Subject Code: KME501

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

B.TECH.

(SEM- V) THEORY EXAMINATION

[MODEL PAPER-2]

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.	Define overall heat transfer coefficient and contact resistance.	2	1
b.	What is the difference between thermal capacity and thermal diffusivity of materials?	2	1
c.	What do you understand by lumped system? Give one example.	2	2
d.	What is Fin? Why fin installed on surface of Electric motor /Transformer.	2	2
e.	Explain the significance of Biot Number in transient heat conduction.	2	3
f.	What is the significance of Reynold's No. (Re) and Grashoff's No.	2	3
g.	What is Kirchhoff's Law? What is the main conclusion of this Law.	2	4
h.	Explain black body, opaque body, white body, and grey body also.	2	4
i.	What is Heat Exchanger? Write full form of LMTD & NTU.	2	5
j.	State Fick's Law of Mass diffusion. Give 1 example 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 cartesian (rectangular) coordinates system with proper assumptions.	10	1
b.	A wall is constructed of several layers. The first layer consists of bricks **(k = 0.66 W/mK)**, **25 cm** thick, the second layer is **2.5 cm** thick mortar **(k = 0.7 W/mK)**, the third layer is **10 cm** thick limestone **(k = 0.66 W/m.K)** and outer layer of **1.25 cm** thick plaster **(k = 0.7 W/m.K)**. The heat transfers co-efficient on interior and exterior of the wall fluid layers is **5.8 W/m^{2}K** and **11.6 W/m^{2}K**, respectively. Find: (i) OAHTC (ii) Overall thermal resistance per m^2, (iii) Rate of heat transfer per m^2, if the interior of the room at **26 ºC** while outer air is at **7 ºC**.	10	1
c.	What is the significance of Fins? For a fin of rectangular cross section with insulated tip derive the expression for temperature profile and heat transfer rate through that fin with the help of neat sketch.	10	2
d.	What is radiation shield? Two large plates at temperatures **1000 K** and **600 K** have emissivity of **0.5** and **0.8** respectively. A radiation shield having emissivity **0.1** on one side and **0.05** on other side is paced between the plates. Determine the percentage reduction in heat transfer rate	10	4
e.	Explain working principle of Heat pipe with neat sketch. Discuss pool boiling and explain regimes of pool boiling with the help of diagram	10	5

SECTION C

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

Q no.	Question	Marks	CO
a.	Calculate the critical radius of insulation for asbestos (**k = 0.172 W/m.K**) surrounding a pipe and exposed to room air at **300 K** with **h = 2.8 W/m^{2}K** Calculate the heat loss from a **475 K** & **60 mm** diameter pipe when covered with critical radius of insulation and without insulation.	10	1

b.	A plane wall of area **5 m^2** and thickness **10 cm** is subjected to one dimensional heat conduction. Find the heat transfer rate if the surface of wall is at **400 °C** and **100 °C** and the conductivity of wall varies as follows **K = 0.5 (1 + 0.0065 t)** where **K is in W/m.°C** and **t** is in **°C.**	10	1

Q4 Attempt any ONE questions of the following.

Q no.	Question	Marks	CO
a.	Define Radiation shape factor and Reciprocity theorem. Describe the various rules used in determination of radiation shape factor. Also define **F_{12}** and **F_{21}** with the help of suitable diagram.	10	4
b.	A small sphere (outside diameter = **60 mm**) with a surface temperature of **300 °C** is located at the geometric centre of a large sphere (inside diameter = **360 mm**) with an inner surface temperature of **15 °C**. Calculate how much of heat emitted from the large sphere inner surface is incident upon the outer surface of the small sphere, assuming that both surfaces approach black body behavior. What is the net exchange of heat between the two spheres?	10	4

Q5 Attempt any ONE questions of the following.

Q no.	Question	Marks	CO
a.	Draw hydrodynamic and thermal boundary layer over a flat plate. Explain the following dimensionless numbers with their significance- Nusselt Number, Grashoff Number, Prandtl Number and Reynolds No.	10	3
b.	A plate is heated and its temperature is maintained at **60 °C**. Air at **27 °C** and **1 bar** flows over this plate at **2.0 m/s** velocity. Calculate the heat transferred per hour per unit width up to **400 mm** from leading edge of the plate. For air at mean temperature of **43.5 °C**, TAKE: **ν = 17.36 x 106 m^2/s, k = 0.02749 W/m.°C, C_p = 1.006 kJ/kg.°C, R = 187 Nm/kg.mK** and **Pr = 0.7**. Assume the equation => **[$Nu = 0.664 (Re^{1/2}) \times (Pr^{1/3})$]**	10	3

Q6 Attempt any ONE question of the following.

Q no.	Question	Marks	CO
a.	A large aluminum plate of **10 cm** thickness is initially at a uniform temperature of **500 °C** is suddenly immersed in a liquid at **100 °C** with heat transfer coefficient as **1200 W/m^2K**. Find: (a) The temperature at the centre line and at the outer Surface of the plate 1 minute after immersion. (b) Time taken by the mid plane to reach a temperature of 300 oC. For Aluminum take: **$\alpha = 8.4 \times 10^{-5}$ m^2/s, k = 215 W/mK, ρ = 2700 kg/m^3** and **C_p= 900 kJ/kg.K**	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 **$(t-t_a)/(t_i-t_a) = \exp[\tau / \tau^*]$** ; where symbol have usual meanings.	10	2

Q7 Attempt any ONE question 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 is **650 W/m^2°C**. Calculate: (i) The area of heat exchanger. (ii) the rate of heat transfer	10	5
b.	Derive an expression LMTD for parallel flow heat exchanger & derive an expression of effectiveness for counter flow heat exchanger by using NTU method	10	5