PAPER ID-410858

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B. TECH.
(SEM V) THEORY EXAMINATION 2021-22
Heat and Mass Transfer

Time: 3 Hours ***Total Marks: 70***

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt *all* questions in brief. **2 x 7 = 14**

a.	Define three different modes of heat transfer. Give a practical example where all three modes are occurring simultaneously.
b.	What is critical radius of insulation?
c.	What is lumped parameter analysis?
d.	What is effectiveness of fin?
e.	What is Reynolds number?
f.	Differentiate between condenser and evaporator as a heat exchanger.
g.	Define Nusselt and Prandtl Number.

SECTION B

2. Attempt any *three* of the following: **7x3=21**

a.	A furnace wall of thickness of 0.5 m having an average thermal conductivity of 1.4 W/mK. The wall is to be insulated with a material having thermal conductivity of 0.35 W/mK so that the heat loss will not exceed 1450W/m^2. Assuming that the inner and outer surface temperatures are 1200°C and 25°C respectively, Calculate the thickness of insulation required.
b.	Explain the significance of Biot number in lumped parameter analysis of unsteady state heat transfer.
c.	Show that for free convection the Nusselt no (Nu) is function of Prandtl no. (Pr) and Grashoff No. (Gr) by $Nu=C(Pr^m.Gr^n)$.
d.	Consider two large parallel plates, one at 1000K with emissivity 0.8 and other is at 300K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity as 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer as a result of radiation shield.
e.	State flicks law of diffusion. What are its limitations?

SECTION C

3. Attempt any *one* part of the following: **7x1=7**

a.	Derive the expression for general heat conduction equation in cartesian co-ordinate.
b.	A steel pipe line (k=50W/mK) of 100 mm I.D. and 110 mm O.D. is to be covered with two layers of insulation each having thickness of 50 mm. The thermal conductivity of first insulation material is 0.06 W/mK and that of the second is 0.12 W/mK. Estimate heat loss per meter length of pipe and the interface temperature between two layers of insulation when the temperature of the inside tube is 250°C and that of outside surface of the insulation is 50°C.

4. Attempt any *one* part of the following: **7x1=7**

a.	Derive the expression for temperature distribution and heat distribution in a straight fin of rectangular profile for an infinitely long fin.
b.	An aluminum alloy plate of 400mm x400mm x 4mm size at 200°C is suddenly quenched into liquid oxygen at -183°C. Starting from fundamentals or deriving the necessary expression determine the time required for the plate to reach a temperature of –70°C. Assume h=20000KJ/m^2hr°C, c_p=0.8 kJ/kg°C and ρ= 3000kg/m^3.

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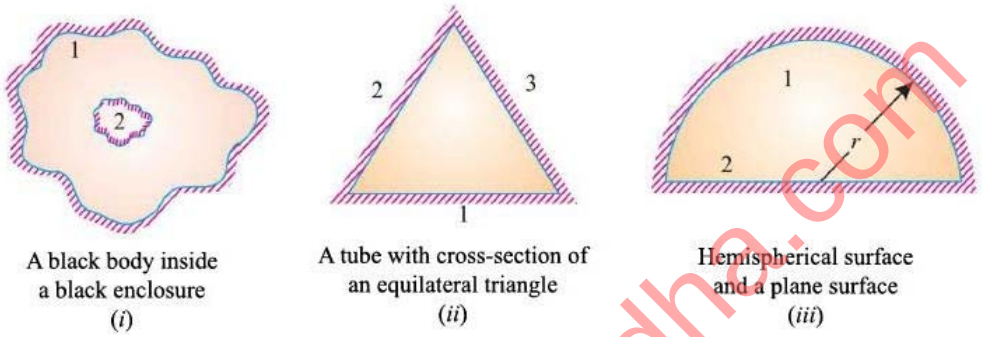
5. Attempt any *one* part of the following: 7x1=7

a.	Air at 20°C flows over a thin plate with a velocity of 3m/s, the plate is 2m long and 1m wide. Estimate the boundary layer thickness at trailing edge of the plate and total drag force experienced by the plate. Also calculate the mass flow of air which enters the boundary layer between x= 30cm and x=80cm. The physical properties of air at 20°C are: ρ=1.17 kg/m^3 and v=15 x 10^{-6} m^2/s, $Re_{x,c}$ =5 x 10^5
b.	Define the following term with expression: (i) Boundary Layer Thickness (ii) Displacement Thickness (iii) Momentum Thickness (iv) Energy Thickness

6. Attempt any *one* part of the following: 7x1=7

a.	Derive an expression for electrical network analogy for thermal radiation systems.
b.	Calculate the shape factors for the configuration shown in the figures below.  A black body inside a black enclosure (*i*) A tube with cross-section of an equilateral triangle (*ii*) Hemispherical surface and a plane surface (*iii*)

7. Attempt any *one* part of the following: 7x1=7

a.	Derive an expression for logarithmic mean temperature difference for parallel flow heat exchanger.
b.	A surface condenser was designed for a condensation rate of 50kg of vapour per hour. It contained 100, 1cm outside diameter, 1m long tubes arranged in a 10 x 10 array. The condenser was by mistake installed in a vertical position (tubes vertical) instead of horizontal position (tubes horizontal) for which position it was designed. Would there be any change in condensation rate?