GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets.

Section A

1. (a) State the characteristic gas equation in both of its forms. (2)

   (b) A gas whose original pressure, temperature and volume were 150 kPa, 0.15 m^3 and 30°C respectively is compressed until its new temperature and pressure are 70°C and 800 kPa.

   Determine EACH of the following:

   (i) the new volume of the gas; (3)

   (ii) the mass of the gas. (3)

   Note: R = 0.29 kJ/kgK

2. A quantity of gas whose original volume and temperature are 0.2 m^3 and 303°C respectively is cooled at constant pressure until its volume becomes 0.1 m^3. The gas is then heated at constant volume until its pressure is doubled.

   Determine EACH of the following:

   (a) sketch the processes on a pressure-volume diagram; (2)

   (b) the temperature of the gas after the initial cooling process; (3)

   (c) the temperature after the heating process. (3)

3. 0.5 kg Benzene (C_6H_6) is completely burned in 30% excess air.

   Calculate EACH of the following:

   (a) the mass of carbon dioxide in the exhaust gases of the fuel; (4)

   (b) the mass of nitrogen in the exhaust gases per kg of fuel. (4)

4. (a) State TWO desirable properties of refrigerants. (1)

(b) In a vapour compression refrigeration plant, briefly explain EACH of the following:

(i) under-cooling and its effect; (2)

(ii) the cause of the low pressure side into which expansion occurs through the TEV; (2)

(iii) How the refrigerant flow rate is controlled. (3)

5. State and describe the THREE modes of heat transfer, giving an example of each. (9)

6. A 2 stroke diesel engine is tested over a 24 hour period and uses 18 tonnes of fuel. The power of the engine is tested using a dynamometer which gives a steady state torque reading of 50 kNm at 800 rpm. The mechanical efficiency was later found to be 87%.

Calculate EACH of the following:

(a) the brake power; (3)

(b) the indicated specific fuel consumption; (3)

(c) the brake thermal efficiency. (3)

Note: the calorific value of the fuel = 44 MJ/kg

10. A conductor with an effective length of 500 mm and a diameter of 12.5 mm is carrying a current of 45 A at right angles to a magnetic field. The force on the conductor is 7 N.

Calculate EACH of the following:

(a) the flux density; (4)

(b) the magnetic flux. (4)

11. A section of a water retaining wall with a gate at the bottom is shown in Fig Q11. The gate is 0.7 m wide and is hinged at point A.

Determine EACH of the following:

(a) the thrust force on the gate when the water level is 3.2 m; (4)

(b) the minimum force, F, required at the bottom of the gate to keep the gate closed if the thrust force acts at a point 0.02 m below the gate centroid. (4)

Note: density of water is 1020 kg/m^3

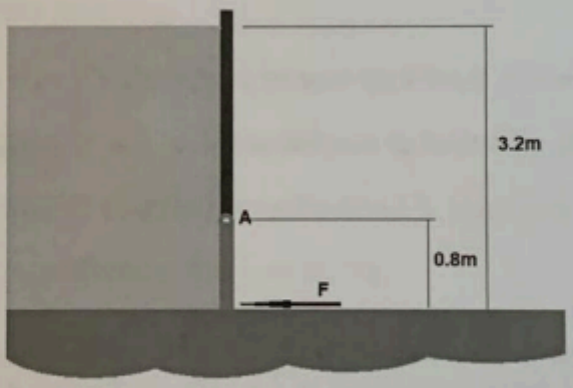

Fig Q11

12. A ship, initially upright, has a mass, M, of 8000 tonnes, KM is 8.6 m and KG is 8 m. During bad weather a piece of deck cargo was lost overboard which had a KG of 10 m and was 8 m from the centreline, this resulted in a list of 3°.

Determine EACH of the following:

(a) the mass of cargo lost overboard; (5)

(b) the new KG of the vessel after the loss of cargo; (4)

(c) the new GM after the loss of cargo. (1)