GENERAL ENGINEERING SCIENCE I

Attempt ALL questions

Marks for each question are shown in brackets.

1. An equilateral triangle has an area of 2.68m^2.

    Calculate the length of the sides of the triangle. (8)

2. A rectangular sheet of metal, x cm by y cm, has squares of z cm cut from EACH corner. The sheet is then bent to form a tray of depth z cm.

    (a) Derive an expression for the contained volume of this tray. (4)

    (b) Calculate the volume of the tray using the expression derived from Q2(a) and the following values, $x = 6$cm, $y = 8$cm and $z = 1$cm. (4)

3. The following formula relates to acceleration, time and distance.

    $$a = 2\frac{(s - ut)}{t^2}$$

    (a) Transpose the formula to make u the subject. (4)

    (b) Find the value of u in km/h when $s = 90$m, $a = 9.81$ m/s^2 and $t = 2.75$s. (4)

4. Calculate the mass of a piece of steel tube 1.85m long having an outside diameter of 38mm and a tube wall thickness of 5.5mm. (10)

    Note: Steel is 7.7 times heavier than an equal volume of fresh water.

5. A uniform beam AB supported at each end is 7m long and has a mass of 2.15 tonne. A uniformly distributed load of 4kN/m run is applied from the A or left hand end over a length of 3m.

    Calculate the value of the reaction forces at points A and B. (8)

6. A box barge is 18m long x 6m beam and floats at a draught of 5m in water of density 1024kg/m^3. When a mass of 3 tonne, already on board, is moved 4m across the deck the barge heels by 1.3°.

Calculate the height of the transverse metacentre M above the keel given that KG = 2m. (8)

Note: m × d = Δ GM tan θ

7. An observation tank is 4m long x 4m wide x 5m deep and contains liquid of density 1006kg/m^3 to a depth of 4.3m.

A square glass viewing port, 0.5m x 0.5m, is fitted in the centre of one side.

Calculate EACH of the following:

(a) the hydrostatic pressure on the bottom edge of the glass viewing port; (4)

(b) the hydrostatic force on the glass. (4)

8. A vessel has an underwater volume of 2439m^3 in water of density 1025kg/m^3 with KG = 3.95m.

Two cylindrical tanks 5m diameter and 12m long are located symmetrically about the centre line and are now filled with liquid having a density of 1018kg/m^3.
KG of tanks = 2.7m.

Calculate the shift in the centre of gravity G in the vessel in BOTH magnitude and direction. (8)

9. A flywheel has a diameter of 120mm and rotates at 98 rad/s.

Calculate EACH of the following:

(a) the angular velocity of the flywheel in revolutions per minute; (2)

(b) the linear velocity of a point on the rim in km/h. (6)

10. A worm and wheel lifting device has a single start worm which is operated by a belt driven pulley 150mm in diameter. The wheel has 50 teeth and the load drum diameter is 100mm.

Calculate EACH of the following:

(a) the movement ratio; (3)

(b) the effective pull in the belt if the efficiency is 35% and the load is 265kg. (5)

11. The coefficient of friction between a body of mass 40kg and a horizontal plane is 0.4.

Calculate EACH of the following:

(a) the least horizontal force to just cause motion;   (2)

(b) the acceleration of the body if the force is increased to 300N;   (4)

(c) the distance the body moves in 5 seconds from rest under the action of the accelerating force.   (4)

12. A hole 22mm in diameter is to be punched through a piece of plate 25.4mm thick.

Calculate the load in the punch given that the shear strength of the plate material is 400N/mm^2.   (8)