

MARIA COLLEGE OF ENGINEERING AND TECHNOLOGY,

ATTOOR

DEPARTMENT OF MECHANICAL ENGINEERING

ME 41 HEAT AND MASS TRANSFER

2 MARKS QUESTIONS & ANSWERS

UNIT-1

1. What are the modes of heat transfer?

- *. Conduction
- *. Convection
- *. Radiation

2. What is conduction?

Heat conduction is a mechanism of heat transfer from a region of high temperature to a region of low temperature with in a medium (solid,liquid,gas) or different medium in direct physical contact.

3. State Fourier's law of conduction?

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

$$Q \propto -A \frac{dT}{dx}$$

4. Define thermal conductivity?

Thermal conductivity is defined as the ability of a substance to conduct heat .

5. Write down the equation for conduction of heat through a slab or plane wall?

$$\text{Heat transfer } Q = \frac{\Delta T_{\text{overall}}}{R}$$

Where $R = \frac{L}{KA}$ = thermal resistance of slab.

6 . Write down the equation for conduction of heat through a hollow cylinder?

$$\text{Heat transfer } Q = \frac{\Delta T_{\text{overall}}}{R}$$

Where $R = \frac{1}{2\pi LK} \ln\left(\frac{r_2}{r_1}\right)$ = thermal resistance of hollow cylinder

7. Write down the equation for conduction of heat through a hollow sphere?

$$\text{Heat transfer } Q = \frac{\Delta T_{\text{overall}}}{R}$$

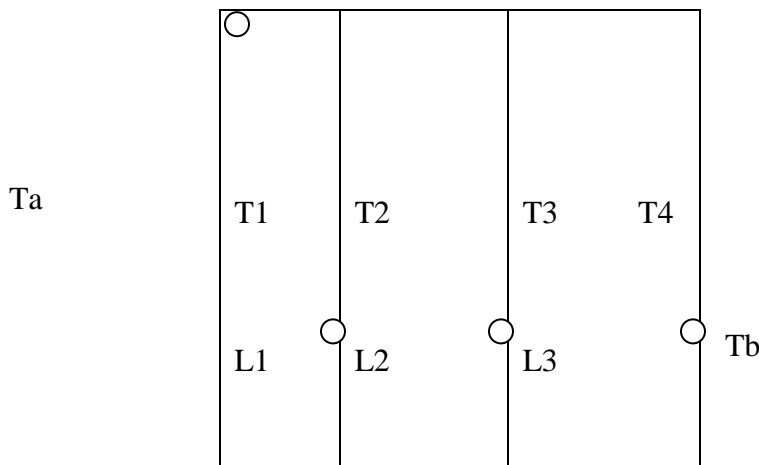
$$\text{Where } R = \frac{r_2 - r_1}{4\pi K(r_1 r_2)} = \text{thermal resistance of hollow sphere.}$$

8. State Newton's law of cooling or convection law?

Heat transfer by convection is given by Newton's law of cooling

$$Q = hA(T_s - T_a)$$

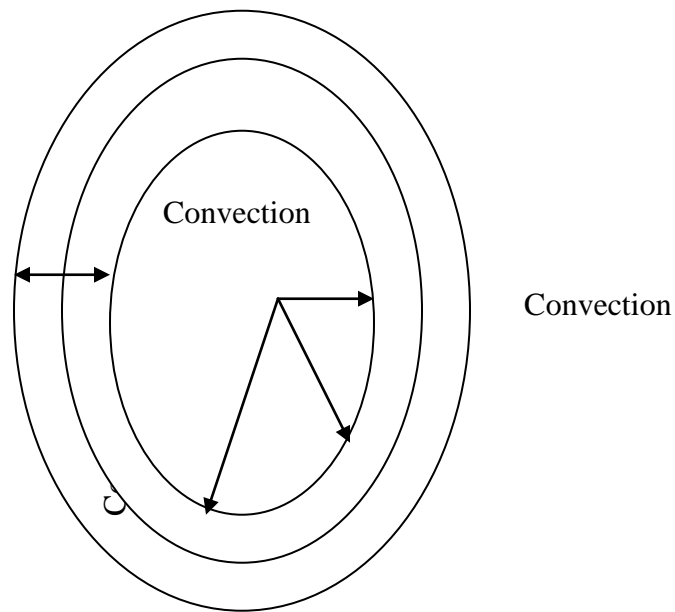
9. Write down the equation for conduction of heat through a composite plane wall?



$$\text{Heat transfer } Q = \frac{\Delta T_{\text{overall}}}{R}$$

$$\text{Where } R = \frac{1}{h_a A} + \frac{L_1}{K_1 A} + \frac{L_2}{K_2 A} + \frac{L_3}{K_3 A} + \frac{1}{h_b A}$$

10. Write down the equation for heat transfer through composite pipes or cylinder?



$$\text{Heat transfer } Q = \frac{\Delta T_{\text{overall}}}{R}$$

$$\text{Where } R = \frac{1}{2\pi L h_a r_1} + \frac{\ln\left(\frac{r_2}{r_1}\right)}{K_1} + \frac{\ln\left(\frac{r_3}{r_2}\right)}{K_2} + \frac{L}{h_b r_3}$$

11. Define overall heat transfer coefficient ?

The overall heat transfer by combined modes is usually expressed in terms of an overall conductance or overall heat transfer coefficient, U.

$$\text{Heat transfer } Q = UA \Delta T$$

12. Write down the general equation for one dimensional steady state heat transfer

in slab with heat generation?

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} + \frac{q}{K} = \frac{1}{\alpha} \frac{\partial T}{\partial t}$$

13. Define fin efficiency?

The efficiency of a fin is defined as the ratio of actual heat transfer by the fin to the maximum possible heat transfer by the fin.

14. Define fin effectiveness?

Fin effectiveness is defined as the ratio the heat transfer with fin to that without fin.

15. What is meant by Lumped heat analysis?

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

16. What is meant by semi infinite solids?

In a semi infinite solid at any instant of time, there is always a point where the effect of heating or cooling at one of its boundaries is not felt at all. At this point the temperature remains unchanged .

17. Define biot number?

It is defined as the ratio of internal conductive resistance to the surface convective resistance.

18. What is the significance of biot number?

Biot number is used to find lumped heat analysis ,semi infinite solids and infinite solids.

19. Explain the significance of fourier number?

It is defined as the ratio of characteristic body dimension to temperature wave penetration depth in time . it signifies the degree of penetration of heating or cooling effect of solid.

20. What are the factors affecting the thermal conductivity?

- *. Moisture
- * density of material.
- *. Pressure
- *. Temperature
- *. Structure of material

UNIT-2

1. Define convection?

Convection is a process of heat transfer that will occur between a solid surface and a fluid medium when they are at different temperatures.

2. What is dimensional analysis?

Dimensional analysis is a mathematical method which makes use of study of the dimensions for solving several engineering problems. This method can be applied to all types of fluid resistances, heat flow problems in fluid mechanism and thermodynamics.

3. State Buckingham Π theorem?

It states that if there are n variables in a dimensionally homogeneous equation and if these contain m fundamental dimension, then the variables are arranged in to $(n-m)$ dimension less terms. These dimension less term are called Π Terms.

4. What are the advantages of dimensional analysis?

- *. It express is the functional relationship between the variables.
- *. It enables getting up a theoretical solution in a simplified dimension less forms.

5. What are the limitations of dimensional analysis?

- * No information is given about the internal mechanism of physical phenomenon
- *. Dimensional analysis does not give any clue regarding selection of variables.

6. Define Reynolds number?

It is defied as the ratio of inertia force to viscous force.

7 Define prandtl number?

It is the ratio of the momentum diffusivity to the thermal diffusivity.

8. Define Nusselt number?

It is defined as the ratio of the heat flow by convection process to the heat flow rate by conduction process.

9. Define Grashof number?

It is defined as the ratio product of inertia force and buoyancy force to the square of viscous force.

10. Define Stanton number?

It is the ratio of Nusselt number to the product of Reynolds number and Prandtl number.

11. What is meant by Newtonian and non-Newtonian fluid?

The fluids which obey the Newton's law of viscosity are called Newtonian fluids. Those which do not obey are called non-Newtonian fluid.

12. What is meant by laminar flow and turbulent flow?

- *. Laminar flow is called stream line flow. In this type of flow the fluid moves in layers and each fluid particle follows a smooth continuous path.
- *. A distinct irregular flow is frequently observed in nature. This type of flow is called turbulent flow.

13. What is hydrodynamic boundary layer?

In hydrodynamic boundary layer, velocity of the fluid is less than 99% of free stream velocity.

14. What is meant by free or natural convection?

If the fluid motion is produced due to change in density resulting from temperature gradients, the mode of heat transfer is said to be free or natural convection.

15. What is forced convection?

If the fluid motion is artificially created by means of an external force like a blower or fan, that type of heat transfer is known as forced convection.

16. What is the form of equation used to calculate heat transfer for flow through cylindrical pipes?

$$Nu = 0.023 (Re)^{0.8} (Pr)^n$$

Where $n=0.4$ for heating of fluids

$n=0.3$ for cooling of fluids

17. What are the dimension less parameters used in forced convection?

*.reynolds number

*. Nusselt number

*prandtl number

18. Define boundary layer thickness?

The thickness of the boundary layer is defined as the distance from the surface at which local velocity temperature reaches 99% of a external velocity or temperature.

19. What are the types of flow over bank of tubes?

*.In-line

*. Staggered

20. What are the types of boundary layer?

*. Hydrodynamic boundary layer

*. thermal boundary layer

UNIT-3

1. Define boiling?

The change of phase change from liquid state to vapour state is known as boiling.

2. What is meant by condensation?

The change of phase change from vapour state to liquid state is known as condensation.

3. What is meant by pool boiling?

If heat is added to a liquid from a submerged solid surface, the boiling process is referred to as pool boiling.

4. What is meant by filmwise condensation?

The liquid condensate wets the solid surface, spreads out and forms a continuous film over the entire surface is known as filmwise condensation.

5. What is meant by dropwise condensation?

In dropwise condensation, the vapour condenses into small liquid droplets of various sizes which fall down the surface in a random fashion.

6. Give the merits of dropwise condensation?

- *. A large portion of the area of the plate is directly exposed to vapour
- *. The heat transfer rate is 10 times higher than film condensation

7. What is heat exchanger?

A heat exchanger is defined as an equipment which transfers the heat from a hot fluid to a cold fluid.

8. What are the types of heat exchangers?

- *. Direct contact heat exchangers
- *. Indirect contact heat exchangers
- *. surface heat exchangers.
- *. parallel flow heat exchangers
- *. counter flow heat exchangers etc.

9. What is meant by direct contact heat exchanger?

In direct contact heat exchanger, the heat exchange takes place by direct mixing of hot and cold fluids.

10. What is meant by indirect contact heat exchanger?

In this type of heat exchanges the transfer of heat between 2 fluids could be carried out by transmission through a wall which separates the 2 fluids.

11. What is meant by regenerators?

In this type of heat exchanges, hot and cold fluids flow alternately through a same space.

12. What is meant recuperators?

This is the most common type of heat exchanges in which the hot and cold fluids do not come into direct contact with each other but are separated by a tube wall or a surface.

13. What is meant by parallel flow heat exchanger?

In this type of heat exchanger. Hot and cold fluids move in the same direction.

14. What is meant by counter flow heat exchanger?

In this type of heat exchanger. Hot and cold fluids move in parallel but opposite direction.

15. What is meant by cross flow heat exchanger?

In this type of heat exchanger hot and cold fluids move at right angles to each other.

16. What is meant by shell and tube heat exchanger?

In this type of heat exchanger , one of the fluids move through a bundle of tubes enclosed by a shell. The other fluids is forced through the shell and it moves over the outside surface of the tubes.

17. What is meant by compact heat exchanger?

There are many special purpose heat exchangers called compact heat exchangers. They are generally employed when convective heat transfer coefficient associated with one of the fluids is much smaller than that associated with the other fluid.

18. What is meant by LMTD?

The temperature different between the hot and cold fluid in the heat exchanger varies from point to point. In addition varies modes of heat transfer are involved. Therefore based on concept of appropriate mean temperature different also called logarithmic mean temperature different .

19. What is meant by fouling factor?

The surfaces of the heat exchanges do not remain clean after it has been in use for sometime. The surfaces become fouled with scaling or deposits. The effect of these deposits affecting the value of overall heat

transfer coefficient. this effect is taken care of by introducing an additional thermal resistance called the fouling resistance.

20. What is meant by effectiveness?

The heat exchanger effectiveness is defined as the ratio of actual heat transfer to the maximum possible heat transfer.

UNIT-IV

1) Define radiation?

The heat transfer from one body to another without any transmitting medium is known as radiation.

2. Define emissive power?

The emissive power is defined as the total amount of radiation emitted by a body per unit time and unit area.

3. Define monochromatic emissive power?

The energy emitted by the surface at a given length per unit time per unit area in all direction is known as monochromatic emissive power.

4. What is mean by absorptivity ?

It is defined as the ratio between radiation absorbed and incident radiation.

5. What is meant by reflectivity?

It is defined as the ratio of radiation reflected to the incident radiation.

6. What is meant by transmissivity?

It is defined as the ratio of radiation transmitted to the incident radiation.

7. What is black body?

Black body is an ideal surface having the following properties.

- a. the black body absorbs all incident radiation, regard less of wavelength and direction.

- b. For a prescribed temperature and wavelength, no surface can emit more energy than blackbody.
- c.
8. State planks distribution law?

The relationship between the monochromatic emissive power of a blackbody and a wavelength of a radiation of a particular temperature is given by Plank as follows.

$$E_{b\lambda} = \frac{c_1 \lambda^{-5}}{e^{\frac{c_2}{\lambda T}} - 1}$$

9. State Wiens displacement law?

It gives relationship between temperature and wavelength corresponding to the maximum spectral emissive power of the blackbody at that temperature.

$$\lambda_{\max} T = c_3$$

10. State stephans boltzmen law?

The emissive power of the blackbody is proportional to the fourth power of absolute temperature .

11. Define emissivity?

It is defined as the ability of the surface to radiate heat. It is also defined as the ratio of emissive power of any body to the emissive power of black

body of equal temperature. $\varepsilon = \frac{E}{E_b}$

12. What is meant by gray body?

If a body absorbs a definite percentage of incident radiation irrespective of their wavelength , the body is known as gray body.

13. State kirchoffs law of radiation?

It states that the ratio of total emissive power to the absorptivity is constant for all surfaces which are in thermal equilibrium with the surroundings.

$$\frac{E_1}{\alpha_1} = \frac{E_2}{\alpha_2} = \dots$$

14. Define intensity of radiation?

It is defined as the rate of energy leaving a space in a given direction per unit solid angle per unit area of the emitting surfaces normal to the mean direction in space.

15. State Lamberts cosine law?

It states that total emissive power from a radiating plane surface. In any direction proportional to the cosine of the angle of emission.

16. What is the purpose of radiation shield?

Radiation shields constructed from low emissivity materials are used to reduce the net radiation transfer between two surfaces.

17. Define irradiation?

It is defined as the radiation incident upon a surface per unit time per unit area

18. What is Radiosity?

It is used to indicate total radiation leaving a surface per unit time per unit area.

19. What is meant by shape factor?

It is defined as the fraction of radiative energy that is defused from one surface element and strikes the other surface directly with no intervening reflection.

20. A perfect blackbody is one which -----

Absorbs heat radiation of all wavelength falling on it .

UNIT-5

1. What is mass transfer?

The process of transfer of mass as a result of species concentration different in a mixture is known as mass transfer.

2. Give the examples of mass transfer?

- *. Humidification of air in a cooling tower.
- * evaporation of petrol in the ic engine.

3. What are the modes of mass transfer?

- * diffusion mass transfer
- * Convective mass transfer

4. What is molecular diffusion?

The transport of water on a microscopic level as a result of diffusion from a region of higher concentration to a region of lower concentration in a mixture of liquids or gases is known as molecular diffusion.

5. What is eddy diffusion?

When one of the diffusion fluids is in turbulent motion, eddy diffusion takes place.

6. What is convective mass transfer?

Convective mass transfer is a process of mass transfer that will occur between surface and a fluid medium when they are at different concentration.

7. What is free convective mass transfer?

If the fluid motion is produced due to change in density resulting from concentration gradients, the mode of mass transfer is said to be free convective mass transfer.

8. Define forced convective mass transfer?

If the fluid motion is artificially created by means of an external force like a blower or fan, that type of mass transfer is known as convective mass transfer.

9. Define Schmidt number?

It is defined as a ratio of the molecular diffusivity of momentum to the molecular diffusivity of mass.

10. Define Sherwood number?

It is defined as the ratio of concentration gradients at the boundary.

$$Sh = \frac{h_m x}{D_{ab}}$$

11. State Fick's law?

The diffusion rate is given by Fick's law which states that molar flux of an element per unit area is directly proportional to concentration gradients.

$$\frac{m_a}{A} = -D_{ab} \frac{dC_a}{dx}$$

12. The amount of radiation mainly depends on -----

nature of body, temperature of body and type of surface of body.

13. Heat transfer equation $Q = \sigma AT^4$ is known as -----

Stephan boltzman equation

14. According to Stephan boltzman law, ideal radiators emits at a radiant energy at a rate proportional to -----

Fourth power of absolute temperature

15. Molar flux formula for equimolar counter diffusion

$$\text{molar flux, } \frac{m_a}{A} = \frac{D_{ab}}{GT} \left[\frac{P_{a1} - P_{a2}}{x_2 - x_1} \right]$$

16. Define molar concentration?

The molar concentration is the number of moles of species per unit volume of the mixture.

$$C_a = \frac{\rho_a}{M_a}$$

17. Define mass fraction?

Mass fraction is defined as the ratio of the mass concentration of species to the total mass density.

$$m_a = \frac{\rho_a}{\rho}$$

18. Formula for surface resistances of the body

$$\frac{1 - \varepsilon}{A\varepsilon}$$

19. Formula for space resistance

$$\frac{1}{A_1 F_{12}}$$

20. Give reciprocity theorem?

$$A_1 F_{12} = A_2 F_{21}$$