**Printed Pages : 4**

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**ECH402**

(Following Paper ID and Roll No. to be filled in your Answer Book)

**PAPER ID : 151406**

**Roll No.** | | | | | | | | | | |

# B.Tech

## (SEM. IV) THEORY EXAMINATION 2014-15

## HEAT TRANSFER

Time : **3** Hours] [Total Marks : **100**

Note: Attempt all questions. All questions carry equal marks. In case of numerical problems assume data wherever not provided

**1** Attempt any **four** parts of the following: **5x4=20**

(a) Define thermal conductivity. How do thermal conductivities of gases and liquids vary with temperature?

(b) What do you understand by combined heat transfer mechanism? Explain.

(c) Derive an equation for finding the critical insulation thickness for an electrical wire (or a steam carrying pipeline).

(d) Explain Wilson's method for determining film coefficient.

(e) Write down equation to calculate Nusselt number in laminar flow and explain all the terms.

(f) Draw a graphical diagram indicating co-current and counter current heat exchange and give expression for LMTD in both the cases.

**2** Attempt any **Two** parts of the following: **10x2=20**

(a) In a co-current heat exchanger an oil steam is cooled from 500 K to 400 K by water at an inlet temperature of 250 K and outlet temperature of 380 K. the exchanger has tubes of lm length each. Calculate the tube length if now we want to cool the oil to 390 K by keeping all the other parameters same.

(b) Prove that the heat transfer coefficient is independent of axial location for thermally fully developed flow of a fluid of constant properties through a pipe.

(c) A steel ball of 5 cm diameter at 500°C is suddenly placed in a controlled environment maintained at 100°C. Taking following data find the time required to maintain central point temperature of 150°C in the ball. Cp=450 J/kg °C, K=35 W/m-°C, h= 10 $W/m^2$-K, p=8000$kg/m^3$.

**3** Attempt any **Two** parts of the following: **10x2=20**

(a) Explain the significance of fin effectiveness and fin efficiency. A fin of circular X-section, diameter 2.5cm is placed in a furnace with large portion of it projecting in a room where temperature is 28°C. After steady state conditions prevail, the temperature at two points 10cm apart are found to be 110°C and 85°C. The convective heat transfer coefficient between the rod surface and surrounding air is 28.4 $W/m^2$ K. Determine the thermal conductivity of fin material.

(b) Differentiate between
(i) Hydrodynamic and thermal boundary layer thickness
(ii) Reynold's number and Grashoff's number

(c) Derive an expression for surface resistance of a gray body. Derive an expression for radiation heat exchange between small gray body in a large gray enclosure.

**4** Attempt any **Two** parts of the following: **10x2=20**

(a) A furnace is insulated with 230 mm thick fire brick, 115 mm of insulating brick, 230mm thickness of building brick. The inside temperature of furnace is 1213 K and outside temperature is 318 K. The thermal conductivities of fire brick, insulating brick, building bricks are 6.047, 0.581 and 2.33 W/m K Find out
(i) Heat loss per unit area.
(ii) Temperatures at interfaces

(b) Cold fluid is flowing through a double pipe heat exchanger at a rate of 15 $m^3$/hr. /hr. It enters at 303 K and is to be heated to 328 K. Hot thermal fluid is available at the rate of 21 $m^3$/hr at 383K.
Data:
1) Specific heat of thermal fluid = 2.72 KJ/kgK
2) Density of water = 1 gm/$cm^3$
3) Density of thermal fluid = 0.95 gm/$cm^3$
4) Specific heat of water = 4.187 KJ/kg K

Find out the log mean temperature difference for counter current type of flow by the following steps:
i) Outlet temperature of hot fluid
ii) Temperature difference at two ends
iii) LMTD

(c) Evaporator at atmospheric pressure is fed at the rate of 10,000 kg/hr of 4% concentration-of caustic soda. Thick liquor leaving evaporator contains 20% caustic soda. Find:
i) Capacity of evaporator.
ii) If 9000 kg of steam is fed. What will be the economy of an evaporator?

**5** Attempt any **Two** parts of the following: **10x2=20**

(a) How does filmwise condensation differ from dropwise condensation ? Which type has higher heat transfer coefficient and point out the reason thereof? An electric wire of 1.25mm diameter and 250 mm long is laid horizontally and submerged in water at 7 bar (saturation temperature of water at 7 bar is 165 °C). The wire has an applied voltage of 2.2V and carries a current of 330amperers. If the surface of wire is maintained at 200 °C, make calculation for the heat flux and boiling heat transfer coefficient.

(b) Explain why radiation is usually treated as a surface phenomenon. A thin aluminum sheet with an emissivity of 0.1 on both sides is placed between two very large parallel plates that are maintained at uniform temperatures $T_1$= 800K and $T_2$= 500K and have emissivities 0.2 and 0.7 respectively. Determine the net rate of radiation heat transfer between the two plates and compare the result to that without shield.

(c) Write short notes on following
(i) Heisler charts
(ii) Fouling factor
(iii) Classification of furnaces
(iv) pool boiling.

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