Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI(OLD) – EXAMINATION – SUMMER 2019

Subject Code:161906 **Date:31/05/2019**

Subject Name: Heat And Mass Transfer

Time:10:30 AM TO 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 general heat conduction equation in Cylindrical coordinates with general notations **07**

(b) A metal plate of 4 mm thickness with thermal conductivity 95.5W/m ^{0}C is exposed to vapour at 100^{0}C on one side and cooling water at 25^{0}C on the opposite side. The heat transfer coefficients on vapour side and water side are 14500 W/m^2 ^{0}C and 2250 W/m^2 ^{0}C respectively. Determine **07**

i) The rate of heat transfer
ii) The overall heat transfer coefficient and
iii) Temperature drop at each side of heat transfer

Q.2 **(a)** Write a short note on critical thickness of insulation **07**

(b) Derive an expression for heat dissipation in rectangular fin of uniform cross-section which is insulated at tip. **07**

OR

(b) An egg with mean diameter of 4 cm and initially at 25 ^{0}C is placed in a boiling water pan for 4 minutes and found to be boiled. For how long should a similar egg be boiled when taken from a refrigerator at 5 ^{0}C? **07**

Q.3 **(a)** Define Reynolds number, Nusselt number and Prandtl number. Explain their importance in convection heat transfer. **07**

(b) Air at atmospheric pressure and 200 ^{0}C flows over a plate with a velocity of 5 m/s. The plate is 15 mm wide and is maintained at a temperature of 120 ^{0}C. Calculate the thicknesses of hydrodynamic and thermal boundary layers and the local heat transfer coefficient at a distance of 0.5 m from the leading edge. Assume that flow is on one side of the plate. Density of air is 0.815 kg/m^3, dynamic viscosity is 24.5*10^{-6} Ns /m^2 ^{0}C, Prandtl number is 0.7 and thermal conductivity is 0.0364 W/m ^{0}C

OR

Q.3 **(a)** Obtain a general form of equation for forced Convective heat transfer using dimensional analysis **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 ^{0}C. if the surface temperature is 40 ^{0}C and radiation is neglected, what is heat transfer rate by convection. **07**
Use equation Nu = 0.53 (Gr.Pr)$^{0.25}$. Kinematic viscosity is 15.6*10^{-6} m^2/s, Prandtl number is 0.701 and thermal conductivity is 2.673 *10^{-2} W/m K.

Q.4 **(a)** Describe briefly the factors considered for the selection criteria for heat exchanger. **07**

(b) In a certain double pipe heat exchanger hot water flows at a rate of 5000kg/h and gets cooled from 95 ^{0}C to 65 ^{0}C. At the same time 50000kg/h of cooling water at 30 ^{0}C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^2 K. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. For the both the streams , assume specific heat at constant pressure to be 4.2 kJ/kg K. **07**

OR

Q.4 **(a)** Explain the typical boiling curve for water at 1 atm pressure with a neat sketch. **07**

(b) Write short notes: **07**

i. Film condensation
ii. Dropwise condensation

Q.5 **(a)** State the following laws for radiation heat transfer **07**

i) Plank's law
ii) Wien's law
iii) Stefan Boltzmann law
iv) Kirchhoff's law
v) Lambert cosine law

(b) A furnace emits radiation at 2000 K treating it as a black body radiation, calculate the following: **07**

i) Monochromatic radiant flux density at 1 μ wavelength.
ii) Wavelength at which emission is maximum and corresponding radiant flux density.
iii) Total emissive power.

OR

Q.5 **(a)** State and explain Fick's law of diffusion. Express Fick's law in terms of partial pressures of gases **07**

(b) A 30 mm deep pan is filled with water to a level of 15 mm and is exposed to dry air at 40 ^{0}C. Assuming the mass diffusivity as 0.25*10^{-4} m^2/s, calculate the time required for all the water to evaporate. **07**

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