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MATRIC NO: 15/ENG04/033
COURSE CODE: EEE 552

Assignment

a)i) $E = \pi L$

$\therefore L = \frac{E}{\pi}$

with reflector factor

$L = \frac{E}{\pi} \times$ reflector factor

$= \frac{44000}{\pi} \times 85\%$

$= \frac{44000}{3.142} \times \frac{85}{100}$

$= 11903.24 = 1.19 \times 10^4 \ Cd/m^2$

ii) using $E = 0.22$ lux

$L = \frac{0.22}{3.142} \times \frac{85}{100}$

$= 0.0595 = 5.95 \times 10^{-2} \ Cd/m^2$

b)i) Total flux emitted by the globe

$\phi = 120 \times 4\pi$

$= 1508.16$ lumen

flux absorbed by the globe

$1508.16 \times \frac{30}{100} = 452.448$ lumen

flux emitted by globe

$= 1508.16 - 452.448$

$= 1055.712$ lumen

Total luminance $= \frac{\text{flux emitted}}{\text{Area}}$

Area $= \frac{\pi d^2}{4} = \frac{\pi \cdot 22^2}{4} = 380.182$

Luminance $= \frac{1055.714}{380.182}$

$= 2.777$ lumen/m^2

ii.) Candle power $= \frac{\text{lumen}}{\omega} = \frac{1055.712}{4\pi} = 84$ cd

c.) Area $= 75\ cm^2 = 75 \times 10^{-4}\ m^2$

thickness $= 2cm = 2 \times 10^{-2}\ m$

$C = \frac{\varepsilon_0 \varepsilon_r A}{t} = \frac{8.85 \times 10^{-2} \times 6.5 \times 75 \times 10^{-4}}{2 \times 10^{-2}}$

$C = 21.57 \times 10^{-12}\ F$

$\omega = 2\pi f = 2\pi \times 20 \times 10^6$

$= 125.664 \times 10^6$ rad/s

$\cos\phi = 0.04$

$\phi = \cos^{-1}(0.04)$

$\phi = 87.7^\circ$

$\delta = 90° - \phi$

$= 90° - 87.7°$

$= 2.3°$

Density $= \frac{\text{Mass}}{\text{volume}}$

Mass of slab $= 75 \times 2 \times 0.55$

$= 82.5g$

Heat required = Mass x specific heat x temp rise

$= MC\Delta\theta$

$= 82.5 \times 0.25 \times (80 - 30)$

$= 1051.88$ Cal

Total heat required $= \frac{1051.88}{1} \times \frac{85}{100} = 894.098$ Cal

Recall 1 cal $= 4.186$ J or W-S

Therefore energy input $= 894.098 \times 4.186 = 3742.7$ W-S

$P = \frac{\text{Energy input}}{\text{time}}$ time $= 8 \times 60 = 480$ secs

$P = \frac{3742.7}{480} = 7.797$W

Recall; $P_d = V^2 \omega C \tan\delta$

$7.797 = V^2 \times 125.664 \times 10^6 \times 21.57 \times 10^{-12} \times \tan(2.3°)$

$V^2 = \frac{7.797}{1.08868 \times 10^{-4}}$ $V = 267.62$ V

$P = IV\cos\phi$ $I = \frac{P}{V\cos\phi}$

$I = \frac{7.797}{267.62 \times 0.04} = 0.7284$A