PAPER ID-310691

Subject Code: KME501

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

BTECH
(SEM V) THEORY EXAMINATION 2023-24
HEAT AND MASS TRANSFER

TIME: 3 HRS **M.MARKS: 100**

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

SECTION A

1. Attempt *all* questions in brief. **2x10 = 20**

Qno	Questions	CO
(a)	Discuss the effect of temperature on thermal conductivity of metals. Write SI unit of thermal conductivity.	1
(b)	Discuss the concept of thermal resistance.	1
(c)	Define unsteady state heat conduction.	2
(d)	Define effectiveness of fin and efficiency of fin.	2
(e)	Differentiate between natural and forced convection.	3
(f)	Draw velocity boundary layer over a flat plate.	3
(g)	Describe any 4 rules used in determination of radiation shape factor.	4
(h)	Explain black body and gray body.	4
(i)	Define Fouling factor used in analysis of heat exchanger.	5
(j)	What are the various modes of mass transfer?	5

SECTION B

2. Attempt any *three* of the following: **10x3 = 30**

(a)	Derive a general heat conduction equation for Cartesian (rectangular) coordinates	1
(b)	State the assumptions made in Lumped Parametric analysis. For transient heat conduction, derive the following- $\theta/\theta i = \exp(-Bi.Fo)$ where $\theta = T-T_a$	2
(c)	Explain Reynolds analogy and colburn analogy. Obtain the expression for Nusselt Number for turbulent flow over flat plate using colburn analogy.	3
(d)	State and prove the reciprocity theorem used to determine shape factor.	4
(e)	Illustrate the following- i) Fick's Law of Mass diffusion ii) Film-wise and drop-wise condensation.	5

SECTION C

3. Attempt any *one* part of the following: **10x1=10**

(a)	Derive the expression for critical radius of insulation for a cylinder.A10 mm cable is to be laid in atmosphere of 20°c with outside heat transfer coefficient 8.5 W/m^{2o} C. The surface temperature is likely to be 65°C due to heat generation.Will the rubber insulation (K=0.155W/m^2 °C) be effective? If yes, determine the maximum effective thickness of insulation for maximum heat transfer rate.	1
(b)	Obtain the expression for steady state one dimensional heat transfer rate without heat generation through a hollow cylinder. A stainless steel tube (Ks=19W/mK) of 2 cm internal diameter 5 cm outer diameter is insulated with 3 cm thick asbestos (Ks=0.2 W/mK). If the temperature difference between the innermost and outermost surfaces is 600°C.Determine the heat transfer rate per unit length.	1

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4. Attempt any *one* part of the following: 10x1=10

(a)	Derive the expression for temperature distribution for fin insulated at tip.	2
(b)	The aluminium square fins (0.5 mm x 0.5 mm) of 10 mm length are provided on a surface of semiconductor device to carry 1 Watts of energy generated by electronic device. The temperature at surface of device should not exceed 80°C, when surrounding temperature is 40Oc. Determine the number of fins required to carry out this duty. Neglect the heat loss room end of fins. $K_{aluminium}$= 200 W/m°C and h = 15 W/m^2 °C	2

5. Attempt any *one* part of the following: 10x1=10

(a)	Explain the following dimensionless numbers- Nusselt Number, Grashoff Number, Prandtl Number, and Stanton Number.	3
(b)	Estimate The coefficient of heat transfer from a vertical plate (height and width=2m x 2m) to the surrounding air at 25°C.The plate surface temperature is 150°C, Also calculate the rate of heat transfer from the plate. For air assume the kinematic viscosity as 16 X 10^{-6} m^2/s. The properties of air film temperature are density 0.972Kg/m^3, C_p=1.0059KJ/KgK, K=3.13 W/mK, Pr = 0.69. The constant C and n in Nusselt number are-0.15 and 1/3.	3

6. Attempt any *one* part of the following: 10x1=10

(a)	Two large plates at temperatures 1000 K and 500 K have emissivity of 0.5 and 0.7 respectively. A radiation shield having emissivity 0.1 on both sides is placed between the plates. Determine the percentage reduction in heat transfer rate.	4
(b)	Explain the following - Kirchhoff's Law of radiation, Steffan Boltzmann's law of radiation, absorptivity, reflectivity and transmissibility of a surface.	4

7. Attempt any *one* part of the following: 10x1=10

(a)	Derive an expression for effectiveness of a heat exchanger by NTU method for parallel flow.	5
(b)	i) Draw boiling curve and also name regimes of pool boiling. ii)A counter flow heat exchanger is used to cool 50000 Kg/hr of a liquid from 65°C to 40°C using 40000 Kg/hr of water at 10°C Determine the surface area of heat exchanger required. Take $C_{p(liquid)}$ = 3700J/KgK, $C_{p(water)}$ = 4180J/KgK, Overall heat transfer coefficient as 580 W/m^2K.	5