Code: D-02 **Subject: APPLIED MECHANICS**
Time: 3 Hours **Max. Marks: 100**

NOTE: There are 11 Questions in all.

- **Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: **(2x8)**

a. A motor boat moves due East with a speed of 12 km/h for ½ hour and then moves due North with a speed of 8 km/h for 1 hour. The magnitude of the displacement would be

(A) 6 km. **(B)** 8 km.
(C) 10 km. **(D)** None of these.

b. A force of 5 N moves a body of weight 20 N by 5 m on a rough horizontal table. The work done by the weight would be

(A) 0. **(B)** 25 J.
(C) 50 J **(D)** 100 J.

c. The distance between the corner and centroid of an L of equal side *b* is

(A) 0. **(B)** $\frac{b}{\sqrt{4}}$.
(C) $\frac{b}{\sqrt{2}}$. **(D)** $\frac{b}{\sqrt{8}}$.

d. In a simple machine an effort of 20 N, moving a distance of 80 cm, lifts a load of 120 N by 10 cm. The mechanical efficiency would be

(A) 60%. **(B)** 75%.
(C) 80%. **(D)** 90%.

e. A particle is executing simple harmonic motion. Its path would be

(A) a circle **(B)** a parabola
(C) a sine curve **(D)** none of these

f. A uniform rod of mass m and length L is pinned at one end and rotating at an angular velocity ω. The kinetic energy of the rod would be

(A) $mL^2\omega^2/24$. **(B)** $mL^2\omega^2/12$
(C) $mL^2\omega^2/6$ **(D)** none of these.

g. A solid shaft of radius r, length L, modulus of rigidity G has an angle of twist θ. The maximum shear strain γ_{max} in the shaft would be

(A) $\theta r/L$ **(B)** θ/L

(C) $G\theta r/L$ **(D)** none of these.

h. A beam is subjected to pure bending. Its curvature would be

(A) zero. **(B)** constant.

(C) varying linearly. **(D)** none of these.

PART I

Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. A mass of 2 kg is acted upon by a force of 8 N in the x direction and another force of 16 N at an angle of $120°$ to the x axis in the xy plane. Determine the acceleration of the mass in the x and y directions. **(6)**

b. Determine the magnitude, direction and location on the plate of the simplest resultant of the forces shown in Fig.1. **(8)**

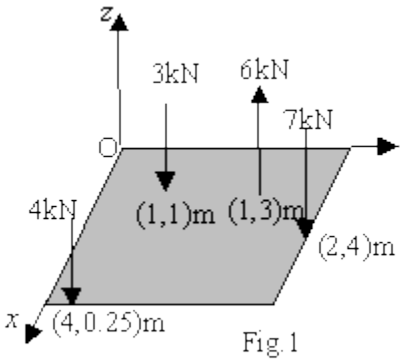

Fig.1

Q.3 a. Two smooth balls A and B, each having a weight of 20 N, rest between the inclined planes shown in Fig.2. Draw the free body diagrams for ball A and for ball B. **(7)**

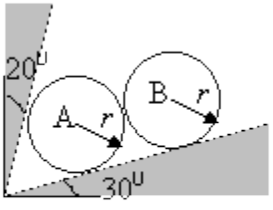

Fig.2

b. Determine the forces in each member of the truss shown in Fig.3. **(7)**

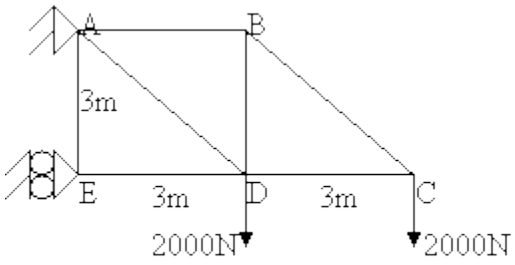

Fig.3

Q.4 For the unequal flange I section shown in Fig.4, determine the location of the centroid and the polar moment of inertia about its centroidal axis. **(14)**

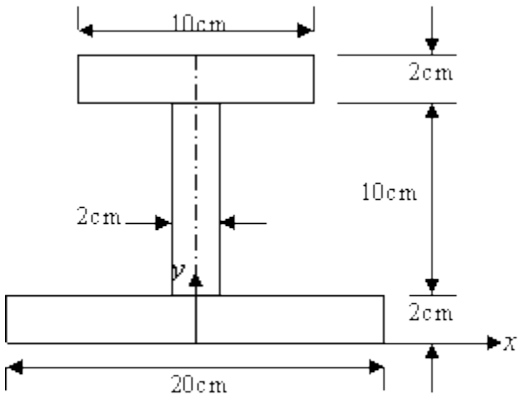

Fig.4

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Q.5 A symmetrical wedge of angle θ is driven into a wooden block. If the weight of the wedge is negligible and the coefficient of friction between the wedge and the block is μ, determine an expression for the minimum force P required to drive the wedge in. Also find the minimum value of the coefficient of friction μ so that the wedge is self locking. **(14)**

Q.6 a. An enemy plane is flying in a straight path at 200 km/hr at a height of 1000 m above the ground. An anti-aircraft gun located on the ground fires a shell with an initial velocity of 300 m/s at an instant when the plane is vertically above it. Determine the required inclination to the vertical of the gun to hit the plane. Obtain the time after firing when the shell hits the plane and the horizontal distance of the plane from the gun. **(8)**

b. A flywheel of diameter 1m is rotating with angular speed of 2 rad/s and angular acceleration of 3 rad/s^2. Determine the acceleration of a point on the rim of the wheel. **(6)**

PART II

Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. A 10 kg mass is suspended by a light string wound round a drum of mass 50 kg and radius 40 cm. If the radius of gyration of the drum is 30 cm and the drum is free to rotate about its axis, determine the angular acceleration of the drum and the tension in the string. **(8)**

b. A hammer of mass 50 kg drops freely from a height of 2.5 m on to a pile of mass 20 kg and drives it 10 cm into the ground. If the impact is perfectly plastic, determine the average resistance of the ground. **(6)**

Q.8 a. In a uniaxial tension test, the load-elongation diagram is an shown in Fig 5. The specimen cross-sectional area was 100 mm^2 and gauge length was 200 mm. Obtain the Young's modulus, 0.2% proof stress, the ultimate stress and percentage elongation. Take the elastic limit as 30 kN. **(10)**

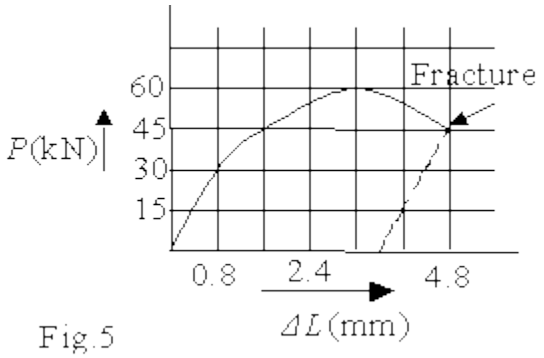


Fig.5

b. A hole of diameter *d* has to be punched in a plate of thickness *t*. If the ultimate shear strength of the plate material is τ, determine the punch force required. **(4)**

Q.9 A hollow steel shaft is to transmit 628 kW at 200 rpm without exceeding a shearing stress of 80 Mpa and an angle of twist of $3.0°$ over a length of 4 m. Determine the shaft diameter. Take the modulus of rigidity for steel as 80 Gpa. **(14)**

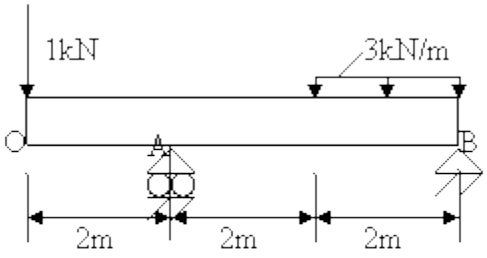
Q.10 

Fig.6

A beam is supported and loaded as shown in Fig.6. Draw the S.F. and B.M. diagrams. Find the maximum bending moment and its location. **(14)**

Q.11 a. State the moment area theorems. **(4)**

b. A cantilever BCD is subjected to a load *P* at the free end B as shown in Fig.7. The flexural rigidity of the beam for the portion BC is *EI* and for the portion CD is 2*EI*. Find the slope and deflection at the free end. Neglect the weight of the beam. **(10)**

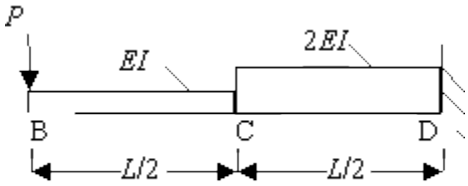


Fig.7