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TCET 2220 Chapter 3 HW

3-1. A traveling wave of current in milliamperes is given by i=8 cos($2\pi * 10^6 t - 0.025x$) with t in seconds and x in meters. Determine the following :

(a) Direction of propagation:

Positive

(b) Peak value

8

(c) Angular frequency:

$2*\pi*f = 2\pi*10^6 = 6.28*10^6$

(d) Phase constant:

$\beta=.025$

(e) Cyclic frequency:

$f=\frac{\omega}{2*\pi} = \frac{6.28*10^6}{2*\pi} = 1*10^6$

(f) Period:

$T=\frac{1}{f}=\frac{1}{10^6} = 1*10^{-6}$

(g) Wavelength:

$\lambda=\frac{2\pi}{\beta}=\frac{2\pi}{.025} = 251.327$ m

(h) Velocity of propagation:

$V=f*\lambda= 10^6 * 251.327 = 2.51*10^8$

3-2. A traveling wave of voltage in volts in given by v= 15 cos($10^8 t+0.35x$) with t in seconds and x in meters. Determine the following:

(a) Direction of propagation:

Negative

(b) Peak value:

15

(c) Angular frequency:

10^8

(d) Phase constant

$\beta=.35$

(e) Cyclic frequency:

$f=\frac{\omega}{2*\pi}=\frac{10^8}{2*\pi}= 1.59 *10^7$

(f) Period:

$T=\frac{1}{f}=\frac{1}{1.59*10^7}=6.289 *10^{-8}$

(g) Wavelength:

$\lambda=\frac{2\pi}{\beta}=\frac{2\pi}{.35}=17.952$

(h) Velocity of propagation:

$V=f*\lambda= 1.59 *10^7 *17.952=2.86 *10^8$

3-3. A sinusoidal current with a peak value of 2 A and a frequency of 50 MHz is traveling in the positive x-direction with a velocity of 2 x 10^8 m/s. Determine the following:

(a) Period

$T=\frac{1}{f}=\frac{1}{50*10^6}= 20 * 10^{-9}$

(b) Angular frequency

$\omega= 2*\pi*f= 2*\pi*50 * 10^6= 3.14 *10^8$

(c) Phase constant

$$\beta = \frac{\omega}{v}=\frac{3.14*10^8}{2*10^8}= 1.57$$

(d) Wavelength

$\lambda=\frac{2\pi}{\beta}=\frac{2\pi}{1.57}=4.00203$

(e) An equation for the current

$= 2* \cos (3.14 *10^8 t-1.57x)$

3-4. A sinusoidal voltage with a peak value of 25 V and a radian frequency of 20 Mrad/s is traveling in the negative x-direction with a velocity of 3 x 10^8 m/s. Determine the following:

(a) Cylic frequency:

$f=\frac{\omega}{2*\pi} = \frac{20*10^6}{2*\pi}= 3.18 *10^6$

(b) Period:

$T=\frac{1}{f}=\frac{1}{3.18*10^6}= 3.14 *10^{-7}$

(c) Phase constant:

$$\beta = \frac{\omega}{v} = \frac{20*10^6}{3*10^8} = .06667$$

(d) Wavelength:

$\lambda=\frac{2\pi}{.06667}=94.2$

(e) An equation for the voltage:

$= 25*\cos(20 * 10^6 t + (.06667x))$

3-5. Consider the current traveling wave of Problem 3-1. Determine the following:

$$i = 8\cos(2\pi * 10^6 t - 0.025x)$$

(a) a fixed phasor representation in peak units as either $\bar{I}^+$ or $\bar{I}^-$ (You decide which label is appropriate.)

$\bar{I}^+ = 8 * e^0 = 8\angle 0$

(b) the corresponding distance-varying phasor $\bar{I}(x)$ in peak units

$\bar{I}(x) = \bar{I}^+ = 8 * e^0 * e^{j\beta x}$

$= 8 * e^0 * e^{j-0.025}$

$= (8\angle 0)*(1\angle -.0025x)$

$=(8\angle -.0025x)$

(c) the value of the distance-varying phasor at x=100 m.

$=(8\angle -.0025x)$

$=(8\angle -.0025*100)$

$=8\angle -2.5$

3-6. Consider the voltage traveling wave of Problem 3-2. Determine the following:

$$15\cos(10^8 t + 0.35x)$$

(a) a fixed phasor representation in peak units as either $\bar{V}^+$ or $\bar{V}^-$ (You decide which label is appropriate.)

$\bar{V}^- = 15*e^{j0} = 15\angle 0$

(b) the corresponding distance-varying phasor $\bar{V}(x)$ in peak units

$\bar{V}(x) = \bar{V}^- * e^{j\beta x}$

$= 15*e^{j0} * e^{j0.35}$

$= 15\angle -0.35*x$

(c) the value of the distance-varying phasor at x=4 m.

$\bar{V}(4) = 15\angle -0.35*x$

$\bar{V}(4) = 15\angle -0.35*4$

$\bar{V}(4) = 15\angle -1.20$

3-7. Repeat the analysis of Problem 3-5 if the current of Problem 3-1 has a fixed phase shift such that it is described by

$$i=8\cos(2\pi * 10^6 t - 0.025x + 1.5)$$

(a) $\bar{I}^{+} = 8 * e^{1.5} = 8\angle 1.5$
(b) $\bar{I} = \bar{I}^{+} * e^{j-0.025}$

$= 8 * e^{1.5} * e^{j-0.025}$

$= 8\angle 1.5 - 0.25 * x$

(c) $\bar{I}(100) = 8\angle 1.5 - 0.25 * 100$
$= 8\angle 1.5 - 0.25 * 100$
$= 8\angle -1$

3-8. Repeat the analysis of Problem 3-5 if the current of Problem 3-1 has a fixed phase shift such that it is described by

$$v = 15\cos(10^8 t + 0.35x - \frac{\pi}{3})$$

a) $\bar{V}^{-} = 15 * e^{j-\frac{\pi}{3}}$

b) $\bar{V} = 15 * e^{j-\frac{\pi}{3}} * e^{j0.35x}$

$= 15\angle -\frac{\pi}{3} + 0.35x$

c) $\bar{V}(4) = 15\angle -\frac{\pi}{3} + 0.35 * 4$
$= 15\angle -58.6$

3-9. Redefine the fixed phasor of Problem 3-5 so that the phasor magnitude is expressed in rms units, and determine the average power dissipated in 50-Ω resistance.

a)Irms=

$$= \frac{\bar{I}+ = 8 * e^{j0} = 8\angle 0}{\sqrt{2}}$$

$= 5.65$

b)Power dissipated= $(I)^2 * R = (5.65)^2 * 50 = 1600$ watts

3-10. Redefine the fixed phasor of Problem 3-6 so that the phasor magnitude is expressed in rms units, and determine the average power dissipated in75-Ω resistance.

a)Vrms=

$$= \frac{\bar{V}^{-} = 8 * e^{j0} = 15\angle 0}{\sqrt{2}}$$

$= 10.61\angle 0$

b)Power dissipated= $\frac{V^2}{R} = \frac{(10.61)^2}{75}$ =1.501 watts

3-11. Redefine the fixed phasor of Problem 3-7 so that the phasor magnitude is expressed in rms units. Would the power dissipated in a 50-Ω resistance be the same as in Problem 3-9?

a) Irms=

$$= \frac{\bar{I}+ = 8 * e^{j1.5} = 8\angle 1.5}{\sqrt{2}}$$

=5.56<1.5

b) Power dissipated= (I)2* R= (5.56)2 * 75 =1600 watts

3-12. Redefine the fixed phasor of Problem 3-8 so that the phasor magnitude is expressed in rms units. Would the power dissipated in a 75-Ω resistance be the same as in Problem 3-10?

a)Vrms=

$$= \frac{\bar{V}^{-} = 15 * e^{j-\frac{\pi}{3}} = 15\angle -\frac{\pi}{3}}{\sqrt{2}}$$

$=10.61 \angle - \frac{\pi}{3}$

b)Power dissipated= $\frac{V^2}{R} = \frac{(10.61)^2}{75}$ =1.501 watts ; same as Problem 3-10

3-13. Under steady-state ac conditions, the forward current wave on a certain lossless 50-Ω line is $\bar{I}^{+}$ =2∠0 A. Determine the voltage forward wave.

a) $\bar{I}^{+}$ =2∠0 A.

b) $\bar{V}^{+} = R_0 * \bar{I}^{+}$

=2∠0 A * 50

$\bar{V}^{+}$ =100∠0

3-14. Under steady-state ac conditions, the forward voltage wave in a 300-Ω lossless line is $\overline{V}^{+}$=15∠3 A. Determine the current forward wave.

$\bar{I}^{+} = \frac{\bar{V}^{+}}{R0} = \frac{15\angle 3}{300}$ = .05∠3 A

3-15. Under steady-state ac conditions, the reverse voltage wave on a lossless 50-Ω line is $\bar{V}^{-}$ =200∠0 A. Determine the reverse current wave.

$\bar{I}^{-} = -\frac{\bar{V}^{-}}{R0} = \frac{200\angle 0}{-50}$ = - 4∠0 A

3-16. Under steady-state ac conditions, the reverse current wave on a lossless 75-Ω line is $\bar{I}^{-}$ =.5∠2 . Determine the reverse voltage wave.

$\bar{V}^{-}$ = R0 * $\bar{I}^{-}$ = -75 *(.5∠2 A)= -37.5∠2

3-17. A table of specifications for one version of RG-8/U 50-Ω coaxial cable indicates that the attenuation per 100 ft at 50MHz is 1.2 dB. At this frequency, determine the following:

(a) attenuation factor in decibels per foot.

$\alpha = \frac{1.2\ dB}{100\ ft}$ =.012

(b) attenuation factor in nepers per foot.

$L_{NP} = \frac{.012\ dB}{8.868\ ft}$ =1.382* 10^{-3}

For a length of 300 ft, determine the following:

(c) total attenuation in decibels.

300 ft * .012 =3.6 dB

(d) total attenuation in nepers

L_{NP} = (1.382 * 10^{-3})* 300 =.4146

(e) $\frac{V_2}{V_1}$ ratio using both decibels and nepers for a single wave

$\frac{V_2}{V_1} = e^{-L} = e^{-(1.382\ *\ 10^{-3})}$ =.999

$\frac{V_2}{V_1} = 10 * \frac{-3.6}{20}$ =.661

3-18. A transmission line has an attenuation of 0.05 dB/m. Determine the following:

(a) attenuation factor in nepers/m

For a length of 400 m, determine the following:

$\frac{L\frac{dB}{m}}{8.686} = \frac{.005}{8.686} = 5.76 * 10^{-4}$

(b) total attenuation in decibels.

L_{db} =.05 *400 =20

(c) total attenuation in nepers

$5.76 * 10^{-3} * 400 = 2.304$

(d) $\frac{V_2}{V_1}$ ratio using both decibels and nepers for a single wave.

$\frac{V_2}{V_1} = 10 * \frac{-20}{20} = .1$

3-19. A single frequency wave is propagating in one direction on a transmission line of length of 200 m. With an input rms voltage of 50 V, the output rms voltage is measured as 20 V. Determine the following:

(a) total attenuation in decibels.

1) $= 20 \log_{10} \frac{V_1}{V_2}$

8 $L_{db} = 20 \log_{10} (\frac{50}{20})$

2) $\alpha \frac{N_p}{m} = \frac{\text{Ldb}}{8.686 * d} = \frac{8}{8.686 * 200} = .004511$

3) $\alpha_{db} = 8.686 * .004511 = .039991$

4) $L_{db} = .039991 * 200 = 7.9982$

(b) total attenuation in nepers.

$L_{NP} = \alpha * d = .004511 * 200 = .9022$

(c) attenuation factor in decibels/meter

$\alpha_{db} = 8.686 * .004511 = .039991$

(d) attenuation factor in nepers/meter

$\alpha_{Np} = 4.511 * 10^{-3} \frac{N_p}{m}$

3-20. A single frequency wave is propagating in one direction on a transmission line of length 400 m. The input power to the line is 40 W, and the output power is 12 W. Determine the following:

(a) total attenuation in decibels.

1) $L_{db} = 10 \log_{10} (\frac{P_1}{P_2})$

$L_{db} = 10 \log_{10} (\frac{40}{12}) = 5.228$

2) $\alpha \frac{N_p}{m} = \frac{\text{Ldb}}{8.686 * d} = \frac{5.228}{8.686 * 200} = .00334 = 3.34 * 10^{-3} \frac{N_p}{m}$

3) $\alpha_{db} = 8.686 * .00334 = .029011$

4) .029011 *400=11.6044

(b) total attenuation in nepers.
$L_{NP}=\alpha$ *d=.00334 *400= 1.34

(c) attenuation constant in decibels/meters
α_{db} =8.686 *.004511 =.039991

(d) attenuation factor in nepers/meter
$\alpha \frac{N_p}{m} = \frac{\text{Ldb}}{8.686*d} = \frac{5.228}{8.686*200} = .00334 = 3.34 * 10^{-3} \frac{N_p}{m}$

3-21. A transmission line has the following parameters at 50 MHz: L=1.2 μH/m, R= 15 Ω/m, C= 10 pF/m, and G= 4 μS/m. Determine the following:

(a) Z =R +jωL= 15 + j ((2*π*50*10^6) *1.2 * 10^{-6}))= 15 +j (376.991)
= 377 ∠1.5

(b) Y= G +jωC= 4* 10^{-6}+ j ((2*π*50*10^6) *10 * 10^{-12}))= .000004 +j (.003142)
= .003142 ∠1.5

(c) γ,α, and β
$\gamma = \sqrt{Z \angle Y} = \sqrt{(377\angle 1.5) * (.00314\angle 1.57)}$ = .0223341 +j (1.08855)
α =.0223341
β = 1.08855

(d) attenuation in dB/m
α_{db} =8.686 *.0223341 =.193994 $\frac{dB}{m}$

(e) $v = \frac{\omega}{\beta} = \frac{2*\pi*50*10^6}{1.08855} = 2.885 * 10^8 \frac{m}{s}$

(f) $Z_0 = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{15 + j\,(376.991)}{.000004 + j\,(.003142)}}$ =346.46 –j(6.67) = 346.525 ∠-.02

3-22. A lossy audio-frequency line has the following parameters at 2 kHz: L= 0.1 μH/ft, R= 0.2 Ω/ft, C= 2 pF/ft, and G is negligible. Determine the following:

(a) Z = R +jωL= .2 +j((2*π*2000) *.1 * 10^{-6} = .2 +j(0.12566) = .200394 ∠ .0627

(b) Y= G +jωC= j ((2*π*2000) *2 * 10^{-12}))= j (2.513*10^{-8})=
= 2.513*10^{-8}∠1.5

(c) γ,α, and β
(d) γ,α, and β
$\gamma = \sqrt{Z\angle Y} = \sqrt{(.2\ + \mathrm{j}(0.12566)\ ) * (.\mathrm{j}\ (2.513 * 10^{-8})} = .000049 + \mathrm{j}\ (.000052)$
$\alpha = .000049$
$\beta = .000052$

(e) attenuation in dB/ft
$\alpha_{db} = 8.686 * .000049 = .000426 \frac{dB}{ft}$

(f) $v = \frac{\omega}{\beta} = \frac{2*\pi*2000}{.000052} = 2.42 * 10^8 \frac{m}{s}$

(g) $Z_0 = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{.2 + \mathrm{j}(0.12566)}{\mathrm{j}\ (2.513*10^{-8})}} = 2823.88 \angle -.754$

3-23. A coaxial cable has the following parameters at a frequency of 1 MHz:

series resistance= 0.3 Ω/m

series reactance = 2 Ω/m

shunt conductance = 0.5 μS/m

shunt susceptance =0.6 mS/m

Determine the following:

1) Z =R +jL= .3 + j 2= 2.022 $\angle 1.4$

2) Y= G +jC= $.5*10^{-6} + \mathrm{j}\ ((.6*10^{-3})) = .5*10^{-6} + \mathrm{j}.0006$
$= .0006 \angle 1.57$

(a) γ,α, and β
$\gamma = \sqrt{Z\angle Y} = \sqrt{2.022\angle 1.4 * (.0006 \angle 1.57)} = .002985 + \mathrm{j}\ (.034703)$
$\alpha = .002985$
$\beta = .034703$

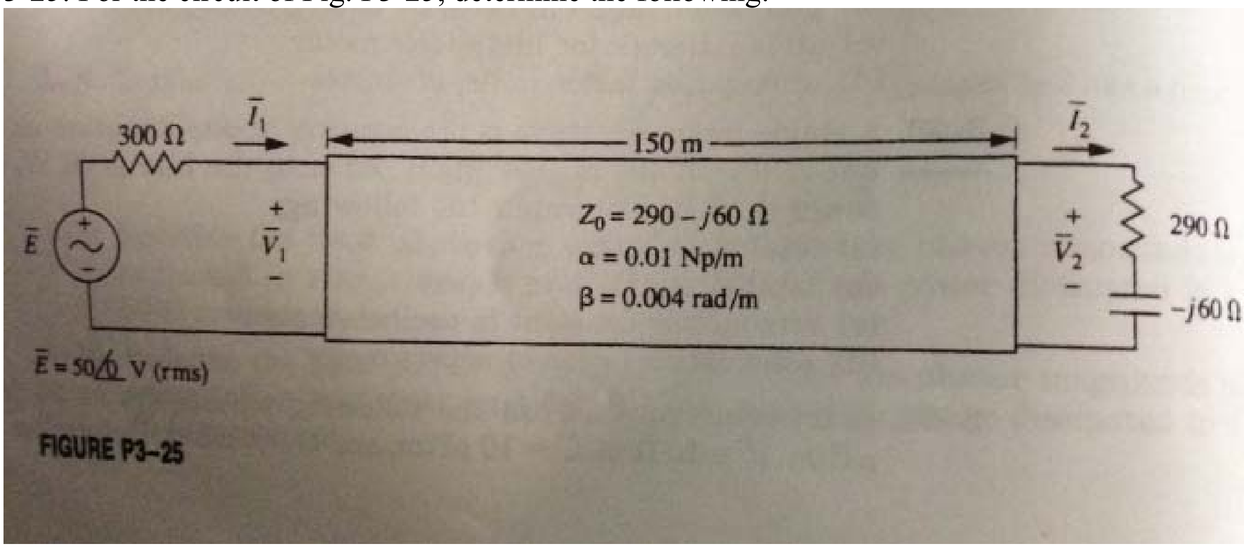
(b) attenuation in dB/ft
$\alpha_{db} = 8.686 * .002985 = .025928 \frac{dB}{m}$

(c) $v = \frac{\omega}{\beta} = \frac{2*\pi*1*10^6}{.034703} = 1.81 * 10^8 \frac{m}{s}$

(d) $Z_0 = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{.3 + \mathrm{j}\ 2}{.5*10^{-6} + \mathrm{j}.0006)}} = 333.337 - \mathrm{j}(490972) = 337.062 \angle -.14$

3-24. For the coaxial cable of Problem 3-23, repeat the analysis at 100 MHz if the series resistance increases to 1 Ω/m, but the shunt conductance remains essentially the same. (*Note* : You must apply basic ac circuit theory to determine the new values for the reactance and susceptance.) (Not Answered)

3-25. For the circuit of Fig. P3-25, determine the following:



$\alpha * d = .001 * 150 = 1.5$

$\beta * d = .004 * 150 = .6$

(a) input current $\bar{I}_1$

$\bar{I}_1 = \frac{E}{Z_1 + z_0} = \frac{50\angle 0}{300 + 290 - j60} = .799903 + j.081066 = .084\ \angle .101$

(b) input voltage $\bar{V}_1$

$\bar{V}_1 = z_0 * \bar{I}_1 = (290 - j60) * (.799903 + j.081066) = 236.836 - j24.485 = 238.098\angle -.103$

(c) input power P_1

$P_1 = (\bar{I}_1)^2 * R_0 = (.084)^2 * 290 = 2.04$ w

(d) load current $\bar{I}_2$

$\bar{I}_2 = \bar{I}_1 * e^{-\alpha * d} * e^{-j\beta * d} = (.084\ \angle .101) * e^{-1.5} * e^{-j.6} = .01794\ \angle -.499$

(e) load voltage $\bar{V}_2$

$\bar{V}_2 = \bar{V}_1 * e^{-\alpha * d} * e^{-j\beta * d} = (238.098\angle -.103) * e^{-1.5} * e^{-j.6} = 555\angle -.703$

(f) load power P_2

$P_2 = (\bar{I}_2)^2 * R_0 = (.01794)^2 * 290 = .0933$ w

(g) line loss in dB

$L_{db} = 10 \log_{10} (\frac{P_1}{P_2}) = 10 \log_{10} (\frac{2.04}{.0933}) = 13.41$

3-26. For the circuit of Fig. P3-26, determine the following: (Not sure)

$\alpha \frac{N_p}{mi} = \frac{\text{Ldb}}{8.686*d} = \frac{4}{8.686*6} = .077$

α *d =.077 *6 =.462

β*d =.5*6=.6

(a) input current $\bar{I}_1$

$\bar{I}_1 = \frac{E}{Z_1+z_0} = \frac{80\angle 0}{1216<.165} = .0649 - j.010806 = .0658\angle -.165$

(b) input voltage $\bar{V}_1$

$\bar{V}_1 = z_0 * \bar{I}_1 = (600+j100) *(.0649 - j.010806) = 606.484+j38.94 = 607.732\angle .064118$

(c) input power P_1

1 $P_1 = (\bar{I}_1)^2 * R_0 = (.0658)^2 *290 = 1.2556$ w

(d) load current $\bar{I}_2$

(e) load voltage $\bar{V}_2$

(f) load power P_2

(g) line loss in nepers

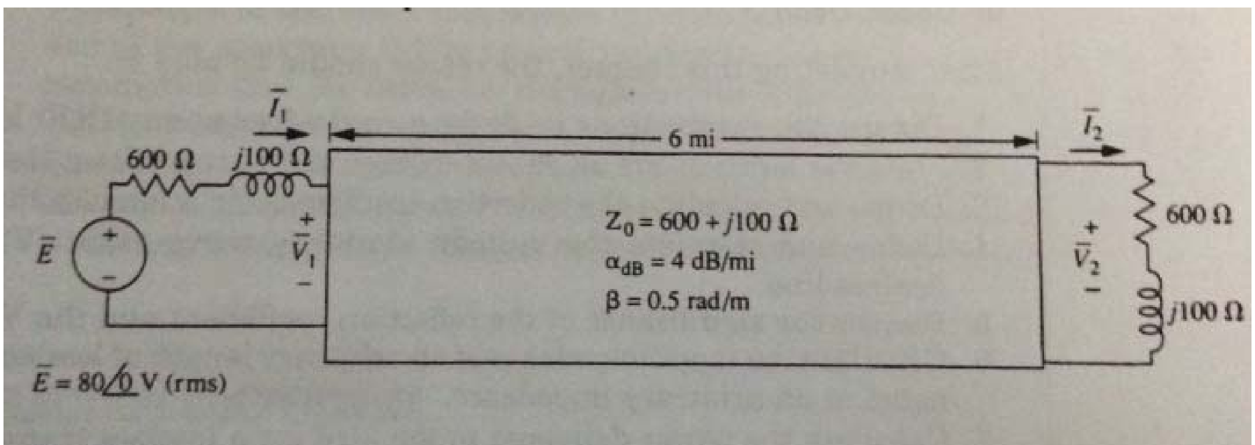


FIGURE P3-26