

## Series 5

### Electromagnetic field's propagation

#### Exercise 1

A 10-MHz uniform plane wave is traveling in a nonmagnetic medium with  $\mu = \mu_0$  and  $\epsilon_r = 9$ . Find

- (a) the phase velocity,
- (b) the wavenumber,
- (c) the wavelength in the medium, and
- (d) the intrinsic impedance of the medium.

#### Exercise 2:

The electric field phasor of a uniform plane wave traveling in a lossless medium with an intrinsic impedance of  $188.5 \Omega$  is given by  $\tilde{E} = \hat{z} 10e^{-j4\pi y}$  (mV/m). Determine

- (a) the associated magnetic field phasor and
- (b) the instantaneous expression for  $E(y,t)$  if the medium is nonmagnetic ( $\mu = \mu_0$ ).

#### Exercise 3:

If the magnetic field phasor of a plane wave traveling in a medium with intrinsic impedance  $\eta = 100 \Omega$  is given by  $\tilde{H} = (\hat{y} 10 + \hat{z} 20)e^{-j4x}$  (mA/m), find the associated electric field phasor.

#### Exercise 4:

The electric field of a plane wave is given by  $E(z,t) = \hat{x} 3 \cos(\omega t - kz) + \hat{y} 4 \cos(\omega t - kz)$  (V/m). Determine

- (a) the polarization state,
- (b) the modulus of  $E$ , and
- (c) the inclination angle.

#### Exercise 5

The constitutive parameters of copper are  $\mu = \mu_0 = 4\pi \times 10^{-7}$  (H/m),  $\epsilon = \epsilon_0' (1/36\pi) \times 10^{-9}$  (F/m), and  $\sigma = 5.8 \times 10^7$  (S/m). Assuming that these parameters are frequency independent, over what frequency range of the electromagnetic spectrum is copper a good conductor?