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TCET2220

HW # 2

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Chapter 1

1.1-1.32

1. Calculate the free space wavelength in meter for the following frequencies:
2. 2kHz
3. 200kHz
4. 20 MHz
5. 2 GHz
6. $λ=\frac{C}{f}=\frac{3X10^{8}}{2X10^{3}}=150 km$
7. $λ=\frac{C}{f}=\frac{3X10^{8}}{200X10^{3}}=1.5 km$
8. $λ=\frac{C}{f}=\frac{3X10^{8}}{20X10^{6}}=15 m$
9. $λ=\frac{C}{f}=\frac{3X10^{8}}{2X10^{9}}=15 cm$
10. Calculate the free space wavelength in meter for the following frequencies:
11. 80 kHz
12. 8 MHz
13. 800 MHz
14. 8 GHz
15. $λ=\frac{C}{f}=\frac{3X10^{8}}{80X10^{3}}=3750 m$
16. $λ=\frac{C}{f}=\frac{3X10^{8}}{8X10^{6}}=37.5 m$
17. $λ=\frac{C}{f}=\frac{3X10^{8}}{800X10^{6}}=0.375 m$
18. $λ=\frac{C}{f}=\frac{3X10^{8}}{8X10^{9}}=3.75 cm$
19. Calculate the free space wavelength in miles for the frequency of 400 Hz.

$$λ=\frac{C}{f}=\frac{3X10^{8}}{400}=750 Km=\left(750 km\right)\left(\frac{1 mile}{1.609 km}\right)=466 miles$$

1. Calculate the free space wavelength in miles for the frequency of 1.5 kHz.

$$λ=\frac{C}{f}=\frac{3X10^{8}}{1.5X10^{3}}=200 Km=\left(200 km\right)\left(\frac{1 mile}{1.609 km}\right)=124 miles$$

1. A sinusoidal signal has a free-space wavelength of 80 m. calculate the frequency.

$$f=\frac{C}{λ}=\frac{3X10^{8}}{80}=3.75 MHz$$

1. A sinusoidal signal has a free-space wavelength of 6 m. calculate the frequency.

$$f=\frac{C}{λ}=\frac{3X10^{8}}{80}=50 MHz$$

1. A digital signal utilizes pulses whose minimum widths are about 3 ns. Assuming the speed of light, determine the longest lengths of wire-pair that can be allowed based on the 10% rule.

$$t\_{1}=\left(0.1\right)\left(3ns\right)=0.3ns$$

$$d=ct\_{1}=\left(3X10^{8}\right)\left(0.3X10^{-9}\right)=9 cm$$

1. The longest connecting wires in a digital system are about 20 cm. assuming the speed of light, determine the shortest acceptable pulse width based on the 10% rule.

$$d=ct\_{1}-\rightarrow t\_{1}= \frac{d}{c}=\frac{20X10^{-2}}{3X10^{8}}=0.67 ns$$

$$Width=\frac{0.67X10^{-9}}{0.1}=6.7 ns$$

1. A communication system operates a frequency of 800 MHz. Assuming the speed of light, determine the length of connecting line that could be used without considering frequency- domain effects based on the 10% rule.

$$λ=\frac{C}{f}=\frac{3X10^{8}}{800X10^{6}}=0.375 m$$

$$d=\left(0.1\right)\left(0.373\right)=3.75 cm$$

1. The length of a connecting cable between two points in a radio frequency system is 50 cm. Assuming the speed of light, determine the high operating frequency that should be used without considering frequency domain effects based on the 10% rule.

$$λ=\frac{d}{0.1}=\frac{50X10^{-2}}{0.1}=5 m$$

$$f=\frac{c}{λ}=\frac{3X10^{8}}{5}=60 MHz$$

1. In a coil, a current of 100 mA results in magnetic flux of 50 µWb. Determine the inductance.

$$Inductance=\frac{flux}{current}=\frac{50 μWb}{100 mA}=500 μH$$

1. A current of 4 mA is flowing in a 20 µH coil. Determine the magnetic flux.

$$Inductance=\frac{flux}{current}$$

$$-\rightarrow flux=\left(current\right)\left(Inductance\right)=\left(4X10^{-3}A\right)\left(20X10^{-6}H\right)=80 nWb$$

1. In a capacitor, a voltage of 20V result in charge storage of 5 µC. Determine the capacitance.

$$C=\frac{Charge}{voltage}=\frac{5X10^{-6}c}{20 V}=0.25 μF$$

1. A capacitance of 40 µF is charged to a voltage of 12 V. Determine the electric charge.

$$C=\frac{Charge}{voltage}-\rightarrow charge=\left(Capacitance\right)\left(voltage\right)=\left(40X10^{-6}\right)\left(12 V\right)=0.48mC$$

1. A lossless transmission line has an inductance of 320 nH/m and a capacitance of 57 pF/m. Determine the characteristic impedance.

$$R\_{o}=\sqrt{\frac{L}{C}}=\sqrt{\frac{320X10^{-9}{H}/{m}}{57X10^{-12}{F}/{m}}}=74.93Ω$$

1. A lossless transmission line has an inductance of 1.2 µH/m and a capacitance of 15 pF/m. determine the characteristic impedance.

$$R\_{o}=\sqrt{\frac{L}{C}}=\sqrt{\frac{1.2X10^{-6}{H}/{m}}{15X10^{-12}{F}/{m}}}=282.8Ω$$

1. The dielectric constant of mica is 6. Determine the permittivity.

$$\in =\in \_{r}\in \_{o}=\left(6\right)\left(8.84X10^{-12}{F}/{m}\right)=5.3X10^{-11}{F}/{m}$$

1. The permittivity of a material is 14X10-12 F/m. Determine the dielectric constant.

$$\in =\in \_{r}\in \_{o}-\rightarrow \in \_{r}=\frac{\in }{\in \_{o}}=\frac{14X10^{-12}{F}/{m}}{8.84X10^{-12}{F}/{m}}=1.6$$

1. The permeability of nickel is 800. Determine the actual permeability.

$$μ=μ\_{r}μ\_{0}=\left(800\right)\left(4πX10^{-7}{H}/{m}\right)=1X10^{-3}{F}/{m}$$

1. The permeability of a ferromagnetic material is 10-4 H/m. Determine the relative permeability.

$$μ\_{r}=\frac{μ}{μ\_{0}}=\frac{10^{-4}{H}/{m}}{4πX10^{-7}{H}/{m}}=79.5$$

1. Determine the velocity of propagation of the transmission line of problem 15.

$$v=\frac{1}{\sqrt{LC}}=\frac{1}{\sqrt{(320X10^{-9}{H}/{m})(57X10^{-12}{F}/{m})}}=2.34X10^{8}{m}/{s}$$

1. Determine the velocity of propagation of the transmission line of problem 16.

$$v=\frac{1}{\sqrt{LC}}=\frac{1}{\sqrt{\left(1.2X10^{-6}{H}/{m}\right)\left(15X10^{-12}{F}/{m}\right)}}=2.36X10^{8}{m}/{s}$$

1. The dielectric constant in a transmission line is 4.7 and µ=$μ\_{o}$. Determine the velocity of propagation.

$$v=\frac{c}{\sqrt{\in \_{r}}}=\frac{3X10^{8}}{\sqrt{(4.7)}}=1.38X10^{8}{m}/{s}$$

1. The dielectric constant in a certain transmission line is 3 and µ=$μ\_{o}$. Determine the velocity of propagation.

$$v=\frac{c}{\sqrt{\in \_{r}}}=\frac{3X10^{8}}{\sqrt{\left(3\right)}}=1.73X10^{8}{m}/{s}$$

1. A coaxial cable has the following specification: $R\_{o}=73 Ω$, and velocity of propagation = 2.1X108 m/s. Determine L and C.

$$L=\frac{R\_{o}}{v}=\frac{73}{2.1X10^{8}}=347.6 nH$$

$$C=\frac{1}{R\_{o}v}=\frac{1}{(73)(2.1X10^{8})}=65.2 pF$$

1. A transmission line has the following specification:$ R\_{o}=150 Ω$, and velocity factor of 0.8. Determine L and C.

$$L=\frac{R\_{o}}{0.8c}=\frac{150}{0.8(3X10^{8})}=0.625 µH$$

$$C=\frac{1}{0.8cR\_{o}}=\frac{1}{\left(0.8\right)\left(3X10^{8}\right)\left(150\right)}=27.78 pF$$

1. The lower end of a commercial AM band is about 550 KHz. AM station use “quarter wave” vertical antenna whose length are 0.25λ. Determine the length in meters of a vertical antenna operating at the lower end.

$$0.25λ=0.25\frac{C}{f}=0.25\frac{3X10^{8}}{550X10^{3}}=1.36 m$$

1. The upper end of a commercial AM band referred to problem 27 is about 1610 KHz. Determine the length in meters of a vertical antenna operating at the upper end.

$$0.25λ=0.25\frac{C}{f}=0.25\frac{3X10^{8}}{1610X10^{3}}=46.6 m$$

1. One popular single antenna is the “half wave” horizontal antenna whose theoretical length is 0.5λ at the operating frequency. In practice, however, the antenna is usually shortened by about 5% due to the end effect. Determine the practical length in meters for a half wave antenna to provide optimum reception at the lower end of the commercial FM band, which is about 88 MHz.

$$0.5λ=0.5\frac{C}{f}=0.5\frac{3X10^{8}}{88X10^{6}}=1.7 m$$

$$Pactical length=1.7\left(1-0.05\right)=1.619 m$$

1. Based on the discussion of problem 29, determine the practical length in meters for a half wave antenna to provide optimum reception at the upper end of the FM band, which is 108 MHz.

$$0.5λ=0.5\frac{C}{f}=0.5\frac{3X10^{8}}{108X10^{6}}=1.39 m$$

$$Pactical length=1.39\left(1-0.05\right)=1.319 m$$

1. Show that the free space velocity of light in feet/second is very closed to 982X106

ft/s.

$$c=3X10^{8}^{m}/\_{s}=\left(3X10^{8}^{m}/\_{s}\right)\left(3.28^{ft}/\_{m}\right)=984X10^{6}^{ft}/\_{s}$$

1. Show that the free space wavelength in feet can be expressed as $λ\left(ft\right)=\frac{982}{f(MHz)}$.

$$λ=\frac{c(^{m}/\_{s})}{f(Hz)}=\frac{(3X10^{8}^{m}/\_{s})(3.28^{ft}/\_{m})}{f(Hz)}=\frac{984X10^{6}^{ft}/\_{s}}{f(Hz)}=\frac{984}{f(MHz)}$$