Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2017

EN2ES02 Engineering Mechanics

Programme: Diploma Branch/Specialisation: All

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. A body is in equilibrium, lines of action of all the forces passing through a single point. **1**

(a) Concurrent (b) Non-concurrent

(c) Parallel (d) None of these

ii. A beam is freely rest on the two end support is known as **1**

(a) Simply supported beam (b) Fixed beam

(c) Over hanging beam (d) Cantilever beam

iii. Kinetic energy of a particle is: **1**

(a) $^3/_2\ mv^2$ (b) mv (c) $\frac{1}{2}\ mv^2$ (d) mv^2

iv. Unit of power is **1**

(a) Watt/s (b) J/s (c) N/s (d) m/s

v. The point at which the entire weight of an object is assumed to be acting is called **1**

(a) Centroid (b) Center of gravity

(c) Median (d) Moment of inertia

vi. Moment of inertia of an area is minimum about an axis. **1**

(a) Passing through top face (b) Passing through bottom face

(c) Passing through centroid (d) None of these

vii. Unit of impulse. **1**

(a) Kg-m (b) Kg-s (c) N/s (d) Kg-m/s

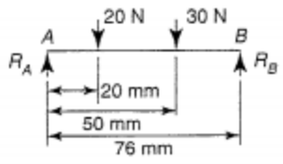
viii. In an inelastic collision ..... is conserved and .....is not conserved. **1**

(a) Energy, momentum (b) Energy, impulse

(c) Momentum, energy (d) Impulse, energy

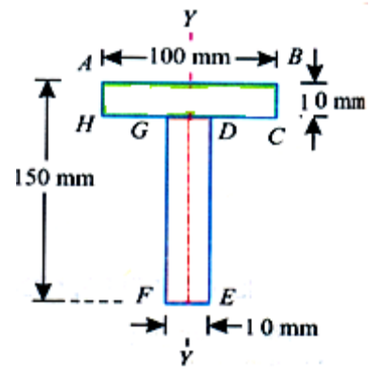
P.T.O.

	ix.	The coefficient of static force is always ..... coefficient of dynamic friction (a) Equal (b) More than (c) Less than (d) Insufficient data	**1**
	x.	In the case of belt friction, relationship between tension on tight side (T_2) and slack side (T_1) is (a) $T_1 = T_2\,\mu\theta$ (b) $T_2 = T_1\mu\theta$ (c) $T_1 = T_2\,e^{\mu\theta}$ (d) $T_2 = T_1\,e^{\mu\theta}$	**1**
Q.2	i.	Define Lami's theorem?	**2**
	ii.	Define law of parallelogram of forces with diagram. Write expression of resultant of forces?	**3**
	iii.	Write short note on (a) Polygon law of forces (b) Varignon's theorem	**5**
OR	iv.	Determine the values of the forces acting at A and B for the force system shown below?	**5**



Q.3	i.	Define Potential and Kinetic energy with example.	**2**
	ii.	Define Indicated power, Brake Power and Efficiency.	**3**
	iii.	Derive an expression for any two equation of motion.	**5**
OR	iv.	A body of mass 2.5 Kg is moving with a constant velocity of 5 m/s. In order to bring it to rest at a distance of 4m. Calculate the work done and force required?	**5**
Q.4	i.	Difference between centroid and center of gravity.[Any two]	**2**
	ii.	State and prove parallel axis theorem.	**3**
	iii.	Write formula of coordinate of centroid for given geometrical shape. (a) Rectangle (b) Triangle (c) Circle (d) Semi-Circle (e) Quarter-Circle	**5**

OR	iv.	Find the centroid of a 100mmX 150mm X 10mmT-section.	**5**



Q.5	i.	What is law of conservation of momentum?	**2**
	ii.	Define coefficient of restitution force, and its value for elastic and plastic collision.	**3**
	iii.	Drive an expression for elastic collision of two balls moving along a straight line.	**5**
OR	iv	A 10 kg mass travelling 2 m/s meets and collides elastically with a 2 kg mass travelling 4 m/s in the opposite direction. Find the final velocities of both objects.	**5**
Q.6	i.	Define angle of repose with diagram?	**2**
	ii.	Write any three applications of static and dynamic friction.	**3**
	iii.	Give any five differences between open and cross belt drive.	**5**
OR	iv.	A body of weight 100 Newtons is placed on a rough horizontal plan. Determine the co-efficient of friction if a horizontal force of 60 Newtons just causes the body to slide over the horizontal plane. And also write coefficient of friction depends on which factor.	**5**

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EN2ES02 Engineering Mechanics

Marking Scheme

Q.1 i. A body is in equilibrium, lines of action of all the forces passing through a single point. **1**
(a) concurrent

ii. A beam is freely rest on the two end support is known as **1**
(a) simply supported beam

iii. Kinetic energy of a particle is: **1**
(c) ½ mv^2

iv. Unit of power is **1**
(b) J/s

v. The point at which the entire weight of an object is assumed to be acting is called **1**
(b) center of gravity

vi. Moment of inertia of an area is minimum about an axis. **1**
(c) passing through centroid

vii. Unit of impulse. **1**
(d) Kg-m/s

viii. In as inelastic collision ..... is conserved and .....is not conserved. **1**
(c) momentum, energy

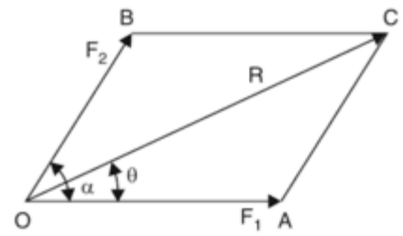
ix. The coefficient of static force is always ..... coefficient of dynamic friction **1**
(b) more than

x. In the case of belt friction, relationship between tension on tight side(T_2) and slack side (T_1)is . **1**
(d) $T_2 = T_1 e^{\mu\theta}$

Q.2 i. Lami's theorem **2**

ii. Law of parallelogram of forces with diagram
Expression of resultant of forces

Ans This law is used to determine the resultant of two coplanar forces acting on a point. **1**
It states that, *if two forces acting on a point be represented in magnitude and direction by the two adjacent sides of a parallelogram, then their resultant is represented in magnitude and direction by the diagonal of the parallelogram passing through that point.*

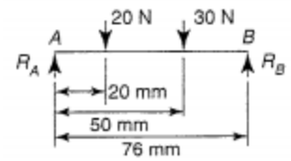


1

$$R = \sqrt{F_1^2 + F_2^2 + 2F_1 F_2 \cos\alpha}$$ **1**

iii. Write short note on: [**2.5 Each]** **5**
(a) Polygon law of forces
(c) Varignon's theorem

iv. Determine the values of the forces acting at A and B for the force system shown below?



Ans

At equilibrium, $R_A + R_B = 20 + 30 = 50$ N **1**

Taking moments about point A gives:

clockwise moment = anticlockwise moment **1**

Hence, $20 \times 20 + 30 \times 50 = R_B \times 76$

i.e. $400 + 1500 = 76\, R_B$ **1**

from which, force acting at B, $\mathbf{R_B = \frac{1900}{76} = 25\ N}$ **1**

From equation (1), $R_A + 25 = 50$

from which, $\mathbf{R_A = 50 - 25 = 25\ N}$ **1**

Q.3 i. Define Potential **1**

Kinetic energy. **1**

ii. Define Indicated power **1**

Brake Power **1**

Efficiency. **1**

iii. Derive an expression of equation of motion. [**2.5** Each] **5**

OR iv A body of mass 2.5 Kg is moving with a constant velocity of 5 m/s. In order to bring it to rest at a distance of 4m. Calculate the work done and force required?

Ans W.D = change of kinetic energy **1**

= ½ mv2

= 1/2x2.5x5x5 **1**

W.D = 31.25 J Ans **1**

Force = W.D/Displacement

= 31.25/4 **1**

Force =7.8125 N Ans **1**

Q.4 i. Difference between centroid and center of gravity.[Any two] **2**

ii. State and **1**

Prove parallel axis theorem. **2**

iii. Write formula of coordinate of centroid for given geometrical shape.

A Rectangle **1**

B Triangle **1**

C Circle **1**

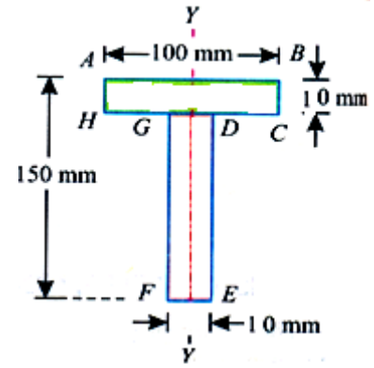
D Semi-Circle **1**

E Quarter-Circle **1**

Ans

S.No.	Shape	$\bar{x}$	$\bar{y}$
1.	Rectangle	$\frac{b}{2}$	$\frac{h}{2}$
2.	Triangle (a)	$\frac{b}{3}$	$\frac{h}{3}$
3.	Circle	$\frac{d}{2}$	$\frac{d}{2}$
4.	Semi-circle	$\frac{d}{2}$	$\frac{4r}{3\pi}$
5.	Quadrant circle	0.3 r	$\frac{4r}{3\pi}$

OR iv Find the centroid of a 100mmX 150mm X 10mmT-section.



Ans Taking base X-X axis as reference line.

Dividing the "T" section in to two rectangles areas. (flange +web)

Area of rectangles flange $A_1 = 100x10 = 1000\ mm^2$ **1**

$y_1 = 140 + \frac{10}{2} = 145$ mm from the bottom of the base **1**

Area of rectangle web (2) $A_2 = 140x10 = 1400\ mm^2$

$y_2 = \frac{140}{2} = 70$ mm from the bottom of the web X.X axis

distance of centroid from bottom of web XX i. e.,

$$\bar{y} = \frac{A_1 y_1 + A_2 y_2}{A_1 + A_2} = \frac{1000 \times 145 + 1400 \times 70}{1000 + 1400}$$

$$\frac{98000 + 145000}{2400} = 101.25\text{mm}$$

1

$\bar{X} = 50$ mm

1

$\bar{y}$ 101.25mm

Ans

Q.5 i. What is law of conservation of momentum? **2**

ii. Define coefficient of restitution force, and its value for elastic and plastic collision.

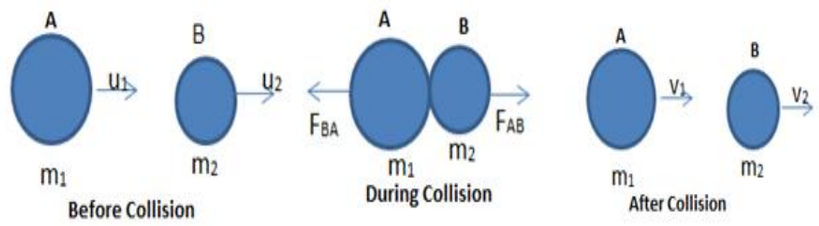
$$\text{Coefficient of restitution } (e) = \frac{\text{Relative velocity after collision}}{\text{Relative velocity before collision}}$$

1

1 would be a perfectly **elastic collision**. **1**
O would be a perfectly **Plastic collision**. **1**

iii. Drive an expression for elastic collision of two balls moving along a straight line.

Ans The simplest type of elastic collision i.e. collision of two balls moving along a straight line. This is called collision in one dimension.



1

Consider that ball A of mass m_1 moving with velocity v_1 collides with another ball B of mass m_2 moving with velocity v_2. Conservation of momentum gives,

$m_1v_1 + mv2 = m_1v_1' + m_2v_2'$ **1**

Conservation of K.E. gives

$1/2\ m_1v_1^2 + 1/2\ m_1v_1^2 + 1/2\ m_2v_2'^2$ **1**

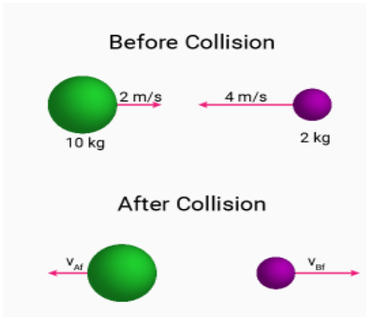
If we solve both equations, we get

$v_1' = (m_1-m_2)/(m_1+m_2)\ v_1 + 2m_2/(m_1+m_2)\ v_2$ **1**

$v'_2 = 2m_2/(m_1+m_2)\ v_1 + (m_1-m_2)/(m_1+m_2)\ v_2$ **1**

Bodies will move with different velocities and hence will have different kinetic energy after collision.

Q.5 iv Ans



1

m_A = 10 kg

V_{Ai} 2 m/s

m_B = 2 kg

V_{Bi} = −4 m/s. The negative sign is because the velocity is in the negative

Now we need to find V_{Af} and V_{Bf}. Use the equations from above. Let's s

V_{Af}.

$$V_{Af} = \frac{m_A - m_B}{m_A + m_B} V_{Ai} + \frac{2m_B}{m_A + m_B} V_{Bi}$$

Plug in our known values.

$$V_{Af} = \frac{(10 - 2)\text{kg}}{(10 + 2)\text{kg}} \cdot (2\ \text{m/s}) + \frac{2(2\ \text{kg})}{(10 + 2)\text{kg}} \cdot (-4\ \text{m/s})$$

1

$$V_{Af} = \frac{8}{12} \cdot (2\ m/s) + \frac{4}{12} \cdot (-4\ m/s)$$

$$V_{Af} = \frac{16}{12}\ m/s + \frac{-16}{12}\ m/s$$

$$V_{Af} = 0\ m/s$$

The final velocity of the larger mass is zero. The collision completely sto mass. **1**

Now for V_{Bf}

$$V_{Bf} = \frac{2m_A}{(m_A + m_B)} V_{AI} + \frac{(m_B - m_A)}{(m_A + m_B)} V_{BI}$$

$$V_{Bf} = \frac{2(10\ kg)}{(10 + 2)\ kg} \cdot 2\ m/s + \frac{(2 - 10)\ kg}{(10 + 2)\ kg} \cdot -4\ m/s$$

$$V_{Bf} = \frac{20\ kg}{12\ kg} \cdot 2\ m/s + \frac{-8\ kg}{12\ kg} \cdot -4\ m/s$$

$$V_{Bf} = \frac{40}{12}\ m/s + \frac{32}{12}\ m/s$$

$$V_{Bf} = \frac{72}{12}\ m/s$$

$$V_{Bf} = 6\ m/s$$

1

Q.6 i. Define angle of repose **1**

with diagram? **1**

ii. Write application of static and dynamic friction. [Any three] **3**

iii. Difference between open and cross belt drive.[Any five] **5**

iv. A body of weight 100 Newtons is placed on a rough horizontal plan. Determine the co-efficient of friction if a horizontal force of 60 Newtons just causes the body to slide over the horizontal plane.

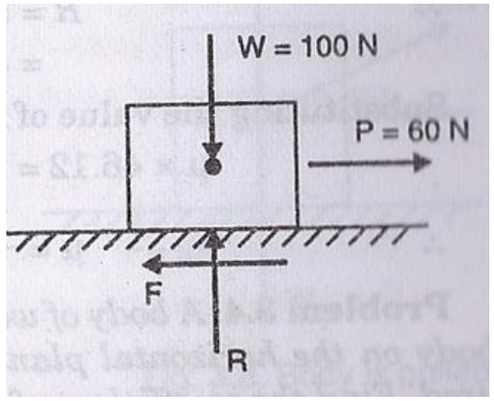
Ans

Weight of body, W = 100 N

Horizontal force applied,

P = 60N

∴ Limiting force of friction,



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F = P = 60N **1**

Let μ = Co-efficient of friction.

The normal reaction of the body is given as

R = W= 100 N **1**

Using equation (3.1),

F = μR **1**

or $\mu = \frac{F}{R} = \frac{60}{100} = \mathbf{0.6\ Ans.}$

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