Printed Page:- **Subject Code:- BME0401**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: IV - THEORY EXAMINATION (20..... - 20.....)

Subject: Heat & 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. A flat plate has thickness 5 cm, thermal conductivity 1 W/(mK), convective heat transfer coefficients on its two flat faces of 10 W/(m^2K) and 20 W/(m^2K). The overall heat transfer co-efficient for such a flat plate is: [CO1,K2] 1

(a) 5 W/(m2K)

(b) 6.33 W/(m2K)

(c) 20 W/(m2K)

(d) 30 W/(M2k)

1-b. 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-c. A fin protrudes from a surface which is held at a temperature higher than that of its environment. The heat transferred away from the fin is. [CO2,K1] 1

(a) Heat escaping from the tip of the fin

(b) Heat conducted along the fin length

(c) Convective heat transfer from the fin surface

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(d) Sum of heat conducted along the fin length and that convected from the surface.

1-d. Which one of the following is correct? The effectiveness of a fin will be maximum in an environment with . [CO2,K1] 1

(a) Free convection
(b) Forced convection
(c) Radiation
(d) Convection and radiation

1-e. For calculation of heat transfer by natural convection from a horizontal cylinder, what is the characteristic length in Grashof Number? [CO3,K1] 1

(a) Diameter of the cylinder
(b) Length of the cylinder
(c) Circumference of the base of the cylinder
(d) Half the circumference of the base of the cylinder

1-f. 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-g. In radiative heat transfer, a gray surface is one [CO4,K1] 1

(a) Which appears gray to the eye
(b) Whose emissivity is independent of wavelength
(c) Which has reflectivity equal to zero
(d) Which appears equally bright from all directions.

1-h. 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-i. For evaporators and condensers, for the given conditions, the logarithmic mean temperature difference (LMTD) for parallel flow is: [CO5,K1] 1

(a) Equal to that for counter flow
(b) Greater than that for counter flow
(c) Smaller than that for counter flow
(d) Very much smaller than that for counter flow

1-j. What are the compact heat exchangers? [CO5,K1] 1

(a) The heat exchangers having small surface area per unit volume
(b) The heat exchangers having large surface area per unit volume

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(c) The heat exchangers having small surface area per unit weight

(d) The heat exchangers having large surface area per unit weight

2. Attempt all parts:-

2.a.	Define overall heat transfer coefficient. [CO1,K1]	2
2.b.	Define effectiveness of the fin. [CO2,K1]	2
2.c.	Differentiate viscous sub layer and buffer layer **[CO3,K1]**	2
2.d.	State Lambert's cosine law. [CO4,K1]	2
2.e.	What is LMTD in heat exchanger? [CO5,K2]	2

SECTION-B 30

3. Answer any five 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/mK) 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,K3]	6
3-b.	A furnace wall consists of three layers. The inner layer of 10 cm thickness is made of firebrick (k =1.04 W/mK). The intermediate layer of 25 cm thickness is made of masonry brick (k = 0.69 W/mK) followed by a 5 cm thick concrete wall (k = 1.37 W/mK). When the furnace is in continuous operation the inner surface of the furnace is at 800°C while the outer concrete surface is at 50°C. Calculate the rate of heat loss per unit area of the wall, the temperature at the interface of the firebrick and masonry brick and the temperature at the interface of the masonry brick and concrete. [CO1,K3]	6
3-c.	One end of a 30 cm long steel rod (k = 25 W/m.K) is connected to a wall at 204°C. The other end is connected to other wall at 93°C. The air is blown across the rod with h = 17 W/m2.K. The diameter of the rod is 5 cm and air temperature is 30°C, what is the net rate of heat dissipation to air ? [CO2,K3]	6
3-d.	What is transient heat conduction? State two example of transient heat conduction. [CO2,K2]	6
3.e.	State the relationship between Nusselt, Grashof and Prandtl number in case of heat transfer by nature convection. [CO3,K2]	6
3.f.	What do you understand by radiation shield? Derive the expression of net heat transfer rate for a system of two parallel plates separated by n-shields of emissivity's $\varepsilon 1, \varepsilon 2, \varepsilon 3, \varepsilon 4, \varepsilon 5 \ldots\ldots \varepsilon n$. [CO4,K3]	6
3.g.	Obtain an expression for overall heat transfer coefficient for tubular heat exchanger, subjected to fouling on its two sides of heat transfer surface.[CO5,K3]	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Derive the one dimensional equation for heat transfer in a composite hollow cylinder. [CO1,K3]	10

4-b.	A composite wall consists. of 10 cm thick layer of building brick, k = 0.7 W/mK and 3 cm thick plaster, k = 0.5 W/mK. An insulating material of k = 0.08 W/mK is to be added to reduce the heat transfer through the wall by 40%. Find its thickness. [CO1,K3]	10

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

5-a.	Derive the heat transfer equation of finite length fin and convection occurs at the tip of the fin. [CO2,K3]	10
5-b.	A temperature rise of 50°C in a circular shaft of 50 mm diameter is caused by the amount of heat generated due to friction in the bearing mounted on the crankshaft. The thermal conductivity of shaft material is 55 W/mK and heat transfer co efficient is 7 W/m2 K. Determine the amount of heat transferred through shaft assume that the shaft is a rod of infinite length. [CO2,K3]	10

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

6-a.	Deduce the expression for local convective heat transfer coefficient at a certain position x from leading edge of flat plate. [CO3,K3]	10
6-b.	Water flows at 30°C at 10 kg/s through the diffuser having 5 cm diameter at the entrance and 10 cm diameter at its exit. Calculate the fluid velocity and Reynolds number at the inlet and exit of the diffuser.[CO3, K3]	10

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

7-a.	A long cylinder heater 30 mm in diameter is maintained at 6000C and has surface resistivity of 0.8. The heater is located in a large room whose walls are at 270C. 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,K3]	10
7-b.	Derive the expression for net radiation heat exchange between two concentric cylinders. [CO4,K3]	10

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

8-a.	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/m^2.K. [CO5,K3]	10
8-b.	Derive an expression for log mean temperature difference of parallel flow heat exchanger. [CO5,K3]	10

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