GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets.

Section A

1 A perfect gas occupies 0.08 m^3 at 3 bar and 30°C. It is compressed to a volume of 0.01 m^3 while its pressure rises to 35 bar.

Determine EACH of the following:

(a) the mass of the gas; (4)

(b) the final temperature of the gas. (4)

Note: $R = 0.28\ kJ/kgK$.

2 (a) Define EACH of the following: (2)

(i) Specific Enthalpy of Evaporation; (2)

(ii) the Enthalpy of Fusion.

(b) A 1.5 kg block of ice at -10°C is heated until it becomes water at 25°C. (4)

Calculate the total heat energy required.

Note: $C_{ice} = 2.11\ kJ/kgK$, $C_{water} = 4.18\ kJ/kgK$,
$h_{fusion} = 335\ kJ/kg$.

3. The following parameters may be determined during the analysis of a diesel engine.

Define EACH of the following terms and state a formula for calculating the values of each:

(a) indicated power, indicating reason for variations between 2 & 4 stroke cycles; (2)

(b) shaft power; (2)

(c) engine mechanical efficiency indicating reasons for losses; (2)

(d) power loss to exhaust. (2)

4. A steel steam pipe is 35 m long at 15°C. When in use, it carries steam at 350°C.

(a) Calculate the extension of the pipe in millimetres. (4)

(b) Explain one practical method used in shipboard piping to accommodate this expansion. (4)

Note: Coefficient of thermal expansion_{steel} = 12 x10^{-6} /°C.

5. Butane (C_4H_{10}) is completely burned in 30% excess air by mass.

Determine EACH of the following:

(a) the balanced chemical equation for stoichiometric combustion; (2)

(b) the mass of air required to burn 5kg of Butane; (2)

(c) the mass of carbon dioxide in the exhaust gases per kg of fuel; (2)

(d) the mass of nitrogen in the exhaust gases per kg of fuel. (2)

6. (a) Sketch a water cooled vapour compression refrigeration cycle on a P-h diagram indicating the relevant heat and workflows. Also indicate sub-cooling and superheating at some points in the cycle. (4)

(b) For the 4 key component exit points in the refrigeration circuit in Question 6(a), state the physical condition of the refrigerant including relative temperature and pressure. (4)

(c) Discuss the impact of a sudden increase in cooling water temperature on the circuit in Question 6(a) assuming fluid flow rates remain unchanged. (2)

Section B

7. A resistor of 10 Ω is connected in series with a resistor of 20 Ω to a 12 V supply.

Determine EACH of the following:

(a) total resistance; (2)

(b) current in the circuit; (2)

(c) voltage across each resistor. (4)

8. The tungsten filament of a lamp has a resistance of 1500 ohms at 2200°C.

(a) determine its resistance at a room temperature of 20°C; (5)

(b) calculate the current variation from an initial "cold" current surge if connected to a 230V supply. (3)

Note: temperature coefficient of resistance of tungsten = 0.005 /°C.

9. (a) State how the resistance of metals change as their temperature decreases. (2)

(b) Give an example of where the changing property described in Q9(a) is used. (2)

(c) Determine the total resistance across a, b in the circuit shown in FIG Q9. (4)

(d) Determine the current across the 50 Ω resistor in the circuit shown in FIG Q9 for a 48 volt supply. (2)

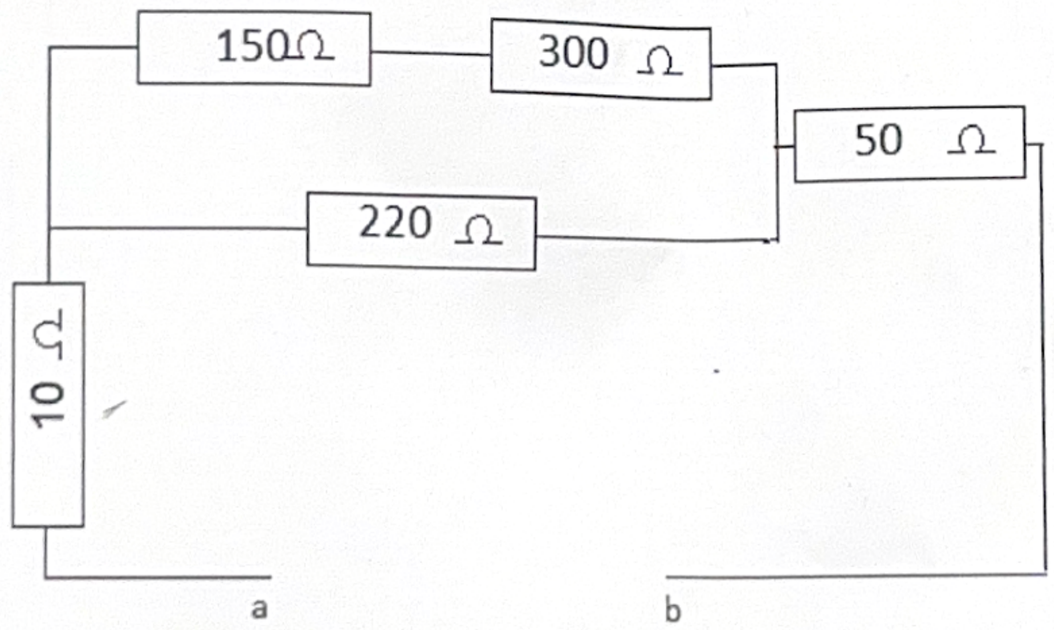


FIG Q9

10. (a) State Faraday's Law. (3)

(b) A coil of 800 turns is linked by a flux of 10 mWb. If the flux is reversed in 0.02 seconds, find the average induced EMF. (5)

11. A ship of 10000 tonnes displacement has a rectangular fuel tank 15 m long, 12 m wide and 4 m deep. The tank is full of fuel oil with a density of 900 kg/m^3 and the tank bottom is 1.2 m above the keel. The KG of the vessel is 6.2 m when the tank is full.

Calculate the new KG after all of the oil has been used. (8)

12. A rectangular river dam is 40 m wide. When flooded to its top edge with water, the total thrust on the dam is measured at 45 MN.

Calculate the height of the dam.

Note: density of water = 1000 kg/m^3. (8)