A

1200MET302052303

Pages: 3

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R, S) / S4 (PT) (R,S) Examination June 2023 (2019 Scheme)

Course Code: MET302

Course Name: HEAT AND MASS TRANSFER

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

PART A

Answer all questions, each carries 3 marks. Marks

1	Distinguish between (i) steady and unsteady conduction (ii) 1-D and 2-D conduction.	(3)
2	Write the assumptions used for Fourier's law of heat conduction	(3)
3	Discuss the differences between natural and forced convection?	(3)
4	Explain the significance of Reynolds number	(3)
5	Discuss "correction factor" in heat exchanger analysis?	(3)
6	Illustrate cross flow heat exchanger	(3)
7	State and explain Kirchhoff's law of thermal radiation	(3)
8	List and explain the factors affecting the rate of emission of radiation by a body	(3)
9	Discuss the three modes of mass transfer	(3)
10	What is convective mass transfer coefficient? What is its dimension?	(3)

PART B

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

Module I

11	a)	A 5 mm diameter and 2 m long electric wire is insulated with a 2 mm thick layer of fibrous cotton (k=0.8W/mK) followed by plastic layer(k=0.15 W/mK) of 3mm thickness. Electrical measurements indicate that a current of 20 A passes through the wire and there is a voltage drop of 25 V along the wire. If the insulated wire is exposed to air at T∞ = 30°C with a convection heat transfer coefficient of h = 12 W/m²-K, determine the temperature at the interface of the wire and the fibrous cotton cover in steady operation.	(7)
	b)	Explain critical thickness of insulation of a cylinder and derive an expression for the same.	(7)

OR

12 a) Calculate the rate of heat loss through the vertical walls of a boiler furnace of size 4 m × 3 m and 3 m high. The walls are constructed from an inner fire brick wall 25 cm thick of thermal conductivity 0.4 W/mK , a layer of ceramic blanket insulation of thermal conductivity 0.2 W/mK and 8 cm thick , and a steel protective layer of thermal conductivity 55 W/mK and 2 mm thick. The inside temperature of the fire brick layer was measured at 600 ^{0}C and the temperature of the outside of the insulation 60^0 C. Also find the interface temperature of layers. (7)

b) A steam pipe of 10 cm inner diameter and 11 cm outer diameter is covered with an insulating substance k = 1 W/mK. The steam temperature is 200^0 C and ambient temperature is 20^0 C. If the convective heat transfer coefficient between insulating surface and air is 8 W/m^{2}K, find the critical radius of insulation and for this value of r_c, calculate the heat loss per m of pipe and the outer surface temperature. Neglect the resistance of the pipe material. (7)

Module II

13 a) When 0.6 kg of water per minute is passed through a tube of 2 cm diameter, it is found to be heated from 20°C to 60°C. The heating is achieved by condensing steam on the surface of the tube and subsequently the surface temperature of the tube is maintained at 90° C. Determine the length of the tube required for fully developed flow. (9)

b) State and explain Newtons law of cooling. (5)

OR

14 a) A vertical pipe 80 mm diameter and 2 m height is maintained at a constant temperature of 120°C. The pipe is surrounded by still atmospheric air at 30° C. Find heat loss by natural convection. (10)

b) Illustrate thermal boundary layer over a flat plate when the plate surface is hotter than fluid. (4)

Module III

15 a) Explain the classification of heat exchanger by the 'nature of heat exchange' with the help of diagrams. (7)

b) Derive the expression for log mean temperature difference in parallel flow heat exchanger (7)

OR

16 a) A chemical having specific heat of 3.3 kJ/kgK enters a parallel flow heat exchanger at 120 ^{0}C with a mass flow rate of 20000 kg/h. The flow rate of cooling water is 50000 kg/h with an inlet temperature of 20 ^{0}C. The heat transfer area is 10 m^2 and overall heat transfer coefficient is 1050 W/m^{2}K. Find the outlet temperature of water and chemical. (Take C_P of water =4.18kJ/kgK) (10)

b) State the causes of fouling in heat exchanger. How fouling is accounted in heat exchanger analysis? (4)

Module IV

17 a) Compare white body with grey body (5)

b) A boiler furnace, whose surfaces closely approximate black surface, is made in the shape of a cylinder of height 2.4 m and diameter 6 m. The base, top and curved surfaces are maintained at 800K, 1500K and 600K respectively. Determine net radiation heat transfer between top and curved surfaces. (9)

OR

18 a) Two large plates are maintained at a temperature of 900 K and 500 K respectively. Each plate has area of 6m^2. Compare the net heat exchange between the plates for the following cases. i) Both plates are black and ii) Plates have an emissivity of 0.5 (8)

b) The filament of a 75 W light bulb may be considered as a black body radiating into a black enclosure at 70^0 C. Considering the radiation, determine the filament temperature, if the filament diameter is 0.10 mm and length is 5 cm. (6)

Module V

19 a) State and explain governing law of diffusion mass transfer. (6)

b) Explain steady state diffusion through a plane membrane (8)

OR

20 a) Air at 50 ^{0}C and 1 atm. flow over the surface of a water reservoir at an average velocity of 2.3 m/s. The water surface is 0.65 m long and 0.65 m wide. The water surface temperature is estimated to be 30^{0}C. The relative humidity of air is 40%. The density of air is 1.105kg/m^3 and its kinematic viscosity is 17.58×10^{-6} m^2/s. Calculate the amount of water vapour evaporates per hour per square meter of water surface in kg/m^{2}h. Diffusion coefficient= $0.256 \times 10^{-4}\ m^2/s$. (14)

****