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**Registration No :** | | | | | | | | | | |

**Total Number of Pages : 02** **B.Tech**

**PME5I102**

**$5^{th}$ Semester Regular / Back Examination 2018-19**

**HEAT TRANSFER**

**BRANCH : MECH**

**Time : 3 Hours**

**Max Marks : 100**

**Q.CODE : E397**

**Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.**

**The figures in the right hand margin indicate marks.**

## Part- I

**Q1 Short Answer Type Questions (Answer All-10)** **(2 x 10)**

**a)** Give an example where all three modes of heat transfer are predominant.
**b)** Ice is a black body. Justify.
**c)** What do you mean by NTU and LMTD?
**d)** What is thermal resistance?
**e)** What do you mean by thermal boundary layer?
**f)** What are the generally accepted values of critical Reynolds number for a) flow over a flat plate b) flow in a tube?
**g)** What is the difference between Nusselt number and Biot number?
**h)** What do you mean by subcooled boiling?
**i)** Draw the laminar and turbulent velocity boundary layer for natural convection on a vertical plate.
**j)** What is the critical insulation radius when k=0.20 W/mK and h=5 W/m2K?

## Part- II

**Q2 Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

**a)** What is overall heat transfer coefficient? Deduce expression for this in composite wall having three different materials of three different thickness and thermal conductivities. Two different fluid having different fluid properties are passing over two outer surfaces of the composite wall.
**b)** Deduce the expression for Critical thickness of insulation in cylindrical pipe.
**c)** A 0.8 m high and 1.5 m wide double-pane window consists of two 4 mm thick layers of glass(k=78W/m K) separated by a 10 mm wide stagnant air space (k=0.026 W/mK). Determine the rate of heat transfer through this window and temperature of inside surface, when the room is maintained at 20°C and the out side air is at -10°C. take the convection coefficient on the inside and out side surfaces of the window as 10 and 40 W/m2K respectively. Find the overall heat transfer coefficient.
**d)** Write down the essential differences between forced convection and free convection heat transfer.
**e)** Experimental results for heat transfer over a flat plate with an extremely rough surface were found to be correlated by an expression of the form

$$Nu_x = 0.04\, Re_x^{0.9}\, Pr^{1/3}$$

Where Nux is the local value of the Nusselt number at a position x measured from the leading edge of the plate. Obtain an expression for the ratio of the average heat transfer coefficient between the leading edge and a location x to the local heat transfer coefficient at x.

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**f)** A fan that can provide air speeds up to 50 m/s is to be used in a low speed wind tunnel with atmospheric air at 25°C. If one wishes to use the wind tunnel to study flat plate boundary layer behavior up to Reynolds numbers of 108, what is the minimum plate length? At what distance from the leading edge would transition occur, if the critical Reynolds number is 5×105?

**g)** Draw the boiling curve and explain the different portions in it.

**h)** Differntiate between LMTD and NTU method

**i)** Explain about Kirchhoff's law, Planck's law, Wein's law and Stefan Boltzman law

**j)** What is radiation shield? Mention the formula for this in case of shield between two parallel plates and shield between two concentric cylinders.

**k)** Define fin effectiveness. How is it different from fin efficiency?

**l)** Differentiate between Film wise and drop wise condensation.

**Part-III**

**Long Answer Type Questions (Answer Any Two out of Four)**

**Q3** Derive the 3-D steady state general heat conduction equation in Cartesian coordinates and deduce the expressions for temperature distribution and heat dissipation in a straight fin of circular profile for the infinitely long fin case. **(16)**

**Q4** A stainless steel rod of outer diameter 1cm originally at a temperature of 3000C is suddenly immersed in a liquid at 1200C for which the convective heat transfer coefficient is 50W/$m^2$K.Determine the time required for the rod to reach a temperature of 1000C.Assume the density of steel 7800kg/m3,Specific heat as 450J/kgK and thermal conductivity 40W/mK. **(16)**

Derive the formulae used to solve the above problem.

**Q5** In the heat transfer relation Q=UAΔTlm for a heat exchanger, what is ΔTlm called? Derive the expression for parallel flow heat exchanger. **(16)**

A liquid (Cp=0.8 kJ/kg K) is entering a counter flow heat exchanger at 25°C at a rate of 2.5 kg/s. It is heated to 75°C by another fluid (Cp=1 kJ/kg K) with a flow rate of 2 kg/s entering at 1000°C. With these things remaining same, what will be percentage change in the area of heat exchanger if the fluid is heated up to 600°C instead of 750°C?

**Q6** A long duct of equilateral triangle section of side w=0.75 m has its surface 1 at 700 K, surface 2 at 1000 K, and surface 3 is insulated. Further, surface 1 has an emissivity of 0.8 and surface 2 is black. Determine the rate at which energy must be supplied to surface 2 to maintain these operating conditions. **(16)**