Enrollment No: _____ Exam Seat No:_____

C.U.SHAH UNIVERSITY
Summer Examination-2018

Subject Name: Heat and Mass Transfer

Subject Code: 4TE06HMT1 **Branch: B.Tech (Mechanical)**

Semester: 6 **Date: 25/04/2018** **Time: 02:30 To 05:30** **Marks: 70**

Instructions:
(1) Use of Programmable calculator & any other electronic instrument is prohibited.
(2) Instructions written on main answer book are strictly to be obeyed.
(3) Draw neat diagrams and figures (if necessary) at right places.
(4) Assume suitable data if needed.

Q-1 **Attempt the following questions:** **(14)**

a) Differentiate between thermodynamics and heat transfer.

b) If the purpose of insulation is to reduce the heat transfer rate, then outside radius of tube (r_1) should be greater than radius (r_c). True or False?

c) Define overall heat transfer coefficient.

d) What is the function of Extended surfaces?

e) What is Natural convection?

f) What is dimensionless analysis?

g) Gives name of two accepted theory of radiation.

h) What is irradiation of a surface?

i) What is the value of Heat capacity ratio?

j) What is NTU measure?

k) What is bulk boiling?

l) In the case of film condensation the filmed formed on the surface offers thermal resistances to heat transfer due to low thermal conductivity. True or False?

m) Write statement of Fick's law.

n) Write name of modes for mass transfer.

Attempt any four questions from Q-2 to Q-8

Q-2 **Attempt all questions**

a) Derive the governing differential equation for temperature distribution of constant cross-sectional area fin. Hence derive expression for temperature distribution for long fin stating the assumption made. **(7)**

b) A 240 mm diameter steam pipe, 200 meter long is covered with 50 mm of high temperature insulation of thermal conductivity 0.092 W/m°C and 50 mm of low **(7)**

temperature insulation of thermal conductivity 0.062 W/m°C. The inner and outer surface temperatures are maintained at 340°C and 35°C respectively. Calculate: Total heat loss per hour, Heat loss per m^2 of pipe surface, Heat loss per m^2 of outer surface and Temperature between interfaces of two layers of insulation. Neglect heat conduction through pipe material.

Q-3 **Attempt all questions**

a) A wall 30 mm thick of size 5m x 3m made of red bricks (k=0.35W/mK). It is covered on both sides by the layers of plaster 2 cm thick (k=0.6W/mK). The wall has a window of size 1m x 2m. The 12 mm thick window glass is having thermal conductivity of 1.2 W/mK. Estimate the rate of heat flow through the wall. The temperatures of inner and outer faces are 10°C and 40°C respectively. Also draw electrical analogy for it. **(7)**

b) State any three important aspects related to critical radius of insulation. Derive the expression for critical thickness of insulation for cylinder. **(7)**

Q-4 **Attempt all questions**

a) A gas turbine blade made of stainless steel (k=32W/m°C) is 70 mm long, 500 mm^2 cross sectional area and 120 mm perimeter. The temperature of the root of blade is 500 °C and it is exposed to the combustion product of the fuel passing from turbine at 830°C. If the film coefficient between the blade and the combustion gases is 300 W/m^2°C, Determine: Temperature at the middle of blade and rate of heat flow from the blade. **(7)**

b) Derive the continuity equation for fluid flow in Cartesian coordinates based on the law of conservation of mass. **(7)**

Q-5 **Attempt all questions**

a) Derive equation for heat convection in Cartesian coordinates. **(7)**

b) Water (Cp=4.2 kJ/kg ^{o} C) is heated at the rate of 1.4 kg/s from 40 ^{o} C to 70 ^{o} C by an oil (Cp=2 kJ/kg ^{o} C) entering at 110 ^{o} C and leaving at 60 ^{o} C in a counter flow heat exchanger. If U = 350 W/m^2 ^{o} C, calculate the surface area required. Using the same entering fluid temperatures and the same oil flow rate, calculate the exit temperature of oil and water and the rate of heat transfer, when the mass flow rate of water is halved. **(7)**

Q-6 **Attempt all questions**

a) Derive a general relation for the radiation shape factor in case of radiation between two surfaces. **(7)**

b) Derive an expression for LMTD for counter flow heat exchanger stating the assumption made. **(7)**

Q-7 **Attempt all questions**

a) What is condensation? When does it occur? Differentiate between film wise and drop wise condensation. Which type has better heat transfer coefficient? In condenser design which type of condensation is usually selected and why? **(7)**

b) Express Fick's law in terms of partial pressure of gases. **(7)**

Q-8 **Attempt all questions**

a) Discuss in details the various regimes in boiling. **(7)**

b) State and explain Kirchhoff's law. **(7)**