Exam-01

1. Consider a transmission line (T-line) with length $\ell > 2\lambda$ that is terminated with a load $Z_L = (1/2)\, Z_0$.
   (a) Draw, with amplitudes properly scaled, a (i) forward-propagating voltage wave and (ii) backward-propagating voltage wave for a lossless T-line.
   (b) Draw a (i) forward-propagating voltage wave and (ii) backward-propagating voltage wave for a lossy T-line.
   (c) Next consider that $Z_{Load} = 0$ and $\ell = 5/4\ \lambda$. For a lossless T-line, draw the resulting standing voltage wave and indicate the locations of nodes and antinodes.

2. Consider and plot a coordinate system in the complex plane with the abscissa (horizontal axis) "**Re**" and the ordinate (vertical axis) "j **Im**".
   (a) Plot the points of the attenuation constant α for a (i) lossless, (ii) weakly lossy, and (iii) strongly lossy transmission line for a sinusoidal wave propagating on the line.
   (b) Plot the points of the propagation constant γ for a (i) lossless, (ii) weakly lossy, and (iii) strongly lossy transmission line for the wave.
   (c) Plot the point of γ if the wave would propagate in free space (vacuum).
   (d) Next plot a new complex coordinate system. Assume that the T-line is terminated by an (i) open circuit (OC) and (ii) short circuit (SC). Plot the point of the voltage reflection coefficient Γ for each case.
   (e) The T-line is now terminated by a capacitor. Plot the point of the voltage reflection coefficient Γ for (i) $\omega \to 0$, (ii) $\omega \to \infty$, and (iii) a finite ω.

3. A lossless transmission line (T-line) with a characteristic impedance of $Z_0 = 50\ \Omega$ consumes 30 mA when a sinusoidal signal of 1.0 V is applied to its input. Assume that the T-line's input impedance, Z_{Input}, and characteristic impedance, Z_0, are purely resistive.
   (a) What is the input impedance, Z_{Input}, of the T-line?
   (b) Assume that the sinusoidal signal propagating on the T-line has a wavelength of 30 cm and that the length of the T-line is 1.5 m. What is the voltage reflection coefficient, Γ, at the end of the T-line?
   (c) What is the load impedance, Z_{Load}, of the T-line?

4. Are the following statements (***i***) true, (***ii***) false, or (***iii***) impossible to determine due to lack of information?
   (a) A T-line with length $\ell = \lambda/4$ acts as a short circuit (SC) at its input side.
   (b) In the context of T-lines, "improving the conductance G'" means "reducing the numerical value of G'".
   (c) The G' of a coaxial T-line can be reduced by replacing the dielectric material between the center conductor and the outer conductor with vacuum.
   (d) The phase constant β of a lossless transmission line increases with the frequency of the propagating wave.