find the retardation and the distance travelled by the train before it comes to a halt. Nov / Dec 2009**

Data given: Initial velocity  $u = 80 \text{ km/h} = 22.22 \text{ m/s}$

Final velocity:  $v = 0$

Time: 50 sec

Solution:

$$v = u + at$$
$$0 = 22.22 + a(50)$$
$$a = -0.44 \text{ m/s}^2$$
$$v^2 = u^2 + 2aS$$
$$0 = (22.22)^2 + (2 \times (-0.44) \times S)$$
$$S = 561 \text{ m}$$

- 19. State Newton's law concerning equilibrium of particle. May / June 2009**

Everybody continues in its state of rest or uniform motion in a straight line, unless it is compelled by some external force to change that state.

- 20. What do you mean by impact of elastic bodies? May / June 2009**

The phenomenon of collision of two bodies occurs in a very small interval of time and during which the two bodies exert a very large force and each other is called an impact.

- 21. The angular rotation of an accelerated disc is given by  $\theta = (9/32)t^3 + (3/4)t^2 + 6t$  radians. Find its angular acceleration when  $t = 2 \text{ sec}$ . Nov / Dec 2010**

Ans: Angular acceleration =  $4.875 \text{ rad / sec}$

- 22. A point P moves along a straight line according to the equation  $x = 4t^3 - 2t - 5$ , where x is in meters, t is in seconds. Determine the velocity and acceleration when  $t = 3 \text{ sec}$**

Ans: Velocity @ 3s =  $106 \text{ m/s}$ , Acceleration @ 3s =  $72 \text{ m/s}^2$



## **QUESTION BANK**

### **ME 3351 ENGINEERING MECHANICS**

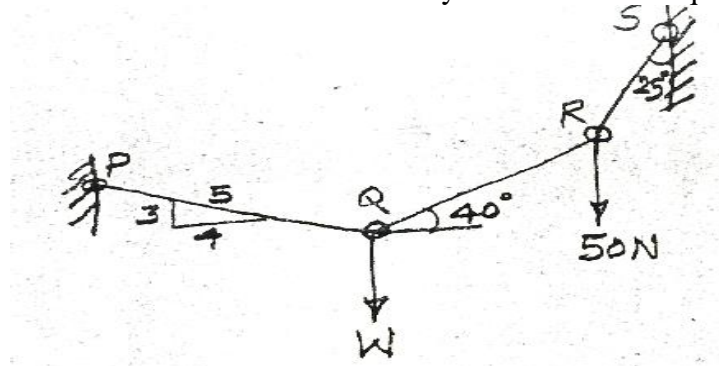
**(R 2021)**

**Class: II Year – Civil & Mechanical Engineering**

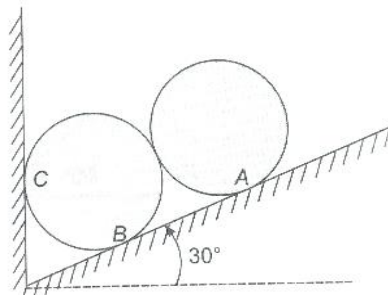
#### **PART B**

## UNIT – I

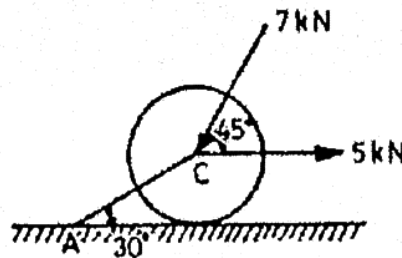
- Three links PQ, QR and RS connected as shown in fig. support loads W and 50 N. Find the weight W and the force in each link if the system remains in equilibrium.



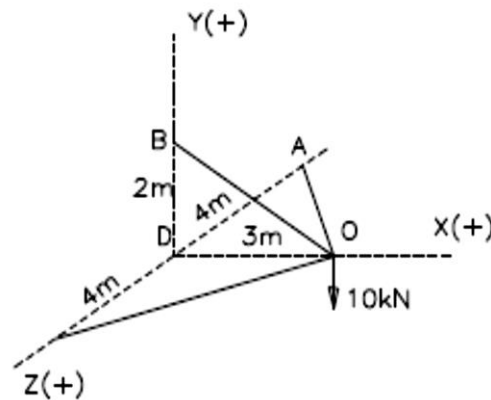
- Two identical rollers each of weight 65N are supported by an inclined plane and a vertical wall as shown in fig. Find the reactions at the points of supports A, B, C and between the spheres. Assume all the surfaces are smooth.



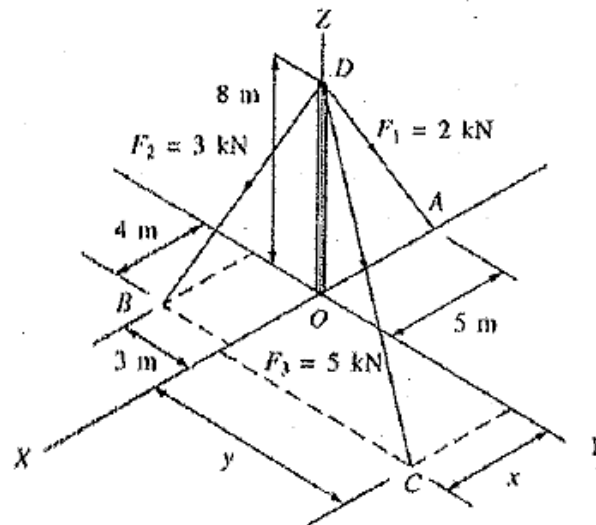
- A roller of weight 10 kN rests on a smooth horizontal floor and is connected to the floor by the bar AC as shown in fig. Determine the force in the bar AC and reaction from floor, if the roller is subjected to a horizontal force of 5kN and an inclined force of 7kN as shown in fig.



- Members OA, OB and OC form a three-member space truss. A weight of 10 KN is suspended at the joint 'O' as shown in fig. Determine the magnitude and nature of forces in each of the three members of the truss.

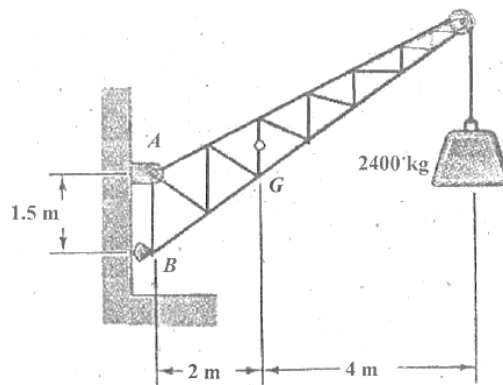


5. A pole is held in place by three cables. If the force of each cable acting on the pole is shown, determine the position  $(x, y, 0)$  for fixing cable DC so that the resultant force exerted on the pole is directed along its axis.

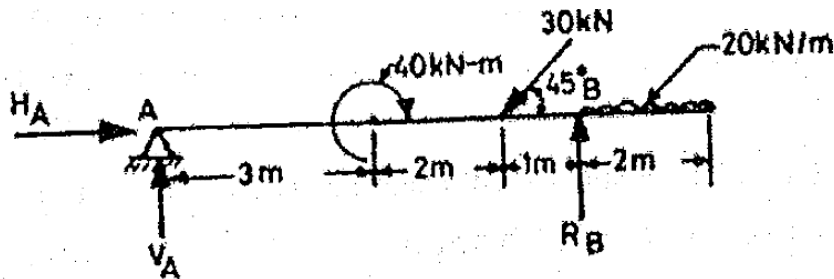


## UNIT – II

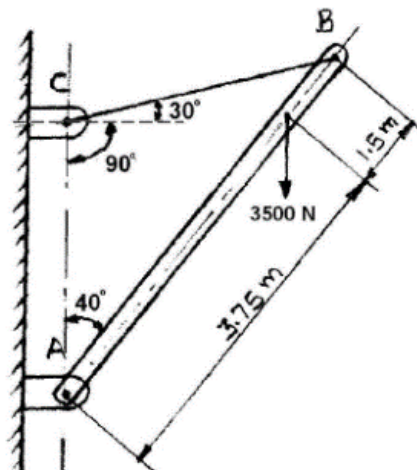
6. A fixed crane has a mass of 1000 kg and it is used to lift a 2400 kg weight. It is held in place by a pin at A and rocker at B. The centre of gravity of the crane is located at G. Determine the components of reaction at A and B.



7. Determine the reactions at A and B of the over-hanging beam shown in fig.

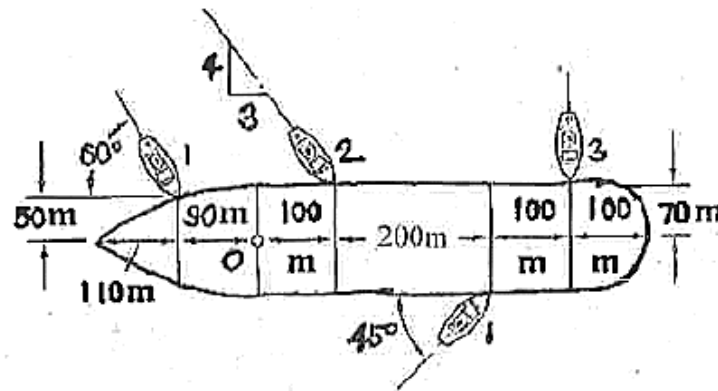


8. Determine the tension in cable BC and reaction at A as shown in fig. Neglect the self-weight AB

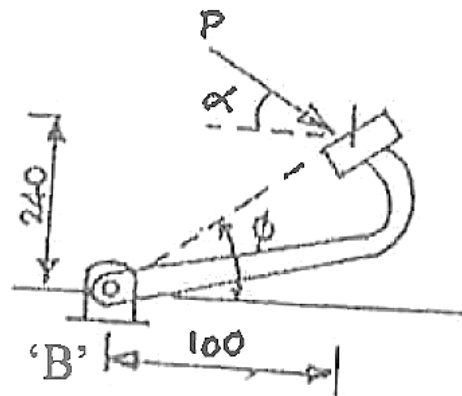


9. Four tug boats are used to bring a large ship to its pier. Each tug boat exerts a 5000 N force in the direction as shown in fig. Determine the equivalent force-couple system at point 'O' and the point on hull where a single more powerful tug boat should push to produce the same effect as the original four tugboats.



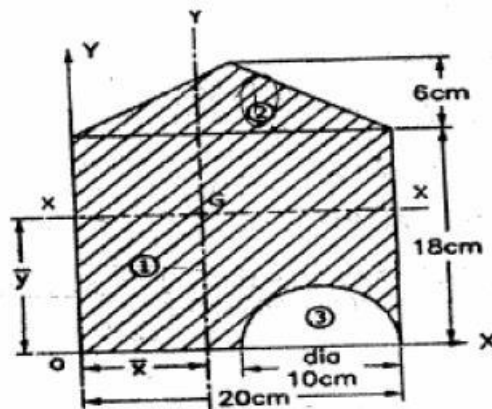


10. For the brake pedal shown in fig, determine the magnitude and direction of the smallest force  $P$  which has a 104 Nm clockwise moment about B.

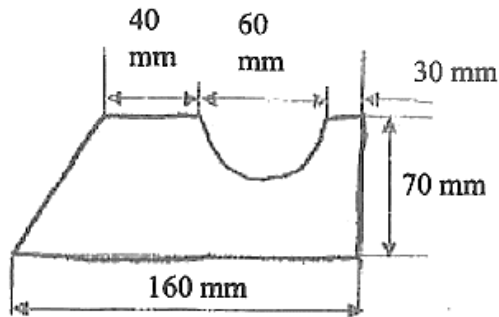


## UNIT – III

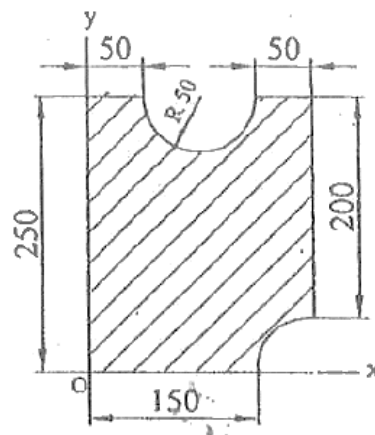
11. Determine the centroid of the lamina as shown in fig



12. Find the MI of an I section about centroidal axes. Top flange: 150mm×15mm, Web: 200mm×10mm, Bottom flange: 300mm×15mm.
13. Find the moment of inertia of the centroidal axes for the section shown in fig.

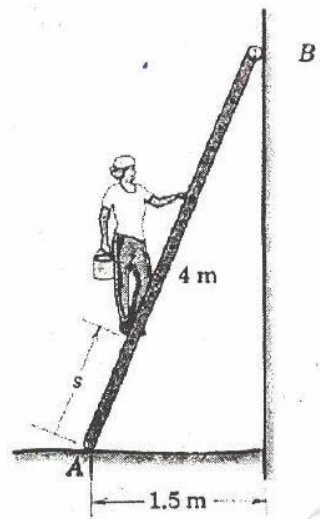


14. Determine the location of centroid for the right-angle triangle from the first principles and find the volume of cone using Pappus-Guldinus theorem.
15. Locate the centroid of the shaded area shown in fig. The dimensions are in mm.

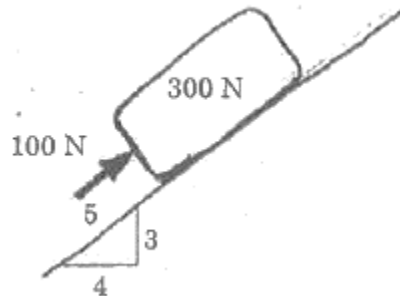


## UNIT – IV

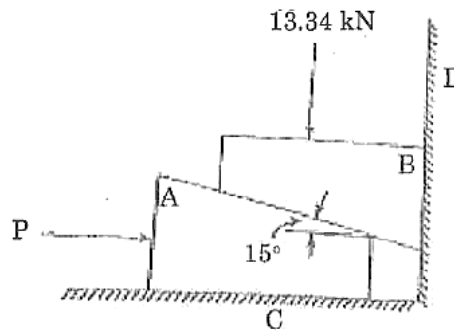
16. Determine the distance  $s$  to which the 90 kg painter can climb without causing the 4 m ladder to slip at its lower end A as shown in fig.. The top of ladder has a small roller, and at the ground the coefficient of static friction is 0.25. The mass center of the painter is directly above her feet



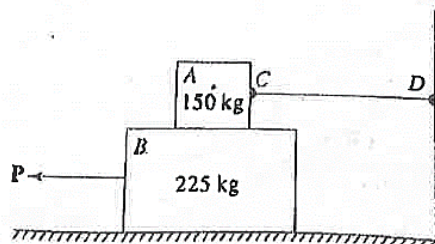
17. A 100 N force acts on a 300 N block placed on an inclined plane as shown in fig. The Coefficients of friction between the block and the plane are  $\mu_s = 0.25$  and  $\mu_k = 0.20$ . Determine whether the block is in equilibrium, and find the value of the friction force.



18. Determine the smallest force  $P$  required to lift the 13.34 kN load shown in fig. The coefficient of static friction between A and C and B and D is 0.3 and that between A and B is 0.4.

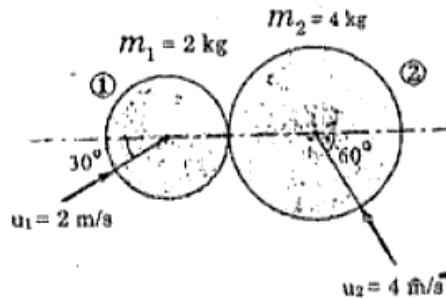


19. A ladder 5 m long rests on a horizontal ground and leans against a smooth vertical wall at an angle  $70^\circ$  with the horizontal. The weight of the ladder is 900 N and acts at the middle. The ladder is at the point of sliding, when a man is weighing 750 N stands on a rung 1.5 m from the bottom of the ladder. Calculate the coefficient of friction between the ladder and the floor.
20. Determine the smallest force  $P$  required to move the block B if (a) block A is restrained by cable CD as shown in fig. (b) Cable CD removed. Take the coefficients of frictions as  $\mu_s = 0.3$  and  $\mu_k = 0.25$  between all the surfaces of contact.



## UNIT – V

21. A steel ball of weight 60N is dropped onto a spring of stiffness 500 N/m from a height of 100 mm. Find the maximum deflection of the spring (Use the work-energy principle)
22. Two stones A and B are projected from the same point at inclinations of  $15^\circ$  and  $30^\circ$  respectively to the horizontal. Find the ratio of the velocities of projection of A and B if the maximum height reached by them is the same.
23. Two smooth spheres 1 and 2 having a mass of 2 kg and 4 kg respectively collide with initial velocities as shown in fig. If the coefficient of restitution for the spheres is  $e=0.8$ , determine the velocities of each sphere after collision.



24. A block of mass 8 kg is dragged up an inclined plane by a rope inclined at  $15^\circ$  to the plane while the plane is inclined at  $30^\circ$  to the horizontal. Find the velocity of the block after 4 seconds if dragged from rest. Take the coefficient of kinetic friction between the block and the plane as 0.2. Also assume that a force of 100 N is applied through the rope for dragging the block upwards the plane. Apply impulse momentum method.
25. Two blocks A and B of masses  $m_A = 280$  kg and  $m_B = 420$  kg are joined by an inextensible cable as shown in fig. Assume that the pulley is frictionless and  $\mu = 0.30$  between block A and the surface. The System is initially at rest. Determine (i) acceleration of block A (ii) velocity after it has moved 3.5 m and (iii) velocity after 1.5 sec.

