

EE1002 Principles of Electronic Engineering
Semester A 2016-17
Part 3: Electromagnetic Waves and Applications

Tutorial 1

1. Find the wavelength of the following: (a) 10 GHz radar, (b) 95 MHz radio, and (c) 10^{11} Hz microwaves.
2. List the following in order of frequency, lowest first: 5 GHz radar, 3 micron infrared radiation, 20 kHz sonar, 4 kHz sound in air, blue light, and 2000 m radio.
3. Calculate the speed, the frequency, and the wavelength of red light in glass, given that the wavelength of the red light in air is $0.633 \mu\text{m}$ and the refractive index of glass is 1.50.
4. Find the time delay t in terms of the periodic time T of a wave that is 90° out of phase.
5. A lightning bolt is seen to strike the topmast of a yacht in a harbor. If the sound of the thunder is heard 5 seconds later, how far away is the yacht, given that the speed of sound in air is 330 m/s.
6. Find the critical angle for a wave travelling from diamond (with a refractive index of 2.4) into air. Find also the refracted wave angle to the normal in air for an incident wave from diamond of 15° to the normal.
7. The vertical and horizontal beam widths of a radar antenna are 20° and 1° , respectively. The radar operates at 9.5 GHz. Calculate the horizontal and vertical dimensions of the antenna.
8. The vertical and horizontal dimensions of a radar antenna are 25 cm and 2.4 m, respectively. If the radar operates at 3.1 GHz, what are the horizontal and vertical beam widths?
9. Describe with a diagram the polarization state of the following EM wave, where the P- and S-polarized electric-field components are given:
P-polarized component: $E(t) = E_0 \sin(2\pi ft + \frac{\pi}{4})$;
S-polarized component: $E(t) = 0.5E_0 \cos(2\pi ft + \frac{\pi}{4})$
10. A radar transmitter has a 40 W power source. If the source radiates isotropically in all directions, what will the intensity be 100 m from the source?
11. An amplifier has a power gain of 30 dB. For an output power of 25 W, what is the input signal power? Express the answer in both W and dBW.
12. A handheld radio operating at 448 MHz emits an equivalent isotropic power of 0.8 W. The noise power at the receiving antenna is -160 dBW. For an acceptable level of reception, the signal-to-noise ratio (SNR) (i.e., the ratio of the signal power to the noise power) at the receiving antenna must be at least 15 dB. Estimate the maximum line-of-sight range for the radio communication.