Homework format:

- Write only on one side of the paper.
- Please try if possible to start each new problem on a clean sheet of paper.

Problems:

1. (Collin problem 3.2) Let a generator with internal resistance $R_g$ be connected to a transmission line of length $l$ and having a characteristic impedance $Z_o$. The line is terminated in a load resistance $R_L$. Let $\tau = l/v$ be the one way propagation time delay. The generator produces a pulsed waveform $P(t)$, $0 \leq t \leq T$. Show that the voltage across $R_L$ is given by

$$V_L = \frac{Z_o}{Z_o + Z_o}(1 + \Gamma_L)[P(t - \tau) + \Gamma_L \Gamma_g P(t - 3\tau) + \Gamma_L^2 \Gamma_g^2 P(t - 5\tau) + \ldots]$$

2. (Collin problem 3.5) In the circuit illustrated below, the battery is connected at $t = 0$. Find and sketch the voltage across $R_L$ as a function of time. Assume that $R_L = R_g = Z_o = 50 \Omega$, $C = 1 \mu F$, $l = 300$ m, and $v = 3 \times 10^8$. Verify your answers with PSpice if you wish.

3. (Collin problem 3.6) The resistor $R_L$ in the previous problem is replaced by a capacitor $C_L = 1 \mu F$. Find the voltage across $C_L$ during the time interval $1 \mu s \leq t \leq 3 \mu s$. Verify your answers with PSpice if you wish.

4. For the transmission line circuit shown below sketch $v_0(t)$, $v_1(t)$, and $v_2(t)$ versus time given the following parameter values: $v_g(t) = 2u(t)$, $Z_o = Z_g = Z_L = 50$ ohms, $T_1 = i_L/v_p = 1$ ns, $T_2 = i_2/v_p = 2$ ns, and $T_3 = i_3/v_p = 250$ ps. To verify your analytical answer you may wish to use a time domain circuit simulator such as PSpice.
5. (Collin problem 3.12) On a transmission line with $Z_o = 50\Omega$, the voltage at distance $0.4\lambda_o$ from the load is $4 + j2$. The corresponding current is $0.1$ A. Determine the normalized load impedance. Note normalized load impedance means $Z_L/Z_o$.

6. A 10 v source with an impedance of $Z_g = 50\Omega$ is connected to a load impedance $Z_L = 80 + j40$ ohms with a 50 ohm lossless transmission line. Calculate the power delivered to the load if the line is $0.3\lambda$ long. What is the power delivered if the line length is increased to $0.6\lambda$? If they are the same explain why.

7. A generator is connected to a transmission line as shown below. Find the voltage as a function of $z$ along the transmission line. Plot the magnitude of the voltage for $l \leq z \leq 0$. Mathcad or MATLAB works well for this problem.