Sub Code:EME504/NME504

Paper Id: 140521 Roll No: | | | | | | | | | | | | | |

B. TECH.
(SEM-V) THEORY EXAMINATION 2019-20
HEAT AND MASS TRANSFER

Time: 3 Hours *Total Marks: 100*

Note: 1. Attempt all Sections. If you require any missing data, choose suitably.
2. Hieslers charts are allowed in the examination, if required

SECTION A

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

a) What is thermal diffusivity? Explain its physical significance.
b) Describe Fick's law of diffusion.
c) What is critical radius of insulation?
d) What is radiation shield?
e) Describe Biot numer and Nusselt number.
f) How counter flow heat exchangers are better than Parallel flow heat exchanger? explain
g) What is irradiation ?
h) What is the use of fins on surfaces?
i) Describe Lumped Parameter Analysis.
j) How thermal conductivities varies with temperature, for solids, liquids and gases.

SECTION B

2. Attempt any *three* of the following: **10 x 3 = 30**

a) Write general three-dimensional heat conduction equation in Cartesian co-ordinates for steady state without heat generation.
b) A furnace wall of thickness of 0.5 m having an average thermal conductivity of 1.4 W/mk. The wall is to be insulated with a material with thermal conductivity of 0.35 W/mk so that the heat loss will not exceed 2000W/m^2 assuming that the inner and outer surface temperatures are 1400^{0}C and 25^{0}C respectively, Calculate the thickness of insulation required.
c) Distinguish between
i. Black body and gray body ii. Emissivity and monochromatic emissivity iii. Radiosity and irradiation
d) Enlist the various applications of boiling heat transfer. Discuss the various regimes of saturated pool boiling.
e) Define equimolar counter diffusion and derive the expression for diffusion flux rate for a binary gas mixture.

SECTION C

3. Attempt any *one* part of the following: **10 x 1 = 10**

a) Explain the significance of Biot number in lumped parameter analysis of unsteady state heat transfer.
b) A vertical cylinder (k=55.7 W/mk) is fitted with 20 longitudinal fins 50 mm long and 3 mm thick height of the cylinder is 120 cm and its outer diameter is 6 cm. Temperature at the outer surface of the cylinder is 80^{0}C.Surrounding temperature and heat transfer coefficient are 18 and 9 W/m^2k respectively. Assuming insulated tip fins, calculate the amount of heat transferred from the cylinder along with the fins.

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4. Attempt any *one* part of the following: 10 x 1 = 10

a) What is the use of radiation shield? Prove that , Heat transfer with n shields/Heat transfer without shield=1/(n+1).

b) Two parallel gray planes have emissivities of 0.82 and 0.68 and are maintained at 800^0C and 1500^0C.What is the net radiant energy exchanger? What would be the reduction in heat transfer if a radiation shield of polished Aluminum (emissivity=0.04) is placed between them?

.5. Attempt any *one* part of the following: 10 x 1 = 10

a) Show that for equimolar counter-diffusion , $M_A=-(DM_A/R_oT)[(P_{A2}- P_{A2})/\Delta x]$

b) A counter flow heat exchanger is employed to cool 0.55kg/s(Cp=2.45 Kj/kg^{0}C) of oil from 115^0C to 40^0C by the use of water. The inlet and outlet temperatures of cooling water are 15^0C and 75^0C,respectively.The overall heat transfer coefficient is exposed to be 1450W/m^{2}C.Using NTU method, calculate the following:

(I) The mass flow rate of water;

(II) The effectiveness of the heat exchanger:

(I) The surface area required.

6. Attempt any *one* part of the following: 10 x 1 = 10

a) Air at 30^0C and at atm pressure flows at a velocity of 2.2 m/sec over a plate maintained at 90^0C.The length and width of the plate are 0.9m and 0.45m respectively. Calculate the heat transfer rate from, i.First half of the plate ii. Full plate and iii. Next half of the plate. The properties of air at 60^0C are as follows. ρ=1.06kg/m^3,C_p=1005J/kgk,k=0.02894W/mk and ν =18.97x10^{-6} m^2/sec pr=0.696 Use following corrélation $N_{ux}=0.332(Re_t)^{1/2}(Pr)^{1/3}$

b) Derive an expression for critical radius of insulation for sphere. Neglecting the resistance offered by sphere material.

7. Attempt any *one* part of the following: 10 x 1 = 10

a) State assumptions made in lumped capacitance method, using this method derive the following relation. $(T-T_\infty)/ (T_0-T_\infty) =\exp^{-(BiFo)}$ with usual notations.

b) Define the terms: NTU, effectiveness and capacity rate ratio. Derive the expression for effectiveness of a counter flow heat exchanger in terms for NTU and capacity ratio. Show that effectiveness of a counter flow heat exchanger with capacity ratio as unity is given by ε=NTU/(1+NTU).