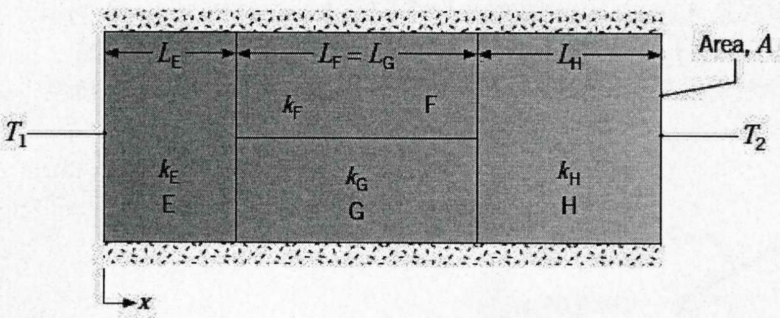
Make up Question paper
HTO
- 2024

Type: DES

Q1. Consider the system in the diagram given below and draw the thermal circuit, For case (*a*) it is presumed that surfaces normal to the *x* direction are isothermal. (*b*) it is assumed that surfaces parallel to the *x* direction are adiabatic.



(4)

Q2. Define Thermal Resistance. How does an extended surface improve the Heat transfer? The system is characterized by *steady-state* conditions if .... (3)

Q3. Develop an expression for the temperature distribution of a plane wall with thermal energy generation for steady-state, one-dimensional conditions. (3)

Q4. A plane wall is a composite of two materials, A and B. The wall of material A has uniform heat generation q=1.5*10^6 W/m^3, k_A =75 W/m.K, and thickness L_A= 50 mm. The wall material B has no generation with k_B =150 W/m.K and thickness L_B= 20 mm. The inner surface of material A is well insulated, while the outer surface of material B is cooled by a water stream with T=30°C and h=1000 W/m^2.K. Determine the temperature T_0 of the insulated surface and the temperature T_2 of the cooled surface. (4)

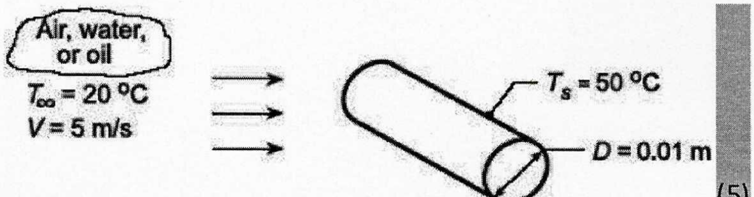
Q5. Experimental results for the local heat transfer coefficient hx for flow over a flat plate with an extremely rough surface were found to fit at the relation $h_x(x)= ax^{-0.1}$, where a is a coefficient (w/m^2. K) and x(m) is the distance from the leading edge of the plate. Develop an expression for the ratio of the average heat transfer coefficient for a plate to the local heat transfer coefficient. (3)

Q6. The hot products of combustion of a fire-tube boiler that flows through an array of thin-walled tubes are used to boil water flowing over the tubes. The overall heat transfer coefficient was 400W/m^2.K at the time of installation. After one year of use, the inner and outer tube surfaces are fouled with corresponding fouling factors of 0.0015 and 0.0005 m^2.k/W respectively. Is it necessary to schedule the cleaning the tube surfaces of the boiler? Justify your answer. (3)

Q7. A fan that can provide air speeds up to 50 m/s is to be used in a low-speed wind tunnel with atmospheric air at 25°C. If one wishes to use the wind tunnel to study flat-plate boundary layer behavior up to Reynolds numbers of Re_x= 10^8, what is the minimum plate length that should be used? At what distance from the leading edge would transition occur if the critical Reynolds number were $Re_{x,c}$ = 5X10^5 (v = 15.71×10^{-6}m^2/s)? explain about types of heat exchangers according to the flow arrangement. (3)

Q8. Consider the following fluids, each with a velocity of V = 5 m/s and a temperature of T=20°C, in cross flow over a 10-mm diameter cylinder maintained at 50°C: atmospheric air, saturated water, and engine oil. Calculate the rate of heat transfer per unit length, q, using the Churchill–Bernstein correlation.

PROPERTIES: *Table A.4*, Air (T_f = 308 K, 1 atm): $\nu = 16.69 \times 10^{-6}$ m^2/s, k = 0.0269 W/m-K, Pr = 0.706; *Table A.6*, Saturated Water (T_f = 308 K): ρ = 994 kg/m^3, $\mu = 725 \times 10^{-6}$ N-s/m^2, k = 0.625 W/m-K, Pr = 4.85; *Table A.5*, Engine Oil (T_f = 308 K): $\nu = 340 \times 10^{-6}$ m^2/s, k = 0.145 W/m-K, Pr = 4000.

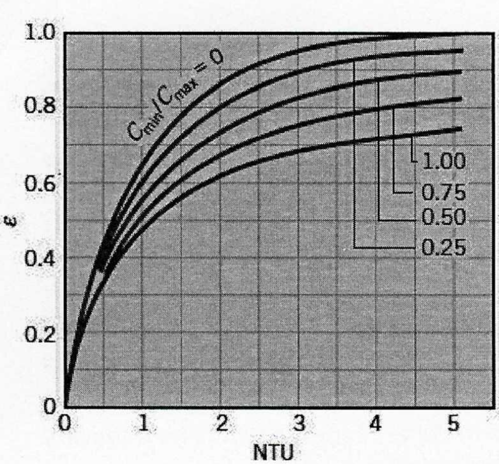


(5)

Q9. Describe about working of Falling Film evaporators. (2)

Q10. Explain types of condensation with the help of a neat diagram. Discuss about Nukiyama's experiment about identifying different regimes of pool boiling. Define pool and forced convection boiling. (5)

Q11. An automobile radiator may be viewed as a cross-flow heat exchanger with both fluids unmixed. Water, which has a flow rate of 0.05 kg/s, enters the radiator at 400 K and is to leave at 330 K. The water is cooled by air that enters at 0.75 kg/s and 300 K. (a) If the overall heat transfer coefficient is 200 W/m^2.K, what is the required heat transfer surface area? Solve using NTU method.



(3)

Q12. Explain total hemispherical emissive power, effectiveness of HEs , Spectral intensity, and Evaporation. (2)

Q13. Ethylene glycol flows at 0.01 kg/s through a 3-mmdiameter, thin-walled tube. The tube is coiled and submerged in a well-stirred water bath maintained at 25°C. If the fluid enters the tube at 85°C, what heat rate and tube length are required for the fluid to leave at 35°C? Neglect heat transfer enhancement associated with the coiling.

PROPERTIES: ***Table A-5*, Ethylene glycol (T_m = (85 + 35)°C/2 = 60°C = 333 K): c_p = 2562 J/kg·K, $\mu = 0.522 \times 10^{-2}$ N·s/m^2, k = 0.260 W/m·K, Pr = 51.3.**

(4)

Q14. A square isothermal chip is of width *w*= 5 mm on a side and is mounted in a substrate such that its side and back surfaces are well insulated, while the front surface is exposed to the flow of a coolant at T_∞= 15°C. From reliability considerations, the chip temperature must not exceed *T*= 85°C. If the coolant is air and the corresponding convection coefficient is *h*= 200 W/m^2 . K, what is the maximum allowable chip power? If the coolant is a dielectric liquid for which *h*= 3000 W/m^2. K, what is the maximum allowable power? (4)

Q15. An electric resistance heater is embedded in a long cylinder of diameter 30 mm. When water with a temperature of 25°C and velocity of 1 m/s flows crosswise over the cylinder, the power per unit length required to maintain the surface at a uniform temperature of 90°C is 28 kW/m. When air, also at 25°C, but with a velocity of 10 m/s is flowing, the power per unit length required to maintain the same surface temperature is 400 W/m. Determine and compare the convection coefficients for the flows of water and air. (2)