

EE 3109 Applied Electromagnetics
Week 9: Tutorial Questions

1. In addition to not dissipating power, a lossless line has two important features: (1) it is dispersionless (v_p is independent of frequency) and (2) its characteristic impedance Z_0 is purely real. Sometimes, it is not possible to design a transmission line such that $R' \ll \omega L'$ and $G' \ll \omega C'$, but it is possible to choose the dimensions of the line and its material properties so as to satisfy the condition $R' C' \ll L' G'$. Such a line is called a distortionless line because despite the fact that it is not lossless, it does nonetheless possess the previously mentioned features of the loss line. Show that for a distortionless line,

$$\alpha = R' \sqrt{\frac{C'}{L'}} = \sqrt{R' G'}, \quad \beta = \omega \sqrt{L' C'}, \quad Z_0 = \sqrt{\frac{L'}{C'}}$$

2. For a distortionless line with $Z_0 = 50 \, \Omega$, $\alpha = 10 \, \text{mNp/m}$, $v_p = 2.5 \times 10^8 \, \text{m/s}$, find the line parameters and λ at 100 MHz.
3. Find α and Z_0 of a distortionless line whose $R' = 8 \, \text{W/m}$ and $G' = 2 \times 10^{-4} \, \text{S/m}$.
4. Polyethylene with $\epsilon_r = 2.25$ is used as the insulating material in a lossless coaxial line with characteristic impedance of $50 \, \Omega$. The radius of the inner conductor is 1.2 mm.
(a) What is the radius of the outer conductor?
(b) What is the phase velocity of the line?
5. Using a slotted line, the voltage on a lossless transmission line was found to have a maximum magnitude of 1.5 V and a minimum magnitude of 0.5 V. Find the magnitude of the load's reflection coefficient.
6. A lossless transmission line of electrical length $l = 0.35\lambda$ and characteristic impedance $Z_0 = 100 \, \Omega$ is terminated in a load impedance $Z_L = 60 + j30 \, \Omega$. Find Γ , S and Z_{in} .
7. At an operating frequency of 300 MHz, a lossless $50 \, \Omega$ air-spaced transmission line 2.5 m in length is terminated with an impedance $Z_L = 40 + j20 \, \Omega$. Find the input impedance.
8. Show that at the position where the magnitude of the voltage on the line is a maximum, the input impedance is purely real.

Source for questions: Ulaby Ch2 Q13-15,17,18,28-30.