APPLIED MECHANICS

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. A plate of mild steel is supported by a vertical force of 1600 N using three cables that are all 30 mm in diameter.

The plate is held at an angle of 20° above the horizontal. The front cable forms an angle of 25° with the steel plate and the two rear cables of equal length form an angle of 50° with the plate as shown in Fig Q1.

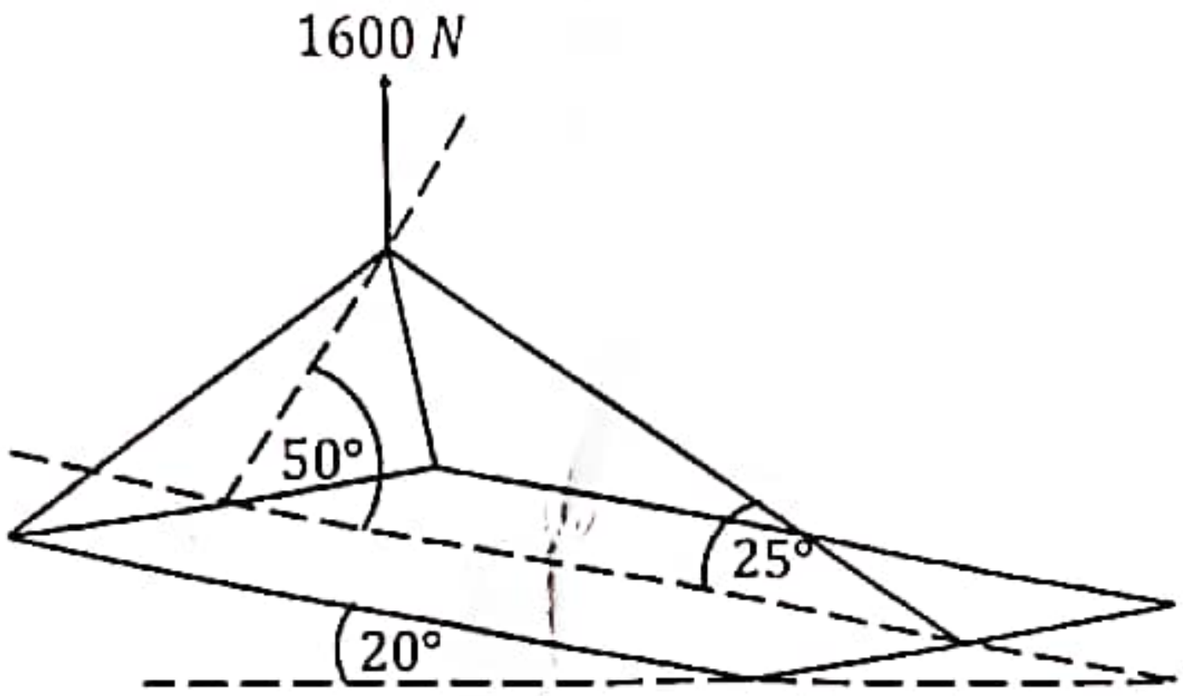

Fig Q1

The angle between the two rear cables at the point of concurrency is 60°.

(a) Determine the tensile force in each of the cables. (14)

(b) Calculate the stress induced in the front cable. (2)

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2. Blocks A and B are initially at rest on a plane inclined 40° above the horizontal as shown in Fig Q2.

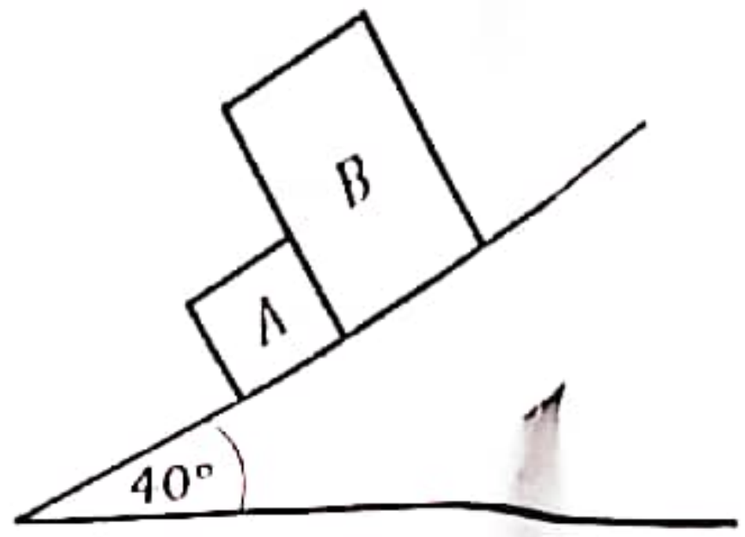

Fig Q2

Block A is 25 kg, block B is 60 kg and the coefficient of friction between contact surfaces is 0.2 for block A and 0.15 for block B.

Calculate the common acceleration of the blocks when they freely slide down the inclined plane. (16)

3. A projectile is fired at an angle of 30° above the horizontal from a cliff top 120 m high. The projectile hits a target 540 m away from the base of the cliff.

Calculate EACH of the following:

(a) the initial velocity of the projectile; (8)

(b) the magnitude and direction of the impact velocity. (8)

4. A conical friction clutch is used to transmit power at 1800 rpm. The clutch has an included angle of 101° with outer and inner diameters of 100 mm and 24 mm respectively. The maximum axial thrust available is 140 N and the coefficient of friction between contact surfaces is 0.36.

Calculate EACH of the following:

(a) the maximum power the clutch can transmit; (12)

(b) the axial thrust if the power output drops to 350 W. (4)

5. A 75 kg flywheel with a 400 mm radius of gyration rotates at an angular speed of 275 rpm on a drive shaft. A 100 kg flywheel with radius of gyration 500 mm is at rest on the corresponding driven shaft. The shafts are then coupled by a clutch.

Calculate EACH of the following:

(a) the angular impulse transmitted to the stationary flywheel; (8)

(b) the kinetic energy lost by engaging the clutch; (6)

(c) the linear velocity of a fixed point on the radius of gyration of the 100 kg flywheel after engagement. (2)

6. A 100 mm diameter solid steel shaft is connected to a 100 mm internal diameter hollow steel shaft by a shear pin that is 12 mm diameter. The shearing stress in the pin must not exceed 75 MN/m^2 at an operational speed of 425 rpm.

The shear pin is in double shear as shown in Fig Q6.

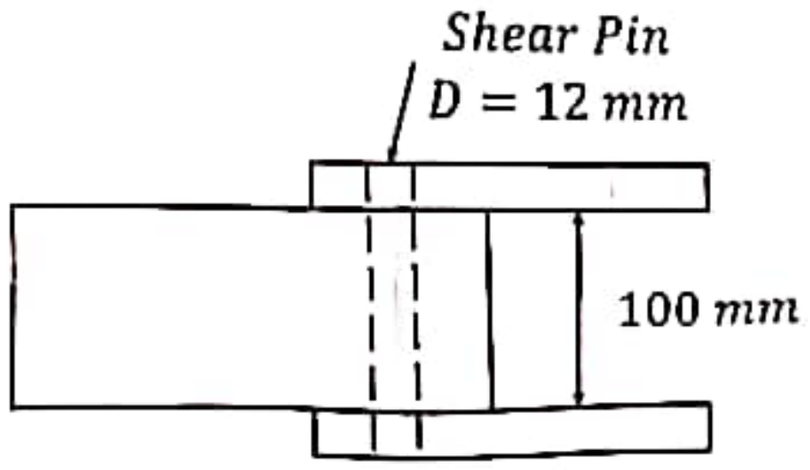

Fig Q6

Calculate EACH of the following:

(a) the maximum power that can be transmitted; (8)

(b) the minimum external diameter of the hollow shaft to limit the angle of twist to 0.1 degrees per metre length at this speed. (8)

Note: Modulus of Rigidity of the steel = 80 GN/m^2

7. A 7.8 m long beam is simply supported beam and loaded as shown in Fig Q7.

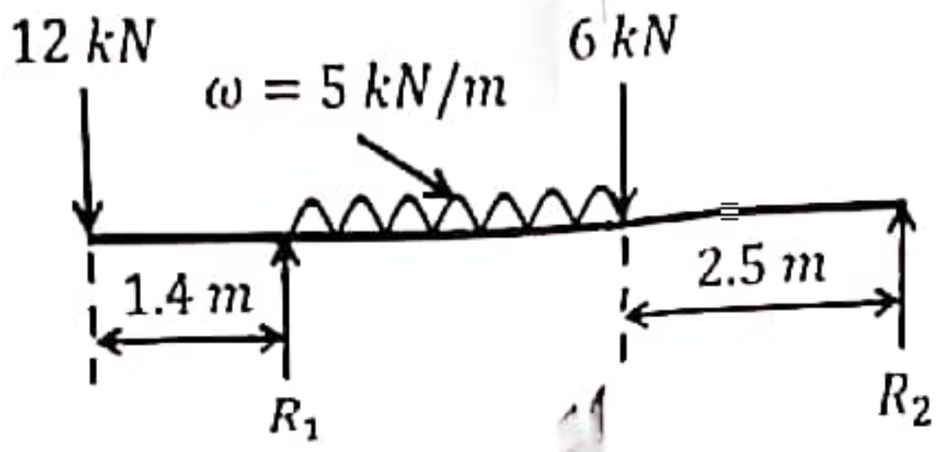

Fig Q7

Calculate the position of the point of contraflexure on the span of the beam. (16)

8. A winch hook with an internal radius of 75 mm is fabricated using 40 mm diameter mild steel as shown in Fig Q8.

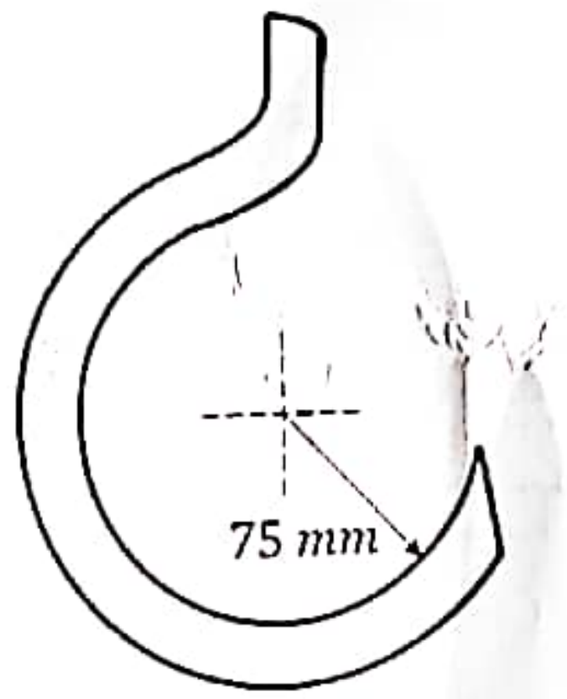

Fig Q8

Calculate the maximum mass that the hook can lift vertically for a maximum shearing stress of 40 MN/m^2. (16)

9. A 2 m long steel rod that is 30 mm in diameter has a concentric 20mm hole drilled in one end to a depth of 800 mm. A 600 Nm torque is applied at the point where the hollow section meets solid section and the rod is rigidly clamped at both ends as shown in Fig Q9.

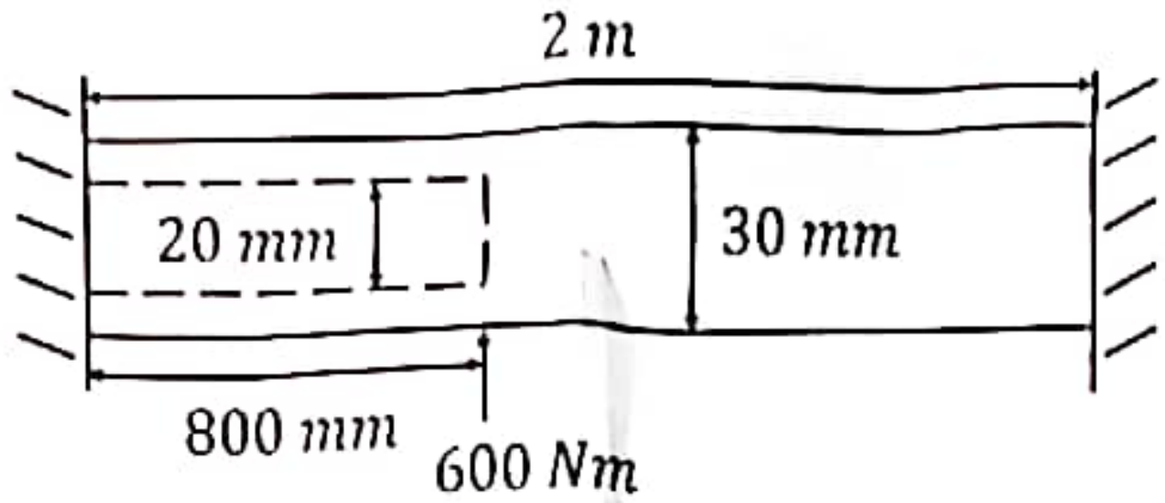

Fig Q9

Calculate EACH of the following:

(a) the shearing stress in both section of rod; (14)

(b) the angle of twist in degrees at the point at which the torque is applied. (2)

Note: Modulus of Rigidity for steel = 90 GN/m²