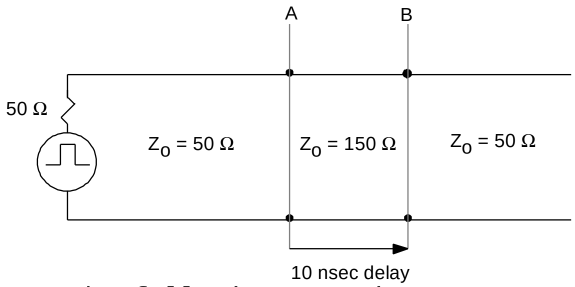
EE 363M Spring 2000, Homework Set 1, Fri. Feb. 4; Due: Fri. Feb. 11

1. (5 pts) Recalling that $V = V_+ + V_-$, $I = I_+ + I_-$, $Z_o = \frac{V_+}{I_+} = -\frac{V_-}{I_-}$, and $Y_O = 1/Z_o$,

show that:

$$V_+ = \frac{V + I \cdot Z_o}{2} \qquad V_- = \frac{V - I \cdot Z_o}{2} \qquad I_+ = \frac{I + V \cdot Y_o}{2} \qquad I_- = \frac{I - V \cdot Y_o}{2}$$

2. (10 pts) A pulse generator with internal impedance 50 Ω is connected to the transmission line arrangement shown below. When the generator is turned on it begins sending voltage pulses down the line, one pulse every 20nsec.



line continuous to infinity

Use the following notation:

- ρ = reflection coefficient for waves incident from a 50 Ω section to a 150 Ω section
- T = transmission coefficient from a 50 Ω section to a 150 Ω one
- ρ' = reflection coefficient from a 150 Ω section to a 50 Ω one
- T' = transmission coefficient from a 150 Ω section to a 50 Ω one
- V_{+i} = forward pulse voltage amplitude in section i
- V_{-i} = backward pulse voltage amplitude in section i

At t = 0 the first pulse sent from the generator is at interface A.
If the pulses sent from the generator have height V_{+1}, what is V_{+2} at:

- t = 5 nsec
- t = 25 nsec
- t = 35 nsec
- t = 45 nsec
- in steady state (i.e. t = ∞) ?

In steady state, what are V_{+3} and V_{-1}?

3. (5 pts) To find the phasor form for the voltage and current along a transmission line (i.e., the Telegraphist's equations in "time harmonic form") you can replace $\partial/\partial t$ by $j\omega$ in:

$$\frac{\partial V}{\partial z} = -L\,\frac{\partial I}{\partial t} \qquad\qquad \frac{\partial I}{\partial z} = -C\,\frac{\partial V}{\partial t}$$

Make this substitution and show that

$$V = V_+ e^{-j\beta z} + V_- e^{j\beta z} \qquad\qquad I = \frac{1}{Z_o}\left[V_+ e^{-j\beta z} - V_- e^{j\beta z}\right]$$

are solutions to the Telegraphist's equations so long as $\beta = \omega\sqrt{LC}$.
[Problem taken from Ramo, problem 5.7a (5.5a in 2nd ed.)]

4. (5 pts) For a transmission line "terminated" at z = 0 by a load impedance Z_L and recalling:

$$Z_o = \frac{V_+}{I_+} = -\frac{V_-}{I_-} \;,\; \rho(z{=}-l) = \frac{V_- \cdot \mathbf{exp}(-j\beta l)}{V_+ \cdot \mathbf{exp}(j\beta l)} \;,\; Z(z{=}-l) = \frac{V}{I} = \frac{V_+ \cdot \mathbf{exp}(j\beta l) + V_- \cdot \mathbf{exp}(-j\beta l)}{I_+ \cdot \mathbf{exp}(j\beta l) + I_- \cdot \mathbf{exp}(-j\beta l)}$$

show that

$$Z(z=-l) = Z_o \frac{1+\rho(z=0)\cdot \mathbf{exp}(-j\,2\beta\,l)}{1-\rho(z=0)\cdot \mathbf{exp}(-j\,2\beta\,l)} = Z_o \frac{Z_L + Z_o \cdot \mathbf{tanh}(j\ \beta\,l)}{Z_o + Z_L \cdot \mathbf{tanh}(j\ \beta\,l)} = Z_o \frac{Z_L + j\ Z_o\ \mathbf{tan}(\beta\,l)}{Z_o + j\ Z_L\ \mathbf{tan}(\beta\,l)}$$