

GUJARAT TECHNOLOGICAL UNIVERSITY**B. E. Sem-IV Examination June- 2011****Subject code: 140503****Subject Name: Process Heat Transfer****Date: 10/06/2011****Time: 10.30 am – 01.00 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 the expression for temperature distribution in a straight fin of rectangular profile assuming insulated end. Mention the most common types of fins and sketch them. **07**
- (b) Prove that the temperature of a body at any time τ during Newtonian heating and cooling is given by the relation **07**
- $$t - t_a / t_i - t_a = \exp [- Bi Fo]$$

- Q.2** (a) Discuss various regimes in boiling and explain the condition for the growth of bubbles. Define critical heat flux and boiling crisis. **07**
- (b) Explain the concept of critical thickness of insulation. How do you decide the thickness of insulation of electric wires and steam pipes? **07**

OR

- (b) A furnace wall consists of steel plate 15 mm thick ($k = 17.5 \text{ W/mK}$) lined on inside with silica bricks 100 mm thick ($k = 2 \text{ W/m K}$) and on the outside with magnesia brick 210 mm thick ($k = 5.3 \text{ W/m K}$). The inside and outside surfaces of the wall are maintained at 700°C and 130°C respectively. Calculate the heat loss from the wall for unit area. If the heat loss is reduced to 2900 W/m^2 by providing an air gap between steel and silica bricks, calculate the necessary width of air gap if the thermal conductivity of air may be taken as 0.035 W/m K . **07**
- Q.3** (a) Define dirt factor. State the factors responsible for the fouling in heat exchanger. How does it affect the performance of a heat exchanger? **07**
- (b) Write notes on vapor recompression in evaporators. **07**

OR

- Q.3** (a) Discuss three basic modes of heat transfer with general laws of heat transfer. **07**
- (b) Discuss the physical significance of the following terms: **07**
- (i) Prandtl number, (ii) Stanton number, (iii) Biot number, (iv) Grashof number (v) Peclet number (vi) Fourier number (vii) Nusselt number

- Q.4** (a) Discuss working principle, advantages, disadvantages and limitations of Forced circulation evaporator. **07**
- (b) Why there is boiling point rise in evaporators? Write a brief note on duhring lines. **07**

OR

- Q.4** (a) State and prove Kirchhoff's law of radiation. What restrictive conditions are inherent in derivation of Kirchhoff's law? **07**
- (b) Define the following terms as applied to radiation heat transfer: (i) Specular and diffused reflection (ii) Emissive power and intensity of radiation (iii) black body. Grey body and reflectivity **07**

- Q.5 (a)** Derive an equation for Reynolds analogy. **07**
- (b)** A pipe carrying steam having an outside diameter of 20cm runs in a large room and is exposed to air at a temperature of 30 °C. The pipe surface temperature is 400 °C. Calculate the loss of heat to surrounding per meter length of pipe due to thermal radiation. The emissivity of the pipe surface is 0.8. What would be the loss of heat by thermal radiation if the pipe is enclosed in a 40 cm diameter brick conduit of emissivity 0.91? **07**

OR

- Q.5 (a)** (i) Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why? **04**
- (ii) Discuss the effect of noncondensable gases on condensation **03**
- (b)** Derive an expression for the logarithmic mean temperature difference in case of counter current flow double pipe heat exchanger. **07**
