Enrollment No: _____ Exam Seat No:_____

C. U. SHAH UNIVERSITY

Winter Examination-2019

Subject Name: Heat and Mass Transfer

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

Semester : 6 **Date : 12/09/2019** **Time : 10:30 To 01:30** **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)	What is the effect of Temperature on Thermal conductivity of liquids?	**01**
b)	What is the thermal conductivity?	**01**
c)	Write a statement of Fourier's Law of Heat conduction.	**01**
d)	What is convection?	**01**
e)	Why the convective heat transfer by forced convection is more than the heat transfer by natural convection.	**01**
f)	Why conduction and convection are not affecting heat transfer into the space?	**01**
g)	Write a statement of Kirchhoff's Law.	**01**
h)	The value of emissivity ranges is?	**01**
i)	The value of Prandtl number for air is about 0.7. True or False	**01**
j)	Write a name of modes for mass transfer.	**01**
k)	The value of heat capacity ratio between 0 to 1. True or False	**01**
l)	Example of pool boiling is the formation of steam in Babcok Wilcox boiler using forced convection. True or False	**01**
m)	The total amount of energy emitted from a surface per unit time per unit surface area is called ……	**01**
n)	Write a name of radiation properties.	**01**

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

Q-2 **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)	Derive general conduction equation in Cartesian coordinate and reduce the same for one dimensional heat conduction.	**(7)**

Q-3 **Attempt all questions**

a)	Define Mass Transfer and explain Modes of Mass Transfer.	**(7)**
b)	Explain Heat Exchanger according to geometry of construction with neat sketch.	**(7)**

Q-4 **Attempt all questions**

a) Indicate a composite system having heat transfer with series and parallel barriers. A composite wall for thermal insulation has a rectangular section 2m x 0.5 m and is made from timber 15 cm thick, cork board 30 cm thick and steel plate 5 cm thick. The temperature at the outside faces of timber and steel are 25 °C and 150°C respectively. How the heat transfer rate would be affected if aluminium roads of 4 cm diameter were inserted through each square meter of the composite wall. Neglect the effect of bolt heads and all lateral heat transfers. **(7)**

The thermal conductivities are:

Timber 0.12 W/mK, cork 0.035 W/mK, Steel 45 W/mK, and aluminium 205 W/mk.

b) The hot combustion gases at 150°C flow through a hollow cylinder pipe of 10 cm inner diameter and 12 cm outer diameter. The pipe is located in a space at 30°C and the thermal conductivity of the pipe material is 200 W/mK. Neglecting surface heat transfer coefficient, calculate the heat loss through the pipe per unit length and the temperature at a point halfway between the inner and outer surface. What should be the surface area normal to the direction of heat flow so that the heat transfer through the pipe can be determined by considering material of the pipe as a plane wall of the same thickness? **(7)**

Q-5 **Attempt all questions**

a) Derive the equation for dimensional analysis of natural convection. **(7)**

b) A Cylinder 5 cm in diameter and 1 m long is provided with 10 longitudinal straight fins of material having thermal conductivity 120 W/m-deg. The fins are 0.75 mm thick and protrude 12.5 m from the cylinder surface. The system is placed in an atmosphere at 40°C and the heat transfer coefficient from the cylinder and the fins to the ambient air is 20 W/m^2-deg. If the surface temperature of the cylinder 150°C, Calculate the rate of heat transfer and the temperature at the end of fins. **(7)**

Consider the fins to be of finite length.

Q-6 **Attempt all questions**

a) 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)**

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

Q-7 **Attempt all questions**

a) State and explain Lambert cosine law. **(7)**

b) Derive the expression for critical thickness of insulation for cylinder. **(7)**

Q-8 **Attempt all questions**

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

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