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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

(Dundigal-500043, Hyderabad)

B.Tech V SEMESTER END EXAMINATIONS (REGULAR) - DECEMBER 2022

Regulation:UG20

HEAT AND MASS TRANSFERS

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
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) Illustrate the concept of electrical analogy considering a multi-layer composite wall with series arrangement. [BL: Understand| CO: 1|Marks: 7]

   (b) A solid copper sphere of 10 cm diameter [ρ= 8954 kg/m^3, c_p=383 J/kg K, k=386 W/m K], initially at a uniform temperature of 250°C, is suddenly immersed in a well-stirred fluid which is maintained at a uniform temperature of 50°C. The heat transfer coefficient between the sphere and the fluid is 200 W/m^2 K. Determine the temperature of the copper block 5 min after the immersion. [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) Explain the development of hydrodynamic boundary over a flat plate when the plate is placed in a flow field. [BL: Understand| CO: 2|Marks: 7]

   (b) Air at 20°C and at a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. If the plate is 280 mm wide and at 56°C, calculate the following quantities at x = 280 mm

   i) Boundary layer thickness

   ii) Local heat transfer coefficient

   iii) Average heat transfer coefficient

   iv) Rate of heat transfer by convection [BL: Apply| CO: 2|Marks: 7]

MODULE – III

3. (a) How does forced convention differ from natural convection? Explain the pool boiling regimes with the help of a neat diagram. [BL: Understand| CO: 3|Marks: 7]

   (b) Water is boiled at the rate of 25 kg/h in a polished copper pan. 280 mm in diameter, at atmospheric pressure. Assuming nucleate boiling conditions, calculate the temperature of the bottom surface of the pan. [BL: Apply| CO: 3|Marks: 7]

4. (a) Determine the expression for LMTD for parallel flow condition for a double pipe heat exchanger. [BL: Understand| CO: 4|Marks: 7]

(b) In a counter-flow double pipe heat exchanger, water is heated from 25°C to 65°C by an oil with a specific heat of 1.45 kJ/kg K and mass flow rate of 0.9 kg/s. The oil is cooled from 230°C to 160°C. If the overall heat transfer coefficient is 420 W/m^2°C, calculate the following:

i) The rate of heat transfer

ii) The mass flow rate of water

iii) The surface area of the heat exchanger. [BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Why drop wise condensation is preferred to film wise condensation? Distinguish between film wise and drop wise condensation. [BL: Understand| CO: 5|Marks: 7]

   (b) Solve the heat transfer rate per m^2 area by radiation between the surfaces of two long cylinders having radii 100mm and 50mm respectively. The smaller cylinder being in the larger cylinder. The axes of the cylinders are parallel to each other and separated by a distance of 20 mm. The surfaces of inner and outer cylinders are maintained at 127°C and 27°C respectively. The emissivity of both the surfaces is 0.5. Assume the medium between the two cylinders is non-absorbing.

   [BL: Apply| CO: 5|Marks: 7]

6. (a) What is the Stefan-Boltzmann Law? Explain the concept of total emissive power of a surface.

   [BL: Understand| CO: 5|Marks: 7]

   (b) Calculate the net radiant heat exchanger per m^2 area for two large parallel plates at temperatures of 427°C and 27°C respectively. ε (hot plate) =0.9 and ε (cold plate)= 0.6. If a polished aluminum shield is placed between them, find the percentage reduction in the heat transfer, ε(shield)=0.4.

   [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) State and explain Fick's law of diffusion and also elaborate the important aspects of Fick's law.

   [BL: Understand| CO: 6|Marks: 7]

   (b) Air is contained in a tyre tube of surface area 0.5m^2 and wall thickness 10 mm. The pressure of air drops from 2.2 bar to 2.18 bar in period of 6 days. The solubility of air in the rubber is 0.072 m^2 of air per m^3 of runner at 1bar. Determine the diffusivity of air in rubber at the operating temperature of 300 K if the volume of air in tube is 0.028 m^2. [BL: Apply| CO: 6|Marks: 7]

8. (a) Using Reynold's and Colburn analogy obtain the relation between the mass transfer coefficient and friction factor. [BL: Understand| CO: 6|Marks: 7]

   (b) Air at temperature of 25°C, 18% RH flows through a pipe of 25 mm inside diameter with a velocity of 4.5 m/s. The inside surface of the tube is constantly wetted with water such that a thin water film is maintained on the surface. Determine the evaporation rate per m^2 of surface area and per meter length. Take ν=15.7x10^{-6} m^2/s; Sc=0.6; D=0.26x$10^{-4}m^2$/s; ρ_{sat}(25°C)=0.231 kg/m^3.

   [BL: Apply| CO: 6|Marks: 7]

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