Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

PDDC - SEMESTER–VI. EXAMINATION – SUMMER 2016

Subject Code:X61903 **Date:06/05/2016**

Subject Name:Heat and Mass Transfer

Time:10:30 AM TO 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1	**(a)**	Write the most general form of three dimensional unsteady state heat conduction equation with heat generation. Hence obtain poisson's,fourier's and Laplace equations ,by specifying the required conditions. Explain the significance of the term thermal diffusivity.	**07**
	(b)	Derive an expression for the temperature distribution and heat transfer rate for a fin of infinite length.	**07**
Q.2	**(a)**	(i)Explain Biot number and lumped heat capacity approach.	**03**
		(ii)A steel ball of 5cm diameter at 450°C is suddenly placed in a controlled environment maintained at 100°C.Taking the following data, find the time required for the ball to attain a temperature of 150°C. C=450J/kg °C, k=35W/m K, h=10 W/m^2°C, ρ=8000kg/m^3	**04**
	(b)	A steel tube with 8 cm OD,6 cm ID and k=15W/mK,is covered with an insulation covering of thickness 2 cm and k=0.2W/mK.A hot gas at 300°C with hi=400 W/m$^{2\circ}$C flows inside the tube.The outer surface of insulation is exposed to cool air at 30°C with ho=50 W/m$^{2\circ}$C.Calculate overall heat transfer coefficient,Uo based on outer surface of insulation and heat loss from the tube for its 25 m length	**07**
		OR	
	(b)	A steel rod (k=30 W/mK) 1 cm in diameter and 5 cm long protrudes from a wall which is maintained at 100 $^\circ$C.The rod is insulated at its tip and is exposed to an environment with h=50 W/m$^{2\circ}$C and temperature =30 $^\circ$C.Calculate the fin efficiency, temperature at the tip of fin and the rate of heat dissipation.	**07**
Q.3	**(a)**	Derive the equation for LMTD in parallel flow heat exchanger.	**07**
	(b)	A simple parallel flow heat exchanger has cold fluid entering at 20°C and leaving at 40°C. The hot fluid enters at 100°C .The capacity ratio of the heat exchanger is unity. Determine % increase in heat exchanger capacity, if: (i) it is operated with counter flow arrangements (ii) it is operated with parallel flow with heat exchanger area doubled.	**07**

OR

Q.3 **(a)** An electrical heater of 1 m length and 5 cm diameter is to be placed in a room at 10°C.The heater surface is maintained at 270°C.Determine the rate of heat transfer from the heater if it is placed (i) in vertical position (ii) in horizontal position. **07**

The properties of air at mean temperature are as follows:
Thermal conductivity =0.035 W/m K
Kinematic viscosity =27.8.x 10^{-6} m^2/s
Prandtl numbe r= 0.684
The following relations may be used:

$$Nu_L = 0.13(Gr_L \Pr)^{1/3} \; for\, vertical\ cylinders$$

$$Nu_D = 0.53(Gr_D \Pr)^{1/4} \; for\, \text{horizontal}\ cylinders$$

(b) Using dimensional analysis show that heat transfer by force convection is given by Nu=f(Re,Pr). **07**

Q.4 **(a)** Explain Kirchhoff's law and wien's displacement law. **07**

(b) A cylindrical heater element with diameter=2 cm has emissivity=0.7.It is kept at 727°C.It is located in a large room whose walls are maintained at 27°C.Find the rate of radiant heat transfer per unit length from the heater towards the walls of the room.If the heater is enclosed in another pipe at 27°C,with diameter=200 mm and emissivity=0.2,what is the rate of radiant heat transfer? **07**

OR

Q.4 **(a)** Derive an expression for reduction in heat transfer by radiation when a radiation shield is inserted between two large parallel plates. **07**

Q.4 **(b)** Discuss various regimes of pool boiling. **07**

Q.5 **(a)** Explain mass transfer by diffusion, convection and phase change with suitable examples. **07**

(b) Explain physical significance of Nusselt Number,Grashof Number and Prandtl Number. **07**

OR

Q.5 **(a)** (i) State the factors which affect the convective heat transfer coefficient **02**

(ii)Discuss development of thermal boundary layer in circular pipe and bring out the concept of thermal entry region and fully developed thermal region **05**

(b) Explain film wise and drop wise condensation. **07**

The heat transfer rates in drop wise condensation are many times more than film wise condensation-Justify.

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