SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)
COIMBATORE-35
DEPARTMENT OF MECHANICAL ENGINEERING

19MEB304-HEAT AND MASS TRANSFER

QUESTION BANK

2MARKS

1.State the Fourier's law of heat conduction.

1. State Fourier's law of condition

The rate of heat conduction is propagation to the area measured normal to the direction of heat flow and to the temperature gradient in that direction.

$$Q \alpha A \frac{dT}{dx}$$

$$Q = -KA \frac{dT}{dx}$$

Where A – area in m^2

$\frac{dT}{dx}$ – Temperature gradient in K/m

K – Temperature conductivity W/mK

2. Write down the three-dimensional heat conduction equations for a cube.

$$\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right) + \frac{\partial}{\partial y}\left(k\frac{\partial T}{\partial y}\right) + \frac{\partial}{\partial z}\left(k\frac{\partial T}{\partial z}\right) + q_V = \rho c_p \frac{\partial T}{\partial t}$$

where
k is the materials conductivity [$W.m^{-1}.K^{-1}$]
q_V is the rate at which energy is generated per unit volume of the medium [$W.m^{-3}$]
ρ is the density [$kg.m^3$]
c_p is the specific heat capacity [$J.kg^{-1}.K^{-1}$]

3. Specify the applications of Heisler's chart.

The Heisler charts are extensively used to determine the temperature distribution and heat flow rate when both conduction and convection resistances are almost of equal importance and Biot no is 1. Biot number is the ratio of internal conductive resistance to external convective resistance.

4. State Newton's law of cooling or convection law.

Newton's law states that the rate of heat loss of a body is proportional to the difference in temperatures between the body and its surroundings while under the effects of a breeze.

Newton's Law of Cooling

$$T(t) = T_s + (T_0 - T_s)e^{kt}$$

T(t) = temperature at time t
T_s = temperature of surrounding environment
T_0 = initial temperature of object
k = constant (different for each object)

5.**Distinguish laminar flow and turbulent flow.**

Difference between Laminar Flow and Turbulent Flow

S.no.	Laminar Flow	Turbulent Flow
01.	All fluid layers move parallel to each other and do not cross one another.	Fluid layers cross each other and do not move parallel. 
02.	Generally it occurs in small diameter pipes and flow at low velocity.	Almost all high velocity and very large diameter pipe flow are turbulent flow.
03.	The flow velocity profile is parabolic and the maximum velocity is at centre of the pipe line.	The velocity profile is almost flat across the centre section of the pipe and drops rapidly extremely close to the wall.
04.	The average flow velocity is approximately one half of the maximum velocity	The average flow velocity is approximately equal to the velocity at the centre of the pipe.
05.	The value of Reynold's number is less than 2000.	The value of Reynold's number is above 4000.

6.List the applications of fins

The Main applications of fins are,

- Cooling of electronic component
- Cooling of motor cycle engine
- Cooling small capacity compressor

7.Define convection

convection, process by which heat is transferred by movement of a heated fluid such as air or water.

Or

Convection is **the transfer of heat by the movement of a fluid (liquid or gas) between areas of different temperature**.

8.State the Reynolds number

$$Re = \frac{Inertial\ Force}{Viscous\ Force}$$

For any Fluid, it can be simplified as follows:

$$Re = \frac{\rho * V * L}{\mu}$$

Where,

Re = Reynolds number

ρ = Density of fluid (in Kg/m^3)

V = Velocity of fluid (in m/s)

L = Characteristics length of Solid in which fluid is flowing (in m)

μ = Dynamic viscosity of fluid (in Ns/m)

9.List down the types of boundary condition.

1) Prescribed temperature
2) Prescribed heat flux
3) Convection boundary condition

10. What is meant by lumped heat analysis?

In Newton heating or cooling process the temperature through the solid is considered to be uniform at a given time. Such an analysis is called Lumped heat capacity analysis.

11. What is meant by semi infinite solids?

In semi infinite solids, at ant instant of time, there is always a point where the effect of heating or cooling at one of its boundaries is not fell at all. At this point the temperature remains unchanged. In semi-infinite solids, the biot number value is infinite.

12. What are the factors affecting in thermal conductivity?

1. Moisture
2. Density of materials,
3. Pressure
4. Temperature
5. Structure of material

16marks

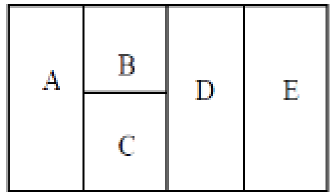
1.Derive the expression for general heat conduction in Cartesian coordinate system.

2. Determine the heat loss from an insulated steel pipe, to the surroundings per meter length of pipe, given the following particulars. Inner diameter of the pipe is 10 cm, wall thickness is 1cm thickness of insulation is 3 cm the temperature of hot liquid is 85° C the temperature of surrounding is 25 ° C k1 for steel is 58 w/mk k2 for insulating material is 0.2 w/mk. The inside heat transfer coefficient is equal to 720 w/m^2k, outside heat transfer coefficient is equal to 9 w/m^2k.

3.Explain the fluid flow along a flat plate i) Velocity distribution in hydrodynamic boundary layer ii) Temperature distribution in thermal boundary layer iii) Variation of heat transfer coefficient along flow

4. A stainless-steel rod of outer diameter 1 cm originally at a temperature of 320 ° C suddenly immersed in liquid at 120 ° C for which convective heat transfer coefficient is 100 w/m^2k t. Determine the time required for the rod to reach a temperature of 200 ° C. state few applications combinations of conduction and convection.

5.Estimate the heat transfer through the composite wall shown in the figure below. Take the conductivities of A, B, C, D & E as 50, 10, 6.67, 20 & 30 W/m-K respectively and assume one dimensional heat transfer. Take of area of A =D= E =$1m^2$ and B=C=0.5 m^2. Temperature entering at wall A is 800 °C and leaving at wall E is 100 ° C shown in fig.



6. Air at 25°C flows past a flat plate at 2.5 m/s. the plate measures 600 mm X 300 mm and is maintained at a uniform temperature at 95° C. Calculate the heat loss from the plate, if the air flows parallel to the 600 mm side.

7. Formulate general heat conduction equation in cylindrical coordinates. State few applications of the same.

8. A 12 cm diameter long bar initially at a uniform temperature of 40 °C is placed in a medium at 650 °C with a convective co efficient of 22 W/m^{2-} K. Evaluate the time required for the bar to reach 255 °C. Take k = 20 W/m-K, ρ = 580 kg/m^3 and c_p = 1050 J/kg- K.