Code : ESC–201 (100310)

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 of the following (any *seven*) : 2×7=14

(a) Which of the following kinetic frictions is smaller?

(i) Limiting friction

(ii) Static friction

(iii) Rolling friction

(iv) Sliding friction

(b) A polar vector is one which

(i) gives the position of an object

(ii) tells how much and in which direction an object has changed its position

(iii) represents rotational effect

(iv) has a starting point of application

(c) In the simplification of the forces for the free body diagram, the net force acts at the ____ of the loading body.

(i) centroid

(ii) centre axis

(iii) corner

(iv) base

(d) SI unit of shear force is

(i) kN/m *(ii)* kN-m

(iii) kN *(iv)* m/N

(e) The acceleration of a particle moving with simple harmonic motion at any instant is given by

(i) $\omega \cdot y$

(ii) $\omega^2 \cdot y$

(iii) ω^2 / y

(iv) $\omega^3 y$

(f) When the motion of a body is confined to only one plane, the motion is said to be

(i) rectilinear motion

(ii) plane motion

(iii) curvilinear motion

(iv) None of the above

(g) The motion of a wheel of a car is

(i) purely translational

(ii) purely rotational

(iii) combined translational and rotational

(iv) None of the above

(h) A body moves from rest with a constant acceleration of 5 m/sec^2. The distance covered in 5 sec is most nearly

(i) 38 m

(ii) 62·5 m

(iii) 96 m

(iv) 124 m

(i) If diameter of a shaft is doubled, the power transmitted capacity will be

(i) either twice or half

(ii) four times

(iii) eight times

(iv) same

(j) When a body of mass moment of inertia I (about a given axis) is rotated about that axis with an angular velocity, then the kinetic energy of rotation is

(i) $0{\cdot}5 I \cdot \omega$

(ii) $I \cdot \omega$

(iii) $0{\cdot}5 I \cdot \omega^2$

(iv) $I \cdot \omega^2$

2. (a) If a and b are consecutive vectors of a parallelogram, express the diagonal vectors in terms of a and b. 4

(b) From the relative tensor A^i_j of weight N, derive a relative scalar of weight N. 5

(c) If A^l_j are the components of an absolute mixed tensor, show that A^l_l is a scalar invariant. 5

3. (a) If $f(x, y) = \dfrac{x^3 + y^3}{x^{99} + y^{98}x + y^{99}}$, find the value of f_y at $(x, y) = (0, 1)$. 7

(b) A flywheel is making 180 r.p.m. and after 20 seconds it is running at 120 r.p.m. How many revolutions will it make and what time will elapse before it stops, if the retardation is uniform? 7

4. (a) Explain the term 'instantaneous centre'. How would you locate the instantaneous centre of a rigid link moving with combined motion of rotation and translation? 6

(b) The bent flat bar rotates about a fixed axis through point O. At the instant depicted, its angular properties are $\omega = 5$ rad/s and $\alpha = 8$ rad/s^2 with directions as indicated in Fig. 1 below. Determine the instantaneous velocity and acceleration of point A : 8

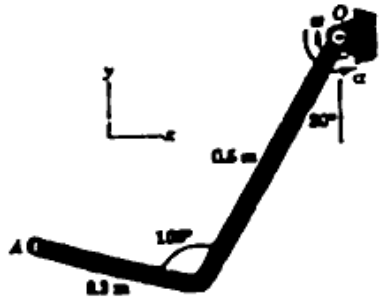

Fig. 1

5. (a) The sliders A and B are connected by a light rigid bar and move with negligible friction in the slots, both of which lie in a horizontal plane. For the position shown in Fig. 2 below, the hydraulic cylinder imparts a velocity and acceleration to slider A of 0·4 m/s and 2 m/s^2, respectively, both to the right. Determine the acceleration of slider B and the force in the bar at this instant : 8

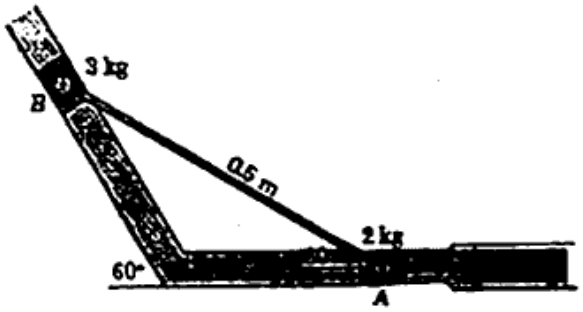

Fig. 2

(b) Explain the dynamic equilibrium of a rigid body in plane motion. 6

6. (a) A mass supported by a spring has a static deflection of 0·5 mm. Determine its natural frequency of oscillation. 3

(b) A simple pendulum of amplitude 4° performs 24 oscillations in one minute. Find *(i)* length of the pendulum, *(ii)* maximum acceleration of the bob, *(iii)* maximum linear velocity of the bob and *(iv)* maximum angular velocity of the bob. 8

(c) State the laws of friction. 3

7. (a) What is the difference between the impact of two bodies and the impact of a body on a fixed plane? 3

(b) A sphere of mass 1 kg, moving at 3 m/s, overtakes another sphere of mass 5 kg, moving in the same line at 60 cm/s. Find the loss of kinetic energy during impact and show that the direction of motion of the first sphere is reversed. Take coefficient of restitution as 0·75. 7

(c) A ball is dropped from a height of 25 metres upon a horizontal floor. Find the coefficient of restitution between the floor and the ball, if it rebounds to a height of 16 metres. 4

8. (a) A light rope passing round a pulley of mass 60 kg, radius 300 mm and radius of gyration 200 mm, has two masses 8 kg and 6 kg attached to its ends. If the rope does not slip as the pulley rotates, determine the acceleration of the two masses and the pulls in the two ropes. 6

(b) What is the principle of conservation of momentum for a general mass system? 4

(c) What is parallel and perpendicular axis theorem? 4

9. (a) Draw the shear and bending moment diagrams for the beam and loading shown in Fig. 3 below : 7

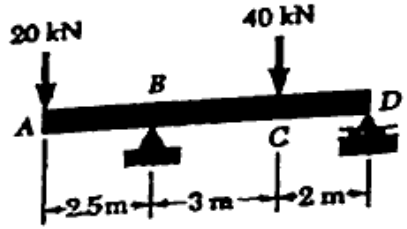

Fig. 3

(b) In a hollow circular shaft of outer and inner diameters of 20 cm and 10 cm respectively, the shear stress is not to exceed 40 N/mm^2. Find the maximum torque which the shaft can safely transmit. 7

★★★