MS exam, ECE 107

Consider a lossless transmission line of characteristic impedance \( Z_0 = 50 \Omega \). The frequency of operation is 1GHz.

1) A load with impedance \( Z_L \) terminates the transmission line at \( z = 0 \). The load consists of a resistor \( R_L \), capacitor \( C_L \), and inductor \( L_L \) connected in series. Give an expression for the reflection coefficient.

2) The capacitance of the capacitor is given as \( C_L = 20 \text{pF} \).
   a. Find combinations of \( R_L \) and \( L_L \) that lead to the reflection coefficients \( \Gamma = 0 \) or \( \Gamma = -1 \) (one combination for each \( \Gamma \)).
   b. Find combinations of \( R_L \) and \( L_L \) that lead to the reflection coefficients \( \Gamma = -0.5 \) or \( \Gamma = 0.5 \) (one combination for each \( \Gamma \)).
   c. Find a combination of \( R_L \) and \( L_L \) that leads to the reflection coefficients \( \Gamma = e^{i\pi/3} \) (i.e. \(|\Gamma| = 1 \) and \( \arg(\Gamma) = \pi/3 \)).

3) Now, the load impedance \( Z_L \) is matched to the characteristic impedance of the transmission line. The phasor voltage at the location \( z = 0 \) is given by \( \tilde{V}(0) = 5e^{j\pi/6} \text{V} \). Give expressions describing the voltage and current in this transmission line in the form of phasors and in the time domain representation.