

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-VII (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2171911

Date: 29/04/2017

Subject Name: Advance Heat Transfer(Department Elective - I)

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) What is the difference between film and drop wise condensation? Which is a more effective mechanism of heat transfer? **07**
- (b) Explain the function of extended surfaces with classification. **07**
- Q.2** (a) Derive Temperature distribution relation for cylinder with Steady state and uniform heat generation. **07**
- (b) A chemical reaction takes place in a packed bed ($k=0.6 \text{ W/m } ^\circ\text{C}$) between two coaxial cylinders with radii 15 mm and 45 mm. the inner surface is at 580°C and it is insulated. Assuming the reaction rate of 0.6 MW/m^3 in the reactor volume, find the temperature at the outer surface of the reactor. **07**
- OR**
- (b) Obtain an expression for the steady state temperature distribution of two dimensional rectangular fin having constant thermal conductivity. The fin has thickness of L in Y -direction and is semi infinite in X - direction. The base temperature of fin and ambient temperature are t_0 and t_∞ respectively. Assume the heat transfer coefficient to be large **07**
- Q.3** (a) What is lumped system analysis? Derive equation for lumped parameter Analysis **07**
- (b) Water in a tank is to be boiled at sea level by a 1-cm-diameter nickel plated steel heating element equipped with electrical resistance wires inside. . Determine the maximum heat flux that can be attained in the nucleate boiling regime and the surface temperature of the heater surface in that case. **07**
- Take following properties of water at saturation temperature of 100°C
 $\rho_l = 957.9 \text{ kg/m}^3$, $\rho_v = 0.6 \text{ kg/m}^3$, $Pr_l = 1.75$, $h_{fg} = 2257 \times 10^3 \text{ J/kg}$, $\mu_l = 0.282 \times 10^{-3} \text{ kg/m.s}$, $C_{pl} = 4217 \text{ J/Kg } ^\circ\text{C}$ and $C_{sf} = 0.006$, $n=1$, $C_{cr} = 0.12$
- OR**
- Q.3** (a) Draw the boiling curve and identify the burnout point on the curve. Explain how burnout is caused. Why is the burnout point avoided in the design of boilers? **07**
- (b) An ordinary egg can be approximated as a 5-cm-diameter sphere with approximately 75% water. The egg is initially at a uniform temperature of 5°C and is dropped into boiling water at 95°C . Taking the convection heat transfer coefficient to be $h = 1200 \text{ W/m}^2 \text{ } ^\circ\text{C}$, determine how long it will take for the center of the egg to reach 70°C . Take thermal conductivity and diffusivity of eggs at the average temperature of 37.5°C ; $k = 0.627 \text{ W/m } ^\circ\text{C}$, $\alpha = 0.151 \times 10^{-6} \text{ m}^2/\text{s}$, $\lambda_1 = 3.0753$ and $A_1 = 1.9958$ **07**
- Q.4** (a) Define: Nusselt Number, Reynolds Number, Prandtl Number and give conventional generalised basic equation for forced convection using these numbers. **07**

- (b) Air at 20 °C and 1.013 bar flows over a rectangular container, with top surface 750 mm long in direction of flow and 1 m wide, at 35 m/s. determine the heat transfer from the top surface maintained at 60 °C. 07
- use following properties of air at average temperature of 40 °C:
 $\mu = 1.906 \times 10^{-5}$ kg/ms, $C_p = 1.007$ kJ/kg °C and $k = 0.0272$ W/m °C, and following correlations for finding average heat transfer coefficient
 $\bar{Nu} = 0.664 (Re_L)^{0.5} (Pr)^{0.33}$ if $Re_L \leq 5 \times 10^5$
 $\bar{Nu} = [0.037 (Re_L)^{0.5} - 850] (Pr)^{0.33}$ if $Re_L > 5 \times 10^5$
- OR**
- Q.4 (a) Explain briefly Flow boiling regimes. 07
- (b) Air at 2 bar and 40 c is heated as it flows through a 30mm diameter tube at a velocity of 10m/s. If the wall temperature is maintained at 100 °C all along the length of the tube, make calculations for heat transfer per unit length of the tube. Proceed to calculate the increase in bulk temperature over one meter length of the tube. Use $Nu = 0.023 (Re^{0.8})(Pr^{0.4})$ 07
- And take following thermo-physical properties of air at the average film temperature of 70 °C
 $\mu = 20.6 \times 10^{-6}$ Ns/m², $C_p = 1.009$ kJ/Kg °C, $k = 0.0297$ W/m °C and $Pr = 0.694$
- Q.5 (a) Explain all the different mechanisms of heat transfer from the human body (a) through the skin and (b) through the lungs. 07
- (b) Explain effect of radiation on measurement of temperature by a bare thermometer. A bare thermometer measuring the temperature of a gas body reads 600 K. The surrounding walls are 500K. The thermometer bulb is 3mm in dia and is spherical, its surface emissivity being 0.7. The convective heat transfer coefficient over the surface is 40 W/ m²K. Determine the gas temperature and error involved. 07
- OR**
- Q.5 (a) Write a short note on Emissivity and absorptivity of gases and gas mixtures 07
- (b) Consider a man of surface area 1.8 m² and convective heat transfer coefficient 4 W/m² °C wearing summer clothes whose thermal resistance is 0.93 m² °C/W. The man feels very comfortable (33 °C) while standing in a room maintained at 22°C with same air temperature. The air motion in the room is negligible. If this man were to stand in that room unclothed, determine the temperature at which the room must be maintained for him to feel thermally comfortable. Take indoor radiation heat transfer coefficient 4.7 W/m² °C 07
