PAPER ID-310724

Subject Code: RME502

Roll No:

BTECH

(SEM V) THEORY EXAMINATION 2023-24

HEAT & MASS TRANSFER

TIME: 3 HRS **M.MARKS: 70**

Note: **1.** Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

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

a.	What is overall heat transfer coefficient?
b.	What is critical thickness of insulation?
c.	What is effectiveness of fin?
d.	What is Fourier number?
e.	State the significance of NTU method.
f.	What is space resistance?
g.	What is Reynolds number?

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

a.	A cold storage room has walls made of 220mm of brick on the outside, 90 mm of plastic foam, and finally 16 mm of wood on the inside. The outside and inside air temperatures are 25°C and – 3°C respectively. If the inside and outside heat transfer coefficients are respectively 30 and 11 W/m2°C, and the thermal conductivity of the brick, foam and wood are 0.99, 0.022 and 0.17 W/m°C respectively , determine: i) The rate of heat removal by refrigeration if total wall area is 85 m^2 ii) The temperature of inside surface of the brick.
b.	What are the advantages and disadvantages of dimensional analysis?
c.	A long cylindrical bar (k= 17.4 W/m°c),α= 0.019 m^2/h) of radius 80 mm comes out of oven at 830°C throughout and is cooled by quenching it in a large bath of 40 °C coolant. The surface coefficient of heat transfer between the bar surface and the coolant is 180 W/m^2°C. Determine i) The time taken by the shaft center to reach 120°C ii) The surface temperature of the shaft when its center temperature is 120°C.
d.	With the help of neat sketch, explain boiling curve.
e.	State flicks law of diffusion. What are its limitations?

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

a.	Derive the expression for general heat conduction equation in cartesian co-ordinate.
b.	The amount of F_{12} used in compression refrigeration system is 4 tonnes/hour. The brine, flowing at 850 kg/min. with inlet temperature of 12°C, is cooled in the evaporator. Assuming F_{12} entering and leaving the evaporator at saturated liquid and saturated vapour respectively, determine the area of evaporation required. Take the following properties: for F_{12} saturation temperature: - 23°C ; c_p= 1.17 kJ/kg°C ; h_{fg}= 167.4 kJ/kg, c_p(brine)6.3 kJ/kg°C ; U=8368 kJ/m^2h°C.

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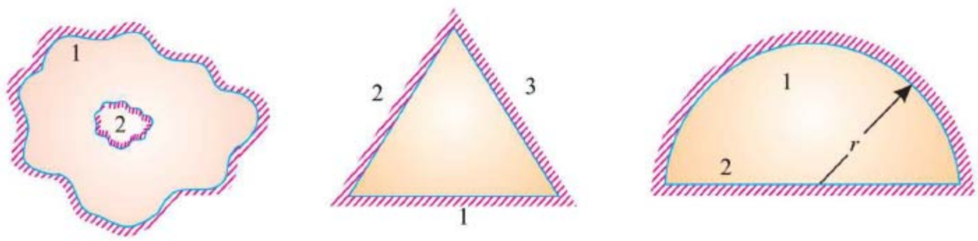
4. Attempt any *one* part of the following: 7 x 1 = 7

a.	An aluminum alloy plate of 400mm x 400mmx 4 mm 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 0f – 70°C. Assume h= 20000KJ/m^2hr°C, c_p=0.8 kJ/kg°C and ρ= 3000 kg/m^3.
b.	Derive the expression for temperature distribution and heat distribution in a straight fin of rectangular profile for an infinitely long fin

5. Attempt any *one* part of the following: 7 x 1 = 7

a.	Derive an expression for LMTD for parallel flow heat exchangers?
b.	Discuss the effects of various parameters on thermal conductivity of solids. The curved surface of the rod is losing heat to the surrounding air at 27°C. The heat transfer coefficient is 10 W/m^2°C calculate the loss of heat from the rod if it is made of (i) copper (k=335 W/m°C) and ii) steel (k=40 W/m^2°C).

6. Attempt any *one* part of the following: 7 x 1 = 7

a.	Derive an expression for electrical network analogy for thermal radiation systems.
b.	Calculate the shape factors for the configuration shown in the figure 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: 7 x 1 = 7

a.	Calculate the net radiant heat exchanger per m^2 area for two large parallel plates at temperatures of 427°C and 27°C respectively. ε (hot plate) = 0.9 and ε (cold plate) = 0.6. if a polished Aluminium shield is placed between them, find the percentage reduction in the heat transfer; ε (shield)=0.4
b.	The velocity distribution in the boundary layer is given by u/U= y/δ, where u is the velocity at a distance y from the plate and u/U at y= δ, δ being boundary layer thickness, find i) the displacement thickness, ii) the momentum thickness, iii) the energy thickness and iv) the value of δ*/θ