(Set-R_1)

B.Tech-2nd

Engineering Mechanics

Full Marks : 70

Time : 3 hours

Answer Q. No. 1 and any five from the rest

The figures in the right-hand margin indicate marks

1. Answer the following : 2×10

(*a*) A hinged square *ABCD* (Fig. 1(a) with diagonal *BD* is subjected to the action of two equal and opposite forces as shown. Determine the forces produced in all the bars.

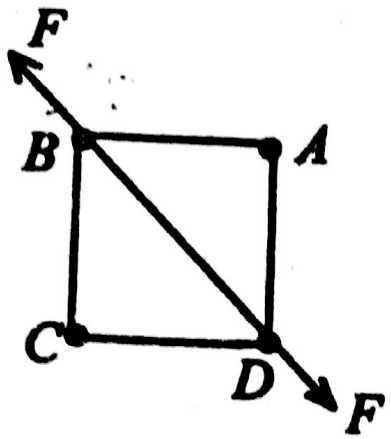

Fig. 1 (*a*)

(*b*) Differentiate

(*i*) limiting friction
(*ii*) static friction
(*iii*) kinetic friction.

Explain with example.

(*c*) How do you determine the resultant of the given system of coplanar parallel forces analytically ? Explain with examples.

(*d*) State the two theorems of Papus to determine the (*i*) surface area of revolution and
(*ii*) volume of revolution.
Compute the location of centre of volume of a right circular base cone of height '*h*' and radius at base '*r*'.

(*e*) Explain the principles used in method of sections in analysis of truss. Demonstrate through an example.

(*f*) State and explain the principle of virtual work. Demonstrate its application through an example.

(g) State and explain parallel axes theorem in determining the moment of inertia. Find the moment of innertia of an equilateral triangular area about one of the sides as a base.

(h) State the principle of conservation of momentum. Give an example.

(i) In curvilinear motion define normal and tangential acceleration of a particle. A particle goes round a circular path with uniform angular velocity. What are its normal and tangential components of accelerations ?

(j) A shaft of radius 'r' rotates with constant angular speed 'w' in bearings for which the coefficient of friction is 'μ'. Through what angle 'θ' will it rotate after the driving torque is removed ?

2. (a) If the resultant of the two forces exerted on the body at A of Fig. 2(a) is to be vertical, determine the value of β for which the

magnitude of P is maximum, and the corresponding magnitude of P. 5

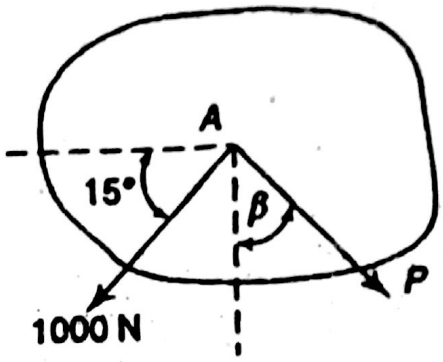

Fig. 2 (*a*)

(*b*) Two heavy right circular rollers of diameters D and d, respectively, rest on a rough horizontal plane as shown in Fig. 2(*b*). The larger roller has a string wound around it to which a horizontal force P can be applied as shown. Assuming that the coefficient of friction μ has the same value for all surfaces of contact, determine the condition (i.e. value of $\mu = ?$) under which the larger roller can be pulled over the smaller one. 5

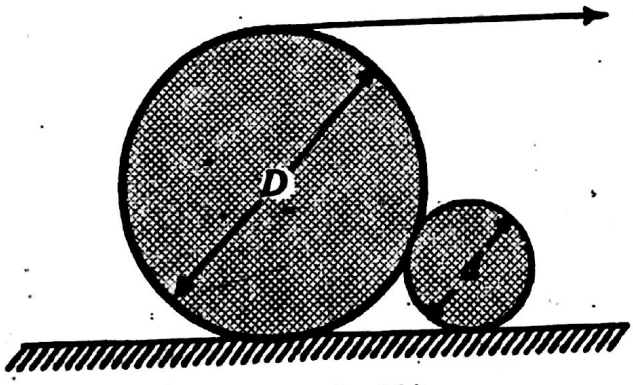

Fig. 2 (*b*)

(*Continued*)

3. (*a*) The beam *AB* in Fig. 3(*a*) is hinged at *A* and supported at *B* by a vertical cord which passes over a frictionless pulley at *C* and carries at its end a load *P* as shown. Determine the distance '*x*' from *A* at which a load *Q* must be placed on the beam if it is to remain in equilibrium in a horizontal position. Neglect the weight of the beam. 5

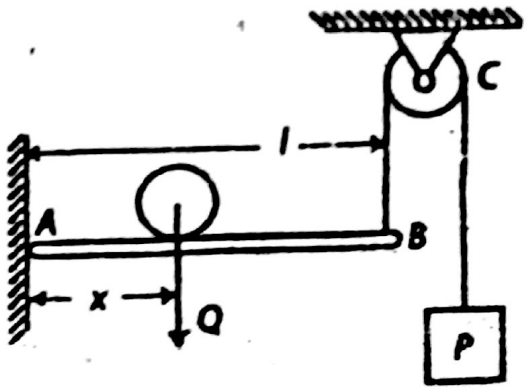

Fig. 3(*a*)

(*b*) Find the following for the unequal-leg channel section shown in Fig. 3(b): 5

(*i*) Position of C.G.

(*ii*) I_{xx}, I_{yy}

(*iii*) $I_{x_cx_c}, I_{y_cy_c}$

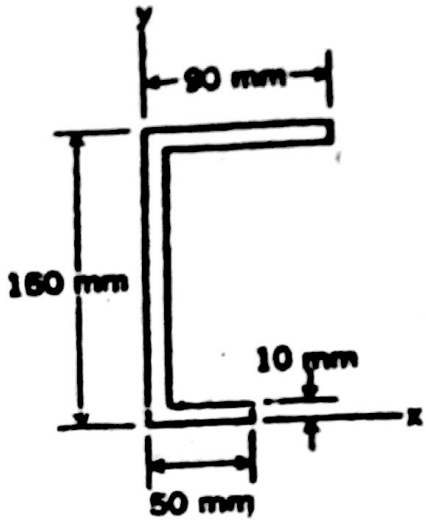

Fig. 3(b)

4. (*a*) A heavy block of weight *W* rests on a rough horizontal plane as shown in Fig. 4(a). Hinged to this block is a slender bar *AB* of length '*l*' which leans against a small frictionless roller at *D* and carries a vertical load *P* at its free end *B*. Find the magnitude of *P* for which sliding of the block will impede if the coefficient of friction on the horizontal plane is μ. The following numerical data are given : 5

$\theta = 30^\circ$, $l = 750$ mm, $h = 250$ mm,

$\mu = \frac{1}{3}$, Neglect the weight of the bar.

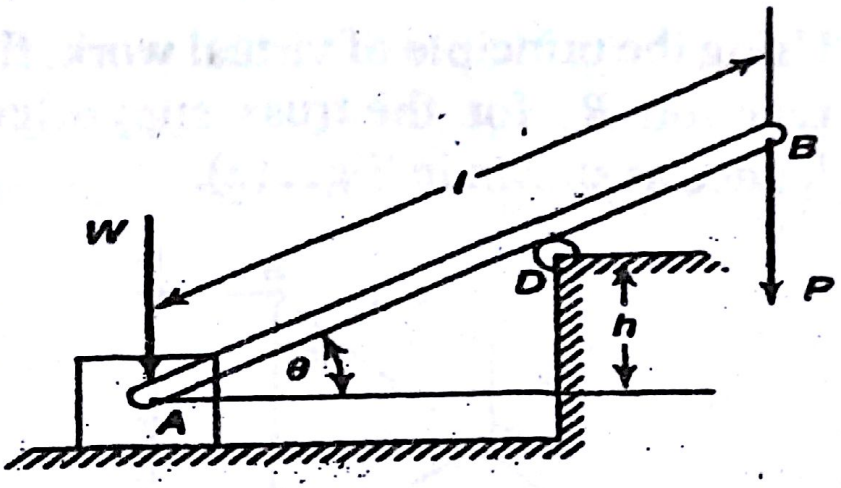

Fig. 4(a)

(*b*) Find the forces in members *CD*, *DG*, and *HG* in the plane truss (Fig. 4(*b*)). 5

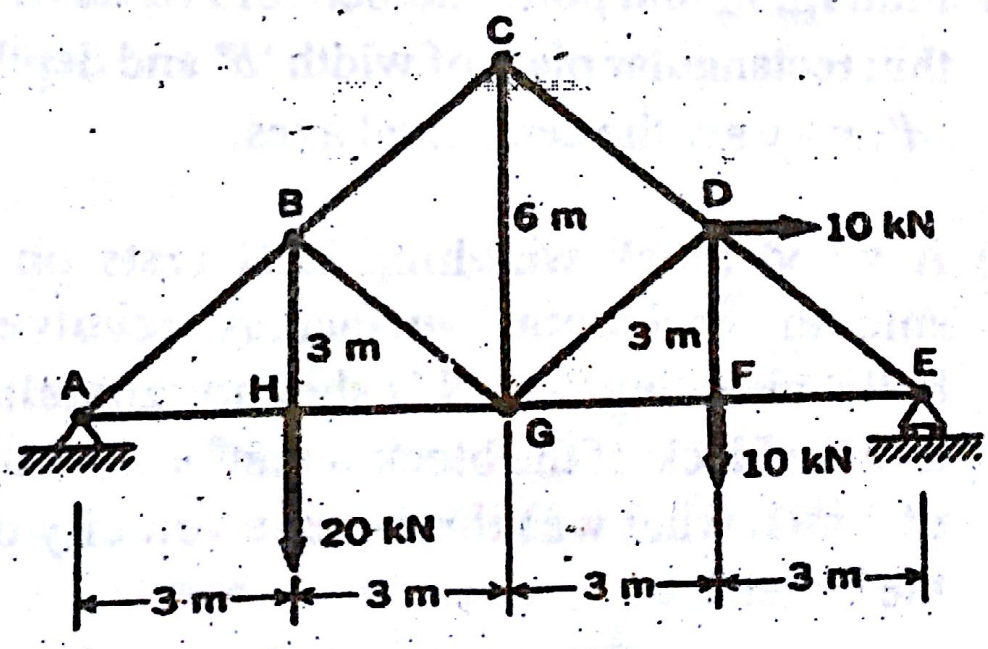

Fig. 4(*b*)

5. (*a*) Using the principle of virtual work, find the reaction R_A for the truss supported and loaded as shown in Fig. 5(a). 5

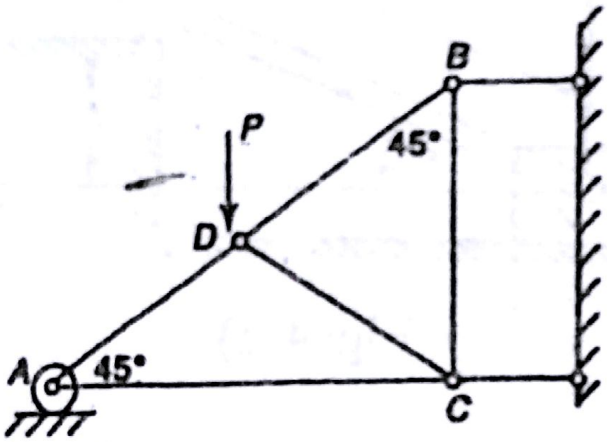

Fig. 5(a)

(*b*) Find I_{xx}, I_{yy} and polar moment of inertia of a thin rectangular plate of width '*b*' and depth '*d*'. $x-y$ are the centroidal axes. 5

6. (*a*) A wood block weighing 25 N rests on a smooth horizontal surface. A revolver bullet weighing 0·15 N is shot horizontally into the block. If the block attains a velocity of 3 m/s, what was the muzzle velocity of the bullet ? 5

(*b*) If the system in Fig. 6(*b*) is released from rest in the configuration shown, find the

velocity 'V' of the block Q after it falls a distance $h = 3$ m. Neglect friction and inertia of the pulleys. Assume $P = Q = 45$ N. 5

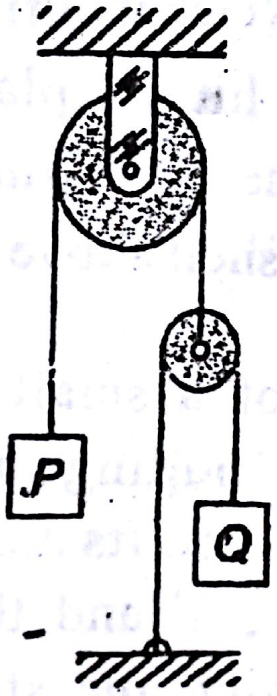

Fig. 6(b)

7. (*a*) At instant $t = 0$, a locomotive starts to move with uniformly accelerated speed along a circular curve of radius $r = 600$ m and acquires by the end of the first 60 s of motion a speed equal to 24 kmp.h. Find the tangential and normal acceleration at the instant $t = 30$ s. 5

(*b*) A shell is fired from a hill 150 m high above a plain. The angle α of firing is 15° above the horizontal, and the muzzle velocity V_0 is 1000 m/s. At what horizontal distance, d, will the shell hit the plain if we neglect friction of the air ? What is the maximum height of the shell above the plain ? 5

8. (*a*) The wheel of a small gyroscope is set spinning by pulling on a string wound around the shaft. Its moment of inertia is $I = 6000$ kg-mm^2 and the diameter of the shaft on which the string is wound is 12 mm. If 750 mm of string is pulled off with a constant force of 50 N, what angular velocity will be imparted to the wheel ? 5

(*b*) The cylinder shown weighs 500 N and has a radius of gyration of 0·3 m. What is the minimum coefficient of friction at *A* that will prevent the body from moving ? Using half of this coefficient of friction, how far

does point O move in 1·2 s if the cylinder is released from rest ? Refer Fig. 8(b). 5

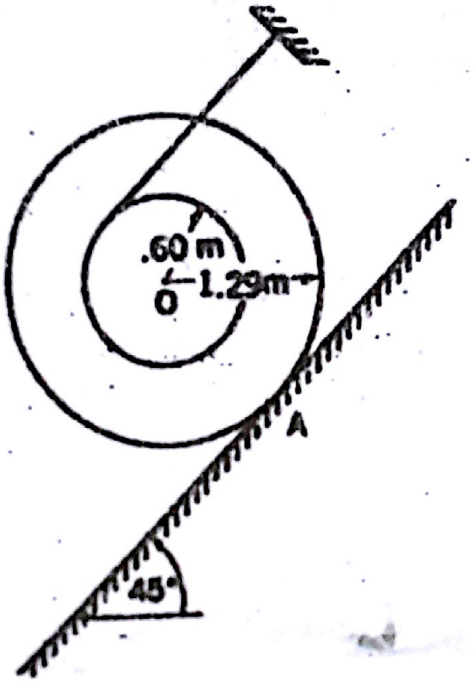

Fig. 8(b)