Printed Page:-04 **Subject Code**:- **AME0501**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: V - THEORY EXAMINATION (2024- 2025)

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. Thermal diffusivity of a substance is (CO1,K1) 1

(a) Inversely proportional to thermal conductivity

(b) Directly proportional to thermal conductivity

(c) Directly proportional to the square of thermal conductivity

(d) Inversely proportional to the square of thermal conductivity

1-b. Heat transfer takes place according to which of the following law? (CO1,K1) 1

(a) Newton's second law of motion

(b) First law of thermodynamics

(c) Newton's law of cooling

(d) Second law of thermodynamics

1-c. On heat transfer surface, fins are provided (CO2,K1) 1

(a) To increase temperature gradient so as to enhance heat transfer

(b) To increase turbulence in flow for enhancing heat transfer

(c) To increase surface are to promote the rate of heat transfer

(d) To decrease the pressure drop of the fluid

1-d. Fins are made as thin as possible to:(CO2,K1) 1

(a) Reduce the total weight

(b) Accommodate more number of fins

(c) Increase the width for the same profile area

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(d) Improve flow of coolant around the fin

1-e. Which one of the following numbers represents the ratio of kinematic viscosity to the thermal diffusivity? (CO3,K2) 1

(a) Grashoff number
(b) Prandtl number
(c) Mach number
(d) Nusselt number

1-f. The ratio of energy transferred by convection to that by conduction is called(CO3,K1) 1

(a) Stanton number
(b) Nusselt number
(c) Biot number
(d) Preclet number

1-g. Fraction of radiative energy leaving one surface that strikes the other surface is called (CO4,K2) 1

(a) Radiative flux
(b) Emissive power of the first surface
(c) View factor
(d) Re-radiation flux

1-h. When α is absorptivity, ρ is reflectivity and τ is Transmissivity, then for transparent body, which of the following relation is valid?(CO4,K2) 1

(a) $\alpha = 1, \rho = 0, \tau = 0$
(b) $\alpha = 0, \rho = 1, \tau = 0$
(c) $\alpha = 0, \rho = 0, \tau = 1$
(d) $\alpha + \rho = 1, \tau = 0$

1-i. Drop wise condensation usually occurs on (CO5,K1) 1

(a) Glazed surface
(b) Smooth surface
(c) Oily surface
(d) Coated surface

1-j. Air enters a counter flow heat exchanger at 70°C and leaves at 40°C. Water enters at 30°C and leaves at 50°C. The LMTD in degree C is:(CO5,K3) 1

(a) 5.65
(b) 4.43
(c) 19.52
(d) 20.17

2. Attempt all parts:-

2.a. How does the heat transfer differ from the thermodynamics? (CO1,K2) 2

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2.b.	Define efficiency of the fin. (CO2,K2)	2
2.c.	State Newton's law of cooling. (CO3,K2)	2
2.d.	What is stefan boltzmann law? (CO4,K2)	2
2.e.	What is LMTD in heat exchanger?(CO5,K2)	2

SECTION-B 30

3. Answer any five of the following:-

3-a.	What are different modes of heat transfer? Explain their potential for occurrence. (CO1,K2)	6
3-b.	Determine heat transfer rate through a spherical copper shell of thermal conductivity of 386 W/m.K, inner radius of 20 mm and outer radius of 60 mm. The inner surface and outer surface temperatures are 200°C and 100°C, respectively.(CO2,K3)	6
3-c.	What is lumped system analysis? What are the assumptions made in the lumped system analysis and when is it applicable? (CO2,K3)	6
3-d.	A person is found dead at 5 p.m. in a room where temperature is 20°C. The temperature of the body is measured to be 25°C when found, and the heat transfer coefficient is estimated to be 8 W/m2.K. Modelling the human body a 30 cm diameter, 1.70 m long cylinder, calculate actual time of death of the person. Take thermo physical properties of the body : k = 6.08 W/m.K, $\rho = 900$ kg/m3, C = 4000 J/kg.K.(CO2,K4)	6
3.e.	Give the physical significance of following dimensionless numbers. (i) Reynold number (ii) Stanton number (iii) Peclet number (CO3,K3)	6
3.f.	Define absorptivity, reflectivity and transmissivity. (CO4,K2)	6
3.g.	In a counter flow double pipe heat exchanger, water is heated from 40°C to 80°C with an oil entering at 105°C and leaving at 70°C. Taking the overall heat transfer coefficient as 300 W/m2.K and the water flow rate as 0.1 kg/s. Calculate the heat exchanger area.(CO5,K4)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Derive general heat conduction equation in Cartesian coordinates and mention the assumptions for this derivation. (CO1,K4)	10
4-b.	A hollow cylinder with inner radius 30 mm and outer radius 50 mm is heated at the inner surface at a rate of 105 W/m2 and dissipated heat by convection from outer surface into a fluid at 80°C with heat transfer coefficient of 400 W/m2.K. There is no energy generation and thermal conductivity of the material is constant at 15 W/m.K. Calculate the temperatures of inside and outside surfaces of the cylinder. (CO1,K4)	10

5. Answer any one of the following:-

5-a.	Derive the governing equation of fins of uniform cross-section.(CO2,K4)	10
5-b.	The two long rods A and B, equivalent in every respect except that one is	10

fabricated from material of known thermal conductivity of kA while other of material of unknown thermal conductivity kB, are attached to a surface of fixed temperature T0 , and are exposed to a fluid at T∞, with convection coefficient h. These rods are instrumented with thermocouples to measure the temperature at a fixed distance x1 from the heat source. If the standard material is of aluminium kA = 200 W/m.K and measurements reveal TA = 75°C and TB = 60°C at x1 when T0 is 100°C and T∞ is 25°C. What is the thermal conductivity of the test material ?(CO2,K4)

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

6-a.	Derive the relation between local and average value of heat transfer coefficient? (CO3,K4)	10
6-b.	Analyze Buckimgham's pie theorem for dimensional analysis.(CO3,K4)	10

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

7-a.	Derive the expression for net radiation heat exchange between two parallel infinite planes. (CO4,K4)	10
7-b.	Two large parallel plates at temperature 1000 K and 600 K have emissivity of 0.5 and 0.8 respectively. A radiation shield having emissivity 0.1 on one side and 0.05 on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square metre with and without radiation shield.(CO4,K4)	10

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

8-a.	Derive an expression for log mean temperature difference of parallel flow heat exchanger. (CO5,K4)	10
8-b.	A counter-flow tubular oil cooler is to be designed to cool 1500 kg/h of oil from temperature 90°C to 30°C by means of water entering the cooler at 20°C and leaving the cooler at 50°C. Calculate the amount of water flow rate required and the heat transfer area. Take Cp of oil as 3 kJ/kg.K and overall heat transfer coefficient equal to 1200 W/m2.K.(CO5,K4)	10