9. A block of 3 kg mass slides down a frictionless loop of 3 m radius and enters a rough horizontal plane and compress a spring of stiffness 250 N/m as shown in Fig. 7.

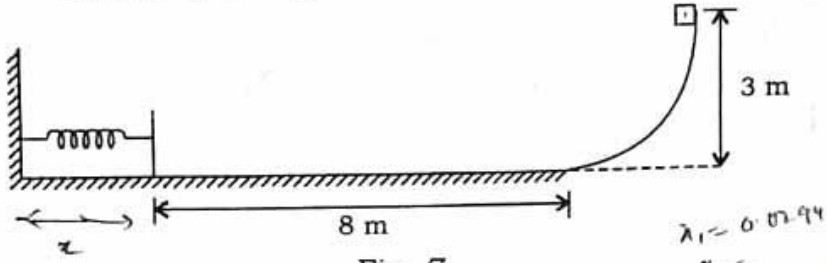

Fig. 7

Determine the compression of the spring, the coefficient of friction between the block and plane being 0·25.

Code : 011201

B.Tech 2nd Semester Exam., 2014

ENGINEERING MECHANICS

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The questions are of equal value.

*(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* of the following :

(a) The principle of transmissibility can be applied only when the body is treated as

(i) a particle

(ii) a rigid body

(iii) deformable

(iv) a continuum

(b) Force couple is a

(i) fixed vector

(ii) sliding vector

(iii) free vector

(iv) unit vector

(c) A force couple system can be reduced to a single force only when the resultant force and couple are —— to each other

(i) parallel

(ii) perpendicular

(iii) inclined at 45°

(iv) inclined at 135°

(d) Three forces acting on a body can keep it in equilibrium, only when they are

(i) collinear

(ii) coplanar and concurrent

(iii) coplanar and parallel

(iv) coplanar and non-concurrent

(e) The tangent of the angle of friction is

(i) angle of repose

(ii) coefficient of friction

(iii) cone of friction

(iv) limiting friction

(f) A screw jack with lead angle θ and friction angle ϕ_s is said to be in self-locking if

(i) $\theta > \phi_s$

(ii) $\theta < \phi_s$

(iii) $\theta = \phi_s$

(iv) $\phi_s = 0$

(g) The centroid of an equilateral triangle of side a with a side parallel to the x-axis is

(i) $a/2,\ a/\sqrt{6}$

(ii) $a/2,\ a/\sqrt{12}$

(iii) $a/2,\ a/\sqrt{24}$

(iv) $a/3,\ a/3$

(h) The product of inertia of a right-angled triangle of base b and height h about its centroidal axes is

(i) $\frac{b^2h^2}{36}$ (ii) $-\frac{b^2h^2}{36}$

(iii) $-\frac{b^2h^2}{72}$ (iv) $\frac{b^2h^2}{48}$

(i) A particle can move with constant velocity when motion is

(i) rectilinear

(ii) curvilinear

(iii) rotational

(iv) general motion

(j) In a conservative force field

(i) work done is zero

(ii) kinetic energy is constant

(iii) potential energy is constant

(iv) total mechanical energy is constant

2. *(a)* Define the terms—continuum, rigid body and particle

(b) Given the following vectors

$$\vec{a} = 2\hat{i} - 2\hat{j} + 3\hat{k}$$
$$\vec{b} = \hat{i} + \hat{j} + 3\hat{k}$$
$$\vec{c} = 2\hat{i} + \hat{j} + \hat{k}$$

Determine whether they are coplanar or not

3. *(a)* Explain the principle of transmissibility of a force

(b) Find the resultant of the forces concurrent at *A* as shown in Fig. 1

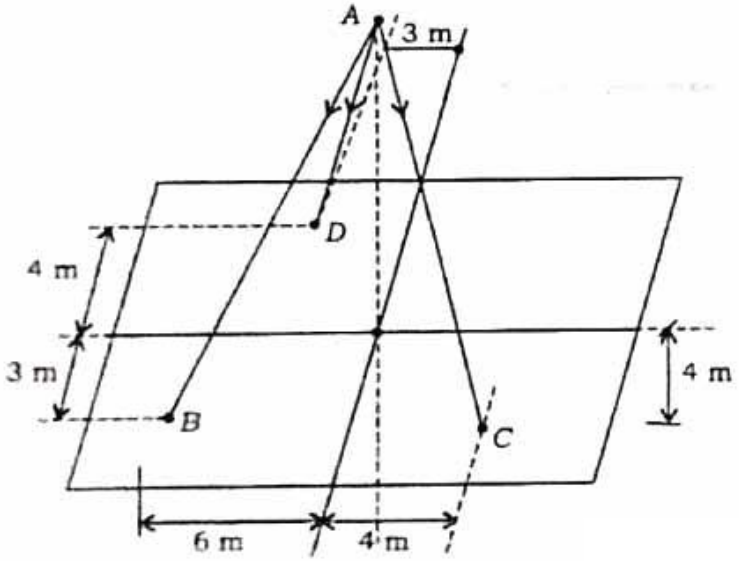

Fig. 1

The magnitudes of forces in cables *AB*, *AC* and *AD* are 1200 N, 1500 N and 1000 N respectively.

4. *(a)* Define force couple and moment of a couple.

(b) Reduce the system of forces as shown in Fig. 2 to an equivalent force and determine its magnitude and location with respect to *A*.

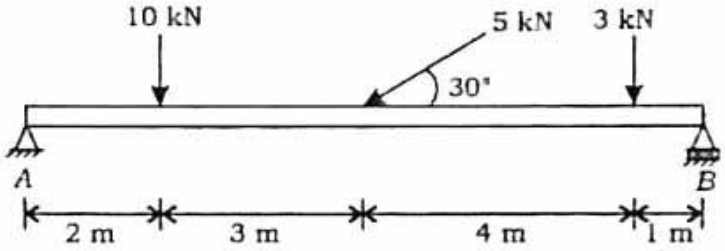

Fig. 2

5. *(a)* Define with sketch the different types of supports.

(b) A smooth pulley supporting a load of 3000 N is mounted at *B* on a horizontal beam *ACF*. A force of 4000 N is acting at free end *F* shown in Fig. 3

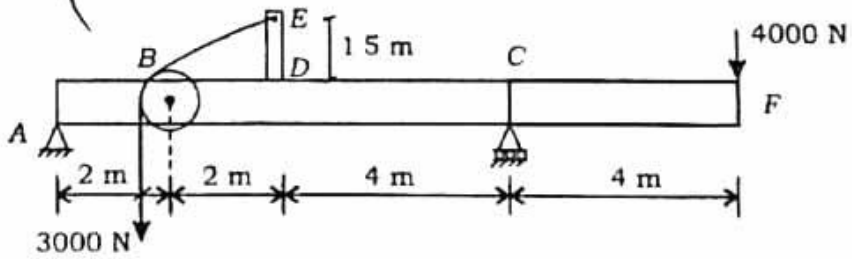

Fig. 3

If the beam weighs 1000 N, find the support reactions. Neglect the weight of pulley and also its size

6. *(a)* Define angle of friction, angle of repose and cone of friction.

(b) As shown in Fig. 4, block *A* of 15 kg mass is connected to another block *B* of 10 kg mass by a string passing over a frictionless pulley.

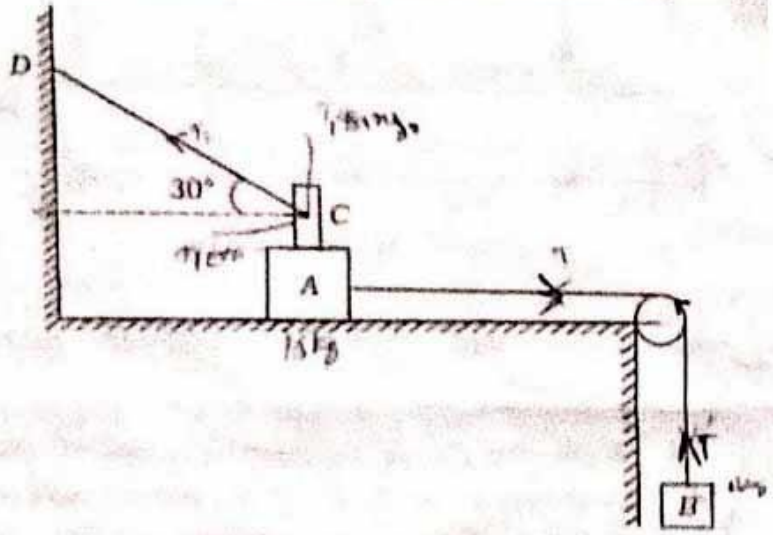

Fig. 4

Determine the minimum mass of the block *C* which is connected to the wall by a string *CD* and placed over block *A* to keep it from sliding. Take coefficient of friction between all contact surfaces to be 0·25.

7. *(a)* The mass moment of inertia gives a measure of resistance to rotation about an axis. Discuss.

(b) Determine the forces in the various members of a pin-jointed framework as shown in Fig. 5 :

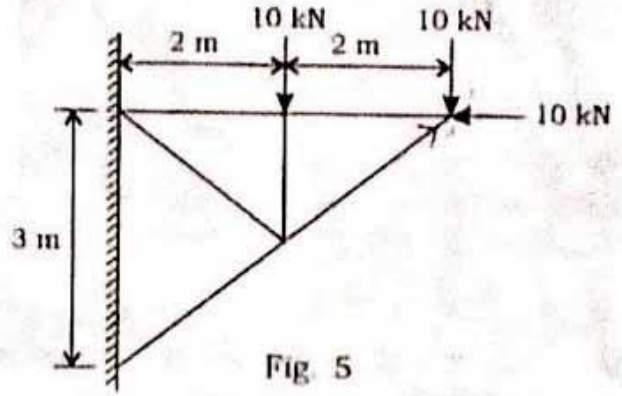

Fig. 5

8. What is meant by instantaneous centre? A long rod *AB* is supported at the upper edge of a wall and on a horizontal floor as shown in Fig. 6 :

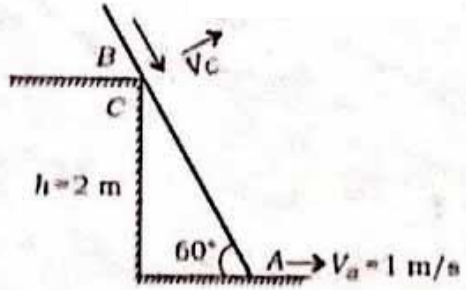

Fig. 6

If the lower end of the rod moves with a velocity 1 m/s, find the velocity of the contact point *C* and the angular velocity of the rod, when the rod is at 60° to the horizontal.