EE2011 Engineering Electromagnetics - Part CXD
Tutorial 1

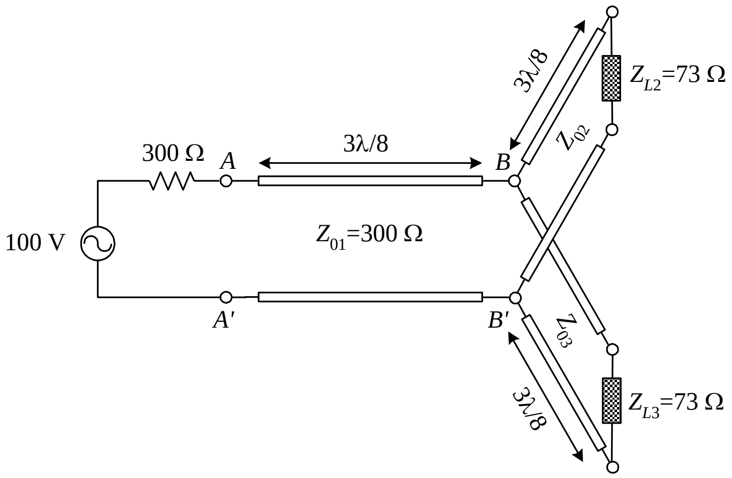
Q1*

Consider a coaxial line with a dielectric constant of ε_r = 2.9 for the material filling the space between the inner and the outer conductors. The characteristic impedance of the coaxial line is Z_0 = 75 Ω. The length of the coaxial line is 38 mm. The operating frequency is at 2 GHz and the line is terminated with a 300 Ω resistor.

(i) Determine the impedance looking into this line.
(ii) Specify the positions of the voltage and current standing-wave maxima on the coaxial line.

Q2*

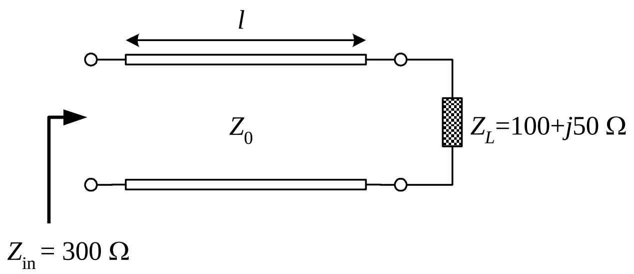
Consider the transmission line circuit shown below. Two antennas, each of input impedance $Z_{L2} = Z_{L3} = 73\,\Omega$, are fed with lossless lines from a generator. Determine the average power delivered to each antenna if $Z_{02} = 150\,\Omega$, $Z_{03} = 100\,\Omega$.



Q3

Consider the circuit shown below. Find the characteristic impedance Z_0 and the minimum normalised length l/λ of the transmission line such that the impedance looking into the circuit is $Z_{\text{in}} = 300\,\Omega$.

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



Q4

A voltage generator with $v_g(t) = 5\cos(2\pi \times 10^9 t)\,\text{V}$ and internal impedance $Z_g = 50\,\Omega$ is connected to a lossless 50-Ω air-spaced transmission line. The line is terminated in a load impedance $Z_L = 100 - j100\,\Omega$. An input impedance $Z_{in} = 12.5 - j12.7\,\Omega$ is measured at the transmission line terminal at the generator.

(i) Calculate the physical length l of the transmission line, given that $l < \lambda/2$.

(ii) Find an expression for the instantaneous load current, $i_L(t)$.

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.

(i) $Z_{in} = Z_0 \dfrac{Z_L + jZ_0 \tan(\beta l)}{Z_0 + jZ_L \tan(\beta l)} = 82.90 + j118.01\ \Omega$

(ii) $\ell_M = \text{maximum voltage locations} = \dfrac{\theta_L \lambda}{4\pi} + \dfrac{n\lambda}{2} = 44n\,(\text{mm}), \quad n = 0,1,2,\cdots$

$$\begin{aligned}\ell_m &= \text{maximum current locations}\\ &= \text{minimum voltage locations}\\ &= \frac{\theta_L \lambda}{4\pi} + \frac{(2n+1)\lambda}{4} = (22 + 44n)\,(\text{mm}), \quad n = 0,1,2,\cdots\end{aligned}$$

Q2.

$P_{L2} = \frac{1}{2}|V_{BB'}|^2 \,\text{Re}\left[1/Z^*_{\text{in}2}\right] = 0.7688\ \text{W}$,

$P_{L3} = \frac{1}{2}|V_{BB'}|^2 \,\text{Re}\left[1/Z^*_{\text{in}3}\right] = 1.3956\ \text{W}$

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