Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – WINTER 2013

Subject Code: 161906 Date: 09-12-2013

Subject Name: Heat and Mass Transfer

Time: 02:30 pm to 05:00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Derive general heat conduction equation in cylindrical coordinate system. **07**

(b) Explain Frick's Law of Diffusion also explain its analogous with Newton's low of viscosity and Fourier's equation of heat-transfer **07**

Q.2 **(a)** In a counter flow heat double pipe heat exchanger ,water is heated from 25^0C to 65^0C by oil with specific heat of 1.45 kJ/kg K and mass flow rate of 0.9 kf/s. The oil is cooled from 230^0C to 160^0C. If overall Heat transfer coefficient is 420 W/m^2 ^{0}C. calculate following
(i) The rate of heat transfer
(ii) The mass flow rate of water , and
(iii) The surface area of heat exchanger

(b) Derive equation of logarithmic mean temperature difference for parallel flow Heat-exchanger. **07**

OR

(b) Derive an expression for heat transfer for an adequately long of Rectangular fin with insulated tip. **07**

Q.3 **(a)** Discuss the concept of thermal boundary layer in case of flow over the plates. How it differ from velocity boundary?. **07**

(b) A copper pipe is maintained at 50^0C. It is having dimension of 50 mm diameter and length 1 m . It is placed in atmosphere, where air is having temperature of 30^0C and flowing at speed of 3m/s. Use the co-relation $Nu = 0.023 (Re)^{0.805}$ calculate the heat loss from the pipe. **07**

OR

Q.3 **(a)** State the relationship between Nusselt, Grashoff and Prandtl number in case of heat transfer by nature convection from a vertical plate **07**

(b) A gas pipe is kept in an atmosphere of 20^0C. The radious of pipe is 3.75cm and is lagged with insulation thickness of 2.5cm. The emissivity of the surface is 0.9. The length of pipe is 6m. surface temperature ts=80^0C calculate (i) The total heat loss from pipe (ii) The overall heat transfer coefficient (iii) The heat transfer co efficient due to only radiation. **07**
The property of air at 50^0C are : $\rho = 1.092$ kg /m^3 ,
$k = 27.81 \times 10^{-3}$ W/m^0C, $\mu = 19.57 \times 10^{-6}$ kg/ms $\sigma = 5.67 \times 10^{-8}$ C_p = 1.007 kJ/kg ^{0}C for convection use co-relation $Nu = 0.53(Gr.Pr)^{1/4}$

Q.4 **(a)** Derive expression for Radiation Heat exchange between two concentric infinite long grey cylinder **07**

(b) The flat floor of a hemispherical furnace is at 800 K and has emissivity of 0.5. The corresponding value for the hemispherical roof are 1200 K and 0.25. Determine the net heat transfer from roof to floor.Take $\sigma_b = 5.67 \times 10^{-8}$. **07**

OR

Q.4 **(a)** What are Fourier and Biot Number? What is the physical significance of these number? **07**

Q.4 **(b)** A solid sphere of 1 cm made up of steel is at initially at 300^0Ctemperature. Properties of steel : k =60 WmK Density = 7800 kg/m^3, sp. Heat =434J/kg K Calculate the time required for cooling it up to 50^0Cin the following two cases **07**
(i) cooling medium is air at 25^0Cwith h = 20 W/m^2 K
(ii) cooling medium is water at 250C with h =100 W/m^2K

Q.5 **(a)** Explain term Boiling also explain various regimes of boiling **07**

(b) Explain with neat sketch Boundary Layer concept and show velocity boundary layer growth due to flow over plate **07**

OR

Q.5 **(a)** Define condensation process also explain film condensation and drop-wise condensation **07**

(b) Answer following **07**
(1) Define following terms related to mass transfer
(i) Prandtal Number Pr (ii) Schmidt number Sc
(iii) Lewis number Le (iv) Sherwood number Sn
(2) Define Heat exchanger Give classification of Heat exchanger

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