

Printed Pages : 4



NCH402

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 151410

Roll No.

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B. Tech.

(SEM. IV) THEORY EXAMINATION, 2014-15
HEAT TRANSFER

Time : 3 Hours]

[Total Marks : 100

Note: Attempt all questions. All questions carry equal marks.
 In case of numerical problems assume data wherever not provided

- 1 Attempt **any four** parts of the following: **5×4=20**
- How the conduction heat transfer differ from convective heat transfer?
 - How is the thermal conductivity of a material defined? What are its units?
 - Derive the expression for fin efficiency of a rectangular fin.
 - Derive the expression for conduction in 3 dimensions assuming unsteady heat flow.
 - Write a brief notes on the role of Reynolds number in heat transfer processes.
 - Discuss the physical significance of Prandtl number (P_r).

2 Attempt **any four** parts of the following: **5×4=20**

- (a) Consider heat exchange between a gas and a liquid phase separated by a wall. Which, one of the side resistances is likely to control the rate of heat exchange?
- (b) Describe natural convection and forced convection.
- (c) How is the boundary layer thickness defined?
- (d) What are the advantage and limitations of dimensional analysis?
- (e) By using Dimensional Analysis prove that $Nu = \Phi[R_e, P_r]$ for forced convection.
- (f) Water flows at 50°C inside a 2.5cm ID tube such that $h_i = 3,500 \text{ W/m}^2 \text{ }^\circ\text{C}$. The tube has a wall thickness of 0.8mm with $K = 16 \text{ W/m}^2 \text{ }^\circ\text{C}$. The outside of the tube losses heat by free convection with $h_o = 7.6 \text{ W/m}^2 \text{ }^\circ\text{C}$. Calculate the overall heat transfer co-efficient and heat loss per unit length to surrounding air at 20°C.

3 Attempt **any two** parts of the following: **10×2=20**

- (a) Explain the film wise condensation and drop wise condensation with Nusselt's analysis. Why, the higher heat transfer rate experienced in drop wise condensation than in film wise condensation.

- (b) Saturated steam at 95°C condenses on a vertical pipe of 0.04m outside diameter and 0.4 m length. The average heat transfer coefficient on tube is $11580\text{ W/m}^2\text{K}$. Assuming the condensate flow to be laminar, find the rate of steam condensation and check if the flow is laminar or not. Steam and condensate properties are:

Enthalpy of inlet steam = 2670 KJ/kg

Enthalpy of outlet condensate = 400 KJ/kg

Viscosity of condensate = $4 \times 10^{-4}\text{ Pa.s}$

Outside water temperature = 80°C

- (c) Explain the phenomenon of Nucleate boiling and film boiling. Discuss the effect of ΔT on 'boiling heat transfer coefficient during the entire boiling operation.

4 Attempt **any two** parts of the following: **$10 \times 2 = 20$**

- (a) Explain why radiation is usually treated as a surface phenomenon. A thin aluminum sheet with an emissivity of 0.1 on both sides is placed between two very large parallel plates that are maintained at uniform temperatures $T_1 = 800\text{K}$ and $T_2 = 500\text{K}$ and have emissivities 0.2 and 0.7 respectively. Determine the net rate of radiation heat transfer between the two plates and compare the result to that without shield.

- (b) Why do evaporators generally operate under vacuum? Discuss various methods of feeding in multiple effect evaporators with the help of neat sketches. Discuss their relative merits and demerits.
- (c) Evaporator at atmospheric pressure is fed at the rate of 10,000 kg/hr of 4% concentration of caustic soda. Thick liquor leaving evaporator contains 20% caustic soda. Find:
- Capacity of evaporator.
 - If 9000 kg of steam is fed. What will be the economy of an evaporator?
- 5 Attempt **any two** parts of the following: **10×2=20**
- (a) Explain versatility of shell and tube heat exchanger. Explain the principle and working of 2-4 shell and tube heat exchanger with neat labeled sketch.
- (b) It is desired to heat 230kg/hr of water from 35 to 93°C with oil ($C_p=2.1\text{kJ/kg.K}$) having an initial temperature of 175°C. The mass flow of oil is also 230 kg/hr. two double pipe heat exchangers are available:
- Exchanger 1 : $U=570\text{W/m}^2.\text{K}$ $A=0.47\text{m}^2$
- Exchanger 2 : $U=370\text{W/m}^2.\text{K}$ $A=0.94\text{m}^2$
- (c) Explain the classification and application of furnaces with neat sketches.