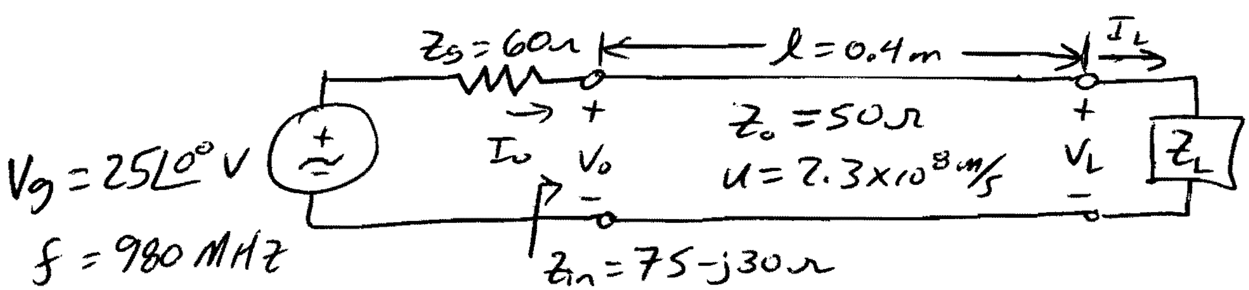
A lossless transmission line ($Z_0 = 50\ \Omega$, $u = 2.3\times10^8$ m/s) of some length l is terminated with an unknown load Z_L. Using a vector network analyzer (VNA), an input impedance $Z_{in} = 75 - j30\ \Omega$ is measured. The transmission line is connected to a generator operating at 980 MHz with a voltage $v_g(t) = 25\cos(\omega t)$ V and impedance $Z_g = 60\ \Omega$. Draw the transmission line circuit. Then, determine (a) the phase constant β & wavelength λ for the transmission line, (b) the phasor current I_0 & voltage V_0 at the input, (c) the input reflection coefficient Γ_{in}, (d) the phasor forward V_0^+ & backward V_0^- voltages, (e) the equations for the phasor current $I_s(z)$ & voltage $V_s(z)$ along the transmission line, and (f) the time-domain equations for the current $I(z,t)$ & voltage $V(z,t)$ along the transmission line.

For the previous problem, if l = 40 cm, determine: (a) the electrical length of the transmission line βl (degrees & radians) as well as its length in terms of wavelengths, (b) the load reflection coefficient Γ_L, (c) the load impedance Z_L, (d) SWR, and (e) the phasor load voltage V_L & current I_L.



From before $\beta = 26.772\ \frac{rad}{m}$, $\lambda = 0.23469\ m$

$\Gamma_{in} = 0.3038\angle -36.699^\circ$ $\quad V_0 = 14.6\angle -9.273^\circ\ V$

$V_0^+ = 11.619\angle -0.967^\circ\ V$ $\quad I_0 = 0.181\angle 12.53^\circ\ A$

$V_0^- = 3.53\angle -37.6656^\circ\ V$

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a) $\beta l = 26.772(0.4) = \underline{10.709\ rad}$

$= 10.709\left(\frac{180^\circ}{\pi}\right) = \underline{613.565^\circ}$

$l = 10.709\left(\frac{\lambda}{2\pi}\right) = \underline{1.704\ \lambda}$

b) $\Gamma_L = \Gamma_{in}\, e^{+j2\beta\ell} = (0.3038\angle{-36.679^\circ})\, e^{j2(10.709)}$

$$\Gamma_L = 0.3038\angle{110.432^\circ}$$

c) $Z_L = Z_0\left(\frac{1+\Gamma_L}{1-\Gamma_L}\right) = 50\left[\frac{1+0.3038\angle{110.432^\circ}}{1-0.3038\angle{110.432^\circ}}\right]$

$$Z_L = 34.795 + j21.824\ \Omega$$

d) (11.38a) $\quad SWR = \frac{1+|\Gamma_L|}{1-|\Gamma_L|}$

$$= \frac{1+0.3038}{1-0.3038}$$

$$SWR = 1.873$$

e) $V_L = V_s(z=\ell=0.4\,m) = V_0^+\, e^{-j\beta\ell}\left[1+\Gamma_L\right]$

$$= (11.619\angle{-0.967^\circ})\, e^{-j26.772(0.4)}\left[1+0.3038\angle{110.432^\circ}\right]$$

$$V_L = 10.901\angle{123.132^\circ}\ V$$

$$I_L = V_L / Z_L = \frac{10.901\angle{123.132^\circ}}{34.795+j21.824} = 0.2654\angle{91.034^\circ}\ A$$