Hall Ticket No | | | | | | | | | | Question Paper Code:AAEC17

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal-500043, Hyderabad

B.Tech IV SEMESTER END EXAMINATIONS (REGULAR) - JULY 2022

Regulation:UG20

HEAT AND MASS TRANSFER

Time: 3 Hours (AERONAUTICAL ENGINEERING) **Max Marks: 70**

Answer ALL questions in Module I and II

Answer ONE out of two questions in Modules III, IV and V

(NOTE: Provision is given to answer TWO questions from among one of the Modules III / IV / V

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

MODULE – I

1. (a) List different modes of heat transfer. Obtain an expression for heat conduction through a composite cylinder. [BL: Understand| CO: 1|Marks: 7]

   (b) A 240 mm steam main, 210 meters long is covered with 50 mm of high temperature insulation ($k = 0.092W/m°C$) and 40 mm of low temperature insulation ($k = 0.062W/m°C$). the inner and outer surface temperatures as measured are 390^0C and 40^0C respectively. Calculate

   i) The total heat loss per hour

   ii) The heat loss per m^2 of pipe surface

   iii) The total heat loss per m^2 of outer surface

   iv) The temperature between two layers of insulation Neglect heat conduction through pipe material [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) With empirical correlations explain the significance of

   i) Nusselt number

   ii) Grashoff number

   iii) Prandtl number [BL: Understand| CO: 2|Marks: 7]

   (b) A 350 mm long glass plate is hung vertically in the air at 24^0C while its temperature is maintained at 80^0C. calculate the boundary layer thickness at the trailing edge of the plate. If a similar plate is placed in a wind tunnel and air is blown it at a velocity of 5 m/s. find the boundary layer thickness at its trailing edge. Also, determine the average heat transfer coefficient for natural and forced convection for the above mentioned data. [BL: Apply| CO: 2|Marks: 7]

MODULE – III

3. (a) Find an expression for LMTD for parallel flow heat exchanger. State the assumptions made. [BL: Understand| CO: 3|Marks: 7]

   (b) A vertical plate 350 mm high and 420 mm wide at 40^0C is exposed to saturated steam at 1 atm. Calculate the following:

   i) The film thickness at the bottom of the plate

ii) The maximum velocity at the bottom of the plate

iii) The total heat flux to the plate.

Assume vapour density is small compared to that of the condensate. [BL: Apply| CO: 3|Marks: 7]

4. (a) How the condensation and boiling phenomenon of heat transfer takes place? Give basic equations. [BL: Understand| CO: 4|Marks: 7]

   (b) A counter flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500 kg/h. the steam enters the heat exchanger at 180 °C and leave at 130°C. the inlet and exit temperatures of water are 30 °C and 80 °C respectively. If overall heat transfer coefficient from steam to water is 814 W/m2°C, calculate the heat transfer area, what would be the increase in area if the fluid flows were parallel. [BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Distinguish radiation from other modes of heat transfer. Also describe the laws governing radiation heat transfer [BL: Understand| CO: 5|Marks: 7]

   (b) Assuming the sun to radiate as a black body, calculate its temperature from the data given below. The average radiant energy flux incident upon the earth's atmosphere (solar constant)=1380W/m^2, radius of the sun=$7.0 * 10^8 m$, distance between the sun and the earth=$15 * 10^8$ m. [BL: Apply| CO: 5|Marks: 7]

6. (a) Develop an expression for the shape factor in case of a radiation exchange between two surfaces. [BL: Understand| CO: 5|Marks: 7]

   (b) Consider two large parallel plates one at $t_1 = 727^0C$ with emissivity $\epsilon_1 = 0.8$ and other at $t_2 = 227^0C$ with emissivity $\epsilon_2 = 0.4$. An aluminum radiation shield with an emissivity $\epsilon_s = 0.4$ on both sides is placed between the plates. Calculate the percentage reduction in heat transfer rate between the two transfer rate between the two plates as a result of the two plates as a result of the shield. Use $\sigma = 5.67x10^{-8}W/m^2K^4$. [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) Discuss the analogy between heat transfer and mass transfer. Explain equimolar counter diffusion. [BL: Understand| CO: 6|Marks: 7]

   (b) Hydrogen gas at 25^0C and 2.5 atmosphere, flows through a rubber tubing of 12 mm inside radius and 24 mm outside radius. The binary diffusion coefficient of hydrogen is $2.1x10^{-8}m^2/s$ and the solubility of hydrogen is $0.055m^3$ of hydrogen per m^3 of rubber at 1 atmosphere. If the gas constant for hydrogen is 4160J/kgK and the concentration of hydrogen at the outer surface of tubing is negligible, calculate the diffusion flux of hydrogen per meter length of rubber tubing. [BL: Apply| CO: 6|Marks: 7]

8. (a) State Fix's law of diffusion and mention its limitations. Explain the modes of mass transfer. [BL: Understand| CO: 6|Marks: 7]

   (b) Due to accidental opening of a valve, the water has been split out on the floor of an industrial plant. The water level is 1.2 mm and temperature 25^0C. The temperature and pressure of air are 25^0C and 1 bar respectively. The specific humidity of air is 1.8 g/kg of dry air. Assuming $D = 0.25x10^{-4}m^2/s$ and the evaporation takes place by molecular diffusion through an air film 6 mm thick, determine the time required to evaporate the water completely. [BL: Apply| CO: 6|Marks: 7]

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