Quiz 1 Solution:

A distortionless cable is 4-m long and has a characteristic impedance of 60 Ω. A signal is attenuated by 0.24 dB at the receiving end and delayed by 80 μs. Find R, G, C, L for the cable.

soln:

Given,

L = 4 m, Z_0 = 60 Ohm, α = 0.24 dB for 4 m, time delay = 80 μsec.

$\alpha = \frac{0.24}{4\times 8.686} = 0.00691\ Np/m$

velocity of signal, v = 4/(80μ) = $5 \times 10^4\ m/sec.$

Condition for distortionless line, $\frac{R}{L} = \frac{G}{C}$

For distortionless line, $\alpha = \sqrt{RG}$, and $Z_0 = \sqrt{\frac{L}{C}}$

$$\therefore R = \alpha Z_0 = 0.414\ \Omega/\mathrm{m}$$

$$L = \frac{Z_0}{v} = 1.2m\ H/m$$

$$G = \frac{R}{Z_0^2} = 115\mu\ S/m$$

Q2. The impedance of the line is

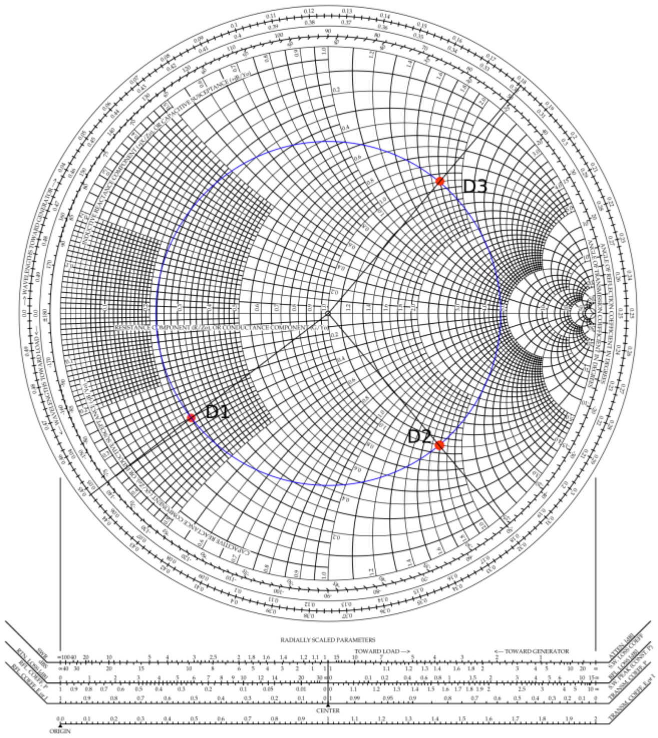
$$Z_\circ = \sqrt{\frac{L}{C}} = 100\,\Omega$$

The normalized **admittance** of the load is

$$Y_L = \frac{Z_\circ}{Z_L} = 0.24 - 0.32j$$

The load admittance is shown as point D1 in the smith chart. To match the impedance, we need to locate a point
= 1 at the constant reflection coefficient circle (shown as blue). This occurs at two points D2 and D3. The wavel
− 0.024 S. The characteristic impedance of the stub is 80 ohms. To offset the previous admittance, we need to ad
+ 0.024 S using the stub.

The Complete Smith Chart



And the wavelength is 0.4m. Using $Y_{is} = -jY_{\circ} \cot \beta l$
, We find the length of the shorted stub to be 0.17m.

Q3.

Reflection coefficient at the load;

$$\Gamma = (ZL - Z0) / (ZL + Z0) = (-1 - j2) / 5$$

Standing wave ratio;

$$SWR = (1 + |\Gamma(z)|) / (1 - |\Gamma(z)|) = (1 + |\Gamma L|) / (1 - |\Gamma L|) = 2.618$$

According to the question, total amplitude at the load is

$$VL = V+ (1 + \Gamma L)$$

$$\Rightarrow V+ = VL / (1 + \Gamma L) = 25 (2 + j) V$$

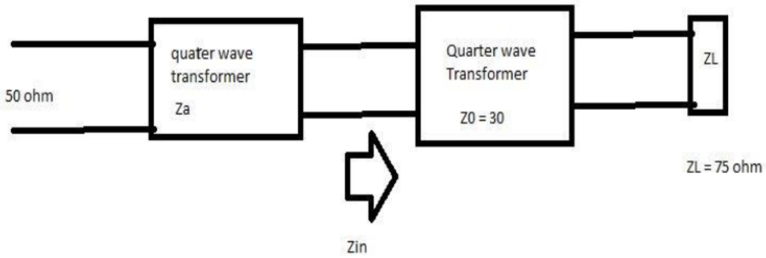
Magnitude of the forward – propagating voltage;

$$| V+ | = 55.9 V$$

$$\text{Maximum voltage} = | V+ |(2 SWR / (SWR + 1)) = 80.9 V$$

$$\text{Minimum voltage} = | V+ |(2 / (SWR + 1)) = 30.9 V$$

Solution 4



Zin= Zo^2/ZL = 30^2/75= 12 ohm

50= Za^2/Zin but Zin = 12 ohm So Za = 24.5 ohm

Q5.

Conditions for low − loss line

$$R \ll \omega L\,, \quad G \ll \omega C$$

$$\omega L = 2\pi * 100 * 10^{6} * 0.2 * 10^{-6} = 40\pi$$

$$R \ll 40\pi$$

Q7.

Characteristic impedance, Z = ((R + jwL)/(G + jwC))^1/2 and γ = ((R + jwL) ∗ (G + jwC))^1/2 = $\alpha + j\beta$.

Z can be real if R/G = L/C but that does not imply that α = 0, so the line is not necessarily lossless. Such a line, where R/G = L/C, is called distortion less transmission line.

Q8

$$\frac{P_{reflected}}{P_{incident}} = 0.2$$

$$\Rightarrow \left(\frac{A_{reflected}}{A_{incident}}\right)^2 = 0.2$$

$$\Rightarrow \Gamma = \sqrt{0.2} = 0.4472$$

$$VSWR = \frac{1+\Gamma}{1-\Gamma} = \frac{1+0.4472}{1-0.4472} = \mathbf{2.618}$$

Q9.

Characteristic Impedance Z0 = 50Ω

f = 30MHz and λ = 10m

Load Impedance ZL = 200Ω

Vin (rms) = 10V

Vout (rms) =?

Since the system is matched the power carried by the wave is (10)^2/50 = 2 W.

In a lossless case, this power has to be delivered to the load giving

(VL)^2/200 = 2 W

VL=20 V

Q10

The given device is a 6 dB attenuator. As the attenuator is terminated in open circuit hence the magnitude of output
Hence the total return loss would be of 12 dB. So, the magnitude of input reflection coefficient is $10^{(-12/20)} = 0.251$.