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B.E DEGREE EXAMINATIONS: APRIL/MAY 2012

Sixth Semester

MECHATRONICS ENGINEERING

MCT116: Thermodynamics and Heat Transfer

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. First law of thermodynamics deals with

   a) Enthalpy b) Entropy c) Energy d) Mass Transfer

2. A system comprised of a single phase is called

   a) Homogeneous b) closed c) open d) isolated

3. Theoretical Cycle, practically impossible is

   a) Otto cycle b) Diesel cycle c) Carnot cycle d) Brayton cycle

4. Jet engine uses which of the following cycle

   a) Rankine cycle b) Carnot cycle c) Brayton cycle d) Sterling cycle

5. The law associated with conduction is

   a) Stefan Boltzmann law b) Newton's law c) Fourier law d) Fick's law

6. What is the unit of thermal conductivity?

   a) W/m^2K^4 b) W/m^2K c) W/mK d) m^2K/W

7. What is the value of emissivity of Black Body?

   a) 0 b) 1 c) ∞ d) -1

8. Stefan Boltzmann law is expressed as

   a) $Q=\sigma AT^4$ b) $Q=\sigma A^2 T^4$ c) $Q=AT^4$ d) $Q=A\sigma T^2$

9. The general solution of $D_{AB} (d^2C_A/dx^2) – k_1C_A = 0$ is

   a) $C_A=C_1\cosh mx+C_2\cosh mx$ b) $C_A= C_1\sinh mx+C_2\cosh mx$

   c) $C_A=C_1\cosh mx+C_2\sinh mx$ d) $CA= C_1\sinh mx+C_2\sinh mx$

10. The mass concentration of a species A, ρ_A , is defined as the mass of A per

    a) unit mass b) unit volume c) unit density d) unit pressure

PART B (10 x 2 = 20 Marks)

11. Differentiate between closed and open systems.

12. Define the term Reversibility.

13. Draw P-V and T-S diagram for Otto cycle.

14. Define the term knocking.

15. Write the general differential equation of heat conduction.

16. State the Fourier's law of heat conduction.

17. What is Grey Body Radiation?

18. Distinguish between Natural and Forced convection.

19. Define convective mass transfer.

20. What do you meant by emissivity?

PART C (5 x 14 = 70 Marks)

21. a) 0.2 m^3 of air at 4 bar and 130^0C is contained in a system. A reversible adiabatic expansion takes place till the pressure falls to 1.02 bar. The gas is then heated at constant pressure till enthalpy increases by 72.5 kJ. Calculate:

(i) The work done

(ii) The index of expansion, if the above processes are replaced by a single reversible polytropic process giving the same work between the same initial and final states.

Take C_p= 1 kJ/kg K, C_v = 0.714 kJ/kg K.

(OR)

b) Derive the basic relations for

(i) Reversible adiabatic process (7)

(ii) ISO thermal Process (7)

22. a) Represent the Otto cycle on P-V and T-S diagrams, Derive an expression for its air standard efficiency in terms of volume ratio. Is this efficiency lower than carnot efficiency?

(OR)

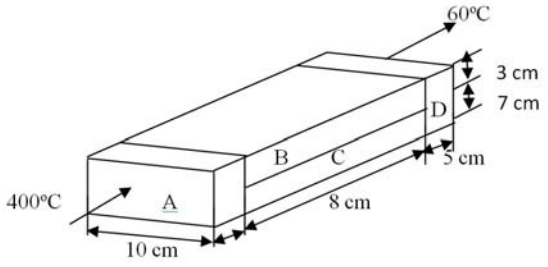
b) Find the heat flow rate through the composite wall as shown in figure. Assume one dimensional flow

k_A = 150 W/m^0C,

k_B = 30 W/m^0C,

k_C = 65 W/m^0C and

k_D = 50 W/m^0C.



23. a) A two-pass surface condenser is required to handle the exhaust from a turbine developing 15 MW with specific steam consumption of 5 kg/kWh The condenser vacuum is 660mm of Hg when the barometer reads 760 mm of Hg. The mean

velocity of water is 3 m/s, water in 4^0C less than the condensate temperature. The quality of exhaust steam is 0.9 dry. The overall heat transfer coefficient based on outer area of tubes is 4000 W/m^{20}C. The water tubes are 38.4 mm in outer diameter and 29.6 mm in inner diameter. Calculate the following:

(i) Mass of cooling water circulated in kg/min,

(ii) Condenser surface area,

(ii) Number of tubes required per pass, and

(iv) Tube length.

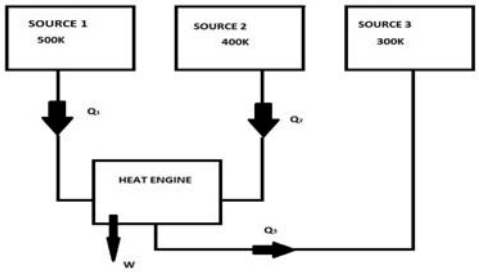
(OR)

b) A body at 1100^0C in black surroundings at 550^0C has an emissivity of 0.4 at 1100^0C and an emissivity of 0.7 at 550^0C. Calculate the ratio of heat loss by radiation per m^2,

(i) When the body is assumed to be grey with □ = 0.4.

(ii) When the body is not grey.

24. a) The connections of a reversible engine to three sources at 500 K, 400 K and 300 K are shown in Figure. It draws 1500 kJ/min of energy from the source at 800 K and develops 200 kJ/min of work.



(i) Determine the heat interactions with the other two sources of heat

(ii) Evaluate the entropy change due to each heat interaction with the engine

(iii) Total entropy change during the cycle.

(OR)

b) Helium gas at 25^0C and a pressure of 4 bar is stored in a spherical silica container of 100 mm inside diameter and 3 mm wall thickness. What is the initial rate of leakage for the system?

25. a) The temperature of an airstream is to be measured, but the thermometer available does not have a sufficiently high range. Accordingly, a damp cover is wrapped around the thermometer before it is placed in the air stream. The thermometer reading is 22^0C. Estimate the true air temperature assuming it is dry at atmospheric pressure.

(OR)

b) Explain the following concepts.

(a) Diffusion mass transfer. (7)

(b) Steady state Molecular diffusion. (7)

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