ENGINEERING MECHANICS
(MECH 2101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Which of the following vector is perpendicular to the vector 3i+2j-k.
(a) 2i+7j-3k (b) -6i+7j-4k
(c) 5i-9j+7k (d) -6i-2j-8k.

(ii) The centroidal axis Xc-Xc and base axis x-x for a plane area A are separated by distance r. Then according to parallel axis theorem:
(a) $I_x I_{Xc} = Ar^2$ (b) $I_{Xc} / I_x = Ar^2$
(c) $I_x = I_{Xc} + Ar^2$ (d) $I_x + I_{Xc} = Ar^2$.

(iii) For stable equilibrium the potential energy will be
(a) maximum (b) minimum
(c) zero (d) equal to kinetic energy.

(iv) Three forces $\sqrt{3}p, p$ and $2p$ acting on a particle are in equilibrium. If the angle between first and second be 90°, the angle between second and third will be
(a) 30° (b) 60° (c) 120° (d) 150°.

(v) A man stands on a spring weighing scale in a lift which carries him upwards with acceleration. The reading on the weighing scale will be
(a) true weight of the man
(b) lower than the true weight
(c) greater than the true weight
(d) zero.

(vi) The centre of gravity of solid hemisphere of radius R from its base is
(a) 3R/8 (b) R/2 (c) 3R/4 (d) 2R.

(vii) Moment of inertia of a triangle of base b and height h about the centroidal axis parallel to base is
(a) $\frac{bh^3}{36}$ (b) $\frac{bh^3}{12}$ (c) $\frac{bh^3}{3}$ (d) $\frac{bh^3}{4}$.

(viii) When a bullet is fired from a gun, it is recoiled in the backward direction. It is due to
(a) impulse (b) inertia
(c) conservation of momentum (d) both (a) &(b).

(ix) Equation of motion of a particle is $s = 2t^3 - t^2 - 2$, where s is displacement in meters and t is time in second. Acceleration of the particle after 1 second will be
(a) 8 m/s^2 (b) 9m/s^2
(c) 10 m/s^2 (d) 5 m/s^2.

(x) The equation of a projectile is $y = \sqrt{3}\,x - \frac{1}{2}gx^2$, the angle of projection is given by
(a) $\tan\theta = 1/\sqrt{3}$ (b) $\tan\theta = \sqrt{3}$ (c) 60° (d)0.

Group – B

2. (a) Explain equivalent vectors.

(b) The line of action of the 500 N force runs through the points A(–7, –2) and B(8, 6). Find scalar components of force $\vec{F}$ along 'x' and 'y' direction.

(c) A force given by $\vec{F} = 3\vec{i} + 2\vec{j} - 4\vec{k}$ is applied at the point $P\ (1, -1, 2)$. Find the magnitude of moment of the force F about the point $A\ (2, -1, 3)$.

2 + 4 + 6=12

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2 + 4 + 6=12

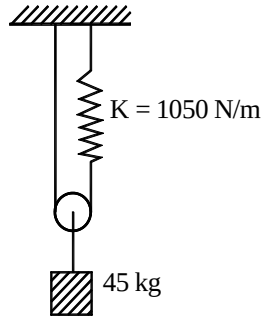

Fig. 12

6 + 6 = 12

3. (a) Explain the law of transmissibility of force.

(b) Using vector method, find the perpendicular distance from the point A(1, 2, 3) to the line joining the origin O and the point B (2, 10, 5).

(c) In the following Fig.1, F = 500N acts along AB where, O (0, 0, 0), A (0,10, 0) and B (5, 0, 4). Calculate the moment of force $\vec{F}$ about O. All space co-ordinates have units in meters.

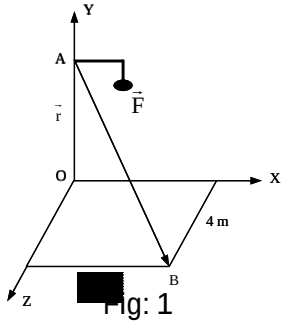

Fig: 1

2+ 4+ 6=12

Group – C

4. (a) Two cylinder P and Q rest in a channel as shown in Fig. 2. The cylinder P has diameter of 100 mm and weighs 200N, whereas the cylinder Q has diameter of 180 mm and weighs 500N. If the bottom width of the channel is 180mm and with one side vertical and the other inclined at 60°, determine the reactions at four points of contact.

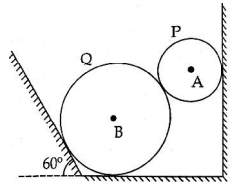

Fig. 2

(b) An electric-light fixture of weight Q = 200 N is supported as shown in Fig. 3. Determine the tensile forces T_1 and T_2 in the wires BA and BC if their angles of inclination are as shown.

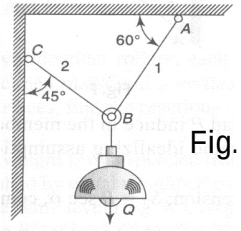

Fig. 3

6 + 6=12

the height, horizontal distance and the time with respect to firing P at which the destruction takes place.

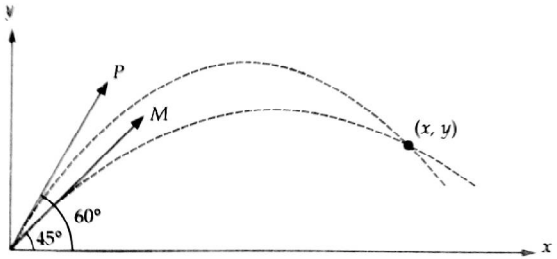

Fig. 10

6 + 6=12

9. (a) Find the tension S in the string during motion of the system shown in Fig.11 if W_1 = 200 N and W_2 = 100 N. The system is in a vertical plane, and the coefficient of friction between the inclined plane and the block W_1 is μ= 0.2. Assume the pulleys to be without mass.

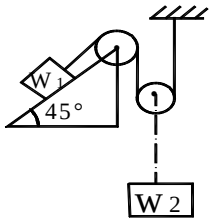

Fig. 11

(b) The system (shown in Fig. 12) is released from rest with the spring initially stretched 75 mm. Calculate the velocity V of the cylinder after it has dropped 12 mm. The spring has a stiffness of 1050 N/m. Neglect the mass of the small pulley.

5. (a) Determine the tension in the tie rod AC=300mm when a circular roller of weight Q=450N and radius r=150mm is rest against a vertical wall at B as shown in Fig. 4.

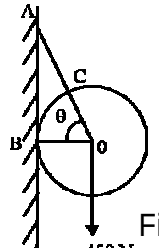

Fig. 4

(b) The uniform 15 m pole has a mass of 150 Kg and is supported by its smooth ends against the vertical walls and by the tension T in the vertical cable. Compute the reactions at A and B. System has been represented in the following figure (Fig. 5).

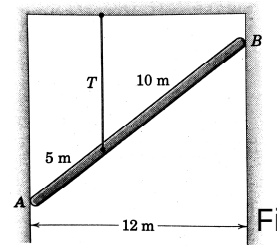

Fig. 5

6 + 6=12

Group – D

6. (a) Two rectangular blocks of weights W_1 and W_2 are connected by a flexible cord and rest upon a horizontal and an inclined plane, respectively, with the cord passing over a pulley as shown in Fig.6. In the particular case where $W_1 = W_2$ and the coefficient of static friction μ is the same for all contiguous surfaces, then find the angle α of inclination of the inclined plane at which motion of the system will impend. Neglect friction in the pulley.

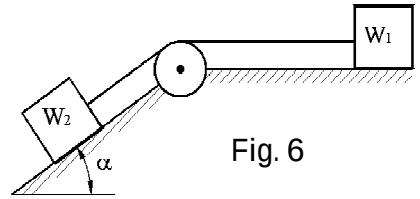

Fig. 6

(b) A block, in the shape of a rectangular prism rests on a rough inclined plane, as shown in Fig.7. The block is tied up by a horizontal string which has a tension of 10N. If the block weighs 35N, determine i) the frictional force on the block ii)

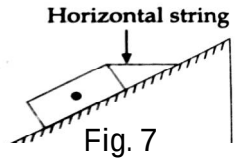

Fig. 7

coefficient of friction between contacting surfaces.

6 + 6=12

7. (a) Locate both the co-ordinates of centroid of the area of the parabolic shaded portion shown in Fig. 8.

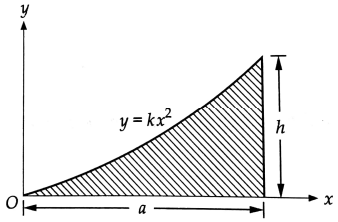

Fig. 8

(b) Find out the moment of inertia about centroidal x axis of an area as shown in Fig. 9.

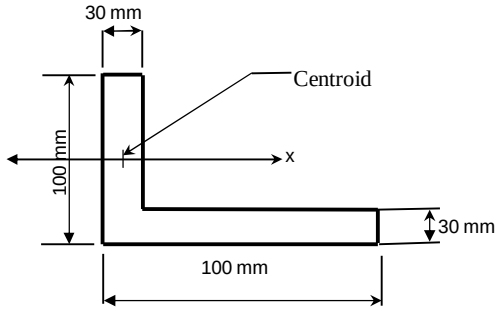

Fig. 9

6 + 6=12

Group – E

8. (a) The acceleration of a particle along a straight line is given by the equation $a = 4 - \frac{t^2}{9}$. If the particle starts with zero initial velocity from a position $x = 0$, find (i) its velocity after 6 sec and (ii) distance travelled in 8 sec.

(b) A projectile P is fired with a velocity of 200 m/s at an angle of 60^0 with the horizontal. After some time a missile M is shot from the same point to destroy the projectile. The angle of projection and the initial velocity for the missile are 45^0 and 2000 m/s respectively. Calculate