CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY
MARINE ENGINEER OFFICER

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 78 as amended MANAGEMENT ENGINEER REG. III/2 (UNLIMITED)

040-31 – APPLIED MECHANICS

TUESDAY, 17 JULY 2018

1315 - 1615 hrs

Examination paper inserts:

Notes for the guidance of candidates:

1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook

APPLIED MECHANICS

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. A circular disc 500 mm diameter has a 50 mm diameter hole with its centre 100 mm directly above the centre of the disc as shown in fig Q1. The disc is free to pivot about a horizontal diameter and is subject to a uniform pressure of 1.5 kN/m^2 on one side.

   Calculate EACH of the following:

   (a) the coordinates of the centroid of the disc; (10)

   (b) the torque which must be applied at the pivot to prevent the disc from rotating. (6)

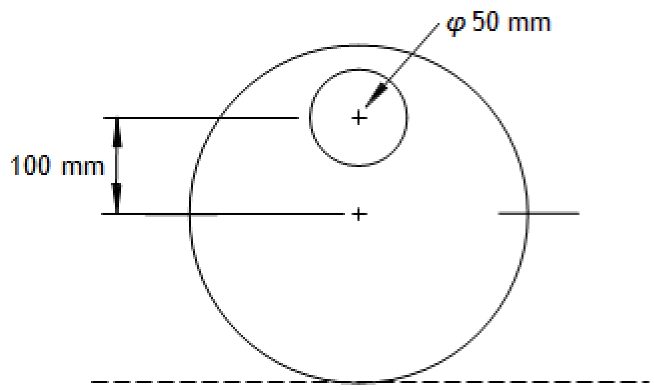

Fig Q1

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2. A vessel 100 m long is trimmed 4 m at the stern. A hatch cover of mass 5 tonne is to be hauled forward, on rollers, under the control of two chains, one attached at the forward end and one at the aft end of the cover. Each chain pulls parallel to the deck and frictional resistance to motion of the cover is constant at 100 N per tonne. The hatch cover moves at a constant velocity of 1.5 m/s.

Calculate EACH of the following:

(a) the forward chain force given that the aft chain force is 250 N; (6)

(b) the power required at the forward chain when the force is the value calculated in 2(a) above; (3)

(c) the time taken to bring the cover to rest if the aft force increases to 2.5 kN and the forward force reduces to 100 N. (7)

3. A moving body is subject to a uniform acceleration and travels a distance of 55 m in a period of 5 seconds and a further 120 m in the following 5 seconds.

(a) Sketch the velocity time graph for this motion. (4)

(b) Calculate EACH of the following:

(i) the acceleration of the body for the 10 seconds; (7)

(ii) the initial and final velocities of the body. (5)

4. A load rope is wrapped around a winch drum of effective diameter 1.2 m to which a brake drum of 900 mm diameter is attached. The drums have a total mass of 200 kg and radius of gyration 450 mm. The coefficient of friction between the brake drum and brake shoe is 0.33.

Calculate EACH of the following:

(a) the force required at the brake shoe to lower a load of 500 kg at constant velocity from the winch drum; (6)

(b) the braking force required to bring the load to rest from a velocity of 1.5 m/s in a distance of 4 m. (10)

5. A mass of 2 kg is suspended from the free end of a close coiled helical spring. The free length of the spring is 1.25 m, the mass of the spring is negligible and its stiffness is 100 N/m. The mass is rotated in a horizontal circular path below its point of suspension and is forming a conical pendulum and the tension in the spring is 75 N.

When the system is rotating, calculate EACH of the following:

(a) the length of the spring after the mass is applied; (4)

(b) the orbital radius of the mass; (6)

(c) the linear velocity of the mass. (6)

6. A short vertical hollow cylindrical column, 200 mm high and fixed at the base, is 120 mm outside diameter and 90 mm inside diameter. It carries a load of 8 kN as shown in Fig Q6.

Calculate EACH of the following:

(a) the maximum compressive stress in the column, stating where this occurs; (12)

(b) the maximum tensile stress in the column, stating where this occurs. (4)

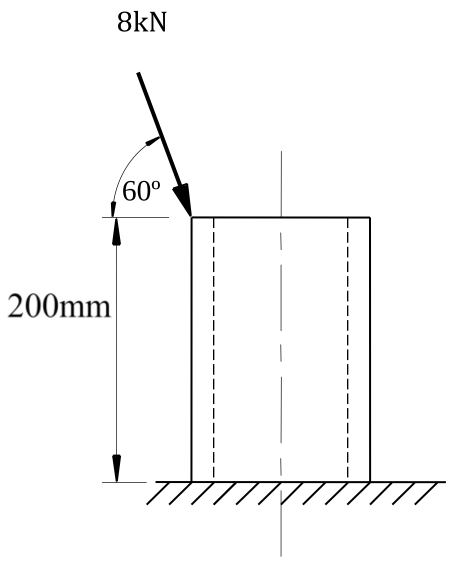

Fig Q6

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7. A single start screw jack with a pitch of 12 mm is arranged to move an engine bedplate horizontally into place. The bedplate has a mass of 4 tonne with the coefficient of friction between the bedplate and its base being 0.28. The torque that is applied to the jack is 120 Nm.

Calculate the efficiency of the operation. (16)

8. A simply supported beam is loaded as shown in Fig Q8. The beam is solid and of square section of side length 100 mm.

Calculate EACH of the following:

(a) the maximum stress due to shear; (4)

(b) the maximum stress due to bending; (4)

(c) the point of contraflexure. (8)

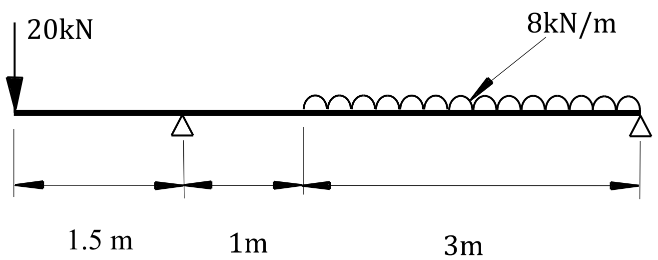

Fig Q8

9. A solid steel shaft 70 mm diameter is connected to a hollow steel shaft of 70 mm diameter by a shear pin of 8 mm diameter fitted diametrically through the solid and hollow shafts. The shafts rotate at 750 rev/min.

Calculate EACH of the following:

(a) the maximum power that can be transmitted by the pin if the shear stress must not exceed 65 MN/m^2; (8)

(b) the minimum outside diameter of the hollow shaft so that the angle of twist does not exceed 0.1° per metre length when delivering the maximum power. (8)

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