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. Which one of the following expresses the thermal diffusivity of a substance in terms of thermal conductivity (k), mass density (ρ) and specific heat (c)? (CO1,K1) 1

(a) k2ρc
(b) 1/ρkc
(c) k/ρc
(d) ρc

1-b. Upto the critical radius of insulation:(CO1,K1) 1

(a) Added insulation increases heat loss
(b) Added insulation decreases heat loss
(c) Convection heat loss is less than conduction heat loss
(d) Heat flux decreases

1-c. The value of Biot number is very small (less than 0.01) when (CO2,K2) 1

(a) The convective resistance of the fluid is negligible
(b) The conductive resistance of the fluid is negligible
(c) The conductive resistance of the solid is negligible
(d) None of these

1-d. For using fins, the heat flow is assumed to be in(CO2,K2) 1

(a) Steady State

(b) Unsteady State

(c) Linearly decreasing

(d) Exponentially increasing

1-e. Which of the following is true for laminar flow?(CO3,K2) 1

(a) $104 < G r P r < 107$

(b) $104 < G r P r < 108$

(c) $104 < G r P r < 109$

(d) $104 < G r P r < 1010$

1-f. A region of fluid motion near a plate in which temperature gradient exist is(CO3,K3) 1

(a) Thermal boundary layer

(b) Diathermia boundary layer

(c) Turbulent flow

(d) Laminar flow

1-g. Which one of the following modes of heat transfer would take place predominantly, from boiler furnace to water wall?(CO4,K2) 1

(a) Convection

(b) Conduction

(c) Radiation

(d) Conduction and convection

1-h. Which phenomenon is related to the term radiation? (CO4,K2) 1

(a) magnetic phenomenon

(b) gravity

(c) electromagnetic phenomenon

(d) none of the above

1-i. 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

1-j. In a heat exchanger with one fluid evaporating or condensing the surface area required is least in(CO5,K2) 1

(a) Parallel flow

(b) Counter flow

(c) Cross flow

(d) Same in all above

2. Attempt all parts:-

2.a.	What is heat flux? How it relates heat transfer rate?(CO1,k2)	2
2.b.	What is meant by transient heat conduction? (CO2,K2)	2
2.c.	Differentiate between Natural & Forced convection.(CO3,K2)	2
2.d.	Define Emissive power of a black surface.(CO4,K2)	2
2.e.	What is effectiveness of a heat exchanger?(CO5,K2)	2

SECTION-B 30

3. Answer any five of the following:-

3-a.	Simplify the three dimensional heat conduction equation in Cartesian coordinates to obtain one dimensional steady state heat conduction with heat generation and constant thermal conductivity.(CO1,K3)	6
3-b.	The thermal conductivity k, the density ρ, and the specific heat C of steel are 61 W/m.K, 7865 kg/m3, and 0.46 kJ/kg.K, respectively. Calculate the thermal diffusivity of the material.(CO1,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.	An aluminium sphere weighing 6 kg and initially at temperature of 350°C is 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, $\rho = 2700$ kg/m^3, k = 205 W/m.K. (CO2,K4)	6
3.e.	Explain laminar and turbulent flow and corresponding values of Reynolds number for flow over flat plate and circular tube.(CO3,K3)	6
3.f.	Define absorptivity, reflectivity and Transmissivity in reference of radiation. (CO4,K3)	6
3.g.	Explain critical heat flux and Leidenfrost point during pool boiling process.(CO5,K3)	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Derive general heat conduction equation in cylindrical coordinates and mention the assumptions for this derivation. (CO1,K4)	10
4-b.	An exterior wall of a house consists of a 10.16 cm layer of common brick having thermal conductivity 0.7 W/m.K. It is followed by a 3.8 cm layer of gypsum plaster with thermal conductivity of 0.48 W/m.K. What thickness of loosely packed rockwool insulation (k = 0.065 W/m.K) should be added to reduce the heat loss through the wall by 80% ?(CO1,K4)	10

5. Answer any one of the following:-

5-a.	Derive the heat transfer equation of infinitely long fin. (CO2,K4)	10
5-b.	Derive the lumped system analysis equation.(CO2,K4)	10

6. Answer any one of the following:-

6-a.	Explain Buckingham π theorem. What are its merits and demerits ? What are	10

repeating variables? How are they selected ? (CO3,K4)

6-b. Discuss the following with their applications: (CO3,K3) 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. Two parallel, infinite gray surfaces are maintained at temperature of 127°C and 227°C respectively. If the temperature of the hot surface is increased to 327°C. By what factor is the net radiation exchange per unit area increased? Assume the emissivities of colder and hotter surfaces to be 0.9 and 0.7, respectively. (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 counter flow heat exchanger.(CO5,K4) 10

8-b. Derive an expression for effectiveness in terms of NTU and capacity rate ratio (C) for counter flow.(CO5,K4) 10