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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (S, FE) / S4 (PT) (S) Examination January 2024 (2019 Scheme)

Course Code: MET 302

Course Name: HEAT AND MASS TRANSFER

Max. Marks: 100 **Duration: 3 Hours**

Use of steam table & Heat and mass transfer data book permitted

PART A

Answer all questions, each carries 3 marks. Marks

1	Discuss the differences between Thermodynamics and Heat transfer	(3)
2	Give any three boundary conditions in heat conduction analysis.	(3)
3	What are the characteristics of thermal and hydrodynamic boundary layers?	(3)
4	Explain the significance of Prandtl number?	(3)
5	Classify recuperative heat exchangers according to construction and flow arrangement	(3)
6	Explain the effectiveness of a heat exchanger.	(3)
7	Distinguish between emissive power and emissivity.	(3)
8	Explain Wein's displacement law.	(3)
9	Distinguish between diffusion and convection mass transfer	(3)
10	Define diffusion resistance. What is its dimension?	(3)

PART B

Answer any one full question from each module, each carries 14 marks.

Module I

11 a) Derive the general heat conduction equation in cylindrical co-ordinates. (7)

b) Compare fin efficiency and fin effectiveness. What are the factors to be considered while providing fins? (7)

OR

12 a) A metallic sphere of 15 mm diameter (k = 43 W/m°C, ρ = 7850 kg/m^3, C = 474 J/kg°C) initially at 625^{0}C is cooled by exposing to air at 25°C with a convective heat transfer coefficient of 120 W/m^2 °C. Find (7)

(i) Time required to cool the sphere to 100°C.

(ii) Initial Rate of cooling in ^{0}C/s

b) Explain critical radius of insulation. Derive an expression for critical radius of insulation for cylindrical surface. (7)

Module II

13 a) Atmospheric air at 20^0C flows over a flat plate with a velocity of 15 m/s. The plate has a length of 2 m (in the flow direction) and a width of 0.5 m. If the plate is maintained at 80^0C, calculate the following quantities. (10)

(i) Average heat transfer coefficient over the region of laminar boundary layer

(ii) Total heat transfer rate from the plate

b) What is natural convection? Draw velocity and temperature profiles for natural convection flow over a hot vertical plate. (4)

OR

14 a) With neat sketch, explain thermal entrance region in internal flow for forced convection. (5)

b) Water at 20 ^{0}C enters 2 cm diameter tube with a velocity of 1.5 m/s. The tube wall is maintained at 100^0C. Find the tube length required to heat the water to a temperature of 60 ^{0}C. (9)

Module III

15 a) A 2-shell pass and 4-tube passes heat exchanger is used to heat glycerine from 20 ^{0}C to 50 ^{0}C by hot water, which enters thin walled 2 cm diameter tube at 80^0C and leaves at 40^0C. The total length of the tube in the heat exchanger is 60m. The convection heat transfer coefficient on shell side is 25 W/m^2K and that on water side is 160 W/m^2K. Using LMTD method, determine the rate of heat transfer in the heat exchanger after fouling with fouling factor of 0.0006 m^2K/W on outer surface of tube. (10)

b) Discuss the factors to be considered in the design of heat exchangers. (4)

OR

16 a) Water flows at the rate of 65 kg/min through a double pipe counter flow heat exchanger. Water is heated from 50° C to 75°C by an oil flowing through the tube. The specific heat of the oil is 1.780 kJ/kg.K. The oil enters at 115°C and leaves at 70°C. The overall heat transfer co-efficient is 340 W/m^2K.Calculate the heat exchanger area and the rate of heat transfer. (10)

b) What is the difference between film and dropwise condensation? Which is more effective mechanism of heat transfer? (4)

Module IV

17 a) A glass plate 30 cm square is used to view radiation from a furnace. The transmissivity of the glass is 0.5 from 0.2 to 3.5μm. The emissivity may be assumed to be 0.3 up to 3.5μm and 0.9 above that. The transmissivity of the glass is zero, except in the range from 0.2 to 3.5 μm. Assuming that furnace is a black body at 2000 ^{0}C, calculate the energy absorbed in the glass and the energy transmitted. (10)

b) Explain Planck's distribution law (4)

OR

18 a) Two very large parallel plates at temperatures 1000K and 600K, both having emissivity 0.5, exchange heat. A polished-aluminium shield having emissivity 0.1 on both sides is placed between them. Find (7)

(i) Net radiation heat exchange between the plates.

(ii) Temperature of the shield at thermal equilibrium.

b) Define radiation shape factor. Discuss any five properties of radiation shape factor. (7)

Module V

19 a) Explain the dimensionless numbers for forced convection mass transfer (7)

b) A well is 40 m deep and 9 m in diameter is exposed to atmosphere at 25 ^{0}C. The air at the top has relative humidity of 50%. Calculate the diffusion rate of water into atmosphere. Take diffusion coefficient as 2.58×10^{-5} m^2/s. (7)

OR

20 a) Derive the general mass diffusion equation in stationary media (8)

b) List any six examples of mass transfer (6)

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