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10AU65

Sixth Semester B.E. Degree Examination, June/July 2019
Heat and Mass Transfer

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of heat transfer data hand book is permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. State the laws governing three basic modes of Heat transfer. **(06 Marks)**

b. Derive general 3-dimensional conduction equation in cartesion co-ordinates system. **(08 Marks)**

c. A hollow sphere is made up of steel having thermal conductivity of 45W/m°C. It is heated by means of a coil of resistance 100Ω which carries a current of 5 amps. The coil is located inside a hollow space at the centre. The outer surface area of sphere is $0.2m^2$ and its mass 32kg assuming density of the spere material to be 8gm/cc. Calculate the temperature difference between the inner and outer surfaces. **(06 Marks)**

2 a. Clearly define i) Fin efficiency ii) Fin effectiveness. **(04 Marks)**

b. Derive an expression for rate of heat transfer and temperature distribution for a plane wall with variable thermal conductivity. **(08 Marks)**

c. An electrically heated sphere with diameter D = 6cm is exposed to an ambient at 25°C with a convection heat transfer co-efficient h = $20W/m^2°C$. The surface of a sphere is to be maintained at T_i = 125°C. Calculate the rate of heat loss from the sphere for

i) The sphere bare
ii) Sphere covered with an insulation (K = 1.0W/m°C) having a radius corresponding to a critical radius of the sphere.
iii) Percentage increase in rate of heat transfer. **(08 Marks)**

3 a. Obtain the expression for temperature distribution instantaneous heat transfer and total heat transfer for lumped heat analysis treatment of heat conduction problems. **(10 Marks)**

b. A 15mm diameter mild steel sphere (K = 42W/m°C) is exposed to cooling air float 20°C resulting in the convective co-efficient h = $120W/m^2°C$. Determine the following :

i) Time required to cool the sphere form 550°C to 90°C
ii) Instantaneous heat transfer rate for 2 mins after start of cooling.
iii) Total energy transferred from the sphere during first 2 mins.

Take for mild steel S = 7850 kg/m^3, C_p = 475 J/kg°C, α = 0.045 m^2/hr **(10 Marks)**

4 a. Distinguish between

i) Hydrodynamic and Thermal Boundary layers
ii) Laminar and turbulent flow. **(08 Marks)**

b. Air at 20°C and at atmospheric pressure floors over a float plate at a velocity of 3m/s. The plate is 30cm long and at 60°C calculate :

i) Velocity and Thermal Boundary layer thickness at 20cms from the leading edge.
ii) Average heat transfer co-efficient
iii) Total drag force on the plate per unit width. **(12 Marks)**

PART – B

5 a. Define clearly and explain the physical significance of
 i) Reynolds number
 ii) Prandtl number
 iii) Nusselt number
 iv) Stanton number **(12 Marks)**

b. Air at 2atm and 200°C is heated as it flows through a tube with a diameter of 25mm at a velocity of 10m/s. Calculate the heat transfer per unit length of tube if a constant heat flux condition is maintained at the wall and the wall temperature is 20°C above the air temperature all along the length of the tube. How much would the bulk temperature increase over a 3m length of the tube? **(08 Marks)**

6 a. Derive an expression for LMTD for a counter flow heat exchanger by stating the assumptions. **(10 Marks)**

b. Water to water heat exchanger of a counter flow arrangement has heating surface area of $2m^2$. Mass flow rates of hot and cold fluids are 2000kg/hr and 1500kg/hr respectively. Temperatures of hot and cold fluids at inlet are 85°C and 25°C respectively. Determine the amount of heat transferred from hot of cold water and their temperatures at the exit if the overall heat transfer co-efficient $U = 1400\ W/m^{2\circ}K$. **(10 Marks)**

7 a. With a neat diagram, explain the regimes of pool Boiling. **(10 Marks)**

b. Saturated water at $T_{sat} = 100°C$ is Boiled inside a copper pan having a heating surface area $5\times10^2 m^2$ which is maintained at uniform surface temperature $T_s = 110°C$. Calculate :
 i) The surface heat flux (q)
 ii) The rate of evaporation (m) **(10 Marks)**

8 a. State and explain the following :
 i) Stefan – Boltzman law
 ii) Kirchoff's law
 iii) Plank's law
 iv) Wein's displacement law. **(08 Marks)**

b. Two large parallel plates are at 1000°K and 800°K. Determine the heat exchange per unit area when
 i) The surfaces are black
 ii) The hot surface has an emissivity of 0.9 and the cold surfaces has emissivity of 0.6
 iii) A large plate of emissivity 0.1 is inserted between them

Also find the percentage reduction in heat transfer because of introduction of the large plate. **(12 Marks)**

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