Code : ESC–202 (100309)

B.Tech 3rd Semester Special Exam., 2020

(New Course)

ENGINEERING MECHANICS

Time : 3 hours　　　　　Full Marks : 70

Instructions :

(i) *The marks are indicated in the right-hand margin.*

(ii) *There are **NINE** questions in this paper.*

(iii) *Attempt **FIVE** questions in all.*

(iv) *Question No. **1** is compulsory.*

1. Choose the correct answer (any *seven*) :

　　　　　　　　　　　　　　　　　2×7=14

(a) The resultant of two forces P and Q acting at an angle θ is equal to

　(i) $\sqrt{(P^2 + Q^2 + 2PQ\sin\theta)}$

　(ii) $\sqrt{(P^2 + Q^2 + 2PQ\cos\theta)}$

　(iii) $\sqrt{(P^2 + Q^2 - 2PQ\sin\theta)}$

　(iv) $\sqrt{(P^2 + Q^2 - 2PQ\cos\theta)}$

(b) The moment of a force about any point is geometrically equal to _____ area of the triangle whose base is the line representing the force and vertex is the point about which the moment is taken.

　(i) half

　(ii) same

　(iii) twice

　(iv) None of the above

(c) A circular hole of radius (r) is cut out from a circular disc of radius (2r) in such a way that the diagonal of the hole is the radius of the disc. The centre of gravity of the section lies at

　(i) the centre of a disc

　(ii) the centre of the hole

　(iii) somewhere in the disc

　(iv) somewhere in the hole

(d) The moment of inertia of a triangular section of base (b) and height (h) about an axis passing through its vertex and parallel to the base is _____ as that passing through its CG and parallel to the base.

　(i) twelve times

　(ii) nine times

　(iii) six times

　(iv) four times

(e) Which of the following statements is correct?

(i) The force of friction does not depend upon the area of contact.

(ii) The magnitude of limiting friction bears a constant ratio to the normal reaction between the two surfaces.

(iii) The static friction is slightly less than the limiting friction.

(iv) All of the above

(f) The efficiency of a screw jack is maximum when the helix angle is equal to

(i) $45° + \dfrac{\phi}{2}$

(ii) $45° - \dfrac{\phi}{2}$

(iii) $\dfrac{\phi}{2} + 30°$

(iv) $\dfrac{\phi}{2} - 30°$

(g) The time of flight of a projectile on an upward inclined plane depends upon

(i) angle of projection

(ii) angle of inclination of the plane

(iii) Both (i) and (ii)

(iv) None of the above

(h) The relationship between linear velocity and angular velocity of a cycle

(i) exists under all conditions

(ii) does not exist under all conditions

(iii) exists only when it does not slip

(iv) exists only when it moves on horizontal plane

(i) The loss of kinetic energy due to direct impact of two bodies depends on

(i) the mass of two bodies

(ii) the initial velocities of two bodies

(iii) the final velocities of two bodies

(iv) Both (i) and (ii)

(j) In order to increase the acceleration of a mass rolling down on a rough inclined plane (without slipping), we have to

(i) increase the mass of the rolling body

(ii) increase the inclination of the plane

(iii) Both (i) and (ii)

(iv) None of the above

2. (a) What is meant by moment of a force? How will you explain it mathematically? 3

(b) State the Varignon's principle of moments. 3

(c) A force F of magnitude 50 N is exerted on the automobile parking-brake lever at the position $x = 250$ mm (Fig. 1). Replace the force by an equivalent force-couple system at the pivot point O. 8
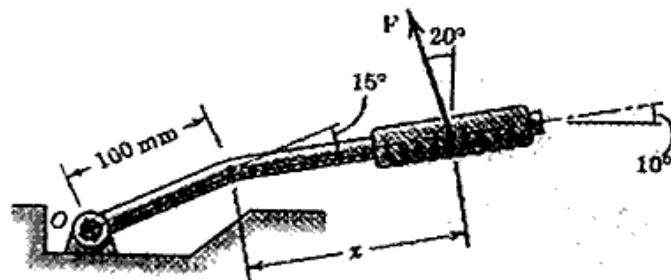

Fig. 1

3. (a) It is known that a force with a moment of 950 N-m about D is required to straighten the fence post CD (Fig. 2). If $d = 2.70$ m, determine the tension that must be developed in the cable of winch

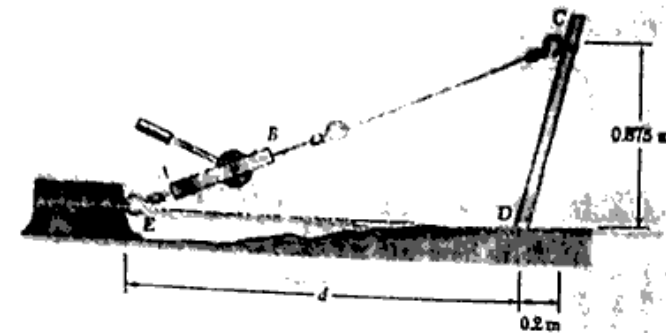puller AB to create the required moment about point D. 8

Fig. 2

(b) Describe the method of finding the line of action of the resultant of a system of parallel forces. 6

4. (a) Two cylinders P and Q rest in a channel as shown in Fig. 3. The cylinder P has diameter of 100 mm and weighs 200 N, whereas the cylinder Q has diameter of 180 mm and weighs 500 N. If the bottom width of the box is 180 mm, with one side vertical and the other inclined

at 60°, determine the pressures at all the four points of contact.   9
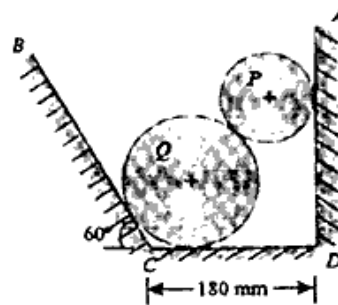

Fig. 3

(b) Show that if three coplanar forces, acting at a point be in equilibrium, then each force is proportional to the sine of the angle between the other two.   5

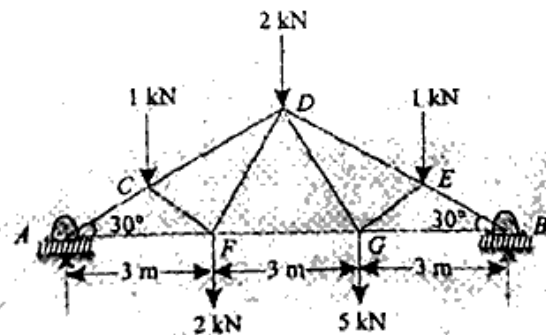5. (a) A truss of 9 m span is loaded as shown in Fig. 4. Find the reactions at the two supports.   8

Fig. 4

(b) State the laws of friction and explain the term angle of friction.   6

6. (a) A rectangular hole is made in a triangular section as shown in Fig. 5. Determine the moment of inertia of the section about X-X axis passing through its centre of gravity and the base BC.   9
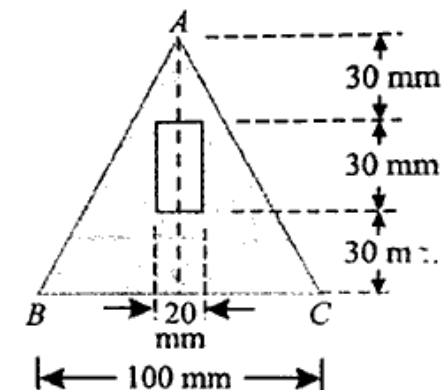

Fig. 5

(b) Prove the parallel axis theorem in the determination of moment of inertia of areas with the help of a neat sketch.   5

7. (a) A body of weight 50 N is hauled along a rough horizontal plane by a pull of 18 N acting at an angle of 14° with the horizontal. Find the coefficient of friction.   0·38   7

(b) Explain the application of the principle of virtual work in case of lifting machines. 7

8. *(a)* The equation of motion of an engine is given by $s = 2t^3 - 6t^2 - 5$, where s is in metres and t in seconds. Calculate *(i)* displacement and acceleration when velocity is zero and *(ii)* displacement and velocity when acceleration is zero. 8

(b) Obtain an equation for the trajectory of a projectile and show that it is a parabola. 6

9. *(a)* A ball of mass 1 kg moving with a velocity of 2 m/s impinges directly on a ball of mass 2 kg at rest. The first ball, after impinging, comes to rest. Find the velocity of the second ball after the impact and the coefficient of restitution. 8

(b) A bullet of mass 30 g is fired into a body of mass 10 kg, which is suspended by a string 0·8 m long. Due to this impact, the body swings through an angle 30°. Find the velocity of the bullet. 6

★ ★ ★