

**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 law 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°C to 65°C 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°C to 160°C. If overall Heat transfer coefficient is 420 W/m<sup>2</sup>°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°C. It is having dimension of 50 mm diameter and length 1 m. It is placed in atmosphere, where air is having temperature of 30°C 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°C. The radius 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  $t_s=80^\circ\text{C}$  calculate (i) The total heat loss from pipe (ii) The overall heat transfer coefficient (iii) The heat transfer coefficient due to only radiation. **07**

The property of air at 50°C are :  $\rho = 1.092 \text{ kg/m}^3$ ,  
 $k = 27.81 \times 10^{-3} \text{ W/m}^\circ\text{C}$ ,  $\mu = 19.57 \times 10^{-6} \text{ kg/ms}$   $\sigma = 5.67 \times 10^{-8}$   $C_p = 1.007 \text{ kJ/kg}^\circ\text{C}$  for convection use co-relation  $Nu = 0.53(\text{Gr.Pr})^{1/4}$

**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°C temperature. **07**  
Properties of steel :  $k = 60 \text{ W/mK}$  Density =  $7800 \text{ kg/m}^3$ , sp. Heat =  $434 \text{ J/kg K}$   
Calculate the time required for cooling it up to 50°C in the following two cases  
(i) cooling medium is air at 25°C with  $h = 20 \text{ W/m}^2 \text{ K}$   
(ii) cooling medium is water at 25°C with  $h = 100 \text{ W/m}^2 \text{ K}$
- 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) Prandtl Number  $Pr$  (ii) Schmidt number  $Sc$   
(iii) Lewis number  $Le$  (iv) Sherwood number  $Sh$   
(2) Define Heat exchanger Give classification of Heat exchanger

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