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B.TECH
(SEM- V) THEORY EXAMINATION 2021-22
HEAT AND MASS TRANSFER

Time: 3 Hours**Total Marks: 100****Note: 1.** Attempt all Sections. If require any missing data; then choose suitably.**SECTION A****1. Attempt all questions in brief.****2 x 10 = 20**

Q no.	Question	Marks	CO
a.	What is the difference between thermodynamics and heat transfer?	2	1
b.	How the thermal conductivity of material is defined? What are its units?	2	1
c.	What is meant by transient heat conduction?	2	2
d.	Explain effectiveness and efficiency of fin.	2	2
e.	What is turbulent flow? Define it.	2	3
f.	Define Reynolds's number, also write the significance of Reynolds's number.	2	3
g.	Define Stefan Boltzmann's law.	2	4
h.	Explain black body, opaque body, white body and grey body also.	2	4
i.	How heat exchangers are classified?	2	5
j.	What are the various modes of mass transfer?	2	5

SECTION B**2. Attempt any three of the following:**

Q no.	Question	Marks	CO
a.	Derive an expression for heat conduction through a composite wall.	10	1
b.	It is required to heat oil to about 300°C for frying purpose. A ladle is used in the frying. The section of the handle is 5 mm x 18 mm. the surroundings are at 30°C. The conductivity of the material is 205 W/m°C. If the temperature at a distance of 380 mm from the oil should not reach 40°C, Determine the convective heat transfer coefficient.	10	2
c.	Differentiate between:- (i) Natural and forced convection. (ii) Hydrodynamic and thermal boundary layer thickness.	10	3
d.	A 70 mm long circular surface of a circular hole of 35 mm diameter maintained at uniform temperature of 250°C. Find the loss of energy to the surroundings at 27°C, assuming the two ends of the hole to be as parallel discs and the metallic surfaces and surroundings have a black body characteristics.	10	4
e.	Derive an expression for effectiveness by NTU method for parallel flow.	10	5

SECTION C**3. Attempt any one part of the following:**

Q no.	Question	Marks	CO
a.	Derive a general heat conduction equation for Cartesian co-ordinate. And also draw the temperature-thickness profile for it.	10	1
b.	A mild steel tank of thickness 12 mm contains water at 95°C. The thermal conductivity of mild steel is 50 W/m°C, and the heat transfer coefficients for the inside and outside the tank are 2850 and 10 W/m ² °C, respectively. If the atmospheric temperature is 15 °C, calculate: (i) The rate of heat loss per square meter of the tank surface area. (ii) The temperature of the outside surface of the tank.	10	1



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4. Attempt any one part of the following:

Q no.	Question	Marks	CO
a.	An aluminium alloy plate of 400 mm x 400 mm x 4mm size at 200 °C is suddenly quenched into liquid oxygen at -183°C. Starting from fundamentals or deriving the necessary expression to determine the time required for the plate to reach a temperature of -70 °C. Assume $h = 20000 \text{ KJ/m}^2 \text{ h } ^\circ\text{C}$, $c_p = 0.8 \text{ KJ/Kg } ^\circ\text{C}$ and density = 3000 Kg/m^3 .	10	2
b.	Prove that for a body whose thermal resistance is zero, the temperature required for cooling or heating can be obtained from the relation $(t-t_a)/(t_i-t_a) = \exp[-Bi Fa]$ Where the symbols have their usual meanings.	10	2

5. Attempt any one part of the following:

Q no.	Question	Marks	CO
a.	A nuclear reactor with its core constructed of parallel vertical plates of 2.2 m high and 1.4 m wide has been designed on free convection heating of liquid bismuth. The maximum temperature of the plate surface is limited to 960°C while the lowest allowable temperature of the bismuth is 340°C. Calculate the maximum possible heat dissipation from the both sides of each plate. For the convection coefficient for the plate is $Nu = 0.13 (Gr.Pr)^{0.333}$ Where different parameter are evaluated at the mean film temperature.	10	3
b.	Air at 20°C flowing over a flat plate which is 200 mm wide and 500 mm long. The plate is maintained at 100°C. Find the heat loss per hour from the plate if the air is flowing parallel to 500 mm side with 2 m/s velocity. What will be the effect on heat transfer if the flow is parallel to 200 mm? The properties of air at $(100+20)/2 = 60^\circ\text{C}$ are $\nu = 18.97 \times 10^{-6} \text{ m}^2/\text{s}$, $k = 0.025 \text{ W/m}^\circ\text{C}$ and $Pr = 0.7$.	10	3

6. Attempt any one part of the following:

Q no.	Question	Marks	CO
a.	Determine the radiant heat exchanger in W/m^2 between two large parallel steel plates of emissivity's 0.8 and 0.5 held at temperature of 1000 k and 500k respectively, if a thin copper plate of emissivity 0.1 is introduced as a radiation shield between the two plates. Use $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \text{K}^4$	10	4
b.	Derive the expression for net heat exchange between black bodies for infinite parallel planes.	10	4

7. Attempt any one part of the following:

Q no.	Question	Marks	CO
a.	The flow rates of hot and cold water streams running through a parallel flow heat exchangers are 0.2 Kg/s and 0.5 Kg/s respectively the inlet a temperatures 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficient on both sides are $650 \text{ W/m}^2\text{ }^\circ\text{C}$. Calculate: (i) The area of heat exchanger. (ii) the rate of heat transfer	10	5
b.	Differentiate between the mechanisms of filmwise and dropwise condensation.	10	5