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10MT71

Seventh Semester B.E. Degree Examination, Dec.2018/Jan.2019
Thermodynamics and Heat Transfer

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of Heat and Mass transfer data hand book permitted.***

PART – A

1 a. Define the following:
(i) Open system
(ii) Thermodynamic cycle.
(iii) Thermodynamic equilibrium. **(06 Marks)**

b. Distinguish between the following:
(i) Intensive and Extensive properties.
(ii) Microscopic and macroscopic description of matter.
(iii) Path function and point function. **(06 Marks)**

c. The readings t_A and t_B of two Celsius temperature thermometers A and B agrees at ice and steam point, but elsewhere are related by the equation $t_A = L + Mt_B + Nt_B^2$ where L, M, N are constants; when both thermo meters are immersed in a system of fluid. A registers 11°C while B registers 10°C. Determine the reading on A when B registers 37.4°C. **(08 Marks)**

2 a. Define work in thermodynamic point of view with example. **(04 Marks)**

b. Derive an expression for workdone in process $PV^n = C$ are represent on P-V diagram. **(06 Marks)**

c. A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to law $PV^2 = C$ until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the Piston retains its original position, heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the network done by fluid for initial volume of 0.05 m^3 represent on P-V diagram. **(10 Marks)**

3 a. State first law of thermodynamics for a clased system under going cyclic process and show internal energy is property of system. **(08 Marks)**

b. 10 kg of gas undergoes a process for which $P = \frac{1500}{V} - V^2$ where P is pressure in kPa and V is the volume in m^3. Initial volume is 5 m^3 and temperature is 200°C. The final volume is 10m^3 and temperature is $-100°C$. If $\frac{du}{dT} = (8T + 2)$ KJ/kgK. Find (i) Work done (ii) Change in internal energy (iii) Heat transfer. **(08 Marks)**

c. Write down the steady flow energy equation and indicate clearly the meaning of each term. **(04 Marks)**

4 a. State Clausius and Kelvin Plank statements of second law of thermodynamics. **(04 Marks)**

b. With the help of P-V diagram, explain Carnot cycle and its efficiency. **(06 Marks)**

c. Two reversible heat engines A and B arranged in series, A rejecting heat to B through an intermediate reservoir. Engine A receives 200 KJ at a temperature of 421°C from a hot source, while Engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B find (i) The intermediate temperature between A and B (ii) The efficiency of each engine (iii) The heat rejected to the cold sink. **(10 Marks)**

PART – B

5 a. Explain the modes of heat transfer with the corresponding basic equations. **(06 Marks)**

b. State the assumptions and derive three dimensional conduction equation in Cartesion coordinates. **(08 Marks)**

c. The wall of a house in cold region consists of three layers, an outerbrick work 15 cm thick, the inner wooden panel 1.2 cm thick, the intermediate layer is insulator of 7 cm thick. The K for brick and wood are 0.7 and 0.18 W/mK. The inside and outside temperature of wall are 21 and $-15^{\circ}C$. If insulation layer offer twice the thermal resistance of brickwall. Calculate (i) Heat loss per unit area (ii) K of insulator. **(06 Marks)**

6 a. What is the significance of critical thickness of insulation and explain. **(04 Marks)**

b. Define (i) Fin (ii) Fin efficiency (iii) Fin effectiveness. **(06 Marks)**

c. A stainless steel fin (K = 20 W/mK) having a dia of 20 mm and length of 0.1 m attached to a wall at 300°C. The ambient temperature is 50°C and convective heat transfer coefficient is 10 W/m^2K. The fin tip is insulated. Determine (i) the rate of heat dissipation from fin (ii) Temperature at fin tip. (iii) The rate of heat transfer from the wall area covered by the fin if fin was not used (iv) Heat transfer from the same fin geometry if the stainless steel fin is replaced by a fictitions fin with infinite thermal conductivity. **(10 Marks)**

7 a. With reference to fluid flow over a flat plate discuss the concept of velocity boundary layer with necessary sketch. **(06 Marks)**

b. Define and write physical significance of the following numbers:
(i) Nusselt number (ii) Prandtle number (iii) Grashoff number (iv) Reynolds number. **(08 Marks)**

c. A tube is 0.036 m outer dia and 40 cm length is maintained at 100°C. It is exposed to air at a temperature of 20°C. Determine the rate of heat transfer from the surface, when (i) Tube is vertical (ii) Tube is horizontal. **(06 Marks)**

8 a. State and explain,
(i) Kirchoff's law (ii) Stefan Boltzman law
(iii) Wein's displacement law (iv) Planck's law. **(08 Marks)**

b. Define the following : (i) Black body (ii) Emissivity (iii) Radiation shield. **(06 Marks)**

c. Two large parallel plates are at 1000 K and 800 K. Determine the heat exchange per unit area when (i) the surfaces are black (ii) the hot surface has an emissivity of 0.9 and cold surface has emissivity of 0.6. **(06 Marks)**

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