Chapter 2

Test 2.1: Transmission Line Effects

For a transmission line of length l carrying a voltage wave of wavelength λ, phase shift and reflection effects can be ignored if:

(a) $l/\lambda > 1$
(b) $l/\lambda < 0.01$
(c) $l < 10$ m, regardless of the value of λ
(d) $l < 1$ cm, regardless of the value of l

Test 2.2: Dispersion

A transmission line is dispersive if:

(a) A wave is transmitted into multiple directions
(b) A wave suffers attenuation
(c) A rectangular pulse changes shape as it travels along the line
(d) The velocity of a sinusoidal wave traveling on the line is independent of the wave's frequency

Test 2.3: TEM

The acronym TEM stands for:

(a) Transmission Eigen Mode
(b) Transmission Elastic Mode
(c) Transverse Elastic Mode
(d) Transverse Electromagnetic

Test 2.4: TEM

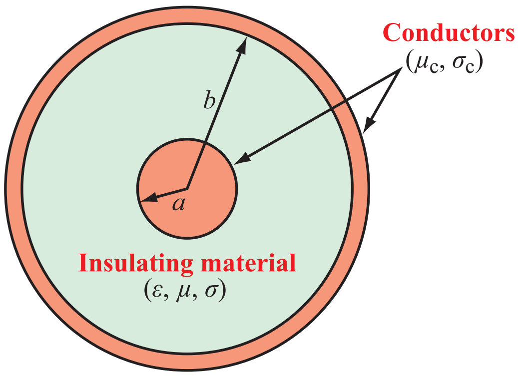
In a TEM mode:

(a) The electric and magnetic fields are always orthogonal to the direction of propagation, but not to one another
(b) At least one directional component of the electric field is orthogonal to the magnetic field
(c) The electric and magnetic fields are parallel to one another

(d) The electric and magnetic fields are always orthogonal to the direction of propagation, as well as to each other.

Test 2.5: Coaxial Line

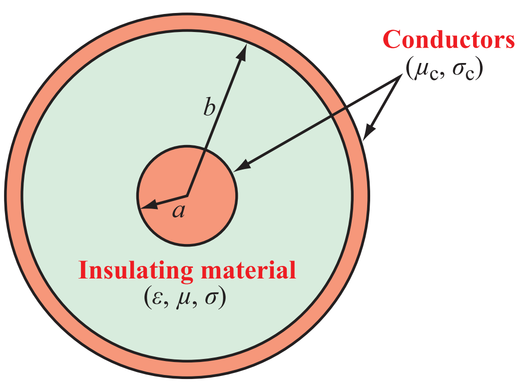
For a coaxial line with $b = 2a$, under what conditions is its line inductance $L' = 0$?



(a) Never
(b) $\varepsilon = \varepsilon_0$
(c) $\sigma_c = \infty$
(d) $\mu = \infty$

Test 2.6: Coaxial Line

For a coaxial line with $b = 2a$, under what conditions is its line inductance $G' = 0$?



(a) $\varepsilon = \varepsilon_0$

(b) $\sigma_c = \infty$
(c) $\mu = \infty$
(d) $\sigma = 0$

Test 2.7: TEM Line

An air-filled coaxial line with $\varepsilon = \varepsilon_0$ and $\mu = \mu_0$ has a line inductance $L' = (1/27)$ μH/m. What is the line capacitance C'?

(a) $C' = 0.1$ nF/m
(b) $C' = 0.3$ nF/m
(c) $C' = 1$ nF/m
(d) $C' = 0.3$ μF/m

Test 2.8: Lossless Line

A lossless transmission line:

(a) Is nondispersive and its $\alpha = 0$.
(b) Is nondispersive but its α may be $\neq 0$.
(c) May or may not be dispersive, but $\alpha = 0$.
(d) May or may not be dispersive and may be $\neq 0$.

Test 2.9: Microstrip Line

A 50 Ω microstrip line uses a dielectric with $\varepsilon_r = 2$. What is the value of $s = w/h$?

(a) $s = 4.2$
(b) $s = 2.1$
(c) $s = 0.33$
(d) $s = 3.33$

Test 2.10: Reflection Coefficient

A lossless 50 Ω line is terminated with an inductance $L = 1$ mH. At $\omega = 50 \times 10^3$ rad/s, what is the reflection coefficient at the end of the line?

(a) $\Gamma = 0$
(b) $\Gamma = -1$
(c) $\Gamma = 1e^{j\theta_r}$, with $\theta = -90^\circ \pm 180^\circ$
(d) $\Gamma = 1e^{j\theta_r}$, with $\theta = 45^\circ \pm 180^\circ$

Test 2.11: SWR

If the reflection coefficient at the load is $|\Gamma| = 0.5e^{j30^\circ}$, what is the SWR?

(a) $S = 0$
(b) $S = 2$
(c) $S = 3$
(d) $S = 5$

Test 2.12: Voltage Max

If the reflection coefficient at the load is $|\Gamma| = 0.5e^{j30^\circ}$ and the magnitude of the incident voltage wave is $|V_0^+| = 2$ V, what is the magnitude of the voltage maximum on the line?

(a) $|\widetilde{V}|_{\max} = 3$ V
(b) $|\widetilde{V}|_{\max} = 1$ V
(c) $|\widetilde{V}|_{\max} = 4$ V
(d) $|\widetilde{V}|_{\max} = 1.5$ V

Test 2.13: Voltage Min

If the reflection coefficient at the load is $|\Gamma| = 0.5e^{j30^\circ}$ and the magnitude of the incident voltage wave is $|V_0^+| = 2$ V, what is the magnitude of the voltage minimum on the line?

(a) $|\widetilde{V}|_{\min} = 0$
(b) $|\widetilde{V}|_{\min} = 0.5$ V
(c) $|\widetilde{V}|_{\min} = 1.5$ V
(d) $|\widetilde{V}|_{\min} = 1$ V

Test 2.14: First Voltage Max

If the reflection coefficient at the load is $|\Gamma| = 0.5e^{j30^\circ}$ and $\lambda = 60$ cm, what is the location of the voltage maximum nearest to the load?

(a) $d_{\max} = 1$ cm
(b) $d_{\max} = 2.5$ cm
(c) $d_{\max} = 5$ cm
(d) $d_{\max} = 10$ cm

Test 2.15: First Voltage Max

If the reflection coefficient at the load is $|\Gamma| = 0.5e^{-j30^\circ}$ and $\lambda = 60$ cm, what is the location of the voltage maximum nearest to the load?

(a) $d_{\text{max}} = 55$ cm
(b) $d_{\text{max}} = 27.5$ cm
(c) $d_{\text{max}} = 18.75$ cm
(d) $d_{\text{max}} = 36$ cm

Test 2.16: Reflection Coefficient

On a lossless transmission line, the distance between successive voltage maxima is 40 cm, the voltage maximum nearest the load is at 5 cm from the load, and $S = 3$. Determine Γ.

(a) $\Gamma = (0.2 + j0.1)$
(b) $\Gamma = (0.4 - j0.2)$
(c) $\Gamma = (0.35 + j0.35)$
(d) $\Gamma = (0.1 - j0.3)$

Test 2.17: Equivalent Inductor

A 100 Ω lossless transmission line is terminated in a short circuit. The line is operated at $f = 2$ GHz and the wavelength on the line is $\lambda = 8$ cm. What should the length of the line be so that its input impedance is equivalent to that of an inductor with $L_{\text{eq}} = (25/\pi)$ nH?

(a) $l = 1$ cm
(b) $l = 2$ cm
(c) $l = 0.5$ cm
(d) $l = 4$ cm

Test 2.18: Input Impedance

The wavelength on a 75 Ω transmission line is 6 cm and the line length is 9 cm. If the line is terminated in $Z_{\text{L}} = 150\ \Omega$, what is the input impedance?

(a) $Z_{\text{in}} = 50\ \Omega$
(b) $Z_{\text{in}} = 75\ \Omega$
(c) $Z_{\text{in}} = 100\ \Omega$
(d) $Z_{\text{in}} = 150\ \Omega$

Test 2.19: Input Impedance

The wavelength on a 75 Ω transmission line is 6 cm and the line length is 7.5 cm. If the line is terminated in $Z_L = 150\ \Omega$, what is the input impedance?

(a) $Z_{in} = 75$ cm
(b) $Z_{in} = 37.5$ cm
(c) $Z_{in} = 10$ cm
(d) $Z_{in} = 150$ cm

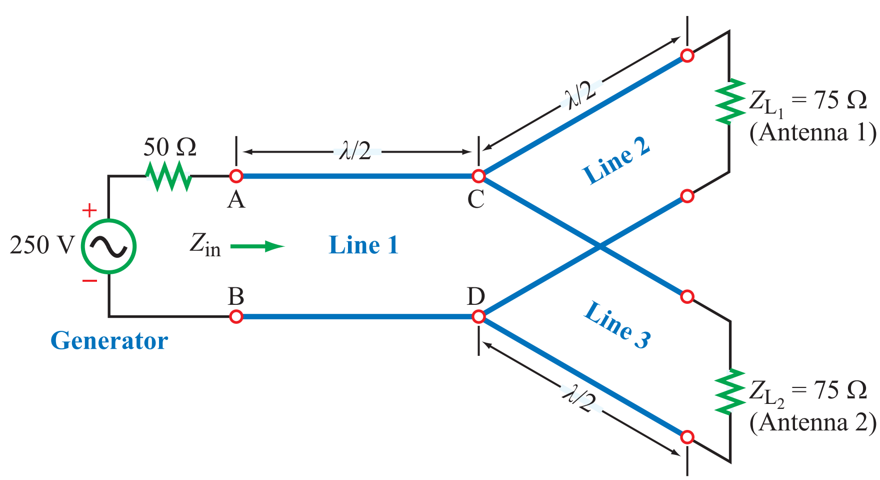
Test 2.20: Transmitted Power

A 100 Ω lossless transmission line is terminated in $Z_L = 150\ \Omega$. What fraction of the incident average power is absorbed by the load?

(a) Power fraction $= 0.2$
(b) Power fraction $= 0.4$
(c) Power fraction $= 0.8$
(d) Power fraction $= 0.96$

Test 2.21: Input Impedance

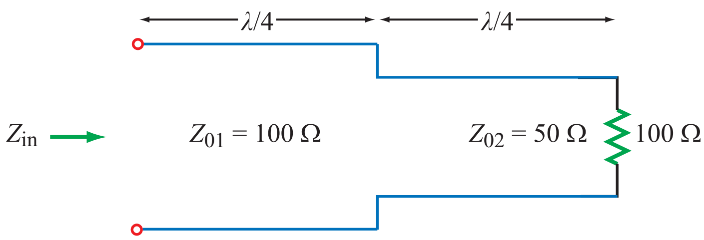
For the circuit shown, what is Z_{in}?



(a) $Z_{in} = 37.5\ \Omega$
(b) $Z_{in} = 75\ \Omega$
(c) $Z_{in} = 50\ \Omega$

(d) $Z_{\text{in}} = 100\ \Omega$

Test 2.22: Input Impedance



Find Z_{in}.

(a) $Z_{\text{in}} = 100\ \Omega$
(b) $Z_{\text{in}} = 200\ \Omega$
(c) $Z_{\text{in}} = 400\ \Omega$
(d) $Z_{\text{in}} = 800\ \Omega$

Test 2.23: Impedance

On a lossless transmission line terminated in $Z_L = 200\ \Omega$, the SWR is 2.0. One possible value is Z_0 is 100 Ω. What is the other possible value?

(a) $Z_0 = 200\ \Omega$
(b) $Z_0 = 400\ \Omega$
(c) $Z_0 = 50\ \Omega$
(d) $Z_0 = 120\ \Omega$

Test 2.24: Input Impedance

A 25 Ω lossless transmission line is terminated in a short circuit. Use a Smith-Chart-Module to determine the input impedance at a distance of 0.8 λ from the load.

(a) $Z_{\text{in}} = 100\ \Omega$
(b) $Z_{\text{in}} = j100\ \Omega$
(c) $Z_{\text{in}} = -j77\ \Omega$
(d) $Z_{\text{in}} = -j150\ \Omega$

Test 2.25: Load Impedance

A lossless 200 Ω transmission line $3\lambda/8$ in length is terminated in an unknown impedance. If the input impedance is $Z_{\text{in}} = -j5$ Ω, use a Smith-Chart Module to determine Z_{L}.

(a) $Z_{\text{L}} = j190$ Ω
(b) $Z_{\text{L}} = 190$ Ω
(c) $Z_{\text{L}} = -j190$ Ω
(d) $Z_{\text{L}} = j95$ Ω

Test 2.26: Input Impedance

At an operating frequency of 5 GHz, a 50 Ω lossless coaxial line with insulating material having a relative permittivity $\varepsilon_{\text{r}} = 2.25$ is terminated in an antenna with impedance $Z_{\text{L}} = 100$ Ω. The line length is 31 cm. Determine the input impedance.

(a) $Z_{\text{in}} = 50$ Ω
(b) $Z_{\text{in}} = 75$ Ω
(c) $Z_{\text{in}} = 25$ Ω
(d) $Z_{\text{in}} = 100$ Ω

Test 2.27: Quarter-Wave Transformer

A lossless 25 Ω line is terminated in a load impedance $Z_{\text{L}} = (50 - j100)$ Ω. To eliminate reflections, a quarter-wave transformer with impedance $Z_{02} = 7.75$ Ω is inserted at a distance d from the load. If $\lambda = 30$ cm, what is the value of d?

(a) $d = 10$ cm
(b) $d = 6.5$ cm
(c) $d = 13$ cm
(d) $d = 1.5$ cm

Test 2.28: Quarter-Wave Transformer

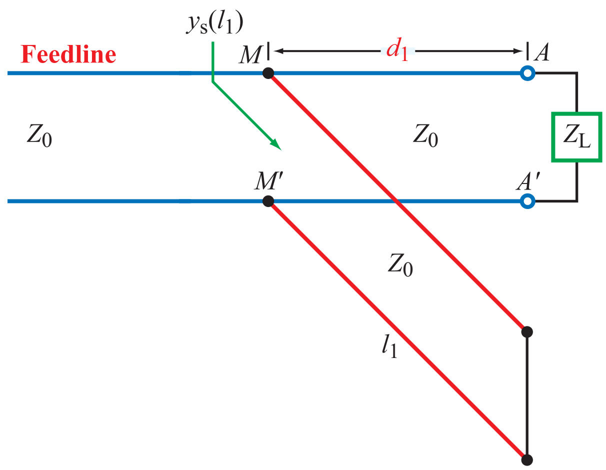
A lossless 25 Ω line is terminated in a load impedance $Z_{\text{L}} = (50 - j100)$ Ω. To eliminate reflections, a quarter-wave transformer was inserted at a distance of 6.5 cm from the load. If $\lambda = 30$ cm, what is the characteristic impedance of the quarter-wave transformer?

(a) $Z_{02} = 7.75$ Ω
(b) $Z_{02} = 25$ Ω

(c) $Z_{02} = 50\ \Omega$
(d) $Z_{02} = 100\ \Omega$

Test 2.29: Matching

A 100 Ω lossless line is to be matched to an antenna with $Z_L = (150 - j40)\ \Omega$ using a shorted stub. For perfect matching, it was determined that the stub should be inserted at $d_1 = 0.104\lambda$ from the load. What should the length of the stub l_1 be?



(a) $l_1 = 0.25\lambda$
(b) $l_1 = 0.35\lambda$
(c) $l_1 = 0.5\lambda$
(d) $l_1 = 0.17\lambda$

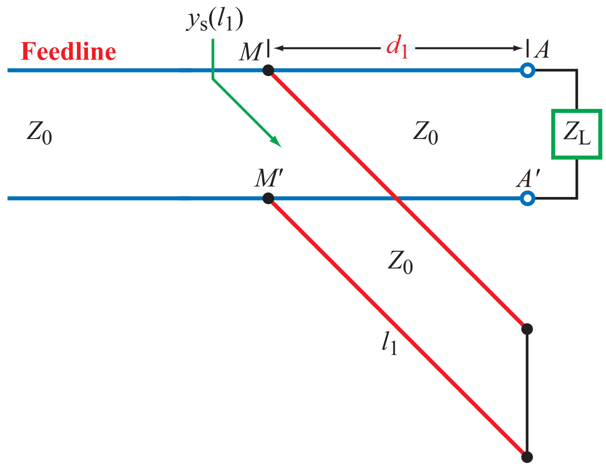
Test 2.30: Matching

A 100 Ω lossless line is to be matched to an antenna with $Z_L = (150 - j40)\ \Omega$ using a shorted stub. For perfect matching, it was determined that the stub should be inserted at d_1 from the load and its length should be $l_1 = 0.173\lambda$. What is the value of d_1?

(a) $d_1 = 0.3\lambda$
(b) $d_1 = 0.2\lambda$
(c) $d_1 = 0.1\lambda$
(d) $d_1 = 0.05\lambda$

Test 2.31: Impedance Matching

A 100 Ω lossless line is to be matched to an antenna with $Z_L = (200 + j100)$ Ω using a shorted stub. For perfect matching, it was determined that the stub should be inserted at $d_1 = 0.2\lambda$ from the load. What should the length of the stub l_1 be?



(a) $l_1 = 0.125\lambda$
(b) $l_1 = 0.25\lambda$
(c) $l_1 = 0.375\lambda$
(d) $l_1 = 0.5\lambda$

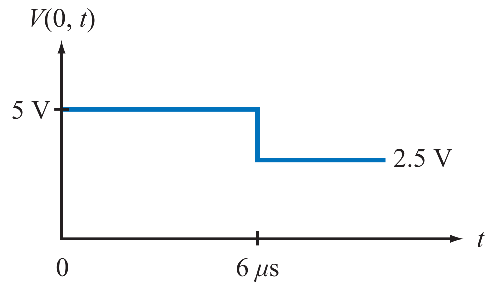
Test 2.32: Impedance Matching

A 100 Ω lossless line is to be matched to an antenna with $Z_L = (200 + j100)$ Ω using a shorted stub. For perfect matching, it was determined that the stub should be inserted at d_1 from the load and its length should be $l_1 = 0.125\lambda$. What is the value of d_1?

(a) $d_1 = 0.1\lambda$
(b) $d_1 = 0.2\lambda$
(c) $d_1 = 0.3\lambda$
(d) $d_1 = 0.4\lambda$

Test 2.33: Transient Response

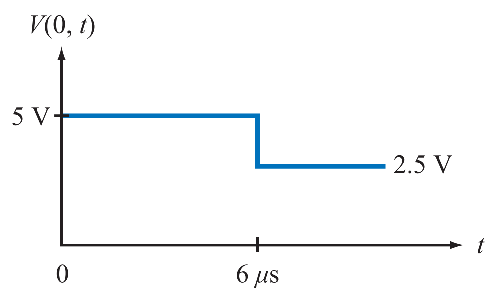
In response to a step voltage, the voltage waveform shown in the figure was observed at the sending end of a lossless transmission line with $R_g = Z_0 = 150$ Ω and $\varepsilon_r = 9$. Determine the length of the line.



(a) $l = 150$ m
(b) $l = 300$ m
(c) $l = 450$ m
(d) $l = 600$ m

Test 2.34: Transient Response

In response to a step voltage, the voltage waveform shown in the figure was observed at the sending end of a lossless transmission line with $R_g = Z_0 = 150\ \Omega$ and $\varepsilon_r = 9$. Determine the load impedance.



(a) $Z_L = 25\ \Omega$
(b) $Z_L = 100\ \Omega$
(c) $Z_L = 150\ \Omega$
(d) $Z_L = 50\ \Omega$