First mid term Examination

Sub:- Utilization of Electrical power

Q.1.(a) Explain the modes of Heat Transfer?

Ans:- Heat transfer is defined as the transmission of energy from one region to another region as a result of temperature gradient takes place by following three mods.

1. conduction
2. Convection
3. Radiation

Heat transmission, in majority of real situations, occurs as a a result of combinations of these modes of heat transfer. Heat always flows in the directions of lower temperature

(1) Conduction:-

In this mode, the heat transfers from one part of substance to another part without the movement in the molecules of substance The rate of condiction of heat along the substance depends upon the temperature gradient.

The amount of heat passed through a cubic body with two parallel face with thickness 'x' meters, having the cross-sectional area of 'A' square meters and the temperature of its two faces T_1°C and T_2°C during 'T' hours is given by

$$Q = \frac{kA}{x}(T_1 - T_2)T \text{ MJ}$$

where, k is the cofficient of the thermal conductivity for the material and its measured in MJ/m3/°c/hr

Example: Refroctory heating, the heating of insulating material etc.

(2) Convection:-

In this mode, the heat transfer takes place from one part to another part of substance or fluid due to the actual motion of the molecules. The rate of conduction of heat depends mainly on the difference in the fluid density at different temperature

Example: Immersion water heater.

Heat dissipation is given by the following expression

$$H = \alpha (T_1 - T_2)^b \text{ W/m}^2$$

where a and b are the constants whose values are depends on the heating surface and T_1 and T_2 are the temperatures of heating elements and fluid in °C, repectively.

(3) Radiation:

In this mode, the heat transfers from source to the substance to be heated without heating the medium in between. It is dependent on the surface

Example: solar heaters.

The rate of heat dissipation through radiation is give by stefan's law.

Heat dissipation $H = 5.72 \times 10^4 \, ke \left[\left(\frac{T_1}{1000} \right)^4 - \left(\frac{T_2}{1000} \right)^4 \right] w/m^2$ --- (1)

where T_1 is the temperature of the source in kelvin, T_2 is the temperature of the substance to be heated in kelvin and k is the radiant efficiency.

= 1, for single element
= 0.5-0.8, for black body
= 0.9, for resistance heating element

From equation (1.1), the radiant heat is proportional to the difference of fourth power of temperature, so it is very efficient heating at high temperature.

(b) A slab of insulating material 130 cm² in area and 1 cm thick is to be heated by dielectric heating. The power required is 380 w at 30 MHz. Material has a relative permittivity of 5 and p.f. of 0.05, Absolute Permittivity = 8.854 $\times 10^{-12}$ F/m. Determine the necessary voltage

Soln:

Given $A = 130 \text{ cm}^2 = 130 \times 10^{-4} \text{ m}^2$

$d = 1 \text{ cm} = 0.01 \text{ m}$

$P = 380 \text{ W}$

$f = 30 \text{ MHz}$

$\varepsilon_r = 5$

$p.f. = 0.05$

$\varepsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$

Voltage, V

$$\text{Capacitance, } C = \frac{\varepsilon_0 \varepsilon_r A}{t}$$

$$= \frac{8.854 \times 10^{-12} \times 5 \times 130 \times 10^{-4}}{0.01}$$

$$= 57.55 \times 10^{-12} \text{ F}$$

$$P = 2\pi f C V^2 \cos\phi$$

$$\Rightarrow 380 = 2\pi \times 30 \times 10^6 \times 57.55 \times 10^{-12} V^2 \times 0.05$$

$$\Rightarrow V^2 = \frac{380}{2\pi \times 30 \times 10^6 \times 57.55 \times 10^{-12} \times 0.05}$$

$$V^2 = 700595$$

$$V = \sqrt{700595}$$

$$V = 837 \text{ V}$$

Ans

Q. 2.

(a) short notes on given terms (any four)

1. plane-angle 2. solid angle 3. Lumen 4. Candle power 5. Illumination.

Ans:-

(1) Plane-angle:- A plane angle subtended at a point in a plane by two converging lines. It is denoted by Greek letter θ and is usually measured in degree or radians.

$$\text{plane angle } (\theta) = \frac{\text{Arc}}{\text{Radius}}$$

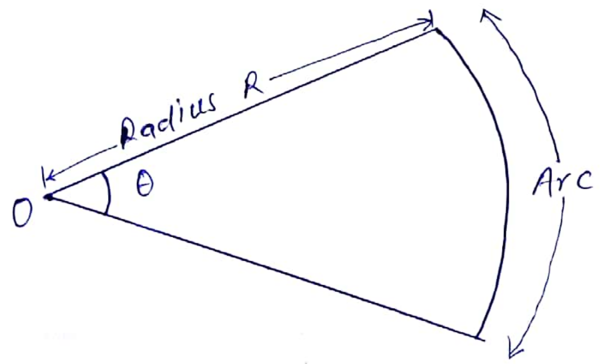

Fig: plane angle

One radian is defined as the angle substended by an arc of a circle whose length is equals to the radius of the circle.

(2) Lumen :-

It is the unit of luminous flux. It is defined as the luminous flux emitted by a source of one candle power per unit solid angle in all directions.

Lumen = Candle power of source x solid angle.

$= CP \times \omega$

Total flux emitted by a source of one candle power is 4π lumens.

(3) Candle power :-

The candle power of a source is defined as the total luminous flux lines emitted by the source in a unit solid angle.

$CP = \frac{Lumen}{\omega}$ Lumen/steradian or candela

(4) Illumination :-

Illumination is defined as the luminous flux recevied by the surface per unit area. It is usually denoted by the symbol 'E' and is measured in Lux or lumen m2 or meter candle or foot candle.

Illumination, $E = \frac{\text{luminous flux}}{\text{Area}}$

$= \frac{\phi}{A} = \frac{CP \times \omega}{A}$ Lux

(b) A source of 500 c.p. is mounted at a distance of 2 meter from a surface receiving light. Calculate illumination on the surface, at a point directly below the source. what will be its magnitude if the distance is doubled.

Solⁿ :-

$I = 500$ c.p

$d_1 = 2$ meter

$E_1 = \frac{CP}{d^2}$

$$E_1 = \frac{cp}{d^2} = \frac{500}{(2)^2}$$

$E_1 = 125$ lumens/m^2

$d_2 = 2 \times 2 = 4$ meters

$$E_2 = \frac{500}{(4)^2}$$

$E_2 = \underline{31.25 \text{ lumens}}/m^2$ Ans