* 1. **Calculate the free-space wavelength in meters for the following frequencies.**
1. **2 kHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{2\*10^{3} Hz}=150 Km$$

1. **200 kHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{200\*10^{3} Hz}=1.5 Km$$

1. **20 MHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{20\*10^{6} Hz}=15 m$$

1. **2GHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{2\*10^{9} Hz}=150 mm$$

* 1. **Calculate the free-space wavelength in meters for the following frequencies**
1. **80 kHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{80\*10^{3} Hz}=3.75 km$$

1. **8 MHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{8\*10^{6} Hz}=37.5 m$$

1. **800 MHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{800\*10^{6} Hz}=375 mm$$

1. **8 GHz**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{8\*10^{9} Hz}=37.5 mm$$

* 1. **Calculate the free-space wavelength in miles for a frequency of 400 Hz**

$$λ=\frac{C\_{0}}{F}=\frac{186\*10^{3} m/s}{400 Hz}=465 mi$$

* 1. **Calculate the free-space wavelength in miles for a frequency of 1.5 Hz**

$$λ=\frac{C\_{0}}{F}=\frac{186\*10^{3} m/s}{1.5 Hz}=124 mi$$

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

$$F=\frac{C\_{0}}{λ}=\frac{3\*10^{8} m/s}{80 m}=3.75 MHz$$

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

$$F=\frac{C\_{0}}{λ}=\frac{3\*10^{8} m/s}{6 m}=50 MHz$$

* 1. **A digital signal utilize pulse whose minimum widths are about 3 ns. Assuming the speed of light, determine the longest length of wired-pair that can be allowed based on the 10% rule.**

$$10\%=0.1$$

$$t\_{1}=0.1\*3 ns=300 ps$$

$$d=\left(3\*10^{8} ^{m}/\_{s}\right)\*\left(300 ps\right)=90 mm$$

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

$$d=0.2 m$$

$$t\_{1}=\frac{0.2 m}{\left(3\*10^{8} ^{m}/\_{s}\right)}=666.66 ps$$

$$Power\_{width}=\frac{666.66 ps}{0.1}=6.66 ns$$

* 1. **A communication system operates at 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.**

$$λ=\frac{C\_{0}}{F}=\frac{3\*10^{8} m/s}{800\*10^{6} Hz}=375 mm$$

* 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 highest operating frequency that should be used without considering frequency-domain effects based on the 10% rule.**

$$F=\frac{C\_{0}}{λ}=\frac{3\*10^{8} m/s}{0.5 m}=600 MHz$$

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

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

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

$$Flux=inductance\*current=\left(20μH\right)\*\left(4mA\right)=80nWb$$

* 1. **In a capacitor, a voltage of 20 V results in charge storage of 5** $μC$**. Determine the Capacitance.**

$$capacitance=\frac{charge}{voltage}=\frac{5μC}{20v}=250 nF$$

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

$$charge=capacitance\*voltage=40 μF\*12 v=480 μC$$

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

$$R\_{0}=\sqrt{\frac{L}{C}}=\sqrt{\frac{320 nH/m}{57 pF/m}}=74.926Ω$$

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

$$Ro=\frac{\sqrt{L}}{C} = \sqrt{1}.2\frac{μH}{m}/ 15\frac{pF}{m} = 282.842 Ω$$

* 1. **The dielectric constant of mica is 6. Determine the permittivity** $ \in =\left(\in \right)\left(\in o\right) \in =8.842 x 10^{-12}\frac{F}{m}$

$\in =\left(6\right)\left(8.842\frac{pF}{m}\right)= 53.052\frac{pF}{m} $

* 1. **The permittivity of a material is** $14\*10^{-12} F/m$**. Determine the dielectric constant.**

$\in \_{x= \in /\in \_{0} }=\frac{14\frac{pF}{m}}{8.842\frac{pF}{m} }=1.583$

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

**µ=**$µ\_{e}$**\*µ= (800)(π X** $10^{-7}\frac{H}{M})=10.05\frac{mH}{m}$

* 1. **The permeability of a ferromagnetic material is** $10^{-4} H/m$**. Determine the relative permeability.**

$µ\_{x=}$**µ/**$µ\_{0}$**=** $\frac{\frac{10^{-4}H}{m}}{}4π x 10^{-7}=79.55 $

* 1. **Determine the velocity of propagation of the transmission line of problem (1.15)**

**V= 1/**$\sqrt{L} xC $**=** $\frac{1}{√(320nH)(57Pf/M)}$ **= 234.146 X** $10^{6}\frac{m}{s}$

* 1. **Determine the velocity of propagation of the transmission line of problem (1.16)**

**V=**$\frac{1}{\left(1.2 µHm\right)\left(15\frac{pf}{m}\right)}$**=235.7** $10^{6 }$**m/s**

* 1. **The dielectric constant in a transmission line is 4.7 and** $μ=μ\_{0}$**. Determine the velocity of propagation.**

**V=** $\frac{C}{√\in \_{X}}$ **=s**$\frac{3 X 10^{8 }m/s}{\sqrt{4}.7}$ **/ = 138.39 x** $10^{6}$

* 1. **The dielectric constant in a certain transmission line is 3 and** $μ=μ\_{0}$**. Determine the velocity of propagation.**

**V=** $\frac{C}{√\in \_{r}}$**=**$\frac{3 X 10^{8 }m/s}{√3}$**= 173.2 x** $10^{6}$

* 1. **A coaxial cable has the following specification:** $R\_{0}=73 Ω$**, and velocity of propagation =** $2.1\*10^{8} m/s$**. Determine L and C**

**L=**$\frac{R0}{v}$**= 73.2/2.1 x** $10^{8}$ **c=**$\frac{1}{R0\*V}$**=**$\frac{1`}{\left(73\right)(2.1 x 10^{8})}$**=65.3 pf**

* 1. **A transmission line has the following specification:** $R\_{0}=150 Ω$**, and velocity factor = 0.8. Determine L and C**

 **L=**$\frac{R0}{v}$**=**$\frac{150}{.8(3 x 10^{8})}$**= 650mh c=**$\frac{1}{R0\*V}$**=**$\frac{1}{\left(150\right)(240x 10^{8})}=27.77pf$

* 1. **The lower end of the commercial amplitude-modulation (AM) band is about 550 kHz. AM stationary use “quarter-wave” vertical antennas whose lengths are** $0.25λ$**. Determine the length in meters of a vertical antenna operating at the lower end.**

$λ=\frac{c}{r}$ **=**$\frac{3 x 10^{8}}{550khz}$**=545.45 .25**$ λ$**= .25(545/.45)= 136.36m**

* 1. **The upper end of the commercial AM band referred to in Problem (1.27) is about 1610 kHz. Determine the length in meters of a vertical antenna operating at the upper end.**

$λ=\frac{c}{r}$ **=**$\frac{3 x 10^{8}}{1610khz}$**= 186.335m**

* 1. **One popular simple 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 end effects. 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 88MHz.**

$λ=\frac{c}{r}$ **=**$\frac{3 x 10^{8}}{88Mhz}$**= 3.4090 m .5**$ λ= .5\left(3.4090\right)=1.7045m $

 **(1.7045-(1.7045\*.05))=1.6197m**

* 1. **Based on the discussion of Problem (1.29), determine the practical length in meter for a half-wave antenna to provide optimum reception ,at the upper end of the FM band, which is about 108 MHz.**

$λ=\frac{c}{r}$ **=**$\frac{3 x 10^{8}}{108Mhz}$**=2.77m**

 **.5**$ λ$**= .5(2.77)=1.388m**

 **(1.388-(1.388\*.05))=1.3194m**

* 1. **Show that the free-space velocity of light in feet/second is very close to** $c=982\*10^{6} ft/s$**.**

$3 x 10^{8}=982\* 10^{6} ft/s$

 **100cm 1in=2.5cm**

 **12inches 1m=40inches**

 **1m= 3.333ft**