Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. - SEMESTER – VII • EXAMINATION – WINTER 2012

Subject code: 170102 Date: 31/12/2012

Subject Name: Theory of Heat Transfer

Time: 10.30 am - 01.00 pm Total Marks: 70

Instructions:

1. **Attempt any five questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Distinguish between the conduction, convection and radiation modes of heat transfer. **07**

(b) Establish the general differential equation in Cartesian co-ordinates for 3-D unsteady heat conduction by considering an infinitesimal volume element. Deduce there from the conduction equations for the following cases. **07**

(i) unsteady state 2-D flow with heat generation at uniform rate within material.

(ii) steady 1-D flow without heat generation.

Q.2 **(a)** Derive equations of temperature distribution and heat dissipation for infinite long fin. **07**

(b) Under what circumstances from the heat transfer point of view, will the use of finned walls be better? **07**

OR

(b) A wall of 0.6 m thickness is to be constructed from a material which has an average thermal conductivity of 1.5 W/mK. The wall is to be insulated with a material having an average thermal conductivity of 0.4 W/mK so that the heat loss per square metre will not exceed 1550 W. assuming that the inner and outer surface temperatures are 1200 ºC and 15 ºC respectively, calculate the thickness of insulation required. **07**

Q.3 **(a)** What is critical thickness of insulation on a small diameter wire or pipe, Explain its physical significance and derive an expression for the same **07**

(b) What is lumped capacity? What are the assumptions for lumped capacity analysis? **07**

OR

Q.3 **(a)** Distinguish between natural and forced convection heat transfer. **07**

(b) The surface of a 3 m long flat plate is maintained at 55 ºC. Water at a temp. of 10ºC and a velocity of 0.7 ms^{-1} flows over the surface. Calculate the heat transfer rate per unit width of plate. **07**

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) Calculate the heat transfer coefficient for water flowing through a 20 mm diameter tube with a velocity of 2.5 m/s. the average temperature of water is 50 ºC and surface temperature of the tube is slightly below this temperature. Assume the flow is turbulent. Use the equation $Nu_a = 0.023 Re^{0.8} Pr^{0.4}$ **07**

The properties at 50 ºC are given below:

Cp = 4182 J/kgK, K= 0.643 W/mK, ρ= 988 kg/m^3 and μ = 544 × 10^{-6} kg/ms

OR

Q.4 (a) Derive an expression for the Logarithmic Mean Temperature Difference for the flow in a counter flow heat exchanger **07**

Q.4 (b) How does drop-wise condensation differ from film condensation? Which mode of condensation is characterized by larger heat transfer rates? **07**

Q.5 (a) Describe the phenomenon of radiation from real surfaces. **07**

(b) What is the Stephen-Boltzmann Law? Explain the concept of total emissive power of a surface **07**

OR

Q.5 (a) State and explain Wien's displacement law and define Lambert's cosine law of radiation. **07**

(b) The total incident radiant energy upon a body which partially reflects, absorbs, and transmits radiant energy is 2200 W/m^2, Of this amount, 450 W/m^2 is reflected and 900 W/m^2 is absorbed by the body. Find the transmissivity τ ? **07**

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