Code : 101304

B.Tech 3rd Semester 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 of the following (any *seven*) : 2×7=14

(a) The moment of inertia of a thin spherical shell of mass m and radius r, about its diameter is

(i) $mr^2/3$

(ii) $2mr^2/3$

(iii) $2mr^2/5$

(iv) $3mr^2/5$

(b) The CG of a plane lamina will not be at its geometrical centre in the case of a/an

(i) right-angled triangle

(ii) equilateral triangle

(iii) square

(iv) circle

(c) Pick up wrong statement about friction force for dry surfaces. Friction force is

(i) proportional to normal load between the surfaces

(ii) dependent on the materials of contact surface

(iii) proportional to velocity of sliding

(iv) independent of the area of contact surfaces

(d) If the body is in equilibrium, but it having a rotational curled ray shown in the free body diagram, then

(i) the diagram is wrong

(ii) such rotations cannot be shown in the free body diagrams

(iii) the ray shown may be correct, but the body is not said to be in equilibrium

(iv) the body is said to be in equilibrium only, as the other forces will cancel out that rotation

(e) Potential energy is stored in the body if some work is done on it. Work done is best given by

(i) $dU = Fdr\cos\theta$

(ii) $dU = Fdr\sin\theta$

(iii) $dU = Fdr\cot\theta$

(iv) $dU = Fdrd\theta$

(f) In a roof supporting truss, the load is transmitted when

(i) first to the truss then the joints through purlins

(ii) first to the purlins then the joints through trusses

(iii) first to the truss then the purlins through joints

(iv) first to the joints then the trusses through purlins

(g) Continuous beams are

(i) statically determinate beams

(ii) statically indeterminate beams

(iii) statically gravity beams

(iv) framed beams

(h) Which of the following methods will give an incorrect relation of the frequency for free vibration?

(i) Equilibrium method

(ii) Energy method

(iii) Rayleigh's method

(iv) Klein's method

(i) What is the effect on the undamped natural frequency of a single-degree-of-freedom system if the mass of the system is increased?

(i) The frequency will increase

(ii) The frequency will stay the same

(iii) The frequency will decrease

(iv) None of the above

(j) D'Alembert's principle is used for

(i) reducing the problem of kinetics to equivalent statics problem

(ii) determining stresses in the truss

(iii) stability of floating bodies

(iv) designing safe structures

2. (a) State and explain D'Alembert's principle. Also discuss its application in plain motion. 6

(b) Replace the loading on the frame shown in Fig. 1 by a single resultant force :

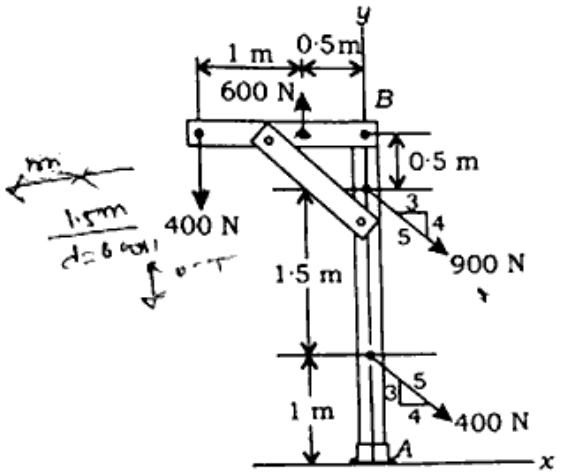

Fig. 1

Specify where its line of action intersects a horizontal line along member *AB*, measured from end *A*. 8

3. The narrow ring of mass *m* is free to rotate in the vertical plane about *O* as shown in Fig. 2 :

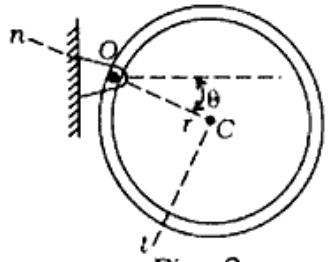

Fig. 2

If the ring is released from rest at $\theta = 0°$, determine the expression for the *n* and *t* components of the force at *O* in terms of θ. 14

4. What is a truss? Determine the force in terms of the load *P* for each member of the truss shown in Fig. 3 and state if the members are in tension or compression : 14

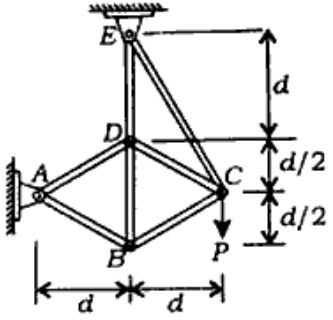

Fig. 3

5. (a) What is dry friction? Explain the characteristics of dry friction. 6

(b) Beam *AB* is subjected to a uniform load of 200 N/m and is supported by *B* at post *BC*, as shown in Fig. 4 :

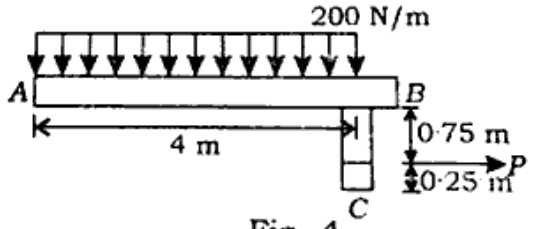

Fig. 4

If the coefficients of static friction at *B* and *C* are $\mu_B = 0{\cdot}2$ and $\mu_C = 0{\cdot}5$, determine the force *P* needed to pull the post out from the beam. Neglect the weight of the members and the thickness of the beam. 8

6. Determine the location of the centroid of the channel's cross-section area and also calculate the moment of inertia of the area about the axis shown in Fig. 5 : 14

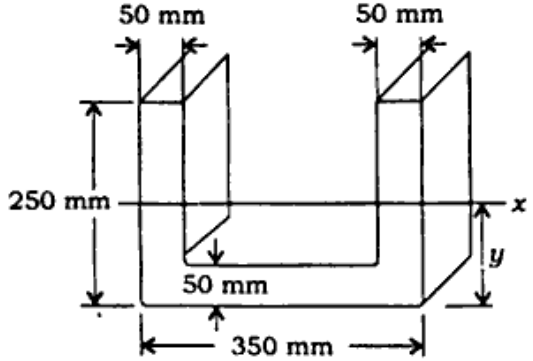

Fig. 5

7. (a) What is virtual work? Explain the principle of virtual work for particle. 6

(b) Determine the required force P in Fig. 6 needed to maintain equilibrium of the scissors linkage when $\theta = 60°$:

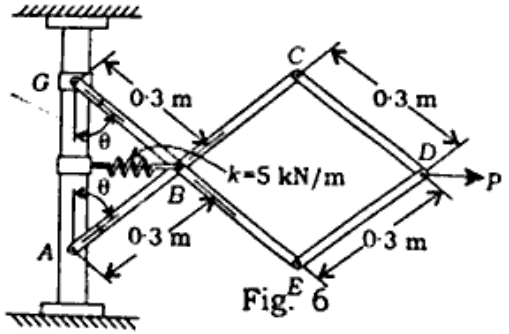

Fig. 6

The spring is upstretched when $\theta = 60°$. Neglect the mass of the links. 8

8. (a) What is direct central impact? Derive the expression for coefficient of restitution in case of direct central impact. 6

(b) The 4 kg ball and the attached light rod rotate in the vertical plane about the fixed axis at O as shown in Fig. 7 :

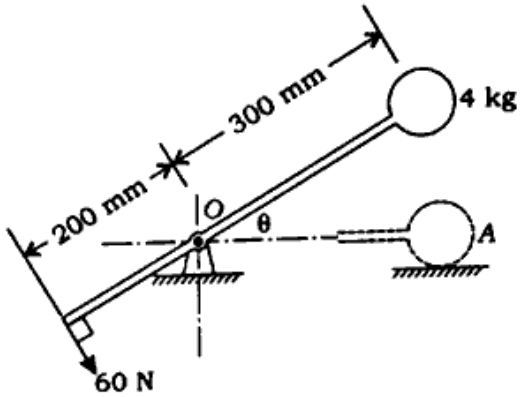

Fig. 7

If the assembly is released from rest at $\theta = 0$ and moves under the action of the 60 N force, which is maintained normal to the rod, determine the velocity v of the ball as θ approaches 90°. Treat the ball as a particle. 8

9. (a) When a 3 kg collar is placed upon the pan which is attached to the spring of unknown constant,

the additional static deflection of the pan is observed to be 40 mm as shown in Fig. 8 :

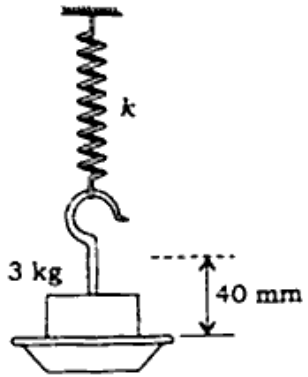

Fig. 8

Determine the spring constant k in N/m. 6

(b) Derive the expression of natural frequency and amplitude for free longitudinal vibration using Rayleigh's method. 8