Statement for Q.1–3:

A telephone line has the following parameters: $R = 60\ \Omega/\text{m}$, $G = 600\ \mu\text{S/m}$, $L = 0.3\ \mu\text{H/m}$, $C = 0.75\ \text{nF/m}$

1. If the line operate at 10 MHz, the characteristic impedance Z_o is

(A) $21.0 - j17.6\ \Omega$ (B) $29.6 - j21.4\ \Omega$

(C) $10.8 - j7.9\ \Omega$ (D) $14.0 - j42\ \Omega$

2. The velocity v will be

(A) 18×10^6 m/s (B) 46×10^6 m/s

(C) 23×10^6 m/s (D) 36×10^6 m/s

3. The voltage will drop by 30 dB in the line after

(A) 1.46 m (B) 3.36 m

(C) 4.39 m (D) 6.43 m

Statement for Q.4–6:

A distortion less line operating at 120 MHz has the following parameters: $R = 18\ \Omega/\text{m}$, $L = 0.9\ \mu\text{H/m}$, $C = 21\ \text{pF/m}$.

4. The voltage will drop 20% in the line after

(A) 93.2 m (B) 18.5 m

(C) 2.6 m (D) 0.67 m

5. The propagation constant is

(A) $(7.56 + j14.25)10^{-9}\ \text{m}^{-1}$ (B) $0.056 + j4.37\ \text{m}^{-1}$

(C) $8.08 \times 10^{-3} - j0.304\ \text{m}^{-1}$ (D) $0.087 + j3.28\ \text{m}^{-1}$

6. To suffer a 45° phase shift it will travel

(A) 2.46 m (B) 2.01 m

(C) 1.48 m (D) 0.24 m

Statement for Q.7–8:

The propagation constant of a lossy transmission line $\gamma = 1 + j2\ \text{m}^{-1}$ and characteristic impedance is $20\ \Omega$ at frequency 1 Mrad/s.

7. The values of G and C are respectively

(A) 0.2 S/m, 0.1 μF/m (B) 0.05 S/m, 1 μF/m

(C) 0.05 S/m, 0.1 μF/m (D) 0.2 S/m, 1 μF/m

8. The values of R and L are respectively

(A) 20 Ω/m, 40 μH/m (B) 40 Ω/m, 50 μH/m

(C) 40 Ω/m, 40 μH/m (D) 20 Ω/m, 50 μH/m

9. A line comprised of two copper wires of diameter 1.2 mm that have 3.2 mm center to center spacing. If the wires are separated by a dielectric material with $\varepsilon_r = 3.5$, the value of characteristic impedance Z_o is

(A) 96 Ω (B) 150 Ω

(C) 74 Ω (D) 105 Ω

Statement for Q.10–11:

Consider the following parameters for an air-filled planer line:

Width $w = 40$ cm

Distance between plane $d = 1.6$ cm

Thickness of conducting plane $t = 4$ mm

Conductivity of plane $\sigma_c = 7 \times 10^7$ S/m

Operating frequency $f = 500$ MHz.

10. The values of R and L are respectively

(A) 26.55 mΩ/m, 50.3 nH/m

(B) 13.28 mΩ/m, 50.3 nH/m

(C) 26.55 mΩ/m, 100.3 nH/m

(D) 13.28 mΩ/m, 100.3 nH/m

11. The values of C and G are respectively
(A) 167 μF/m, 1.75×10^9 S/m (B) 167 μF/m, 0
(C) 221 pF/m, 1.75×10^9 S/m (D) 221 pF/m, 0

12. A $81\,\Omega$ lossless planer line was designed but did not meet a requirement. To get the characteristic impedance of $75\,\Omega$ the fraction of the width of the strip should be
(A) added by 4% (B) removed by 4%
(C) added by 8% (D) removed by 8%

13. A lossless line has a voltage wave $V(z, t) = 10 \sin(\omega t - \beta z)$. The line has parameter $L = 0.2$ μH/m, $C = 0.5$ nF/m. The corresponding current wave is
(A) $20 \sin(\omega t - \beta z)$ (B) $0.5 \sin(\omega t - \beta z)$
(C) $200 \sin(\omega t - \beta z)$ (D) $\sin(\omega t - \beta z)$

Statement for Q.14–15:

On a distrortion less line, the voltage wave is

$$V(z, t) = 180e^{2.5\times 10^{-3} z} \cos(10^8 t + 2z) + 90e^{-2.5\times 10^{-3} z} \cos(10^8 t - 2z)$$

where z is the distance from the load. The load impedance is $Z_L = 300\,\Omega$.

14. The phase velocity is
(A) 12.6×10^9 m/s (B) 3.14×10^8 m/s
(C) 20×10^7 m/s (D) 5×10^7 m/s

15. The characteristic impedance Z_o is
(A) 400 Ω (B) 200 Ω
(C) 100 Ω (D) 70 Ω

Statement for Q.16–17:

A 8.4m long coaxial line has following distributed parameters: $R = 13\ \Omega$/m, $L = 6.8$ μH/m, $G = 4.2$ mS/m, $C = 10.75$ pF/m. The line operates at 2 MHz.

16. The characteristic impedance is
(A) $23 + j186\ \Omega$ (B) $46 + j93\ \Omega$
(C) $109.9 + j91.5\ \Omega$ (D) $55 + j46\ \Omega$

17. The end-to-end propagation time delay is
(A) 260 ns (B) 130 ns
(C) 180 ns (D) 90 ns

18. A lossless transmission line operating at 4.5 GHz has $L = 2.6\,\mu$H/m and $Z_o = 80\,\Omega$. The phase constant β and the phase velocity v is
(A) 148 rad/m, 274×10^5 m/s
(B) 714 rad/m, 30.8×10^4 m/s
(C) 919 rad/m, 30.8×10^6 m/s
(D) None of the above

19. A 60 Ω coaxial cable feeds a $75 + j25\,\Omega$ dipole antenna. The voltage reflection coefficient Γ and standing wave ratio s are respectively
(A) $0.212\angle 48.55°$, 1.538 (B) $0.486\angle 68.4°$, 2.628
(C) $0.486\angle 41.45°$, 2.682 (D) $0.212\angle 68.4°$, 1.538

20. For a short-circuited coaxial transmission line:

Characteristic impedance $Z_o = 35 + j49\ \Omega$,

Propagation constant $\gamma = 1.4 + j5$ m^{-1}

Length of line $l = 0.4$ m.

The input impedance of short-circuited line is
(A) $82 + j39\,\Omega$ (B) $41 + j78\,\Omega$
(C) $68 + j46\,\Omega$ (D) $34 + j23\,\Omega$

Statement for Q.21–22:

Consider the lossless transmission line shown in fig. P8.6.21–22.

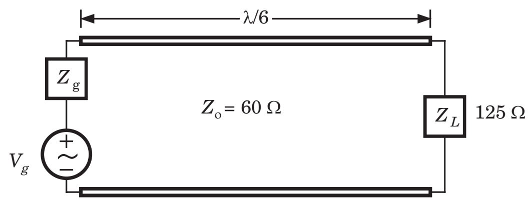

Fig. P8.6.21–22

21. The SWR s is
(A) 2.08 (B) 1.63
(C) 2.44 (D) 1.93

22. The input impedance Z_{in} at the generator is
(A) $36 + j32.4\,\Omega$ (B) $18 + j16.2\ \Omega$
(C) $35 - j24.8\ \Omega$ (D) $54 - j26.4\ \Omega$

23. The quarter-wave lossless $100\,\Omega$ line is terminated by load $Z_L = 210\,\Omega$. If the voltage at the receiving end is 60 V, the voltage at the sending end is

(A) 126 V (B) 28.6 V

(C) 21.3 V (D) 169 V

24. A $60\,\Omega$ lossless line has $V_L = 15e^{j25}$ V and $Z_L = 75e^{j30^\circ}$. The current at $\lambda/8$ from the load is

(A) $0.2e^{j40}$ A (B) $0.46e^{j40}$ A

(C) $0.2e^{j50}$ A (D) $0.46e^{j50}$ A

25. Consider a $300\,\Omega$ quarter-wave long transmission line operating at 1 GHz. It is connected to 10 V, 50 Ω source at one end and is left open circuited at the other end. The magnitude of the voltage at the open circuited end of line is

(A) 10 (B) 5

(C) 0 (D) 7.707

Statement for Q.26–29:

The loss line line shown in fig. P8.6.26-29 has following parameter: $V_g = 10\angle 0^\circ$ V, $Z_g = 50 - j40\,\Omega$, $\beta = 0.25$ rad/m. Determine the input impedance Z_{in} and voltage at the point given in question and choose correct option

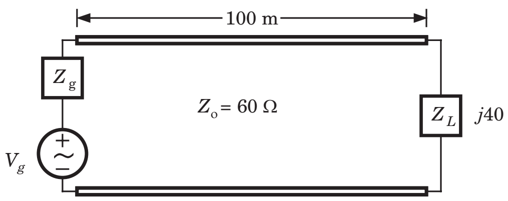

Fig. P8.6.26–29

26. At sending end is

(A) $j29.4\,\Omega$, $2.68\angle 102^\circ$ V (B) $j40.3\,\Omega$, $5.75\angle 102^\circ$ V

(C) $j29.4\,\Omega$, $5.75\angle 102^\circ$ V (D) $j40.3\,\Omega$, $2.68\angle 102^\circ$ V

27. At receiving end is

(A) $j40\,\Omega$, $5.75\angle 109.6^\circ$ V

(B) $j40\,\Omega$, $5.75\angle -109.6^\circ$ V

(C) $60 - j43\,\Omega$, $5.75\angle 109.6^\circ$ V

(D) $60 - j43\,\Omega$, $5.75\angle -109.6^\circ$ V

28. At 4 m from the load is

(A) $-j1436\,\Omega$, $6.75\angle 167^\circ$ V

(B) $j1436\,\Omega$, $6.75\angle 167^\circ$ V

(C) $-j3471\,\Omega$, $5.75\angle 167^\circ$ V

(D) $j3471\,\Omega$, $5.75\angle 167^\circ$ V

29. At 3 m from the source is

(A) $j18.2\,\Omega$, $5.75\angle 59^\circ$ V (B) $-j18.2\,\Omega$, $5.75\angle 59^\circ$ V

(C) $-j18.2\,\Omega$, $5.75\angle -59^\circ$ V (D) $j18.2\,\Omega$, $5.75\angle 59^\circ$ V

30. A lossless transmission line with a characteristic impedance of 80 Ω is terminated by a load of 125 Ω. The length of line is 1.25λ. The input impedance is

(A) 80 Ω (B) 51.2 Ω

(C) 125 Ω (D) 45 Ω

Statement for Q.31–32:

A $50\,\Omega$, 8.4 m long lossless line operates at 150 MHz . The input impedance at the middle of the line is $80 - j60$ Ω. The phase velocity is $0.8c$.

31. The input impedance at the generator is

(A) $40.3 + j38.4\,\Omega$ (B) $21.6 - j20.3\,\Omega$

(C) $43.2 - j40.3\,\Omega$ (D) $80.3 + j76.8\,\Omega$

32. The voltage reflection coefficient at the load is

(A) $0.468\angle -6.34^\circ$ (B) $0.468\angle 6.34^\circ$

(C) $0.468\angle -38.66^\circ$ (D) $0.468\angle 51.34^\circ$

33. Three lossless lines are connected as shown in fig. P8.6.33. The input impedance Z_{in} at A is

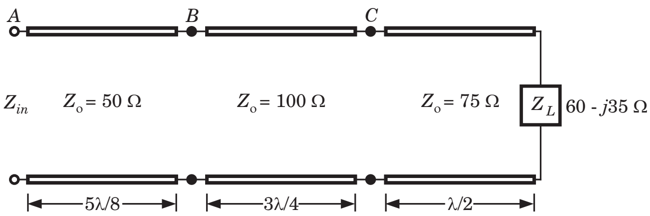

Fig. P8.6.33

(A) $46 - j69\,\Omega$ (B) $39 - j57\,\Omega$

(C) $67 + j48\,\Omega$ (D) $61 + j52\,\Omega$

34. Two $\lambda/4$ transformer in tandem are to connect a 50 Ω line to a 75 Ω load as shown in fig. P8.6.34. If $Z_{o2} = 30$ Ω and there is no reflected wave to the left of A, then the characteristic impedance Z_{o1} is

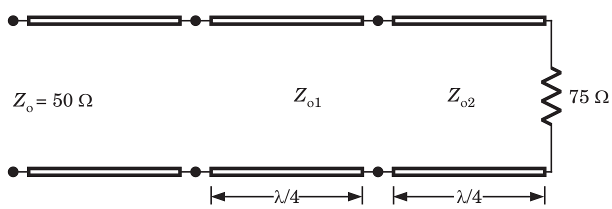

Fig. P8.6.34

(A) 28 Ω (B) 56 Ω

(C) 49 Ω (D) 24.5 Ω

35. Two identical antennas, each of input impedance 74 Ω are fed with three identical 50 Ω quarter-wave lossless transmission lines as shown in fig. P8.6.35. The input impedance at the source end is

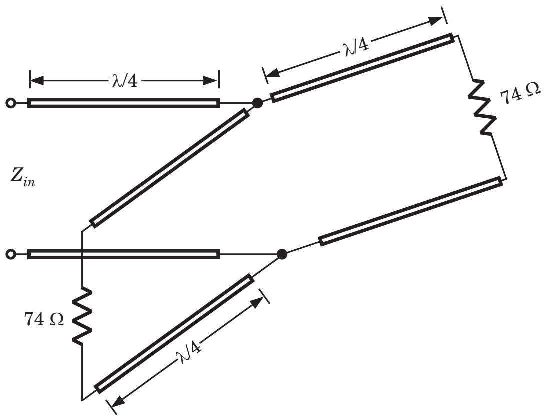

Fig. P8.6.35

(A) 148 Ω (B) 106 Ω

(C) 74 Ω (D) 53 Ω

Statement for Q.36–38:

Consider the three 50 Ω lossless line shown in fig.

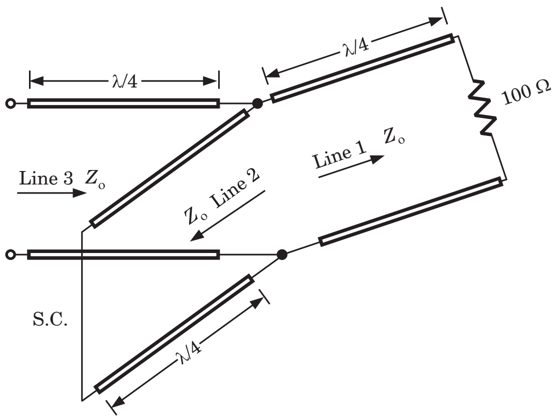

Fig. P8.6.36–38

36. The input impedance Z_{in} looking into line 1 is

(A) o (B) 25 Ω

(C) ∞ (D) 50 Ω

37. The Z_{in} looking into line 2 is

(A) 25 Ω (B) 0

(C) ∞ (D) 100 Ω

38. The Z_{in} looking into line 3 is

(A) 100 Ω (B) 50 Ω

(C) 25 Ω (D) ∞

Statement for Q.39–40:

For the transmission line shown in fig. P8.6.39–40 the $Z_o = 100\ \Omega$.

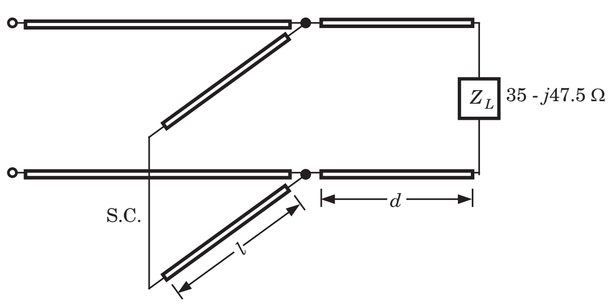

Fig. P8.6.39–40

39. If $Z_L = 0$ the Z_{in} is

(A) $94.11 - j76.45\ \Omega$ (B) $94.11 + j76.45\ \Omega$

(C) $48.23 - j68.2\ \Omega$ (D) $48.23 + j68.2\ \Omega$

40. If $Z_L = \infty$, then Z_{in} is

(A) $39 + j183\ \Omega$ (B) $39 - j183\ \Omega$

(C) $64 + j148\ \Omega$ (D) $64 - j148\ \Omega$

41. The 300 Ω lossless line shown in fig. P8.6.41 is matched to the left of the stub. The value of Z_L is

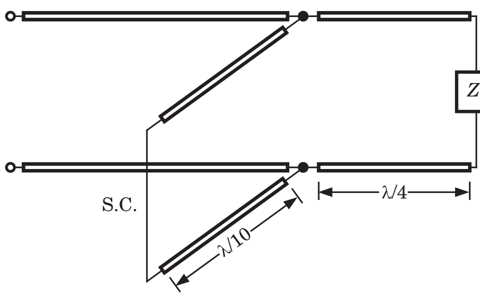

Fig. P8.6.41

(A) $1 - j1.37$ (B) $1 + j1.37$

(C) $300 + j413$ (D) $300 - j413$

42. A short-circuited stub is connected to a 50 Ω transmission line as shown in fig. P8.6.42. The admittance seen at the junction of the stub and the transmission line is

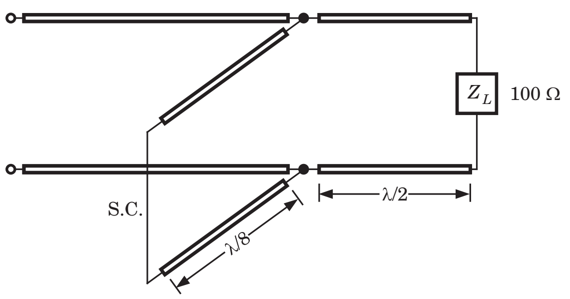

Fig. P8.6.42

(A) 00.01 – j0.02 (B) 0.02 + j0.01

(C) 0.04 + j0.02 (D) 0.04 – j0.02

Statement for Q.43–44:

Consider the fig. P8.6.43–44. A 50 Ω transmission line is connected to a load impedance $Z_L = 35 - j47.5\ \Omega$. A short-circuited stub is connected to match the line.

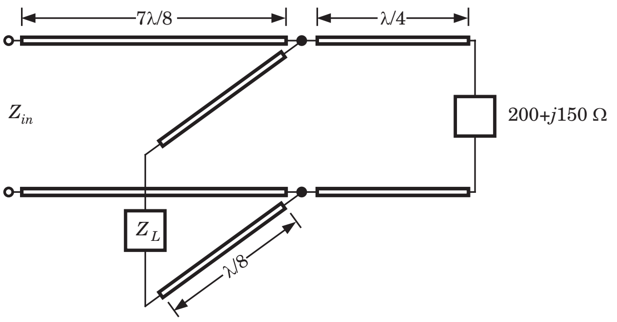

Fig. P8.6.43–44

43. The length d is

(A) 0.111λ (B) 0.06λ

(C) 0.13λ (D) 0.02λ

44. The length l is

(A) 0.67λ (B) 0.13λ

(C) 0.53λ (D) 0.86λ

****

Solutions

1. (B) $R + j\omega L = 60 + j2\pi(10\times10^6)(3\times10^{-7})$

$= 62.7\angle 17.44^\circ$

$G + j\omega C = 600\times10^{-6} + j2\pi(10\times10^6)(0.75\times10^{-9})$

$= 0.047\angle 89.27^\circ$

$$Z_o = \frac{\sqrt{R + j\omega L}}{\sqrt{G + j\omega C}} = \sqrt{\frac{62.7\angle 17.44^\circ}{0.047\angle 89.27^\circ}} = 36.52\angle -35.9^\circ$$

$= 29.6 - j21.4\ \Omega$

2. (B) $\gamma = \sqrt{(R + j\omega L)(G + j\omega C)}$

$= \sqrt{(62.7\angle 17.44^\circ)(0.047\angle 89.2^\circ)} = 1.72\angle 53.32^\circ$

$= 1.027 + j1.38\ \text{m}^{-1}$

$\alpha = 1.027\ \text{Np/m},\ \beta = 1.38\ \text{m}^{-1},$

$$v = \frac{\omega}{\beta} = \frac{2\pi\times10^7}{1.38} = 46\times10^6\ \text{m/s}$$

3. (B) $\alpha = 1.027\ \text{Np/m} = 1.027\times8.686 = 8.92\ \text{dB/m}$

$$\alpha l = 30\ \text{dB} \quad\Rightarrow\quad l = \frac{30}{8.92} = 3.36\ \text{m}$$

4. (B) $V_o e^{-\alpha l} = 0.2V_o$

$e^{-\alpha l} = 0.2 \quad\Rightarrow\quad \alpha l = \ln 5 = 1.61$

$$\alpha = 0.087 \quad\Rightarrow\quad l = \frac{1.61}{0.087} = 18.5\ \text{m}$$

5. (D) For distortion less line, $\dfrac{R}{L} = \dfrac{G}{C}$

$$G = \frac{R}{L}C = \frac{18\times21\times10^{-12}}{9\times10^{-7}} = 4.2\times10^{-4}\ \text{S/m}$$

$\alpha = \sqrt{RG} = \sqrt{18\times4.2\times10^{-4}} = 0.087$

$\beta = \omega\sqrt{LC} = 2\pi\times120\times10^6\sqrt{0.9\times10^{-6}\times21\times10^{-12}} = 3.28$

6. (D) $\beta l = 45^\circ = \dfrac{\pi}{4}$

$$\beta = 3.28 \quad\Rightarrow\quad l = \frac{\pi}{4(3.28)} = 0.24\ \text{m}$$

7. (C) $Z_o = \dfrac{\sqrt{R + j\omega L}}{\sqrt{G + j\omega C}} = 20$

$\Rightarrow \quad R + j\omega L = 400(G + j\omega C)$

$\gamma^2 = (R + j\omega L)(G + j\omega C) = (1 + j2)^2$

$400(G + j\omega C)^2 = (1 + j2)^2 \quad\Rightarrow\quad G + j\omega C = 0.05 + j\,0.1$

$$G = 0.05\ \text{S/m}, \qquad C = \frac{0.1}{10^6} = 0.1\ \mu\text{F/m}$$

8. (A) $R + j\omega L = 400(G + j\omega C) = 400(0.05 + j\,0.1)$

$\Rightarrow \quad R + j\omega L = 20 + j40$

$R = 20\ \Omega/\text{m},\ L = \dfrac{40}{10^6} = 40\ \mu\text{H/m}$

9. (D) $2a = 1.2$ mm, $d = 3.2$ mm

$$L = \frac{\mu}{\pi}\cosh^{-1}\left(\frac{d}{2a}\right) = 4\times10^{-7}\cosh^{-1}\left(\frac{3.2}{1.2}\right) = 0.66\ \mu\text{H/m}$$

$$C = \frac{\pi\varepsilon}{\cosh^{-1}\left(\frac{d}{2a}\right)} = \frac{10^{-9}\times 3.5}{\cosh^{-1}\left(\frac{3.2}{1.2}\right)} = 59.4\ \text{pF/m}$$

$$Z_o = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.66\times10^{-6}}{59.4\times10^{-12}}} = 105\ \Omega$$

10. (A) Skin depth $\delta = \dfrac{1}{\sqrt{\pi f\mu\sigma}}$

$$\Rightarrow \quad \delta = \frac{1}{\sqrt{\pi 5\times10^8\times4\pi\times10^{-7}\times7\times10^7}} = 2.69\times10^{-6}$$

$$R = \frac{2}{w\delta\sigma_c} = \frac{2}{0.4\times2.69\times10^{-6}\times7\times10^7} = 26.55\times10^{-3}\ \Omega$$

$$L = \frac{\mu d}{w} = \frac{4\pi\times10^{-7}\times0.016}{0.4} = 50.3\ \text{nH/m}$$

11. (D) $C = \dfrac{\varepsilon w}{d} = \dfrac{\varepsilon_o 40}{1.6} = 221$ pF

$G = \dfrac{\sigma w}{d}$, $\sigma = 0$ for air thus $G = 0$

12. (C) $Z_o = \sqrt{\dfrac{L}{C}} = \sqrt{\dfrac{\mu d}{w}\dfrac{d}{\varepsilon w}} = \dfrac{d}{w}\sqrt{\dfrac{\mu}{\varepsilon}}$

$Z_o = \dfrac{d}{w}\eta_o = 81\,\Omega,\ Z'_o = \dfrac{d}{w'\eta_o} = 75\,\Omega$

$\dfrac{w'}{w} = \dfrac{81}{75} \quad \Rightarrow \quad w' = 1.08w$

13. (B) $I(z, t) = \dfrac{V_o}{Z_o}\sin(\omega t - \beta z)$

$$Z_o = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.2\times10^{-6}}{0.5\times10^{-9}}} = 20\ \Omega$$

$$I(z, t) = \frac{V(z, t)}{Z_o} = 0.5\sin(\omega t - \beta z)$$

14. (D) $v = \dfrac{\omega}{\beta} = \dfrac{10^8}{2} = 5\times10^7$ m/s

15. (C) $\Gamma = \dfrac{V_o^-}{V_o^+} = \dfrac{90}{180} = \dfrac{1}{2}$

$$\Gamma = \frac{Z_L - Z_o}{Z_L + Z_o} = \frac{300 - Z_o}{300 + Z_o} = \frac{1}{2} \quad\Rightarrow\quad Z_o = 100\,\Omega$$

16. (C) $R + j\omega L = 13 + j(2\pi)(2\times10^6)(6.8\times10^{-6})$

$= 13 + j85.45$

$G + j\omega C = 4.2\times10^{-3} + j(2\pi)(2\times10^6)(10.7\times10^{-12})$

$= (4.2 + j0.13)\times10^{-3}$

$$Z_o = \frac{\sqrt{R + j\omega L}}{\sqrt{G + j\omega C}} = \sqrt{\frac{13 + j85.45}{(4.2 + j\,0.13)\,10^{-3}}} = 109.9 + j91.5$$

17. (A) $\gamma = \sqrt{(R + j\omega L)(G + j\omega C)}$

$\gamma = \sqrt{(13 + j85.45)(4.2 + j0.13)\times10^{-3}} = 0.45 + j0.39$

$\beta = 0.39$ rad/m, $t = \dfrac{\beta l}{\omega} = \dfrac{0.39\times8.4}{2\pi\times2\times10^6} = 260$ ns

18. (C) $Z_o = \sqrt{\dfrac{L}{C}}, \quad \gamma = j\beta = j\omega\sqrt{LC}, \quad Z_o\beta = \omega L,$

$$\beta = \frac{\omega L}{Z_o} = \frac{2\pi\times4.5\times10^9\times2.6\times10^{-6}}{80} = 919\ \text{rad/m}$$

$$v = \frac{\omega}{\beta} = \frac{Z_o}{L} = \frac{80}{2.6\times10^{-6}} = 30.8\times10^6\ \text{m/s}$$

19. (A) $\Gamma = \dfrac{Z_L - Z_o}{Z_L + Z_o} = \dfrac{75 + j25 - 60}{75 + j25 + 60} = 0.212\angle48.55^\circ$

$$s = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.212}{1 - 0.212} = 1.538$$

20. (A) $Z_{in} = Z_{sc} = Z_o\tanh\gamma l = Z_o\dfrac{\sinh\gamma l}{\cosh\gamma l}$

$\gamma l = (1.4 + j5)(0.4) = 0.56 + j2$

$\sinh\gamma l = -0.245 + j1.055$, $\cosh\gamma l = -0.483 + j0.536$

$$Z_{in} = \frac{(35 + j49)(-0.245 + j1.055)}{(-0.483 + j0.536)} = 82 + j39\,\Omega$$

21. (A) $\Gamma = \dfrac{Z_L - Z_o}{Z_L + Z_o} = \dfrac{125 - 60}{125 + 60} = 0.35$

$$s = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.35}{1 - 0.35} = 2.08$$

22. (C) $\beta l = \dfrac{2\pi}{\lambda}\dfrac{\lambda}{6} = 60^\circ$

$$Z_{in} = Z_o\left(\frac{Z_L + jZ_o\tan\beta l}{Z_o + jZ_L\tan\beta l}\right) = 60\left(\frac{125 + j60\tan60^\circ}{60 + j125\tan60^\circ}\right)$$

$= 35 - j24.8$

23. (A) $\Gamma = \dfrac{Z_L - Z_o}{Z_L + Z_o} = \dfrac{210 - 100}{210 + 100} = 0.355$

SWR $s = \frac{1+|\Gamma|}{1-|\Gamma|} = \frac{1+0.355}{1-0.355} = 2.1$

Since the line is $l/4$ long, the sending end will be at $V_{\max}$ and the receiving end will be at $V_{\min}$

$V_{\max} = sV_{\min} = 2.1 \times 60 = 126$ V

24. (A) $\beta l = \frac{2\pi}{\lambda}\frac{\lambda}{8} = 45°$

$I_L = \frac{V_L}{Z_L} = \frac{15e^{j25°}}{75e^{j30°}} = 0.2e^{-j5°}$

$I\left(l = \frac{\lambda}{8}\right) = I_L e^{j\beta l} = 0.2e^{-j5°}e^{j45°} = 0.2e^{j40°}$ A

25. (A) $\alpha = 0$, $\beta = \frac{2\pi}{\lambda}$, $z = \frac{\lambda}{4}$

$\gamma = \alpha + j\beta$, $V_+ = 0$, $V_- = 10$ V

$V = V_+e^{-\gamma z} + V_- e^{\gamma z} = V_- e^{\frac{j\pi}{2}} = j10$ V, $|V| = 10$ V

26. (C) $\beta l = 0.25 \times 100 = 25$ rad $= 1432.4° \equiv 352.4°$

At sending end $Z_{in} = 60\left(\frac{j40 + j60 \tan 352.4°}{60 - 40 \tan 352.4°}\right) = j29.4$

$V(Z=0) = V_o = \frac{Z_{in}}{Z_{in} + Z_g} V_g$

$= \left(\frac{j29.4}{j29.4 + 50 - j\,40}\right) 10\angle 0° = 5.75\angle 102°$

27. (A) $Z_{in} = Z_L = j40\,\Omega$

$V_L = V_s(z = l)$, $V_o = V_L e^{j\beta l}$

$V_L = V_o\, e^{-j\beta l} = (5.75\angle 102°)e^{-j352.4} = 5.75\angle 109.6°$ V

28. (C) $\beta l = 0.25 \times 4 = 1$ rad $= 57.3°$

$Z_{in} = 60\left(\frac{j40 + j60 \tan 57.3°}{60 - 40 \tan 57.3°}\right) = -j3471\,\Omega$

$V = V_L e^{j\beta l} = (5.75\angle 109.6°)e^{j57.3°} = 5.75\angle 167°$ V

29. (B) 3 m from the source is the same as 97 m from the load,

$\beta l = 0.25 \times 97 = 24.25$ rad $= 309.40°$

$Z_{in} = 60\left(\frac{j40 + j60 \tan 309.40°}{60 - 40 \tan 309.40°}\right) = -j18.2$

$V = V_L e^{j\beta l} = (5.75\angle 109.6°)(e^{j309.4°}) = 5.75\angle 59°$

30. (B) $\beta l = \frac{2\pi}{\lambda}(1.25\,\lambda) = \frac{\pi}{2} + 360°$, $\tan\frac{\pi}{2} = \infty$

$Z_{in} = Z_o\left(\frac{Z_L + jZ_o \tan\beta l}{Z_o + jZ_L \tan\beta l}\right)$

if $\tan\beta l = \infty$, $Z_{in} = \frac{Z_o^2}{Z_L} = \frac{80^2}{125} = 51.2\,\Omega$

31. (B) $\beta l = \frac{\omega l}{v} = \frac{2\pi \times 150 \times 10^6 \times 4.2}{0.8 \times 3 \times 10^8} = \frac{21\pi}{4}$

$\tan\beta l = 1$

$Z_{in} = Z_o\left(\frac{Z_L' + jZ_o \tan\beta l}{Z_o + jZ_L' \tan\beta l}\right) = 50\left(\frac{80 - j60 + j50}{50 + 60 + j80}\right)$

$= 21.6 - j203\ \Omega$

32. (D) $\Gamma' = \frac{Z_L' - Z_o}{Z_L' + Z_o} = \frac{80 - j60 - 50}{80 - j60 + 50} = 0.468\angle -38.66°$

$|\Gamma| = |\Gamma'| = 0.468$,

But $\theta_\Gamma = \theta_{\Gamma'} + 2 \times \frac{\pi}{4} = -38.66° + 90° = 51.34°$

$\Gamma = 0.468\angle 51.34°$

33. (B) At C, $\beta l = \frac{2\pi}{\lambda}\frac{\lambda}{2} = \pi$, $\tan\pi = 0$

$Z_{inC} = Z_L = 60 - j35\ \Omega$

At B, $\beta l = \frac{2\pi}{\lambda}\frac{3\lambda}{4} = \frac{3\pi}{4}$, $Z_L = Z_{inC} = 60 - j35\,\Omega$

$Z_{inB} = \frac{Z_o^2}{Z_L} = \frac{100^2}{60 - j35} = 124.4 + j72.5\ \Omega$

At A, $\beta l = \frac{2\pi}{\lambda}\frac{5\lambda}{8} = \frac{5\pi}{4}$, $\tan 225° = 1$, $Z_L = Z_{inB}$

$Z_{in} = Z_o\left(\frac{Z_L + jZ_o}{Z_o + jZ_L}\right) = 50\left(\frac{124.4 + j72.5 + j50}{50 + j124.4 - 72.5}\right)$

$= 39 - j57$

34. (D) $\beta l = \frac{2\pi}{\lambda}\frac{\lambda}{4} = \frac{\pi}{2}$, $\tan\frac{\pi}{2} = \infty$, $Z_{in} = \frac{Z_o^2}{Z_L}$,

$Z_{in2} = \frac{Z_{o2}^2}{75}$, $Z_{L1} = Z_{in2}$

$Z_{in1} = \frac{Z_{o1}^2}{Z_{L1}} = Z_o \Rightarrow Z_{o1}^2 = Z_o Z_{L1} = \frac{50}{75}(30)^2 = 24.5\ \Omega$

35. (A) $\beta l = \frac{2\pi}{\lambda}\frac{\lambda}{4} = \frac{\pi}{2}$, $Z_{in}' = \frac{Z_o^2}{Z_L} = \frac{50^2}{74} = 33.78$

This act as the load to the left line. But there are two such loads in parallel. Due to the two lines on the right

$Z_L' = 16.9\ \Omega$, $Z_{in} = \frac{50^2}{16.9} = 148\,\Omega$

36. (B) $\tan\beta l = \tan\left(\frac{2\pi}{\lambda}\frac{\lambda}{4}\right) = \infty$,

$Z_{in} = \frac{Z_o^2}{Z_L} = \frac{50^2}{100} = 25\Omega$

37. (C) $Z_L = 0$ (short circuit),

$$Z_{in} = \frac{Z_o^2}{0} = \infty \text{ (open circuit).}$$

38. (A) $Z_L = 25 \parallel \infty = 25\,\Omega$, $Z_{in} = \frac{50^2}{25} = 100\,\Omega$

39. (A) For $\frac{\lambda}{4}$ line $\tan\beta l = \infty$

$$Z_{in1} = \frac{Z_o^2}{Z_L} = \frac{100^2}{200 + j150} = 32 - j24$$

For $\frac{\lambda}{8}$ line, $\tan\beta l = 1$

$$Z_{in2} = Z_o\left(\frac{0 + jZ_o}{Z_o + 0}\right) = jZ_o = j100\ \Omega$$

At the $\frac{7\lambda}{8}$ line $Z_{in1} \parallel Z_{in2}$ will be load.

$$Z_L = \frac{(32 - j24)(j100)}{32 - j24 + j100} = 47.06 - j11.76$$

$$\tan\beta l = \tan\left(\frac{2\pi}{\lambda}\cdot\frac{7\lambda}{8}\right) = -1$$

$$Z_{in} = 100\left(\frac{47.06 - j11.76 + j100(-1)}{100 + j(47.06 - j11.76)(-1)}\right) = 94.11 - j76.45$$

40. (D) If $Z_L = \infty$, at the input end of $\frac{\lambda}{8}$ line

$$Z_{in2} = Z_o\left(\frac{Z_L + jZ_o}{Z_o + jZ_L}\right) = -jZ_o = -j100$$

$$Z_L = (32 - j\,24) \parallel (-j100) = 19.5 - j24.4$$

$$Z_{in} = 100\left(\frac{19.5 - j24.4 + j100(-1)}{100 + j(19.5 - j24.4)(-1)}\right) = 64 - j148\ \Omega$$

41. (C) For the line to be matched, it is required that the sum of normalized input admittance of the shorted stub and main line at the point where the stub is connected be unity. For $\frac{\lambda}{10}$ shorted stub, $z_L = 0$ and

$$z_{ins} = \frac{z_L + j\tan\beta l}{1 + z_L j\tan\beta l} = j\tan\beta l,$$

$$y_{ins} = -j\cot\beta l = -j\cot\left(\frac{2\pi}{\lambda}\frac{\lambda}{10}\right) = -j1.3764$$

For line to be matched at junction normalized input admittance of line must be $1 + j1.3764$

$$\tan\beta l = \tan\left(\frac{2\pi}{\lambda}\frac{\lambda}{4}\right) = \infty$$

$$y_{in} = z_L,\quad z_L = 1 + j1.3764,\quad Z_L = Z_o z_L = 300 + j413$$

42. (A) At junction input impedance of line

$$\tan\beta l = \tan\left(\frac{2\pi}{\lambda}\frac{\lambda}{2}\right) = 0$$

$$Z_{inL} = Z_o\left(\frac{Z_L + jZ_o\tan\beta l}{Z_o + jZ_L\tan\beta l}\right) = Z_L = 100\,\Omega$$

input impedance of stub $Z_L = 0$

$$\tan\beta l = \tan\left(\frac{2\pi}{\lambda}\frac{\lambda}{8}\right) = 1$$

$$Z_{ins} = Z_o\left(\frac{Z_L + jZ_o\tan\beta l}{Z_o + jZ_L\tan\beta l}\right) = jZ_o = j50\,\Omega$$

At junction $Y = \frac{1}{Z} = \frac{1}{j50} + \frac{1}{100} = 0.01 - j0.02$

43. (B) Normalized load $z_L = r_L + jx_L$

$$t = \tan\beta d = \begin{cases} \frac{1}{r_L - 1}\left\{x_L \pm \sqrt{r_L\left((1 - r_L)^2 + x_L^2\right)}\right\}, & r_L \neq 1 \\ -\frac{x_L}{2}, & r_L = 1 \end{cases}$$

$$\frac{d}{\lambda} = \begin{cases} \frac{1}{2\pi}\tan^{-1} t, & t \geq 0 \\ \frac{1}{2\pi}(\pi + \tan^{-1} t), & t > 0 \end{cases}$$

$$Z_L = 35 - j47.5,\ Z_o = 50\ \Omega,\ z_L = \frac{Z_L}{Z_o} = 0.7 - j0.95$$

$r_L = 0.7$, $x_L = -0.95$,

$$t = \frac{1}{0.7 - 1}(-0.95 \pm \sqrt{0.7\{0.7(1 - 0.7)^2 + 0.95^2\}}) = 5.93,\ 0.4$$

For $t = 5.93$, $\frac{d}{\lambda} = \frac{1}{2\pi}\tan^{-1} 5.93 = 0.223$

For $t = 0.4$, $\frac{d}{\lambda} = \frac{1}{2\pi}\tan^{-1} 0.4 = 0.06$

44. (B) $b_B = \frac{r_L^2 t - (1 - x_L t)(x_L + t)}{r_L + (x_L + t)^2}$, For $t = 5.93$,

$$b_B = \frac{(0.7)^2(5.93) - \{1 - (-0.95)(5.93)\}(5.93 - 0.95)}{0.7 + (5.93 - 0.95)^2} = -1.18$$

For $t = 0.4$, $b_B = 0.9526$

$$\frac{l}{\lambda} = \begin{cases} \frac{1}{2\pi}\tan^{-1}\frac{1}{b_B}, & b_B \geq 0 \\ \frac{1}{2\pi}\left(\pi + \tan^{-1}\frac{1}{b_B}\right), & b_B > 0 \end{cases}$$

For $b_B = -1.18$, $\frac{l}{\lambda} = 0.388$

For $b_B = 0.953$, $\frac{l}{\lambda} = 0.13$

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