B.E. (Aeronautical Engineering) Semester Fifth (C.B.S.)

Heat Transfer Paper – I

P. Pages : 3 **KNT/KW/16/7370**

Time : Three Hours Max. Marks : 80

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Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Diagrams and chemical equations should be given whenever necessary.
11. Illustrate your answers whenever necessary with the help of neat sketches.
12. Use of non programmable calculator is permitted.
13. Use of Heat transfer data book & steam table is permitted.

1. a) Explain the different modes of heat transfer with appropriate expressions. **5**

b) A 160 mm diameter pipe carrying saturated steam is covered by a layer of lagging of thickness $40\,\text{mm}(K = 0.8\,w/m^{\circ}C)$. Later an extra layer of lagging 10 mm thick $(K = 1.2\,w/m^{\circ}C)$ is added. If the surrounding temperature remains constant and heat transfer coefficient for both the lagging material is $10\,w/m^{2\,\circ}C$, determine percentage change in the rate of heat loss due to extra lagging layer. **8**

OR

2. a) Define Biot and Fourier Nos. **2**

b) What is meant by lumped capacity? What are the physical assumptions necessary for a lumped capacity unsteady state analysis to apply? **2**

c) A slab of Aluminium 5 cm thick initially at 200ºC is suddenly immersed in a liquid at 70ºC for which the convection heat transfer coefficient is $525\,w/m^2K$. Determine the temperature at a depth of 12.5 mm from one of the faces 1 minute after the immersion. Also calculate the energy removed per unit area from the plate during 1 minute of immersion. Take $P = 2700\,\text{bar},\ Cp = 0.9\,kJ/kg-K,\ K = 215\,w/mK,\ \alpha = 8.4\times10^{-5}\,m^2/s$. **9**

3. Cylinder cans of 150 mm length and 65 mm diameters are to be cooled from an initial temperature of 20ºC by placing them in a cooler containing air at a temperature of 1ºC and pressure of 1 bar. Determine the cooling rates when the cans are kept in horizontal and vertical positions. **13**

OR

4, a) Why is higher heat transfer coefficient generally associated with dropwise condensation than with film condensation? **3**

b) Saturated steam at 0.1 bar condenses with a convection coefficient of $6800\,w/m^2-K$ on the outside of a brass tube having inner and outer diameters of 16.5 and 19 mm respectively. The convection coefficient for water flowing inside the tube is $5200\,w/m^2-K$. Estimate the steam condensation rate per unit length of the tube when the mean water temperature is 30ºC. **10**

5. a) For a laminar flow over a flat plate, how do the local heat transfer coefficient and the friction coefficient vary with distance from the leading edge? **6**

b) For flow over a flat plate of length L, the local heat transfer coefficient h_x is known to vary as $x^{-1/2}$, where x is the distance from the leading edge of the plate. What is the ratio of the average Nusslet No. for the enfire plate to the local Nusselt no. at $x = L(Nu_L)$? **7**

OR

6. a) Consider the flow of oil in a circular tube. How will the hydrodynamic and thermal entry lengths compare it the flow is laminar? How would they compare if the flow is turbulent? **4**

b) Engine oil at 100ºC and a velocity of 0.1m/s flows over both surfaces of a 1m long flat plate maintained at 20ºC. **9**

Determine

i) The velocity & thermal boundary thickness at the trailing edge.

ii) The local heat flux and surface shear stress at the trailing edge.

iii) The total drag force and heat transfer per unit area width of the plate.

Assume : engine oil $(T_f = 373K)$: $f = 864\,kg/m^3$; $\nu = 86.1\times10^6\,m^2/s$;
$k = 0.140\,w/m-k$; $Pr = 1081$.

7. a) Two large parallel plates with $\in = 0.5$ each, are maintained at different temperature and are exchanging heat only by radiation two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. **9**

b) For a diffusely emitting surface, how is the emissive power related to the intensity of the emitted radiation. **4**

OR

8. a) What does the view factor represent? When is the view factor form a surface to itself not zero? **3**

b) Radiation leaves the furnace of inside surface temperature 1500 K through an aperture 20 mm in diameter. A portion of the radiation is intercepted by a detector that is 1m from the aperture has a surface area of $10^{-5}\,m^2$, and is oriented as shown below (fig. 8 b). If the aperture is open, what is the rate at which radiation leaving the furnace is intercepted by the detector? If the aperture is covered with a diffuse, semitransparent material of spectral transmissivity $\tau_\lambda = 0.8$ for $\lambda \le 2\mu m$ and $\tau_\lambda = 0$ for $\lambda \ge 2\mu m$, what is the rate at which radiation leaving the furnace is intercepted by the detector? **10**

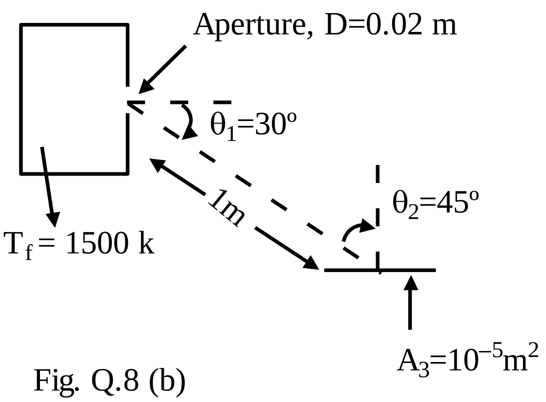

Fig. Q.8 (b)

9. a) Under what conditions can a counter flow heat exchanger have an effectiveness of one? What would be your answer for a parallel flow heat exchanger? **4**

b) Consider a very long concentric tube heat exchanger having hot and cold water inlet temperatures of 85 and 15ºC. The flow rate of the hot water is Twice that of the cold water. Assuming equivalent hot and cold water specifics heats, determine the hot water outlet temperature for the following modes of operations (a) Counter flow, b) Parallel flow. **10**

OR

10. a) Can temperature of the cold fluid rise above the inlet temperature of the hot fluid at any location in the heat exchanger? **4**

b) A concentric tube heat exchanger uses water, which is available at 15ºC, to cool ethylene glycol from 100ºC to 60ºC. The water and glycol flow rates are each 0.5 kg/s. What are the maximum possible heat transfer rate and effectiveness of the exchanger? Which is preferred a parallel flow or counter flow mode of operation? **10**

11. a) Discuss the working of gas turbine engine with the help of the functional components. **7**

b) Write short notes on : **7**
i) Mass transfer
ii) Ablative heat transfer

OR

12. A turbine installation consists a combustion chamber, into which oil is injected at constant pressure, a set of nozzle and impulse turbine. The air is taken in at 2.5 bars and 27ºC and it is the compressed to 4 bar with an adiabatic efficiency of 86%. Heat is added by the combustion to raise the temperature to 570ºC. The combustion efficiency of the nozzle and turbine is 85%. **14**
The calorific value of oil used is 10000 kcal/kg.
Find for air flow of 80 kg/min.
i) The A/F ratio of the turbine.
ii) The final temp. of the exhaust gases.
iii) Net horsepower of installation.
Given up to the point of entry to the turbine :
$Cp = 0.238;\ Cv = 0.17 kJ/kgk$ and after that point.
Take $Cp = 0.25 kJ/kg;\ Cr = 0.19 kJ/kgk$.

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