ANSWERS Assignment 3

1 MARK QUESTIONS

1(a)

2(b)

3. Displacement current is always equal to conduction current and hence equals to 0.25 A

4. The infrared radiation emitted by earth are retained by the earth's atmosphere due to the green house effect and this keeps the earth warm. If the Earth did not have atmosphere, its average temperature would have been low.

ASSERTION REASON TYPE QUESTIONS

5. B 6. A 7. D 8.B

CASE STUDY BASED QUESTIONS

9. (I) (c) dielectric constant of the medium

(I) (b) Hertz

(II) (d) radiation pressure

(III) From Maxwell's equations, the relationship between magnitude of magnetic field and electric field is given as Bo = (Eo/c)

(IV) Permittivity of the medium is nothing but the ability of that medium to store electric potential energy in that medium.

While permeability of the medium is also the ability of the medium to allow the number of magnetic field lines through it.

2 MARKS QUESTIONS

10. The average value of energy density (energy / volume) is given by

Uav = $\mathbf{1/2}\in\boldsymbol{oEo}^{\mathbf{2}}$ /Total volume of the cylinder V = A l ;

Total energy contained in the cylinder, U = (Uav) /V= (1/2 $\in\boldsymbol{oE}$)/Al

= $\mathbf{1}/[(\mathbf{8.86}\ \boldsymbol{X}\ \mathbf{10}^{\mathbf{-12}})(\mathbf{50})^{\mathbf{2}}]/[(10 \text{ X } 10^{-4})(50 \text{ X } 10^{-2})] = 5.5 \text{ X } 10^{-12}$ J

11. If we increase the frequency, the reactance of the capacitor will decrease and consequently conduction current will increase. Since displacement current is equal to conduction current, the displacement current will increase with increase in frequency of a.c. source.

3 MARKS QUESTIONS

12. Here, By =$2 \text{ x } 10^{-7} \sin [0.5 \text{ x } 10^{3} \text{ x} + 1.5 \text{ x } 10^{11} \text{t}]$

(a) The Y-component of the magnetic field is given by By = $B_O \sin 2\pi (/\boldsymbol{\lambda} + \boldsymbol{t}/\boldsymbol{T})$

Comparing the given equation with the above equation:

$2\pi/\lambda = 1/ (0.5 \times 10^3 \lambda) = 1.257 \times 10^{-2}$ m

Also $2\pi/ T = 1.5 \times 10^{11}$ Or $\nu = 2.387 \times 10^{10}$ Hz

(b) Since the argument of sine in the expression for the magnetic field is of the type (kx + ωt), the direction of propagation of the e. m. wave is along negative X-axis and the magnetic field is alongnegative Y-axis.

Hence, the electric field is along negative Z-axis and expression for it is

given by $E_y = E_O \sin 2\boldsymbol{\pi} (x/\boldsymbol{\lambda} + \boldsymbol{t}/ \boldsymbol{T})$

Here, $E_O = B_O c = 2 \times 10^{-7} \times 3 \times 10^8 = 60$ V/m;

$E_z = 60\sin [0.5 \times 10^3 x + 1.5 \times 10^{11} t]$ (in V/m)

13. i) γ-rays are used for the treatment of certain forms of cancer. Its frequency range is 3×10^{19} Hzto 5×10^{22} Hz.

(ii) The thin ozone layer on top of stratosphere absorbs most of the harmful ultraviolet rays coming from the sun towards the earth. They include UVA, UVB and UVC radiations, which can destroy the life system on the earth. Hence, this layer is crucial for human survival.

(iii) An electromagnetic wave transports linear momentum as it travels through space. If an electromagnetic wave transfers a total energy U to a totally absorbing surface in time t, then total linear momentum delivered to the at surface. This means, the momentum range of EM waves is 10^{-19} to 10^{-41}. Thus, the amount of momentum transferred by the EM waves incident on the surfaceis very small.