Homework #3, ME/MSE 485, due on Feb. 3, 2011

1. Cu heavy duty bus bar has dimension of length (L)=80cm, width (W)=20mm and thickness (t)=6mm where the Cu volume resistivity (ρ) is given as 1.8μΩ/cm. Answer the following questions:
   (a) Calculate the Cu sheet resistance, $R_{Cu\text{-}Sheet}$, in unit of Ω/□

   $$R = \frac{\rho w}{t} = \frac{1.8\times10^{-6}\times10}{6} = 3\mu\Omega/\square$$

   (b) Calculate the number of square, N

   $$N = \frac{L}{w} = \frac{80}{2} = 40$$

   (c) Calculate the total line resistance

   $$R_{total} = R_{CuSheet}\times N = 150\times10^{-9}\times800 = 120\mu\Omega$$

   (d) Calculate the power dissipation (in unit of W) if the voltage drop of 10mV is allowed

   $$P = \frac{V^2}{R} = \frac{(10\times10^{-3})^2}{120\times10^{-6}} = 0.83W$$

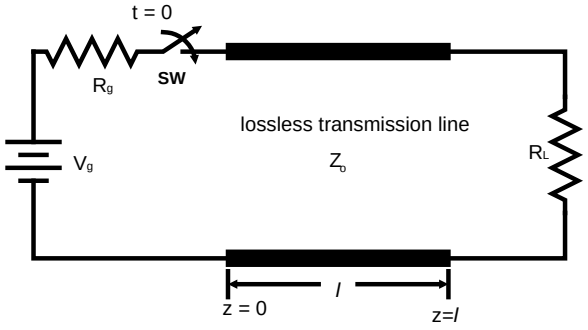
2. The circuit parameters are given by R_g=100Ω, Z_0=50Ω, R_L=100Ω, l=0.3m, v=3x10^{8}m/s, V_g=1V
   (a) Find the initial voltage (SW is turned on at t=0) goes into the transmission line at z=0

   $$V_{ini} = \frac{Z_0 V_g}{R_g + Z_0} = \frac{50\times1}{150} = 0.33$$

   (b) Find the final voltage (t=infinite) at z=0

   $$V_F = \frac{R_L V_g}{R_g + R_L} = \frac{100\times1}{200} = 0.5$$

   (c) Find the voltage at z=0 from t=0 to t=10ns



$$t = \frac{l}{v} = \frac{0.3}{3\times10^8} = 1ns$$

$$\Gamma_L = \frac{R_L - Z_0}{R_L + Z_0} = \frac{1}{3}$$

$$\Gamma_g = \frac{R_g - Z_0}{R_g + Z_0} = \frac{1}{3}$$

$$V_1 = V_{ini} = \frac{1}{3} = 0.33$$

$$V_2 = \Gamma_L V_1 = \frac{1}{9} = 0.11$$

$$V_3 = \Gamma_g(\Gamma_L V_1) = \frac{1}{27} = 0.037$$

$$V_4 = \Gamma_L(\Gamma_g \Gamma_L V_1) = 0.0123$$

$$V_5 = \Gamma_g(\Gamma_L \Gamma_g \Gamma_L V_1) = 0.004$$

$$V_{total} = V_1 + ..V_5 + .. = 0.5V$$

3. The circuit parameters are given by R_g=25Ω, Z_0=50Ω, R_L=25Ω, l=0.3m, v=3x10^8m/s, V_g=1V, see the figure in problem 2
   (a) Find the initial voltage (SW is turned on at t=0) goes into the transmission line at z=0

$$V_{ini} = \frac{Z_0 V_g}{R_g + Z_0} = \frac{50\times1}{75} = 0.67$$

   (b) Find the final voltage (t=infinite) at z=0

$$V_F = \frac{R_L V_g}{R_g + R_L} = \frac{25\times1}{50} = 0.5$$

   (c) Find the voltage at z=0 from t=0 to t=10ns

$$t = \frac{l}{v} = \frac{0.3}{3\times10^8} = 1ns$$

$$\Gamma_L = \frac{R_L - Z_0}{R_L + Z_0} = -\frac{1}{3}$$

$$\Gamma_g = \frac{R_g - Z_0}{R_g + Z_0} = -\frac{1}{3}$$

$$V_1 = V_{ini} = \frac{2}{3} = 0.667$$

$$V_2 = \Gamma_L V_1 = -0.222$$

$$V_3 = \Gamma_g(\Gamma_L V_1) = 0.074$$

$$V_4 = \Gamma_L(\Gamma_g \Gamma_L V_1) = -0.024$$

$$V_5 = \Gamma_g(\Gamma_L \Gamma_g \Gamma_L V_1) = 0.008$$

$$V_{total} = V_1 + ..V_5 + .. = 0.5V$$