Printed Page:- **Subject Code**:- **AME0501**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: V - CARRY OVER THEORY EXAMINATION - APRIL 2023

Subject: Heat and Mass Transfer

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

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. *This Question paper comprises of* **three Sections -A, B, & C.** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*

2. *Maximum marks for each question are indicated on right -hand side of each question.*

3. *Illustrate your answers with neat sketches wherever necessary.*

4. *Assume suitable data if necessary.*

5. *Preferably, write the answers in sequential order.*

6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION A **20**

1. Attempt all parts:-

1-a. 6.0 kJ of conduction heat transfer has to take place in 10 minutes from one end to other end of a metallic cylinder of 10 cm^2 cross-sectional area, length 1 meter and thermal conductivity as 100 W/mK. What is the temperature difference between the two ends of the cylindrical bar? (CO1) 1

(a) 80°C

(b) 100°C

(c) 120°C

(d) 160°C

1-b. The outer surface of a long cylinder is maintained at constant temperature. The cylinder does not have any heat source. The temperature in the cylinder will: (CO1) 1

(a) Increase linearly with radius

(b) Decrease linearly with radius

(c) Be independent of radius

(d) Vary logarithmically with radius

1-c. In order to achieve maximum heat dissipation, the fin should be designed in such a way that: (CO2) 1

(a) It should have maximum lateral surface at the root side of the fin

(b) It should have maximum lateral surface towards the tip side of the fin

(c) It should have maximum lateral surface near the centre of the fin

(d) It should have minimum lateral surface near the centre of the fin

1-d. If heat dissipation for one fin is given by 377.45 k J/hour, then what is the heat dissipation for 12 fins? (CO2) 1

(a) 7529.4 k J/hour

(b) 6529.4 k J/hour

(c) 5529.4 k J/hour

(d) 4529.4 k J/hour

1-e. If velocity of water inside a smooth tube is doubled, then turbulent flow heat transfer coefficient between the water and the tube will: (CO3) 1

(a) Remain unchanged

(b) Increase to double its value

(c) Increase but will not reach double its value

(d) Increase to more than double its value

1-f. The Nusselt number is related to Reynolds number in laminar and turbulent flows respectively as (CO3) 1

(a) $Re^{-1/2}$ and $Re^{0.8}$

(b) $Re^{1/2}$ and $Re^{0.8}$

(c) $Re^{-1/2}$ and $Re^{-0.8}$

(d) $Re^{1/2}$ and $Re^{-0.8}$

1-g. What is the equivalent emissivity for radiant heat exchange between a small body (emissivity = 0.4) in a very large enclosure (emissivity = 0·5)? (CO4) 1

(a) 0.5

(b) 0.4

(c) 0.2

(d) 0.1

1-h. What is the shape factor for concentric spheres? (CO4) 1

(a) 0.85

(b) 0.33

(c) 1

(d) 0.95

1-i. Assumptions made for calculation of logarithmic mean temperature difference are (i) Constant overall heat transfer coefficient (ii) The kinetic and potential energy changes (iii) There is no conduction of heat along the tubes of heat exchangerare negligible Identify the correct statements (CO5) 1

(a) i, ii and iii

(b) i and iii

(c) i and ii

(d) ii and iii

1-j. The direct contact heat exchanger operate under (CO5) 1

(a) Transient conditions

(b) Steady state conditions

(c) Transient/steady state conditions

(d) None

2. Attempt all parts:-

2.a. How does transient heat transfer differ from steady state conduction? (CO1) 2

2.b. State the various assumptions made in the formation of energy equation for one dimensional heat dissipation from an extended surface. (CO2) 2

2.c. What is Colburn analogy? (CO3) 2

2.d. What is stefan boltzmann law? (CO4) 2

2.e. What is overall heat transfer coefficient in a heat exchanger? (CO5) 2

SECTION B **30**

3. Answer any <u>five</u> of the following:-

3-a. An electrical wire, 2 mm in diameter is covered with a 2.5 mm thick layer of plastic insulation (k = 0.5 W/m.K) to reduce the heat loss. Heat is dissipated from the outer surface of insulation to surrounding air at 25°C by convection with heat transfer coefficient of 10 $W/m^2.K$. The wire is maintained at constant temperature of 120°C. Estimate the rate of heat dissipation from the wire per unit length with and without insulation. (CO1) 6

3-b. What are different modes of heat transfer? Explain their potential for occurrence. (CO1) 6

3-c. What is transient heat conduction? State two example of transient heat conduction. (CO2) 6

3-d. An aluminium sphere weighing 6 kg and initially at temperature of 350°C is 6

suddenly immersed in a fluid at 30°C with convection coefficient of 60 W/m^2.K. Estimate the time required to cool the sphere to 100°C. Take thermo-physical properties as C = 900 J/kg.K, ρ = 2700 kg/m^3, k = 205 W/m.K. (CO2)

3.e. State the relationship between Nusselt, Grashof and Prandtl number in case of heat transfer by nature convection. (CO3) 6

3.f. Define absorptivity, reflectivity and Transmissivity in reference of radiation. (CO4) 6

3.g. A double pipe heat exchanger is constructed of 0.287 cm thick steel tubing (k = 35 W/m.K) with 2.09 cm inner tube and 2.66 cm outer tube. The inside and outside coefficients of heat transfer are 1135 W/m^2.K and 5677 W/m^2.K, respectively, and the inner fouling factor is 9.98×10^{-5} m^2.K/W. Calculate the overall coefficient of heat transfer. (CO5) 6

SECTION C **50**

4. Answer any <u>one</u> of the following:-

4-a. A steam pipe of 5 cm inside diameter and 6.5 cm outside diameter is covered with a 2.75 cm radial thickness of high temperature insulation (k = 1.1 W/m.K). The surface heat transfer coefficient for inside and outside surfaces are 4650 W/m^2.K and 11.5 W/m^2.K, respectively. The thermal conductivity of the pipe material is 45 W/m.K. If the steam temperature is 200°C and ambient air temperature is 25°C, determine : (i) Heat loss per metre length of pipe. (ii) Temperature at the interface. (CO1) 10

4-b. Derive a general heat conduction equation for rectangular coordinate system.(CO1) 10

5. Answer any <u>one</u> of the following:-

5-a. A long thin glass walled, 0.3 cm diameter, mercury thermometer is placed in a stream of air with convection coefficient of 60 W/m^2.K for measuring transient temperature of air. Consider cylindrical thermometer bulb consists of mercury only for which k = 8.9 W/m.K and α = 0.016 m^2/h Calculate the time constant and time required for the temperature change to reach half of its initial value. (CO2) 10

5-b. Derive the relation for temperature distribution and heat transfer from a infinitely long fin. (CO2) 10

6. Answer any <u>one</u> of the following:-

6-a. Calculate the appropriate Grashof number and state the type of flow for the following : (a) A central heating radiator, 0.8 m high with a surface temperature of 75°C in a room at 18°C (ν=1.5 × 10– 5 m2/s, Pr = 0.72) (CO3) 10

6-b. Discuss the following with their applications: (CO3) 10

(a) Reynold's Number (b) Grashof number

(c) Nusselt Number (d) Prandtl number

7. Answer any <u>one</u> of the following:-

7-a. Discuss the algebra of shape factor in details with example. (CO4) 10

7-b. A long cylinder heater 25 mm in diameter is maintained at 660^0C and has surface resistivity of 0.8. The heater is located in a large room whose walls are at 27^0C. How much will the radiant transfer from the heater be reduced if it is surrounded by a 300 mm diameter radiation shield of aluminum having an emissivity of 0.2? What is the temperature of the shield? (CO4) 10

8. Answer any <u>one</u> of the following:-

8-a. Steam enters a counter flow heat exchanger, dry saturated at 10 bar and leaves at 350°C. The mass flow rate of the steam is 720 kg/min. The hot gas enters the exchanger at 650°C with mass flow rate of 1320 kg/min. If the tubes are 30 mm in diameter and 3 m long, determine the number of tubes required. Neglect the resistance offered by metallic tubes. Use following data: For steam T_{sat} = 180°C (at 10 bar), Cp,s = 2.71 kJ/kg.K, h_i = 600 W/m^2.K For gas Cp,g = 1 kJ /kg.K, ho = 250 W/m^2.K. (CO5) 10

8-b. Explain pool boiling curve and its different regions in details. (CO5) 10