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1) charateristics impedance of acertain transmission line is 682.5-j195.7ohm. The frequency of operation is 1KHz. At this frequency, the attenciation const in the line was observed to be 0.01 neper/km & phase const 0.035radians/km. Prepare the line const R, L, G, C per km on the line

$Z_0 = 682.5 - 195.7j$ $\quad f = 1KHz$

$\alpha = 0.01$ neper/km $\quad B = 0.035$ radians/Km

WKT $\quad Z_0 = \sqrt{Z/Y} \Rightarrow Z = R + j\omega L \quad Y = G + j\omega C$

$Z_0 = \sqrt{R+j\omega L / G+j\omega C}$ -(1) $\Rightarrow \gamma = \sqrt{ZY} = \sqrt{(R+j\omega L)(G+j\omega C)}$ -(2)

$Z_0 \cdot \gamma = \sqrt{Z/Y}\sqrt{ZY} = \sqrt{Z^2} = Z$

$\gamma / Z_0 = \sqrt{YZ} = Y$

From given, $Z_0 = 682.5 - 195.7j \quad \gamma = 0.01 + 0.035j$

WKT $\quad Z = Z_0 \gamma = [682.5 - 195.7j][0.01 + 0.035j]$

$\Rightarrow Z = 13.67 + 21.93j \Rightarrow Y = \gamma / Z_0 = 0.01 + 0.035j / 682.5 - 195.7j$

$= -4.86 \times 10^{-8} + 5.12 \times 10^{-5} j$

From Z

$Z = R + j\omega L \quad R = 13.67 \Omega/km \quad \omega L = 21.93$

$\omega = 2\pi f = 6283.185$

$L = 21.93/\omega = 3.49 \times 10^{-3}$ H/km $\quad L = 3.49$ mH/km

From Y,

$Y = G + j\omega C = -4.86 \times 10^{-8}$ ℧/km

$\omega C = 5.12 \times 10^{-5} \Rightarrow C = 5.12 \times 10^{-5} / \omega = 8.148 \times 10^{-9}$ Faradi

$C = 8.148$ nF/km

2) A transmission lines has the following parameter per unit length (2)
parameters $L = 0.1 \mu H$ $R = 5\Omega$ $C = 300PF$ $G = 0.01mho$. Calculate propagation constant & characteristic impedence of 500MHz

Given

$L = 0.1 \mu H$ $R = 5\Omega$, $C = 300pF$ $G = 0.01V$

$f = 500MHz$

$Z_0 = \sqrt{Z/Y}$ $Z = R + j\omega L$, $Y = G + j\omega C$

$\omega = 2\pi f$ $Z_0 = \sqrt{R + j\omega L / G + j\omega C}$

$$= \sqrt{\frac{5 + j(2\pi \times 500 \times 10^6)(0.1 \times 10^{-6})}{0.01 + j(2\pi \times 500 \times 10^6)(300 \times 10^{-12})}}$$

$$= \sqrt{5 + 314.159 j / 0.01 + 0.942477 j}$$

$$= \sqrt{333.352 - 1.7382 j}$$

$$= 18.258 \angle -0.3039/2$$

$$Z_0 = 18.258 \angle -0.15195$$

$\gamma = \sqrt{ZY} = \sqrt{(R + j\omega L)(G + j\omega C)}$

$$= \sqrt{(5 + j(2\pi \times 500 \times 10^6)(0.1 \times 10^{-6}))(0.01 + j(2\pi \times 500 \times 10^6)(300 \times 10^{-12}))}$$

$$= \sqrt{(5 + 314.154j)(0.01 + 0.942477j)}$$

$$= \sqrt{-296.037 + 7.853975j}$$

$$= 17.2087 \angle \frac{178.48}{2}$$

$$= 17.2087 \angle 89.24$$

$\gamma = 0.2293 + 17.285j \Rightarrow \alpha = 0.2293$ neper/km

$\beta = 17.285$ rad/km

3) A 100km long line is terminated in its characteristic impedence. A generator of internal impedance of 600 ohm & a voltage of 5 volts operating at frequency of 800 Hz is connected at the I/P end of line

The characteristic impedence of line is $550\angle 75$ & the propogation const $\gamma = 0.045 + j0.0825$ per km. observe the parameter such as;

a) primary constants

b) sending end currents & sending end voltage

c) Recieving end current and recieving end voltage

d) sending end power and Recieving end power

soln

$Z_g = 600\,\Omega$ $Z_0 = 550\angle -15 = 531.259\angle -142.35j$

$V_g = 5$ volts $f = 800Hz$ $\gamma = 0.045 + j0.0825$

length = 100 km

a) primary const.

wkt $Z_0 = \sqrt{Z/y}$ $Z = R + j\omega L$; $Y = G + j\omega C$

$Z_0 = \sqrt{R + j\omega L / G + j\omega C}$ - (1)

$\gamma = \sqrt{Zy}$ $\gamma = \sqrt{(R + j\omega L)(G + j\omega C)}$ - (2)

$Z_0 \cdot \gamma = \sqrt{Z/y}\,\sqrt{Zy} = \sqrt{Z^2} = Z$ - (A)

$\gamma / Z_0 = \sqrt{\dfrac{Z/y}{Z/y}} = \sqrt{y^2} = y$ - (B)

From (A)

$Z = Z_0 \cdot \gamma$

$= (531.259 - 142.35j)(0.045 + j0.0825)$

$= 37.423j + 35.650$

$= 35.650 + 37.423j$

$\gamma / Z_0 = 0.045 + j0.0825 / 531.259 - 142.35j$

$y = 4.0207 \times 10^{-5} + 1.6606 \times 10^{-4} j$

from z $Z = R + j\omega L$ $R = 35.650\,\Omega$

wkt $W = 2\pi f = 2\pi \times 800 = 5026.54$

$\omega L = 37.423$ $L = 37.423 / 5026.54 = 7.44 \times 10^{-3}$ H/km

(4)

from Q:

$Y = G + j\omega C = 4.0207 \times 10^{-5}$ ℧/km

$\omega C = 1.6006 \times 10^{4}$

$C = 1.6006 \times 10^{-4} / 5026.54 = 3.3036 \times 10^{-8}$ farad/km

b) sending end current & sending end voltage

$I_S = V_g / Z_g + Z_0 = 5 / 600 + 531.259 - 142.35j$

$I_S = 5 / 1131.259 - 142.35j = 5 / 1140.18 \angle -7.172$

$= 4.385 \times 10^{-3} \angle 7.172 \; A$

$V_S = I_S Z_0 = (4.385 \times 10^{-3} \angle 7.172)(550 \angle -15)$

$= 2.4117 \angle -7.828 \; V$

$|I_S| = 4.385 \times 10^{-3} A \quad |V_S| = 2.4117 V$

c) recieving end current & receiving end voltage

$I_R = I_S e^{-\gamma x} = I_S e^{-(\alpha + j\beta)x} = I_S e^{-\alpha x} e^{-j\beta x}$

$= I_S e^{-\alpha x} \angle -\beta x$

$= 4.385 \times 10^{-3} \angle 7.172 \, e^{-(0.045)(100)} \angle 0.0825 \times 100)$

$= 4.385 \times 10^{-3} e^{-4.5} \angle 7.172 + 8.25 \, (180/\pi)$

$= 4.385 \times 10^{-3} \times 0.0111 \angle 7.172 + 472.69 - 360)$

$I_R = (0.04867 \times 10^{-3} \angle 112.69 + 7.172)$

$= 0.04867 \times 10^{-3} \angle 119.862 \; A$

$V_R = I_R Z_c = I_R Z_0 = (0.04867 \times 10^{-3} \angle 119.862)(550 \angle -15)$

$= 0.02676 \angle 104.862 \; V$

$|I_R| = 0.04867 \times 10^{-3} A$

$|V_R| = 0.02676 V$

d) sending power & recieving power ~~end~~:

sending end power $= |V_S||I_S| \cos \theta$

$= (2.4117)(4.385 \times 10^{-3}) \cos(-15)$

$= (2.4117)(4.385 \times 10^{-3})(0.9659)$

70.21mW

Recieving end power = $|V_R||I_R|\cos\theta$

$= (0.02676)(0.04867\times10^{-3})\cos(-15)$

$= (0.02676)(0.04867\times10^{-3})(0.9659)$

$= 1.259\times10^{-6}W$

$= 1.257\mu W$

The ratio of spacing 'd' to the radius 'a' of an open wire dissipation less line is 25 & the space btn the conductors has a dielectric of relative permittivity of 8. Recogonise (a) Inductance (b) Capacitance c) Characteristic impedance.

a) Inductance

$L = \mu_0/\pi \ln d/a$

$= 4\pi\times10^{-7}/\pi \ln d/a \Rightarrow L = 4\times10^{-7}\times2.303\log d/a$

$= 9.21\times10^{-7}\times1.3979 \quad = 1.2875\times10^{-6} H/m$

b) Capacitance

$C = \pi\varepsilon/\ln(d/a)$

$\varepsilon = \varepsilon_0\varepsilon_r$

$\varepsilon_r = 8 \quad \Rightarrow \varepsilon = 8.85\times10^{-12}\times8 = 70.8\times10^{-12}$

$C = \pi\times70.8\times10^{-12}/\ln(25) = 222.424\times10^{-12}/3.2188$

c) Characteristic impedance

$Z_0 = \sqrt{L/C} = \sqrt{\dfrac{1.2875\times10^{-6}}{69.299\times10^{-12}}} = 136.5\Omega$

A distortionless transmission has attenuation const $\alpha = 1.15\times10^{-12}$ Np/m & cap of 0.01nF/m. The characteristic ~~im~~ resistance $\sqrt{L/C} = 50\Omega$.

(8)

Identify resistance, inductance & conductance per meter of line

$\alpha = 1.15 \times 10^{-2}$ NP/m ; $C = 0.01$ nF/m

$\sqrt{L/C} = 50\Omega$ $L/C = 50^2$ $L = 50^2 C = 50^2 \times 0.01 \times 10^{-9}$

$= 25$ nH/m

condition for distortionless line $L/C = R/G$

$R/G = L/C = 25 \times 10^{-9} / 0.01 \times 10^{-9} = 2500$

$R = 2500G$ -(1)

$\alpha = \sqrt{RG} = \sqrt{2500G^2}$

$1.15 \times 10^{-2} = 50G$

$G = 1.15 \times 10^{-3} / 50 = 0.023 \times 10^{-3}$

$G = 23 \mu \mho/m$

from (1) $R = 2500G = 2500 \times 23 \times 10^{-6} = 0.0575$

$= 57.5 m\Omega/m$