TempleCity Institute of Technology & Engineering (TITE), Taraboi, Khurda

UTILIZATION OF ELECTRICAL ENERGY AND TRACTION

Diploma BATCH – (2019 – 22) **5th semester**

Fullmark-20 **Time -1hour**

1) Answer any three (3*2 marks)
   a) What is the process taking in fluorescent tube called ?
   b) What is maintenance factor ?
   c) The melting point of tantalum is_____.
   d) Write types of sources of illumination.
2) Answer any two (2*3.5marks)
   a. A 200-V lamp takes a current of 1.2 A, it produces a total flux of 2,860 lumens. Calculate: the MSCP of the lamp
   b. Write down the advantage of incandescent lamp ?
   c. What is Stroboscopic effect
3) Answer Any one (1*07 marks)
   a) Answer all
      i) A Define luminous flux.
      ii) Define lamp efficiency.
      iii) Write down the advantage of incandescent lamp .
   b) States law of illumination.
      i) States the inverse square law of illumination.
      ii) the Lambert's cosine law of illumination.

All the best

1**a.** The phenomenon of the emission is called as *luminescence.*

This luminescence is classified into two ways. They are:

1. **Fluorescence:** In this case, the excitation presents for the excited periods only.
2. **Phosphorescence:** In this case, even after the exciting source is removed, the excitation will present.

b.Maintenance factor

It is defined as the ratio of illumination under normal working conditions to the illumination when everything is clean.

$$\text{Maintanance factor} = \frac{\text{illumination under normal working condition}}{\text{illumination under every thing is clean}}.$$

c. The melting point of tantalum is 3,000°C.

d. four types.

Electric arc lamps

Incandescent lamps

Gaseous discharge lamps

Fluorescent lamps

2a.

Solution:

Given V = 200 V

I = 1.2 A, flux = 2,860 lumens.

$$\text{(i) MSCP} = \frac{\text{total flux}}{4\pi} = \frac{2860}{4\pi} = 227.59.$$

b. *Advantages of fluorescent lamp*

The fluorescent lamp has the following advantages:

- High efficiency.
- The life of the lamp is three times of the ordinary filament lamp.
- The quality of the light obtained is much superior.
- Less chances of glare.

c. We all know that because of 'the alternating nature of supply, it crosses zero two times in a cycle'. For 50-Hz frequency supply of the alternating current, a discharge lamp will be extinguished twice in a cycle and 100 times per second (for 50-Hz supply). A human eye cannotidentify this extinguish phenomenon, because of the persistence of vision. If this light falls upon a moving object, the object appearing like slow moving or fast moving or moving in reverse direction, sometimes stationary. This effect is due to the extinguishing nature of the light of thelamp. This effect is called as '*stroboscopic effect*'.

3a.

i.Luminous flux: It is defined as the energy in the form of light waves radiated per second from a luminous body. It is represented by the symbol 'φ' and measured in lumens.

Ex: Suppose the luminous body is an incandescent lamp.

ii.Lamp efficiency

It is defined as the ratio of the total luminous flux emitting from the source to its electrical power input in watts.

$$\therefore \text{Lamp efficiency} = \frac{\text{luminous flux}}{\text{power input}}.$$

It is expressed in lumen/W.

iii.The advantages of the incandescent lamps

- These lamps are available in various shapes and sizes.
- These are operating at unity power factor.
- These lamps are not affected by surrounding air temperature.
- Different colored light output can be obtained by using different colored glasses.

Inverse square law

This law states that 'the illumination of a surface is inversely proportional to the square of distance between the surface and a point source'.

Proof:

Let, '*S*' be a point source of luminous intensity '*I*' candela, the luminous flux emitting from source crossing the three parallel plates having areas A_1, A_2, and A_3 square meters, which are separated by a distances of *d*, 2*d*, and 3*d* from the point source respectively as shown in Fig. 6.10.

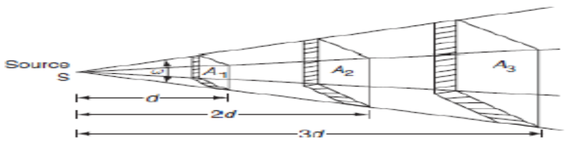

Fig. 6.10 Inverse square law

For area A_1, solid angle $\omega = \frac{A_1}{d^2}$.

Luminous flux reaching the area A_1 = luminous intensity × solid angle

$$= I \times \omega = I \times \frac{A_1}{d^2}.$$

∴ Illumination 'E_1' on the surface area 'A_1' is:

$$E_1 = \frac{\text{flux}}{\text{area}} = \frac{IA_1}{d^2} \times \frac{1}{A_1}$$

$$\therefore E_1 = \frac{I}{d^2} \quad \text{lux.} \qquad (6.5)$$

Similarly, illumination 'E_2' on the surface *area* A_2 is:

$$E_2 = \frac{I}{(2d)^2} \quad \text{lux} \qquad (6.6)$$

and illumination 'E_3' on the surface area A_3 is:

$$E_3 = \frac{I}{(3d)^2} \quad \text{lux.} \qquad (6.7)$$

From Equations (6.5), (6.6), and (6.7)

$$E_1 : E_2 : E_3 = \frac{1}{d^2} : \frac{1}{(2d)^2} : \frac{1}{(3d)^2}. \qquad (6.8)$$

Hence, from Equation (6.8), illumination on any surface is inversely proportional to the square of distance between the surface and the source.

Lambert's cosine law

This law states that 'illumination, *E* at any point on a surface is directly proportional to the cosine of the angle between the normal at that point and the line of flux'.

Proof:

While discussing, the Lambert's cosine law, let us assume that the surface is inclined at an angle '*θ*' to the lines of flux as shown in Fig. 6.11.

Let

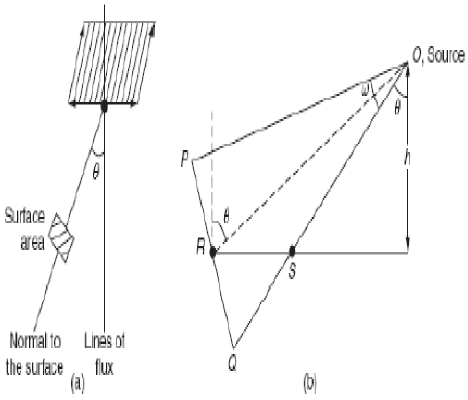

Fig. 6.11 Lambert's cosine law

Let

PQ = The surface area normal to the source and inclined at 'θ' to the vertical axis.

RS = The surface area normal to the vertical axis and inclined at an angle θ to the source 'O'.

Therefore, from Fig. 6.11:

$PQ = RS \cos\theta$.

$\therefore$ The illumination of the surface $PQ, E_{PQ} = \frac{\text{flux}}{\text{area of } PQ}$

$$= \frac{I \times \omega}{\text{area of } PQ} = \frac{I}{\text{area of } PQ} \times \frac{\text{area of } PQ}{d^2} \quad \left[\because \omega = \text{area}/(\text{radius})^2\right]$$

$$= \frac{I}{d^2}. \qquad (6.9)$$

$\therefore$ The illumination of the surface $RS, E_{RS} = \frac{\text{flux}}{\text{area of } RS} = \frac{\text{flux}}{\text{area of } PQ/\cos\theta}$

$$[\because PQ = RS \cos\theta]$$

$$= \frac{I}{d^2}\cos\theta. \qquad \textbf{(6.10)}$$

From Fig. 6.11(b):

$$\cos\theta = \frac{h}{d}$$

$$\text{or } d = \frac{h}{\cos\theta}.$$

Substituting 'd' from the above equation in Equation (6.10):

$$\therefore E_{RS} = \frac{I}{(h/\cos\theta)^2} \times \cos\theta = \frac{I}{h^2}\cos^3\theta \qquad \textbf{(6.11)}$$

$$\therefore E_{RS} = \frac{I}{d^2}\cos\theta = \frac{I}{h^2}\cos^3\theta \qquad \textbf{(6.12)}$$

where d is the distance between the source and the surface in m, h is the height of source from the surface in m, and I is the luminous intensity in candela.

Hence, Equation (6.11) is also known as 'cosine cube' law. This law states that the 'illumination at any point on a surface is dependent on the cube of cosine of the angle between line of flux and normal at that point'.