

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII • EXAMINATION – WINTER • 2014****Subject Code: 170102****Date: 02-12-2014****Subject Name: Theory of Heat Transfer****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.
4. Tables for properties of air and water are permitted.

- Q.1 (a)** Derive general heat conduction equation in Cylindrical coordinates **07**
- (b)** A steam pipe pipe is covered with two layers of insulation, first layer being 3 cm thick and second 5 cm. the pipe is made from steel ($k = 58 \text{ W/m-K}$) having ID of 160 mm and OD of 170 mm. The inside and outside film coefficients are 30 and $5.8 \text{ W/m}^2\text{-K}$, resp. Draw electrical analogy for system and calculate the heat lost per meter of pipe, if the steam temperature is 300°C and air temperature is 50°C . The thermal conductivity of two materials are 0.17 and 0.093 W/m-K , resp. **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 ($k=29 \text{ W/m-k}$) is 60 mm long, 500 mm^2 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 $320 \text{ W/m}^2\text{-K}$, Determine rate of heat flow to the blade. **07**
- OR**
- (b)** What should be thickness of insulation on a small diameter wire and a steam pipe? Explain its physical significance in both the cases & derive an expression for the same. **07**
- Q.3 (a)** Using dimensional analysis, obtain a general form of equation for Natural Convective heat transfer. **07**
- (b)** A horizontal fluorescent tube which is 3.8 cm in diameter and 120 cm long stands in still air at 1 bar and 20°C . If the surface temperature is 40°C and radiation is neglected, what is heat transfer rate by convection? **07**
- Use $\bar{N}_u = 0.53 (\text{Gr.Pr})^{0.25}$
- OR**
- Q.3 (a)** Explain lumped heat capacity method and state its assumptions. **07**
- (b)** A titanium alloy blade of an axial compressor for which $k = 25 \text{ W/m-K}$, $\rho = 4500 \text{ kg/m}^3$ and $C_p = 520 \text{ J/kg-K}$ is initially at 60°C . The effective thickness of the blade is 10 mm and it is exposed to gas stream at 600°C , the blade experiences a heat transfer coefficient of $500 \text{ W/m}^2\text{-K}$. Estimate the temperature of blade after 1, 5, 20 and 100 seconds. **07**
- 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 **07**

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

OR

- Q.4 (a)** Write Von-karman integral momentum equation, for the hydrodynamic laminar boundary layer of fluid flowing over stationary plate. Using this equation, derive the expression for hydrodynamic boundary layer thickness considering the cubic velocity profile. **07**
- (b)** 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**
- Q.5 (a)** Define and explain Radiation shield and Radiation shape factor **07**
- (b)** Consider a tungsten filament light bulb whose filament is at a temp. of 2860 K. If the filament is considered to be grey, what fraction of the total energy emitted by the bulb is in visible wave-length spectrum from 0.35 to 0.7 μm . Comment on its effectiveness as a light source. If the filament is in rectangle in shape of size 5 mm x 2 mm and consumes 100 W, determine the efficiency of a bulb. Take $F_{0-\lambda_1} = 0.00032$ and $F_{0-\lambda_2} = 0.0667$ **07**

OR

- Q.5 (a)** Differentiate parallel flow and counter flow heat exchangers **07**
- (b)** Two large parallel planes with emissivity 0.6 are at 900 K and 300 K. A radiation shield with one side polished and having emissivity of 0.05, while the emissivity of other side is 0.4 is proposed to be used. Which side of the shield to face the hotter plane, if the temperature of shield is to be kept minimum? Justify your answer. **07**
