ENGINEERING MECHANICS
(MEC2101)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Weight of a body is a
(a) Bound vector (b) Free vector
(c) Sliding vector (d) Equivalent vector

(ii) Free body diagram can be applied only in
(a) Dynamic equilibrium problem (b) Static equilibrium problem
(c) Both dynamic and static equilibrium problems (d) None of these

(iii) A framed structure is perfect if it contains members equal to
(a) 2n-3 (b) n-1
(c) 2n-1 (d) n-2

(iv) In the method of virtual work, a diagram, which isolates the system under consideration is called
(a) Active force diagram (b) Free body diagram
(c) Both a and b (d) None of these

(v) The centroidal distance along an axis passing through the center and perpendicular to the base of a solid hemisphere of radius R is
(a) R/2 (b) 3R/8
(c) 3R/4 (d) None of these

(vi) Which option is not correct?
(a) Unit of non-uniform acceleration is m/s^2 (b) Unit of uniform acceleration is m/s^2
(c) Unit of average acceleration is m/s^2 (d) Unit of variable velocity is m^2/s

(vii) Two particles with masses in the ratio 1:4 are moving with equal kinetic energies. The magnitude of their linear momentums will conform to the ratio
(a) 1 : 8 (b) 1 : 2
(c) $\sqrt{2}$: 1 (d) 4 : 1

(viii) The tendency of rotation of the body along any axis is also called
(a) Moment of inertia (b) moment of couple
(c) Torque (d) Force

(ix) If two bodies, one light and the other heavy, have equal kinematic energy, which one has a greater linear momentum?
(a) The heavy body (b) The light body
(c) Both have equal momentum (d) Unpredictable

(x) A ball is rolling on the ground is an example of
(a) Sliding friction (b) Rolling friction
(c) Fluid friction (d) Both sliding and fluid friction

Fill in the blanks with the correct word

(xi) If two vectors have the same magnitude, same direction and same sense, then they are said to be _____ vectors.

(xii) If m = 2j –3, the structure will be statically _____.

(xiii) Dimension of impulse of a moment is _____.

(xiv) The unit of power in S.I. system is _____.

(xv) A force 5**k** N acts through point (0, 0, 0). Its moment about z axis is _____.

Group - B

2. (a) Determine the moment of the 500 N force which acts from point D to point E about point A as shown in the Fig.1 below using the concept of vector algebra.

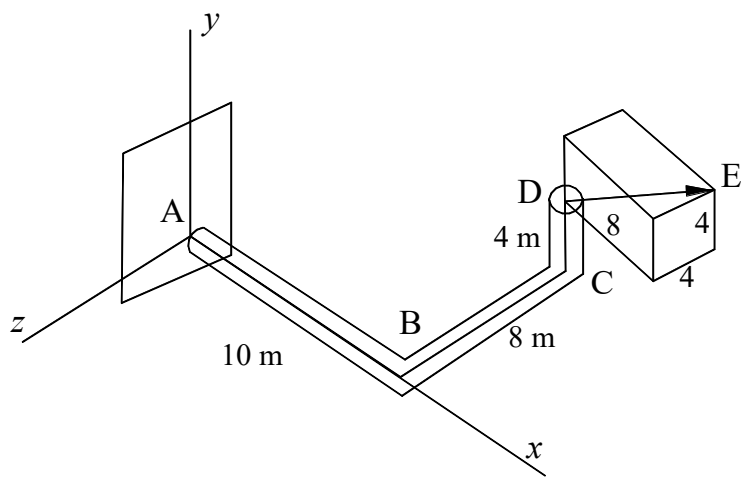

Fig. 1

[(CO2) (Understand/IOCQ)]

(b) Using vector method find the perpendicular distance from the point (2, 2, 3) to the line joining the origin and the point (3,10, 6).

[(CO2) (Understand /IOCQ)]

6 + 6 = 12

3. (a) The 300 N sphere is supported by pull P = 160 N and a weight of 200 N passing over a frictionless pulley as shown in Fig. 2. Determine the values of α and θ that maintain the equilibrium.

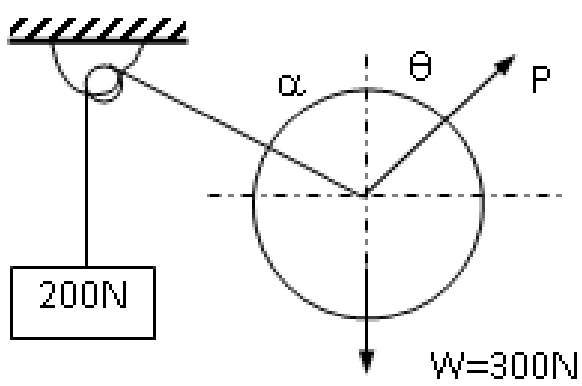

Fig. 2

[(CO3) (Apply/IOCQ)]

(b) A roller of radius 'r' and weight 'W' is to be rolled over a curb of height 'h' by a horizontal force 'P' applied to the end of a string wound around the circumference of the roller as shown in Fig.3. Find the magnitude of P required to start the roller over the curb. Assume that contact at B is frictionless, but there is sufficient friction between the roller surface and the edge of the curb to present slip at A. Given r = 2h.

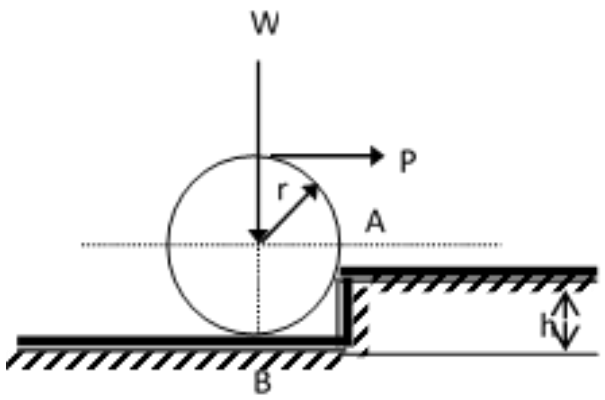

Fig. 3

[(CO3)(Apply/HOCQ)]

6 + 6 = 12

Group - C

4. (a) Explain coefficient of static friction and kinetic friction. *[(CO2)(Understand /LOCQ)]*

(b) A ladder of length 8 m weighing 600 N is placed against a vertical wall as shown in Fig. 4. The coefficient of friction between the wall and the ladder is 0.2 and between ladder and the floor is 0.25. The ladder, in addition to its own weight, has to support a man weighing 800 N at a distance of 6 m from A. Find the minimum horizontal force to be applied at A to prevent slipping.

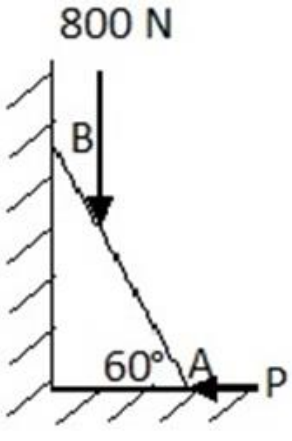

Fig. 4

[(CO3) (Apply/HOCQ)]

(2 + 2) + 8 = 12

5. (a) Refer to the Fig. 5 as shown below. Find the force R_D. The system is in equilibrium.

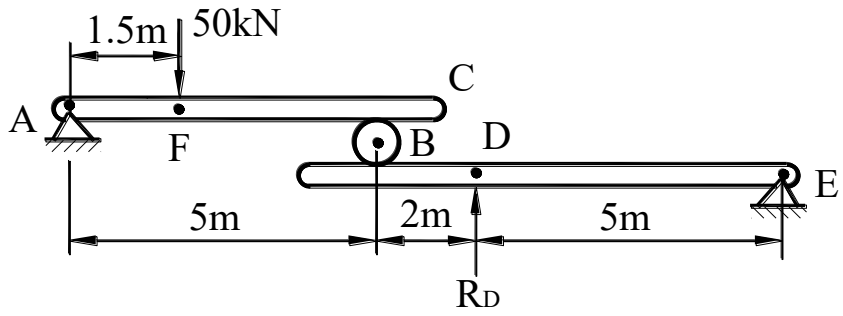

Fig. 5

[(CO3)(Apply/HOCQ)]

(b) Explain the principle of Virtual Work and write the advantages of Virtual Work method. *[(CO2)(Understand/LOCQ)]*

6 + 6 = 12

Group - D

6. (a) State and explain the parallel axis theorem of area moment of inertia. *[(CO1)(Remember/LOCQ)]*

(b) Determine the polar moment of inertia of the section shown in Fig. 6 about its centroidal axis.

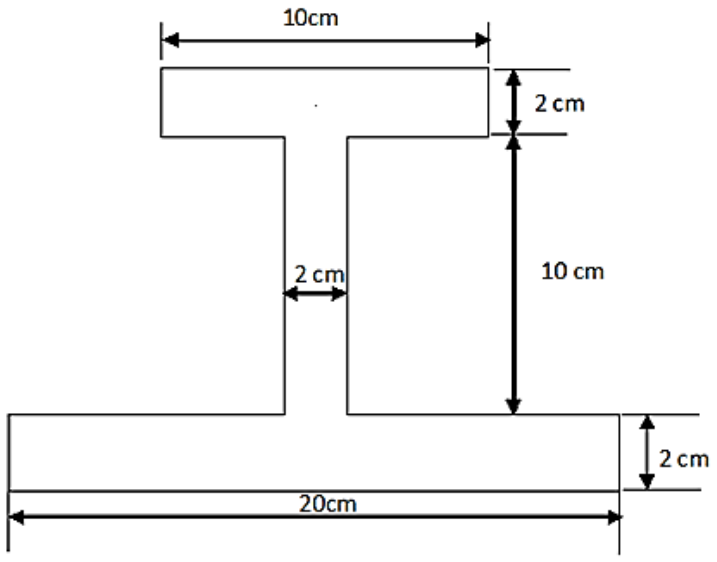

Fig. 6

[(CO5) (Analyse/HOCQ)]

4 + 8 = 12

7. (a) The car is travelling at a constant speed V_o = 100 km/hr on the level portion of the road as shown in Fig. 7. When the 6 percent ($\tan\theta=6/100$) incline is encountered, the driver does not change the throttle setting and consequently the car decelerates at the constant rate $g\sin\theta$. Determine the speed of the car (i) 10 seconds after passing point A and (ii) when S = 100m.

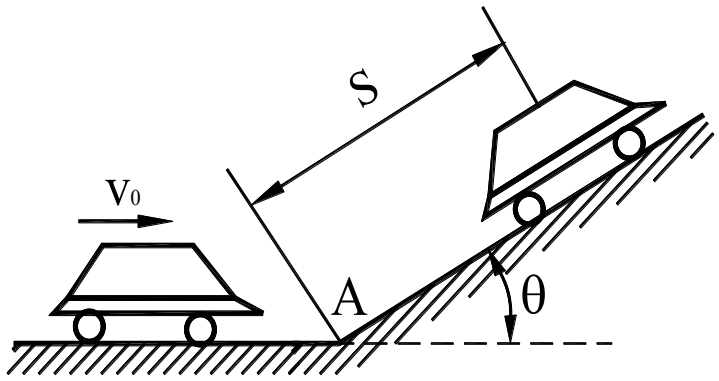

Fig. 7

[(CO4) (Apply/IOCQ)]

(b) A uniform lamina shown in Fig. 8 consists of a rectangle, a circle and a triangle. Determine the center of gravity of the lamina. All dimensions are in mm.

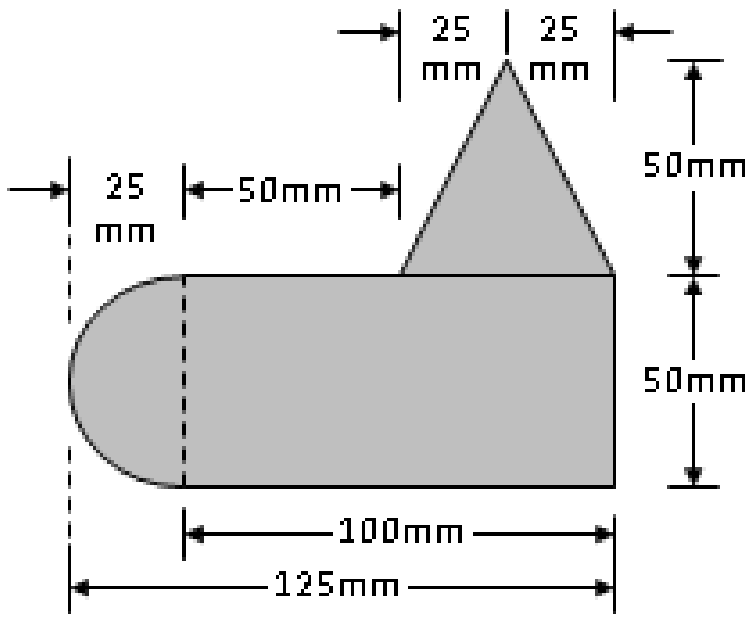

Fig. 8

[(CO5) (Analyse/IOCQ)]

6 + 6 = 12

Group - E

8. (a) The angular displacement of a point on a plate cam rotating about an axis is given by $\theta = 0.3t^2 + 1$ radians. Determine the angular velocity and angular acceleration of the point when t = 0 and t = 10 seconds. *[(CO6)(Analyse/IOCQ)]*

(b) Weight W and 2W are supported in a vertical plane by a string and pulleys arranged as shown in Fig.9. Find the magnitude of an additional weight Q applied on the left which will give a downward acceleration a = 0.1 g to the weight W. Neglect friction and inertia of pulleys.

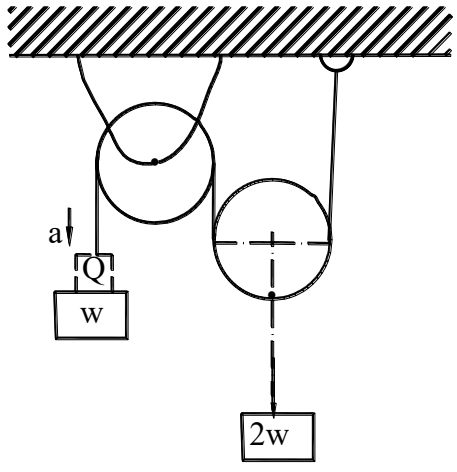

Fig. 9

(CO6)(Analyse /HOCQ)]

6 + 6 = 12

9. (a) Two blocks of weight 1 kgf and 2 kgf are connected by an inextensible cord which passes over a light frictionless pulley as shown in Fig. 10. If the weight 2 kgf falls with acceleration 'a', determine the acceleration 'a' and the tension in the cord.

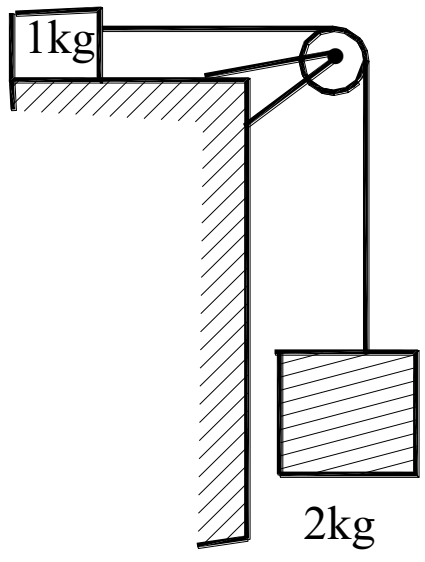

Fig. 10

(b) Prove that work done on motion between any two points is equal to the change in kinetic energy. *[(CO6)(Analyse/HOCQ)]* *[(CO6)(Analyse/IOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	14.6	43.8	41.6