EE2011 Engineering Electromagnetics - Part CXD
Tutorial 2

Q1*

In an experiment conducted on a lossless 50 Ω transmission line terminated in an unknown load impedance, it is found that the standing-wave ratio is 2.0. Successive voltage minima are 25 cm apart, and the first voltage minimum occurs at a distance of 5 cm from the load. Find (a) the reflection coefficient at the load, and (b) the load impedance. (c) Where would the first voltage minimum (except the possible one at the load position) be located if the load were replaced by a short circuit?

Q2*

Consider a lossless 50-Ω transmission line connecting a generator and a load with impedance $Z_L = 100 - j100\,\Omega$. It is known that the length l of the transmission line is less than λ/2.

(a) An input impedance $Z_{in} = 12.5 - j12.7\,\Omega$ is measured at the transmission line terminal at the generator. Use Smith char to calculate the physical length l of the transmission line. (Note: This question is the same as Q4 (a) of Tutorial 1.)

(b) If the length of the transmission line can be adjusted, use Smith chat to determine the length of the transmission line l so that the real part of the input impedance is equal to the characteristic impedance of the transmission line.

Q3

A 50-Ω lossless transmission line connects a generator and a load with impedance $Z_L = 9 + j12\ \Omega$.

(a) If the length of the transmission line is 0.65λ, use Smith chart to find the input impedance Z_{in} looking at the source terminal of the transmission line.

(b) If the length of the transmission line can be adjusted, use Smith chat to determine the length of the transmission line l (given that $l < \lambda/2$) so that the real part of the input impedance is equal to $100\,\Omega$.

Q4

A generator with V_g = 100 V and Z_g = 50 Ω is connected to a load Z_L = 75 Ω through a lossless transmission line with Z_0 = 50 Ω and length $d = 0.15\,\lambda$.

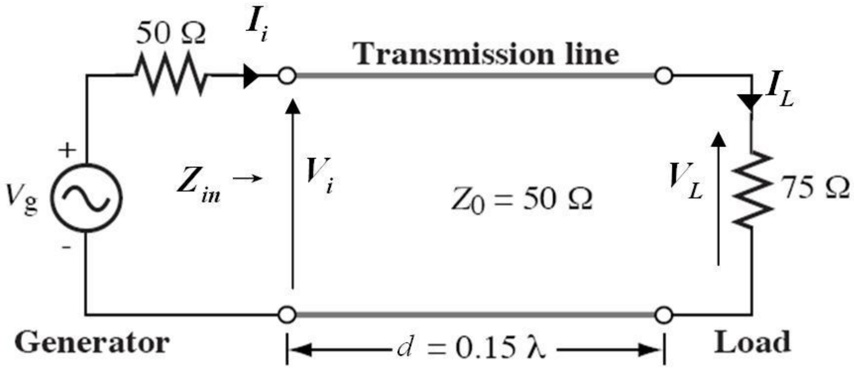
(a) Compute Z_{in}, the input impedance of the line at the generator end.

(b) Compute I_i and V_i.

(c) Compute the time-average power delivered to the line, P_{in}.

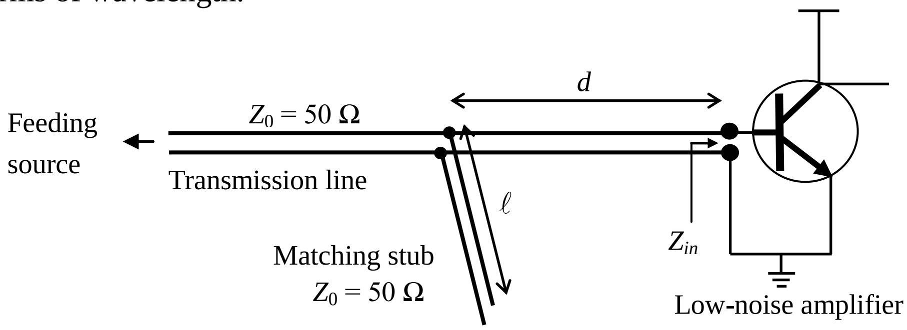
(d) Compute V_L and I_L, the time-average power P_g delivered by the generator, the time-average power P_L dissipated in Z_L, and the time average power P_{int} dissipated in Z_g. Is conservation of power satisfied?

***** Questions to be discussed in the class.



Q5 (Optional)

A stub-matching circuit is to be designed to match a low-noise amplifer (LNA) to a feeding transmission line with a characteristic impedance $Z_0 = 50\ \Omega$, as shown below. If the input impedance of the LNA is $Z_{in} = 35+j10\ \Omega$, by using the Smith chart technique, design a single parallel stub matching circuit to match the LNA to the transmission line so that no reflection occurs along the transmission line after the stub. Use an open-circuit stub with the same characteristic impedance as the transmission line. State the length of the stub ℓ and the position of the stub from the antenna d in terms of wavelength.



For Q1 and Q2, which will be discussed in the tutorial class, the final solutions are given as follows. The full version of solutions will be distributed in due time.

Q1.

(a) $\Gamma_L = |\Gamma_L| e^{j\theta_L} = \frac{1}{3} e^{-j1.885} = -0.1030 - j0.3170$

(b) $Z_L = Z_0 \frac{1+\Gamma_L}{1-\Gamma_L} = 50 \times \frac{1+(-0.1030 - j\,0.3170)}{1-(-0.1030 - j\,0.3170)} = 33.7429 - j24.0682\,\Omega$

(c) $\ell_m = -\frac{\lambda}{4} + \frac{3\lambda}{4} = \frac{\lambda}{2} = 25$ (cm), (the first minimum)

Q2.

(a) $0.459\lambda - 0.292\lambda = 0.167\lambda$

(b) $0.178\lambda + 0.5\lambda - 0.292\lambda = 0.386\lambda$ or $0.322\lambda - 0.292\lambda = 0.03\lambda$

***** Questions to be discussed in the class.