

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- VIIth SEMESTER-EXAMINATION – MAY/JUNE- 2012****Subject code: 170102****Date: 08/06/2012****Subject Name: Theory of Heat Transfer****Time: 02:30 pm – 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 coordinates **07**
 (b) A 20 cm thick plane wall is built from the fire brick material whose thermal conductivity varies linearly with temperature $k = k_o(1+\beta t)$ where $k_o=0.8$ W/m-K and $\beta=0.0005/^\circ\text{C}$. The temp. of wall surface are 1000°C and 200°C . Determine the heat flux from the wall and temp. at 50 mm away from the higher temp. surface. **07**

- Q.2** (a) Derive equations of temperature distribution and heat dissipation for Fin insulated at tip. **07**
 (b) A turbine blade made of stainless steel ($k=29$ W/m-k) is 60 mm long, 500 mm² cross-sectional area and 120 mm perimeter. The temperature of the root of the blade is 480°C and it is exposed to products of combustion passing through the turbine at 828°C . If the film coefficient between the blade and the combustion gases is 320 W/m²-K, determine :(i) temperature at the middle of the blade (ii) rate of heat flow to the blade. **07**

OR

- (b) What is meant by thermal resistance? Explain the electrical analogy for solving heat problems. **07**

- Q.3** (a) Derive an expression for “Critical thickness of insulation” for a pipe. **07**
 (b) A wire of 7 mm diameter at a temperature of 65°C is to be insulated by a material having $k = 0.2$ W/m-K. Convection heat transfer coefficient = 8.5 W/m²-K. The ambient temperature is 20°C . For maximum heat loss, what is the minimum thickness of insulation? What is the heat loss per meter length, without insulation & with insulation? **07**

OR

- Q.3** (a) Explain lumped heat capacity method and state its assumptions. **07**
 (b) Light oil in a tank is maintained at a temp. of 35°C by means of a steam. Condensing in a 3.5 cm diameter coil immersed in the tank. The coil surface temp. is maintained at 95°C . Assuming the coil pipes to be horizontal cylinders determine the outside surface heat transfer coefficient using **07**

$$\bar{N}_u = 0.53 (\text{Gr.Pr})^{0.25}$$

The properties of oil are: $\rho = 885$ kg/m³ $k = 0.134$ W/mK $\beta = 7.2 \times 10^{-4}$ K⁻¹ $C_p = 2009$ J/kgK $\mu = 0.00827$ N

- Q.4** (a) Define Heat Exchanger Effectiveness & explain its significance. **07**

- (b) A test is conducted on cross-flow water-to-air radiator. The radiator has 40 tubes of internal diameter of 0.5 cm and length 65 cm in a closely spaced plate-finned matrix. Hot water enters the tubes at 90°C at the rate of 0.6 kg/s and leaves at 65°C. Air flows across the radiator through the interfin spaces and is heated from 20°C to 40°C. Determine the overall heat transfer coefficient based on inner surface area of tubes and take correction factor as 0.97 07

OR

- Q.4** (a) Draw and Explain boiling curve for water. Explain Nucleate boiling. 07
(b) Differentiate parallel flow and counter flow heat exchangers 07

- Q.5** (a) What is condensation and when does it occur? Distinguish between mechanism of filmwise condensation and dropwise condensation. Which type has the highest heat transfer coefficient and explain why this is so. 07
(b) Using dimensional analysis, obtain a general form of equation for Natural Convective heat transfer. 07

OR

- Q.5** (a) State & Explain the Wien Displacement Law. Show that $E_{b\lambda}$ will be maximum when $\lambda_{\max} T = 2900 \mu k$ 07
(b) For a black body maintained at 15°C, make calculations for 07
(i) Total emissive power
(ii) Wavelength at which the maximum monochromatic power occurs.
