Subject Code: KME501

Roll No: | | | | | | | | | | | | | |

B.TECH.

(SEM- V) THEORY EXAMINATION

[MODEL PAPER-1]

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.	Explain the significance of Thermal Diffusivity.	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.	Define effectiveness and efficiency of fin.	2	2
e.	What is the difference between Laminar flow and turbulent flow?	2	3
f.	What is Nusselt No., also write the significance of Nusselt number.	2	3
g.	Define Stefan Boltzmann's law and Kirchhoff's Law.	2	4
h.	Explain black body, opaque body, white body, and grey body also.	2	4
i.	What is Heat Exchanger? Why it is used?	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.	Drive an expression for general heat conduction equation in cylindrical coordinates system.	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 characteristic.	10	4
e.	Derive an expression for effectiveness by NTU method for parallel flow heat exchanger.	10	5

SECTION C

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

Q no.	Question	Marks	CO
a.	Derive an expression for critical radius of insulation for a cylinder. Give practical example to explain the concept of critical radius	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

Q4 Attempt any ONE questions 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 **500 K** respectively, if a thin copper plate of emissivity **0.1** is introduced as a radiation shield between the two plates. Use σ_b **= 5.67 x 10^{-8} W/ m^2 k^4**	10	4
b.	Derive the expression for net heat exchange between black bodies for infinite parallel planes.	10	4

Q5 Attempt any ONE questions of the following.

Q no.	Question	Marks	CO
a.	Air at **27 °C** and **1 atm**. Flows over a flat plate at a velocity **3 m/s**. The plate is heated over its entire length to a temperature of **70 °C**. Calculate the heat transferred if the plate length is **45 cm** and width is **1 m**. Properties of air **υ= 17.36 x 10^{-6} m^2/s**; k=**0.02749 W/m-K**, **C_p =1.006 KJ/kg**.K, **P_r = 0.7**. Use the following correlation equation. **$N_{UL} = 0.664 (Re_L)^{0.5} Pr^{1/3}$**	10	3
b.	Describe briefly the hydraulic and thermal boundary layer over a flat plate when a free stream of fluids flow longitudinally over it and show the respective relations with relevant diagram.	10	3

Q6 Attempt any ONE question of the following.

Q no.	Question	Marks	CO
a.	An aluminum 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 KJ/m^2 h °C, c_p = 0.8 KJ/Kg °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 **$(t-t_a)/(t_i-t_a) = \exp[-B_i . F_o]$** Where the symbols have their usual meanings.	10	2

Q7 Attempt any ONE question of the following.

Q no.	Question	Marks	CO
a.	A counter flow heat exchanger is used to cool **2000 kg/hr** of oil (**c_p= 2.5 kJ/kgK**) from **105 °C to 30 °C** using water at **15 °C**. If the overall heat transfer coefficient is expected to be **1.5 kW/m^{2}K**, make calculations for the water flow rate, the surface area required and the effectiveness of heat exchanger. Presume that the exit temperature of the water is not to exceed **80 °C**. Use NTU-effectiveness approach.	10	5
b.	Discuss various modes of pool boiling with the help of pool with the help of pool boiling curve. List various regimes of forced boiling inside a tube.	10	5