Assignment - I

1. The maximum electric field 10m from an isotopic point source of light is 2 V/m. What are
a) the maximum value of the magnetic field.
b) the average intensity of light ?
c) What is the power of the source?

=> sol^n,

(a)

$$B_0 = \frac{E_0}{c} = \frac{2}{2.99\times10^8 \, m/s}$$

$$= 6.7\times10^{-9} T$$

b)

$$I = \frac{E_0^2}{2\mu_0 c} = \frac{2^2}{2\times4\pi\times10^{-7}\times2.99\times10^8}$$

$$= 5.3\times10^{-3} \, W/m^2$$

c) The power of the source

$$P = 4\pi r^2 I_{ave}$$

$$= 4\pi (10)^2 (5.3\times10^{-3})$$

$$= 6.7 \, \omega.$$

2) A certain plane electromagnetic wave emitted by a microwave antenna has a wavelenght of 3 cm & a maximum magnitude of electric field of 2×10^{-4} V/m.
i) What is frequency
ii) What the maximum magnetic field
iii) What is the Poynting work,

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⇒ Sol^n,

$\lambda = 3cm = 3\times10^{-2}m$

$E_0 = 2.0\times10^{-4}$ V/cm

$= 2.0\times10^{-4}\times10^{2}$ V/m

$= 2.0\times10^{-2}$ V/m

Then,

i) frequency $(f) = \frac{v}{\lambda} = \frac{3\times10^{8}}{3\times10^{-2}}$

$= 10^{10}$ Hz.

ii) Maximum magnitude of magnetic field.

$B_0 = \frac{E_0}{c}$

$= \frac{2.0\times10^{-2}}{3\times10^{8}}$

$= 6.67\times10^{-11}$ T

iii) Pyonding vector $(S) = \frac{E_0 B_0}{\mu_0} = \frac{2\times10^{-2}\times6.67\times10^{-11}}{4\pi\times10^{-7}}$

$=$

$= 1.061\times10^{-6}$ W/m^2.

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3) The sun deliver about $10^3 W/m^2$ of energy of the earths surface through EM radiation calculation

a) The total power incident on a roof of dimension $8m \times 20m$

b) Radiation pressure & force exerted on the roof, assuming proof is perfect absorber.

=> Soln,

Intensity $(I) = 10^3 \ W/m^2$.

(a) Total Power $(P) = I \times A$

$= 10^3 \times (8 \times 20)$

$= 160000 \ W$

$= 160 \ kW$

(b) Radiation Pressure $(P_1) = \frac{I}{c}$ (For perfect ~~absorb~~)

$= \frac{10^3}{3 \times 10^2}$

c) Force experted on roof $(F) = P \times A$

$= 3.33 \times 10^{-6} \times 8 \times 20$

$= 5.33 \times 10^{-4} \ N$ #

4) A radio wave transmits 25 W/m^2 of power per unit area. The flat surface area is perpendicular to the direction of propagation of wave. Calculate the radiation pressure on it & maximum electric & magnetic field associated with the wave

=> Sol^n,

Intensity $(I) = 25 \ W/m^2$

Then,

(a) Radiation pressure $(P_r) = \frac{I}{c}$

$= \frac{25}{3\times10^8}$

$= 8.33\times10^{-8} \ N/m^2$.

(b) We know.

$I = \frac{cB_0^2}{2\mu_0}$

$B_0 = \sqrt{\frac{2\mu_0 I}{c}}$

$= \sqrt{\frac{2\times4\pi\times10^{-7}\times25}{3\times10^8}} = 4.576\times10^{-7} T$

c) $E_0 = \sqrt{2\mu_0 c I}$

$= \sqrt{2\times4\pi\times10^{-7}\times3\times10^8\times25}$

$= 137.293 \ Vm^{-1}$

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5) A parallel plate capacitor with circular plates of 20 radius ~~of magnitude 20~~ is charged producing uniform displacement current density of magnitude 20 A/m2

Calculate

i) dE/dt in the region.

ii) The displacement current.

iii) Induced magnetic field.

⇒ Sol^n,

radius (r) = 20 cm = 0.2 m

current density (I_d) = 20 A/m^2

Then

(i) $\frac{dE}{dt} = \frac{I_d}{\varepsilon_0 A} = \frac{I_d}{\varepsilon_0} = \frac{20}{8.85 \times 10^{-12}}$

$= 2.259 \times 10^{12}\ Vs^{-1}$

(ii) displacement current (I_d) $= J_d \times A$

$= I_d \times \pi r^2$

$= 20 \times \pi \times (0.2)^2$

$= 2.51 A.$

iii) Induced magnetic field.

$$B = \frac{\mu_0 \varepsilon_0 r}{2} \times \frac{dE}{dt}$$

$$= \frac{4\pi \times 10^{-7} \times 8.85 \times 10^{-12} \times 2.25 \times 10^{12}}{2}$$

$$= 2.51 \times 10^{-6} T$$

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Assignment -7

6) Calculate the displacement current betn the capacitor plates of area $1.5\times10^{-2}\ m^2$, & rate of electric field change is 1.5×10^{-12} v/ms. Also calculate displacement current density.

=> Soln,

Here,

Area $(A) = 1.5\times10^{-2}\ m^2$

$$\frac{dE}{dt} = 1.5\times10^{-12}\ v/ms$$

Then,

$$I_d = \epsilon_0 A \frac{dE}{dt}$$

$$= 8.85\times10^{-12}\times1.5\times10^{-2}\times1.5\times10^{-12}$$

$$= 1.99\times10^{-25}\ A.$$

Then,

displacement current $(J_d) = \frac{I_d}{A}$

$$= \frac{1.99\times10^{-25}}{1.5\times10^{-2}}$$

$$= 1.326\times10^{-23}\ A/m^2$$