EE-302

[Utilization of Electric Power And Traction]

Question-① Explain the Laws of Illumination.

Answer- The illumination (E) of a surface depends upon the following factors

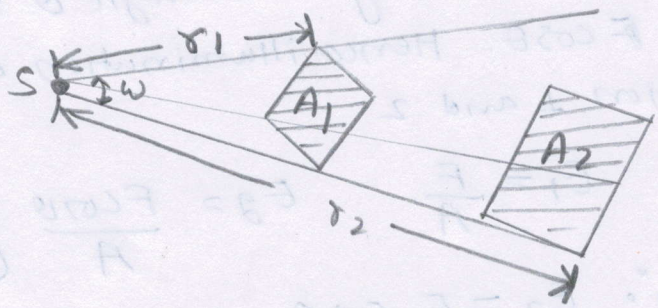
(1) E is directly proportional to the luminous intensity(I) of the source.

$$E \propto I \qquad \left(\because E = \frac{I}{r^2}\right)$$

(2) Inverse square law- The illumination of a surface is inversely proportional to the square of the distance of the surface from the source.

$$E \propto \frac{1}{r^2}$$

proof- Consider surface areas A_1 and A_2 at distance r_1 and r_2 respectively from the point source S of luminous intensity I and normal to the rays as shown in figure



Total luminous flux radiated = $I\omega$ lumens

Illumination of the surface of Area A_1

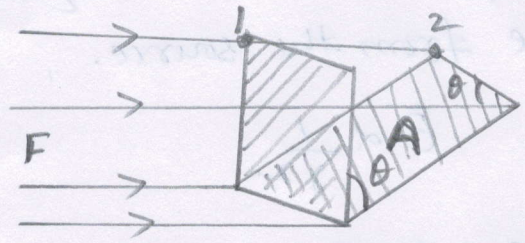
$$E_1 = \frac{I\omega}{A_1} = \frac{I\omega}{\omega r_1^2} = \frac{I}{r_2} \text{ lumen per unit Area}$$

Similarly, illumination on the surface of Area A_2

$$E_2 = \frac{I\omega}{A_2} = \frac{I\omega}{\omega r_2} = \frac{I}{r_2} \text{ lumens per unit area}$$

Hence the illumination of a surface is inversely proportional to the square of the distance between the surface and the light source.

(3) Lambert's Cosine Law – According to this law E is directly proportional to the cosine of the angle made by the normal to the illuminated surface with the direction of the incident flux.



F = Luminous flux
A = Area of the surface

(Lambert's cosine law)

As shown in above figure F be the flux incident on the surface of area A when in position 1. When this surface is turned back through an angle θ then flux incident on it is $F\cos\theta$. Hence illumination of the surface when in position 1 and 2

$$E_1 = \frac{F}{A} \qquad E_2 = \frac{F\cos\theta}{A} \quad \{\text{when in position 2}\}$$

$$\therefore E_2 = E_1 \cos\theta$$

Combining all these factors we get

$$\boxed{E = \frac{I\cos\theta}{r^2}}$$

$$\therefore \boxed{E \propto \cos\theta}$$

Question ② Define the following terms

(i) Luminous intensity (ii) Illumination

(iii) Glare (iv) Candle power (v) Reduction factor

Answer

(i) Luminous Intesity –

Luminous intensity in a given direction is the luminous flux emitted by the source per unit solid angle. It is denoted by symbol 'I' and measured in 'Candela' (cd)

$$I = \frac{F}{\omega}$$

(ii) Illumination - It is the luminous flux received by a surface per ~~unit~~ unit area. It is denoted by symbol 'E' and measured in lumens per square meter or 'Lux'

$$E = \frac{F}{A}$$

(iii) Glare – 'Glare' may be define as the brightness within the field of vision of such a character as to cause annoyance, discomfort, interference with vision or eye-fatigue.

(iv) Candle power – It is define as the numbes of lumens emitted by a source in a unit solid angle in a given direction. It is denoted by symbol C.P.

$$C.P. = \frac{\text{Lumens}}{\omega}$$

(v) Reduction factor –

It is the ratio of its mean spherical candle power to its mean hemispherical candle power

$$\text{Reduction factor} = \frac{\text{M.S.C.P}}{\text{M.H.C.P.}}$$