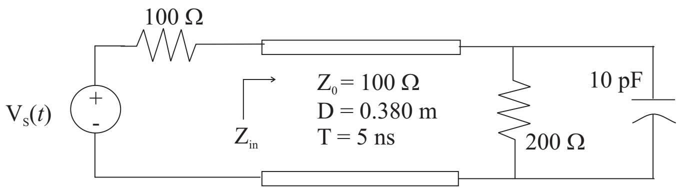
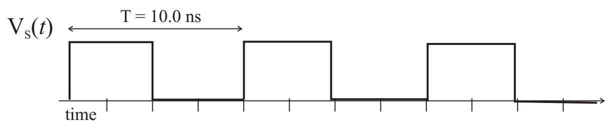
ECE 3025 Homework 5: Sinusoids on Transmission Lines

1. A microstrip line connecting two chips carries a 100 MHz digital clocking signal which is, ideally, a square wave. The source-side chip is matched to the transmission line, while the load-side chip is unmatched with parasitic capacitance. This system can be modeled as the following circuit:



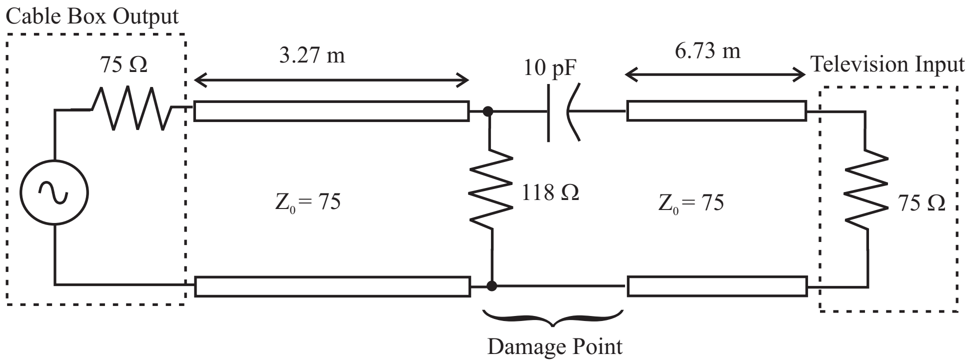


We know from signal analysis that the square wave pulse train can be represented as a *Fourier Series* – a superposition of harmonic cosines. The first 4 non-zero frequencies for this particular clocking signal is 0, 100, 300, and 500 MHz. Calculate the steady-state impedance of the transmission line, Z_{in}, as seen from the source side for these 4 frequencies.

2. Prove that the VSWR of a lossless transmission line is always infinite for a purely reactive load.

3. GT student Eric Tromagnetics has a cable box in the living room that he has connected to the television in his bedroom via a 75Ω coaxial cable that snakes down the hallway of the apartment, along the baseboard. The cable is exactly 10.00 meters long with a velocity of propagation of 2.0×10^8 m/s. Both the output of the cable box and the input to Eric's television set are matched to the standard CATV coaxial transmission line.

   One day, Eric's roommate's girlfriend steps on the hallway cable with stiletto heels, which damages the cable so that it's equivalent circuit now looks like this:



How much transmitted power has been lost to Eric's television set at 100 MHz frequencies? at 400 MHz? at 900 MHz? (10 points)

Hint: Power degradation is usually reported in dB, a logarithmic scale where loss is given by

$$\text{Loss} = 10\log_{10}\left(\frac{\text{Original Power Level}}{\text{New Power Level}}\right)$$