**Printed Pages:02** **Sub Code:RME502**

**Paper Id:** 231870 **Roll No.** | | | | | | | | | | |

**B. TECH**
**(SEM V) THEORY EXAMINATION 2022-23**
**HEAT AND MASS TRANSFER**

***Time: 3 Hours*** ***Total Marks: 70***

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

## SECTION A

**1. Attempt *all* questions in brief. 2x7 = 14**

(a) Discuss limitations of Fouriers' Law of heat Conduction.
(b) Define time constant of a thermocouple.
(c) Explain the significance of Fourier Number in transient heat conduction.
(d) Explain the significance of Stanton Number in forced convection.
(e) Define Radiosity and Irradiation.
(f) Define Total Emissivity and Monochromatic Emissivity.
(g) Discuss, Why counter flow heat exchangers are preferred over parallel flow heat exchangers.

## SECTION B

**2. Attempt any *three* of the following: 7x3 = 21**

(a) Derive expression for general conduction equation in Cylindrical coordinates.
(b) Explain effectiveness and efficiency of fin. A fin has 5 mm diameter and 100 mm length. The thermal conductivity of fin material is 400W/mK. One end of the fin is maintained at 130°C and remaining surface is exposed to ambient air at 30°C. If the convective heat transfer coefficient is 40 $W/m^2K$, determine the heat loss from fin in watts. Assume fin to be insulated at tip.
(c) Explain Reynolds analogy and derive the expressions to evaluate the heat transfer coefficient using it.
(d) Explain the following radiation laws-Stefan Boltzmann's Law, Lamberts Cosine Law, Wein's Displacement Law of radiation, Planck's Law.
(e) Explain Working principle of Heat pipe with neat sketch. Discuss pool boiling and also explain regimes of pool boiling with the help of diagram.

## SECTION C

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

(a) A wire of 6.5 mm diameter at a temperature of 60°C is to be insulated by a material having K=0.17 W/m°C, convective heat transfer coefficient ($h_o$)= 8.722$W/m^{2o}$C. The ambient temperature is 20°C. For maximum heat loss, what is the minimum thickness of insulation and heat loss per metre? Also find percentage increase in the heat dissipation too.
(b) Explain different modes of heat transfer.

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

(a) A spherical thermocouple junction of diameter 0.706 mm is to be used for the measurement of the temperature of a gas stream. The convective heat transfer coefficient on bed surface is 400W/$m^2$K. Thermo physical properties of thermocouple material are- K=20 W/mK, C=400J/KgK and density=8500 kg/$m^3$. If the thermocouple initially at 30ºC is placed in a hot stream of 300$^O$C, Determine the time taken by bead to reach 298ºC

(b) Derive the expression for temperature distribution for fin insulated at tip.

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

(a) Air at 25ºC flows over a thin plate with a velocity of 2.5m/sec. The plate is 2 m long and 1 m wide. Estimate the thermal boundary layer thickness at the trailing edge of the plate and total drag force experienced by the plate. At 25ºC, the density of the air is 1.2kg/$m^3$ and kinematic viscosity is 14 x$10^{-6}$ $m^2$/s. Prandtl number for air is 0.69 .

(b) Estimate The coefficient of heat transfer from a vertical plate 2m x 2m to the surrounding air at 25ºC.The plate surface temperature is 150ºC, 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/$m^3$. Cp=1.0059KJ/Kg-K,K=3.13 W/mK, Pr. 0.69. The constant C and n in Nusselt number are-0.15 and 1/3

$$Nu = 0.036\,\mathrm{Re}^{0.8}.\mathrm{Pr}^{0.33}$$

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

(a) Prove the reciprocity theorem used for determining shape factor.

(b) A cylindrical cavity of diameter 10 cm and depth 20 cm is maintained at 60ºC.Find the heat transfer rate from this cavity to atmosphere at 30ºC. Assume cavity and atmosphere to be black bodies.

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

(a) A process industry employs a counter flow heat exchanger to cool 0.8 Kg/sec of oil ($c_p$=2.5KJ/KgK) from 120ºC TO 40ºC by use of water entering at 20oC.Overall heat transfer coefficient is 1600W/$m^2$K. It is assumed that exit temperature of water will not exceed 80ºC.Using NTU method, determine the following- mass flow rate of water, surface area required, effectiveness of heat exchanger. Take NTU=4

(b) Derive an expression for effectiveness by NTU method for Counter flow heat exchanger.