Tutorial 2

Tutorial 2

1. A satellite in geosynchronous orbit (36,000 km above the equator) is used for communication at 30 GHz. The atmosphere is 15 km thick. Assume free space above the atmosphere and plane wave propagation. Properties of the atmosphere are $\varepsilon=1.05\varepsilon_0$ [F/m], $\mu=\mu_0$ [H/m], and $\sigma=10^{-6}$ S/m:

(a) Calculate the phase velocity in the atmosphere and in free space.
(b) Calculate the attenuation and phase constants in the atmosphere and in free space.
(c) Calculate the propagation constant in the atmosphere (air). Compare with the propagation constant in free space.
(d) Compare the intrinsic impedance in free space and in the atmosphere.
(e) If the minimum electric field intensity required for reception is 10 mV/m, what must be the minimum amplitude of the electric field intensity at the transmitter? Assume the satellite does not amplify the signal but only reflects it, and both transmitter and receiver are on Earth.

Tutorial 2

2. A uniform plane wave travelling in the +z direction has two component of electric field $E_x=5$ V/m and $E_y=10\angle 30^\circ$ V/m. At the same instance t=0, the Ex component is maximum. Find the magnitude and direction of the field at t=0 and t=0.1nsec. Frequency of the wave is 2 GHz. Find the polarization of the wave.

to find polarization find equation of EX and Ey and then judge

Tutorial 2

3. A radar antenna transmits 50 kW at 10 GHz. Assume transmission is in a narrow beam, 1 m^2 in area, and that within the beam, waves are plane waves. The wave is reflected from an aircraft but only 1 % of the power propagates in the direction of the antenna. If the airplane is at a distance of 100 km, calculate the total power received by the antenna. Assume permittivity and permeability of free space and conductivity of 10^{-7} S/m.

Tutorial 2

4. A microwave oven operates a 2450 MHz and at a time-averaged power of 1000 W/m^2. The microwave beam, which can be assumed to be a plane wave, is incident on a copper foil, 1 m^2 in area and 10 μm thick. Assuming that the electric field is parallel to the foil and that only 2% of the incident electric field intensity enters the foil, calculate the amplitude of the electric field intensity just below the other surface of the foil (but still in the copper foil). Use $\varepsilon=\varepsilon_o$ [F/m], $\mu=\mu_o$ [H/m], and $\sigma = 0$ for free space and $\varepsilon=\varepsilon_o$ [F/m], $\mu=\mu_o$ [H/m], and $\sigma = 5.7 \times 10^7$ S/m for copper.

Tutorial 2

5. A medium has infinite conductivity for $z < 0$ and $\epsilon_r = 5$, $\mu_r = 20$ and $\sigma = 0$ for $z > 0$. If the electric field for $z > 0$ is given by

$$E = 10 cos(3 \times 10^8 t - 10x)\ z$$

Find the surface charge density and surface current density at location (2,3,0) at $t = 0.5$ n sec.

Tutorial 2

6. Consider superimposing a left and a right circularly polarized fields of the same amplitude, frequency, and propagation direction, but where a phase shift of radians exists between the two. What is the resulting polarization?

Tutorial 2

7. A uniform plane wave in region 1 is normally incident on the planar boundary separating regions 1 and 2. If $\varepsilon_1'' = \varepsilon_2'' = 0$, while $\varepsilon'_{\mathrm{r}1} = \mu_{r1}^3$ and $\varepsilon'_{\mathrm{r}2} = \mu_{r2}^3$ find the ratio $\varepsilon'_{r2}/\varepsilon'_{r1}$ if 20% of the energy in the incident wave is reflected at the boundary. There are two possible answers.

Tutorial 2

8. In a nonmagnetic medium

$$E = 4 \sin (2\pi \times 10^7 t - 0.8x)\, a_z \text{ V/m.}$$

Find:

a) ε_r and η

b) The time average power carried by the wave

c) Total power crossing $100 cm^2$ of the plane $2x + y = 5$.