Question Bank

Subject Code: BTME-602
Subject Name: Heat Transfer

(Very short answer type questions)

1. Differentiate between laminar and turbulent flow.
2. Define thermodynamic boundary layer thickness.
3. Define hydrodynamic boundary layer. Which non dimensional number governs the relative magnitude of hydrodynamic and thermal boundary layers?
4. Define Grashoff Number. What are the forces associated with it?
5. Define transient state of heat transfer.
6. What is Critical Reynolds Number? State its approximate values for the flow over flat plate and circular tube.
7. What is the utility of extended surface?
8. State Buckingham pi theorem. What are repeating variables, how they are selected?
9. Why thin fins are preferred over a thick fin?
10. State Reyleigh's method of dimensional analysis.
11. Draw temperature profile of a parallel flow heat exchanger.
12. Define effectiveness and efficiency of a heat exchanger.
13. What is fouling factor of a heat exchanger? Write value for overall heat transfer coefficient considering fouling.
14. Define effectiveness and NTU of a heat exchanger.
15. What is the limitation of LMTD method?
16. What is the physical significance of LMTD?
17. What is the physical significance of NTU?
18. What is fouling factor?
19. How are heat exchangers classified?
20. List out the applications of heat exchangers.

(Short Answer Type Questions)

1. Air moving at 0.3 m/s blows over the top of chest-type freezer. The top of the freezer measures 0.9 x 1.5 m. and is poorly insulated so that the surface remains at 10°C. If the temperature of air is 30°C, calculate maximum heat transfer by forced convection from top of the freezer.
2. A steam pipe 50mm diameter and 2.5 m long has been placed horizontally and exposed to still air at 25°C. If the pipe wall temperature is 295°C, determine the rate of heat loss. At the mean temperature of 160°C, the thermo-physical properties of air are:
   Thermal conductivity = 3.64 x 10^{-2} W/m°C, Kinematic viscosity = 30.03 x 10^{-6} m^2/s.
   Prandtl Number = 0.682, β= 2.31 x 10^{-3} /K
3. Write short note on temperature measurement of flow by fins in natural convection.
4. Derive a mathematical expression of LMTD for parallel flow heat exchanger.
5. Derive a mathematical expression of LMTD for counter flow heat exchanger.
6. The temperature rise of cold fluid in a heat exchanger is 20°C and temperature drop of hot fluid is 30°C. The effectiveness of heat exchanger is 0.6. The heat exchanger area is 1m^2 and U=60 W/m^2°C. Find the rate of heat transfer?
7. Write short note on
   (a) Heat exchanger effectiveness and
   (b) Number of transfer units (NTU)
8. In a counter flow double pipe heat exchanger, water is heated from 250ºC to 650ºC by oil with a specific heat of 1.45kJ/kg-K and mass flow rate of 0.9kg/s. the oil is cooled from 2300ºC to 1600ºC. If overall heat transfer coefficient is 420W/m^2-K. Calculate the rate of heat transfer, mass flow rate of water and surface area of heat exchanger.
9. Describe the selection criteria of heat exchanger.
10. A cross-flow heat exchanger with both fluids unmixed is used to heat water (Cp= 4.18 kJ/kgK) from 500ºC to 900ºC, flowing at the rate of 1.0 kg/s. Determine the overall heat transfer coefficient if the hot engine oil (Cp= 1.9 kJ/kgK) flowing at the rate of 3 kg/s enters at 1000ºC. The heat transfer area is 20 m^2.

(Long Answer Type Questions)

1. Prove by dimensional analysis for natural convection, Nu= Φ (Gr, Pr).
2. Prove by dimensional analysis for forced convection, Nu= Φ (Re, Pr).
3. Estimate the heat loss from a vertical wall exposed to nitrogen at one atmospheric pressure and 40ºC. The wall is 0.2 m high and 2.5 m wide, and is maintained at 560ºC. The Nusselt number (Nu) over the height of the plate for natural convection is given by

$Nu = 0.13(Gr. Pr)^{1/3}$. The properties for nitrogen at a mean film temperature of (560 + 40)/2 = 300ºC are given as ρ= 1.142 kg/m^3 , k = 0.026 W/m K, v = 15.63 × 10^{-6} m^2/s, Pr = 0.713

4. Write short note on:

   (a) Hydrodynamic boundary layer and

   (b) Thermal boundary layer.

5. Write short note on:

   (a) Laminar Flow and

   (b) Turbulent Flow

6. Derive NTU of parallel flow heat exchangers.
7. Derive NTU of counter flow heat exchangers.
8. A hot fluid enters a heat exchanger at a temperature of 2000 C at a flow rate of 2.8 kg/sec (Sp. heat 2.0 kJ/kg-K) it is cooled by another fluid with a mass flow rate of 0.7 kg/sec (Sp. heat 0.4 kJ/kg-K). The overall heat transfer coefficient based on outside area of 20 m^2 is 250 W/m^2-K. Calculate the exit temperature of hot fluid when fluids are in parallel.
9. In a Double pipe counter flow heat exchanger 10000 kg/h of oil having a specific heat of 2095 J/kgK is cooled from 800ºC to 500ºC by 8000 kg/h of water entering at 250ºC. Determine the heat exchanger area for an overall heat transfer coefficient of 300 W/m^2K. Take Cp for water as 4180 J/kgK.
10. Hot oil (Cp = 2.09 kJ/kg K) flows through a counter flow heat exchanger at the rate of 0.7kg/s. it enters at 2000ºC and leaves at 700ºC. the cold oil (Cp = 1.67 kJ/kg K) exits at 1500ºC at the rate of 1.2 kg/s. Determine the surface area of the heat exchanger required for the purpose if the overall heat transfer coefficient is 650W/m^2K.