Subject: - Heat Transfer (5ME01)

Assignment 1

1. What is the importance of thermal diffusivity?
2. Deduce Poisson equation and Laplace equation from general 3-D heat conduction equation.
3. Write the thermal conductivity of metals, liquids and gases in decreasing order.
4. Write down general heat conduction equation for Cartesian co-ordinates and cylindrical co-ordinates.
5. Write down the three mode of heat transfer with these formulas.
6. Sketch the effect of temperature on thermal conductivity of most liquids and gases.
7. Explain the concept of driving potential as applied to heat transfer.
8. A steam pipe of O.D. 15 m is planned to be insulated to prevent the heat loss with asbestos (k = 0.1 W/m-K). The heat transfer co-efficient to the surrounding is 4.5 W/m^2-K. Give your advice about utility of asbestos as the insulating material in this case.
9. In slab of material 0.25 m thick and having a thermal conductivity 45 W/m-K, the temperature at x under steady state is given by $T = 100 + 200x - 400x^2$, when x is measured from one face in m. Determine the heat flow at x = 0 , x = 0.125 and x = 0.25 m and also temperatures and temperature gradients at these planes.
10. Prove that the maximum temperature at the centre of wire, carrying electrical current is given by the relation

    $T_{max.} = T_W + (J^2/4k.k_e)R^2$

    J = current density, k_e = electrical conductivity

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Assignment 2

1. What do you mean by fin effectiveness and efficiency?
2. Derive the expression for temperature distribution and heat flow for a very long fin.
3. Explain the following Dimensionless numbers with their physical significance.
   a. Grashof number
   b. Reynold number
   c. Prandtl number
   d. Stanton number
   e. Nusselt number
   f. Biot number

4. Show by dimensional analysis that data for forced convection may be correlated by an equation of the form : $Nu = \phi(Re,Pr)$
5. Derive the expression for the governing the differential equation of the fin.
6. An egg with mean diameter of 40 mm and initially at 20°C is placed in a boiling pan for 4 min. and found to be boiled to consumer taste. For how long should a similar egg for same consumer be boiled when taken from a refrigerator at 5°C? take following properties for egg K= 10 W/m°C, ρ = 1200 kg/m^3, C = 2 KJ/kg °C and h = 100 W/m^2 °C
7. What do you mean by lump system analysis? Give an example to explain
8. Derive the expression for Heat conduction in extended surface (fin surface) for insulated tip.
9. An aluminium alloy plate 400 X 400 X 4 mm^3 size at 200°C is suddenly quenched into liquid oxygen at - 183°C. Determine the time required for the plate to reach a temperature of -70°C. Assume ρ = 3000 kg/m^3, C = 0.8 KJ/kg °C and h = 20000 KJ/h-m^2 °C

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Assignment 3

1. Explain the pool boiling with neat and clean sketch.
2. Why drop wise condensation preferred over film wise condensation?
3. What is the condensation? When does it occur? Distinguish between mechanism of FWC and DWC.
4. Derive the energy equation for the forced convection in the thermal boundary layer.
5. Show by dimensional analysis that data for free convection may be correlated by an equation of the form : $Nu = \phi(Gr,Pr)$
6. Calculate the rate of heat loss from a human body which may be consider as a vertical cylinder 30 cm in diameter and 175 cm high is still air as 15°C. The skin temperature is 35°C. Neglect sweating and effect of clothing. The thermo physical properties of air at 25°C are-

   $\nu = 15.53 \times 10^{-3}\ m^2/s$

   $k = 0.026$ W/m-deg

   $\beta = 0.00335$/degree Kelvin

   Use the relation

   $Nu = (Gr \times Pr)^{0.33}$

7. Develop Nusselt equation of heat transfer for condensation of a vapor over a vertical flat plate as following-
   a) Velocity Distribution
   b) Mass flow rate
   c) Film thickness

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Assignment 4

1. Define the term overall heat transfer co-efficient.
2. What is mean by fouling factor? How does it affect the performance of the heat exchanger?
3. Under what conditions can a counter flow heat exchanger have an effectiveness of one?
4. What is the heat exchanger? Classify the heat exchangers.
5. Water at the rate of 68 kg/min is heated from 35 to 75°C by an oil having a specific heat of 1.9 kJ/kg°C. The fluids are used in a counter-flow double pipe heat exchanger and the oil enters the exchangers at 110°C and leaves at 75°C. The overall heat transfer co-efficient is 320 W/m^2 °C. Calculate the heat exchanger area.
6. Hot water having specific heat 4200 J/kg-K flows through heat exchanger at the rate of 4 kg/min. with an inlet temperature of 100°C. A cold fluid having a specific heat 2400 J/kg-K flows in at a rate of 8 kg/min. and with inlet temperature 20°C. Make calculations for maximum possible effectiveness if the flows through
   a. Parallel flow arrangement
   b. Counter flow arrangement
7. A counter flow heat exchanger is used to cool 2000 kg/hr of oil (c_p= 2.5 kJ/kg-k) from 105° C to 30°C by the use water entering at 15°C. if the overall heat transfer co-efficient is 1.5 kW/m^2-K . The exit temperature of the water is not to exceed 80°C. Calculate
   a. Water flow rate
   b. Surface area the heat exchanger
   c. Effectiveness of the heat exchanger

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Assignment 5

1. Write the short note following
   a. Black Body Surface
   b. Wien's Law
   c. Stefan-Boltzmann Law
   d. Gray Body surface

2. What is the solid angle? Derive the relationship between the emissive power and the intensity of radiation.
3. State the Lambert's law. Prove that for a diffuse black surface, the intensity of normal radiation is 1/π times of the total emissive power of the body.
4. Two infinite parallel plates exchange heat by radiation. The plates are respectively at temperature 480 K and 420 K, emissivities 0.6 and 0.8. Determine the heat flux between the plates.
5. Define the term 'Irradiation' (G) and 'Radiosity' (J). Prove that the following relation

$$G = \frac{J - \varepsilon e}{1 - \varepsilon}$$