[Total No. of Printed Pages:2] **CODE NO:- Z-303**

FACULTY OF ENGINEERING & TECHNOLOGY

T.E (Mech) - Year Examination June – 2015

Heat Transfer

(Revised)

[Time: Three *Hours*] **[Max. Marks: 80]**

"Please check whether you have got the right question paper."

i) Solve any three questions from each sections
ii) Figures to the right indicate full marks
iii) Assume suitable data, if necessary.
iv) Use of non-programmable calculator and data book is allowed

SECTION A

Q.1 a) Derive general three-dimensional heat conduction equation in cylindrical coordinates 08

b) Explain electrical analogy as applied to conduction 05

Q.2 a) Calculate the rate of heat flow per m^2 through a furnace wall consisting of 200 mm thick layer of chrome brick, a center layer of kaolin brick 100mm thick and an outer layer of masonry brick 100mm thick. The unit surface conductance at the inner surface is 74W/m^2 ^{0}C and the outer surface temperature is 70^{0}c. the temperature of the gases inside the furnace is 1670^{0}C. What temperatures prevail at the inner and outer surface of the center layer? 08

Take: $K_{chrome\ brick} = 1.25w/m\,^0c; K_{kaolin\ brick} = 0.074w/m\,^0c; K_{masonry\ brick} = 0.555w/m\,^0c$ assume steady heat flow

b) Explain errors in the measurement of temperature in a thermo well 05

Q.3 a) Air at 20^{0}C is flowing over a flat plate which is 200 mm wide and 500mm long. The plate is maintained at 100^{0}C. Find the heat loss per hour from the plate if the air is flowing parallel to 500mm side with 2m/s velocity. What will be the effect on heat transfer if the flow is parallel to 200mm side 08

The properties of air at $\frac{100+20}{2} = 60^0C$ are $v = 18.97 \times 10^{-6}\ m^2s, k = 0.025W/m^0C$ and $\Pr = 0.7$ 05

b) Explain thermal boundary layer

Q.4 a) A thermometer pocket is inserted in a pipe of 150mm diameter carrying hot air. The pocket is made of brass ($k = 70\ W/m\ ^0c$). The inner and outer diameters of the pocket are 10mm and 15mm respectively. The heat transfer coefficient between the pocket and air is given by $Nu = 0.174(Re)^{0.618}$ 08

Take k (air) $= 0.035$ W/m$^0C$and depth of pocket = 50mm, Reynolds number (Re) of air flow = 25000. 05

Find the actual error in temperature measurement if the pipe wall is at 50^0C and air temperature is 150^0C

b) Differentiate between natural convection and forced convection

Q.5 a) Define and give the physical significance of the following non-dimensional numbers: 08

i) Nu ii) Gr iii) Pr iv) Re

b) Classify fins. Write the applications of fins 06

SECTION B

Q.6 a) Differentiate between the mechanism of film wise and drop wise condensation. 08
b) State and prove Kirchhoff's law 05

Q.7 a) Define and explain a) black body b) white body c) reflectivity 06
b) Two parallel rectangular surfaces $1m \times 2m$ are opposite to each other at a distance of $4m$. surfaces are black and at 100^0C and 200^0C . calculate the heat exchange by radiation between the two surfaces 07

Q.8 a) Derive an expression for the LMTD of a parallel flow heat exchanger 05
b) In a counter-flow double pipe heat exchanger , water is heated from 25^0C to 65^0C by an oil with a specific heat of $1.45kj/kg-k$ and mass flow rate of 0.9 kg/s. the oil is cooled from $230^0C\ to\ 160^0C$, if the overall heat transfer coefficient is $420\mathrm{W/m^{20}}C$, calculate the following: 08
i) The rate of heat transfer ,
ii) The mass flow rate of water
iii) The surface area of the heat exchanger

Q.9 a) Water ($C_{pc} = 4200\ J/kg^0C$) enters a counter – flow double pipe heat exchanger at 38^0C flowing at $0.076\ kg/s$. It is heated by oil ($C_p = 1880\ J/kg^0C$) flowing at the rate of $0.152\ kg/s$ from an inlet temperature of 116^0C. For an area of $1m^2$ and $U = 340W/m^{20}C$, determine the total heat transfer rate 06 07
b) Two large parallel with $\varepsilon = 0.5$ each, are maintained at different temperatures and are exchangeing heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer

Q.10 Write a short notes on <u>any two</u> 14
a) Radiation shield
b) Pool boiling
c) Types of heat exchanger