RFCD QUIZ

1. Use Smith Chart to find (a) load reflection coefficient (b) input impedance (c) VSWR for following circuit (Fig1):

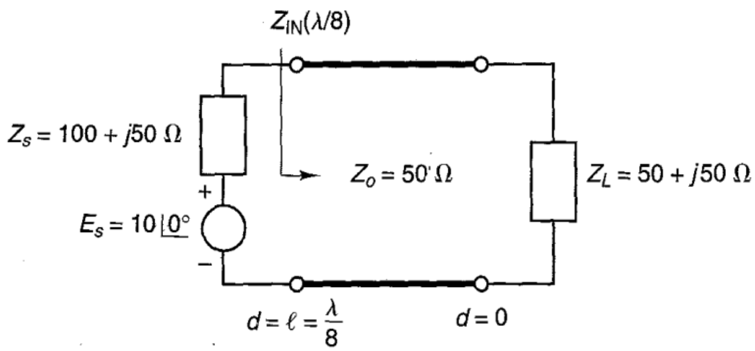


Figure 1

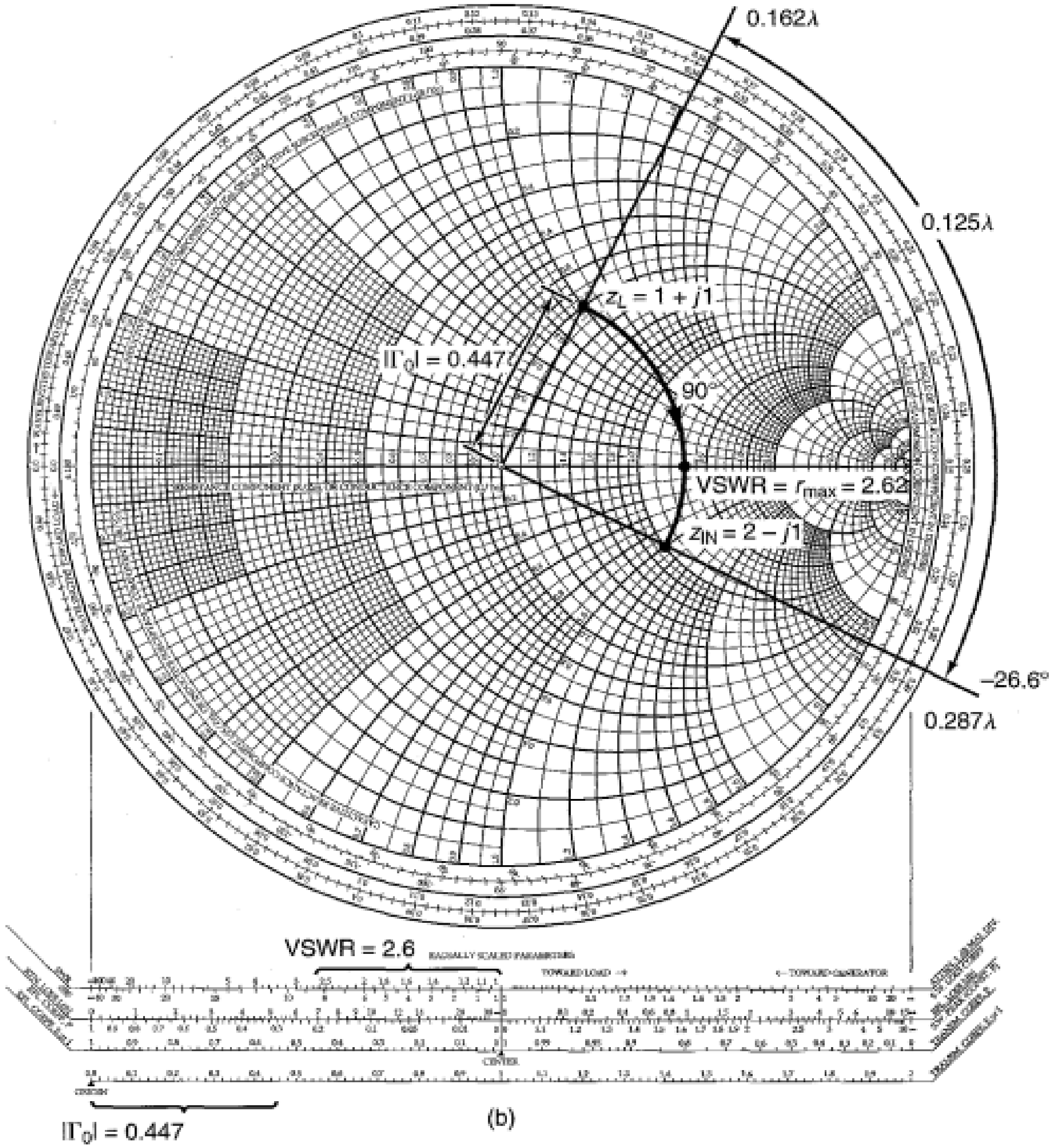
Solution>

(a) load reflection coefficient = 0.447<63.4 deg

(b) input impedance = 100-j50 ohm

(c) VSWR=2.62

See following Smith Chart



(b)

2. Hence or otherwise, find $V(\lambda/8)$, $I(\lambda/8)$, $P_{in}(\lambda/8)$, $V(0)$, $I(0)$, $P_{in}(0)$ in Fig.1.

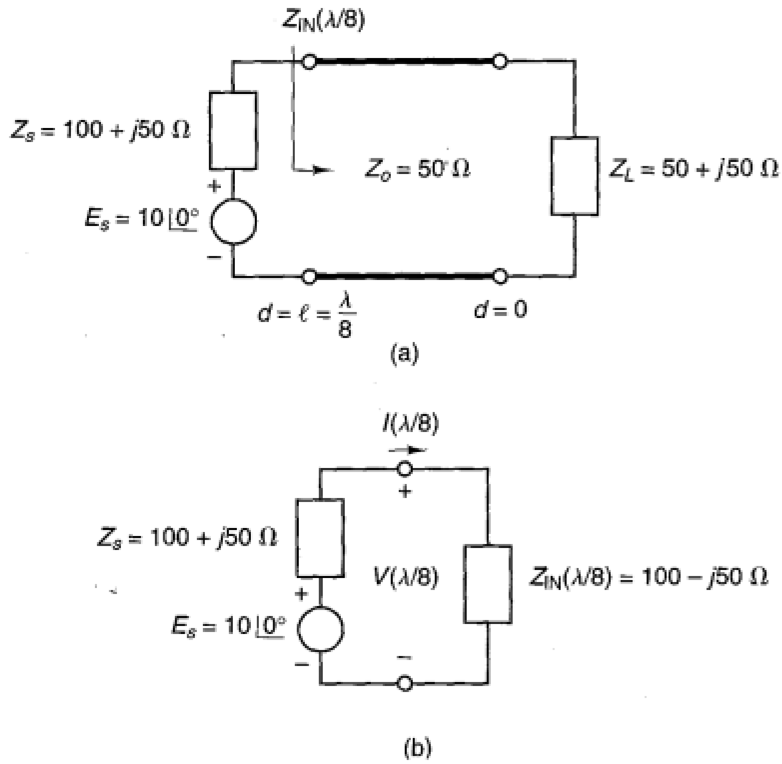


Figure 1.3.8 (a) Transmission line circuit for Example 1.3.1; (b) equivalent circuit at $d = \lambda/8$.

(b) The equivalent circuit at $d = \lambda/8$ is shown in Fig. 1.3.8b. For the given value of Z_s there is maximum power delivered to $Z_{IN}(\lambda/8)$ [since $Z_{IN}(\lambda/8) = Z_s^*$]. Also, since the line is lossless the power delivered to the input of the line is equal to the power delivered to the load.

From Fig. 1.3.8b the value of $V(\lambda/8)$ is

$$V(\lambda/8) = \frac{E_s Z_{IN}(\lambda/8)}{Z_{IN}(\lambda/8) + Z_s} = \frac{10\underline{|0^\circ}\,(100 - j50)}{100 - j50 + 100 + j50} = 5.59\underline{|-26.57^\circ}\ \text{V}$$

and $I(\lambda/8)$ is

$$I(\lambda/8) = \frac{E_s}{Z_{IN}(\lambda/8) + Z_s} = \frac{10\underline{|0^\circ}}{200} = 0.05\ \text{A}$$

The input power $P(\lambda/8)$ can be calculated using

$$P(\lambda/8) = \text{Re}[V_{\text{rms}}(\lambda/8) I^*_{\text{rms}}(\lambda/8)] = \frac{1}{2}\text{Re}[V(\lambda/8) I^*(\lambda/8)]$$

$$= \frac{1}{2}\text{Re}[5.59\underline{|-26.57^\circ}\,(0.05)] = 0.125\ \text{W}$$

where we used the fact that for sinusoidal signals the root mean square (rms) value of the phasor and its peak value are related by $\sqrt{2}$. That is,

$$V_{\text{rms}}(\lambda/8) = \frac{V(\lambda/8)}{\sqrt{2}}$$

and

$$I_{\text{rms}}(\lambda/8) = \frac{I(\lambda/8)}{\sqrt{2}}$$

$$V(d) = A_1(e^{j\beta d} + \Gamma_0 e^{-j\beta d}) = A_1 e^{j\beta d}(1 + \Gamma_0 e^{-j2\beta d}) \qquad (1.3.36)$$

In order to calculate the voltage and current at the load end, we need to evaluate $V(d)$. $V(d)$ is given by (1.3.36), where the complex constant A_1 can be evaluated from the boundary condition at $d = \lambda/8$.

$$V(\lambda/8) = 5.59\underline{|-26.57^\circ} = A_1 e^{j\pi/4}[1 + 0.447\underline{|63.44^\circ}\, e^{-j\pi/2}]$$

which can be solved for A_1, giving

$$A_1 = 3.95\underline{|-63.44^\circ}$$

Therefore,

$$V(d) = 3.95\underline{|-63.44^\circ}\, e^{j\beta d}[1 + 0.447\underline{|63.44^\circ}\, e^{-j2\beta d}]$$

$$= 3.95\underline{|-63.44^\circ}\, e^{j\beta d} + 1.77e^{-j\beta d}$$

This expression gives the value of the voltage at any position along the transmission line. At the load end (i.e., at $d = 0$) we obtain

$$V(0) = 3.95\underline{|-63.44^\circ} + 1.77 = 5\underline{|-45^\circ}\text{ V}$$

The current at the load follows from

$$I(0) = \frac{V(0)}{Z_L} = \frac{5\underline{|-45^\circ}}{50 + j50} = 0.071\underline{|-90^\circ}\text{ A}$$

Finally, the power delivered to the load is

$$P(0) = \text{Re}[V_{\text{rms}}(0)I^*_{\text{rms}}(0)] = \frac{1}{2}\text{Re}[V(0)I^*(0)] = \frac{1}{2}\text{Re}[5\underline{|-45^\circ}(0.071\underline{|90^\circ})]$$
$$= 0.125\text{ W}$$

3. Find Input Impedance(Fig2):

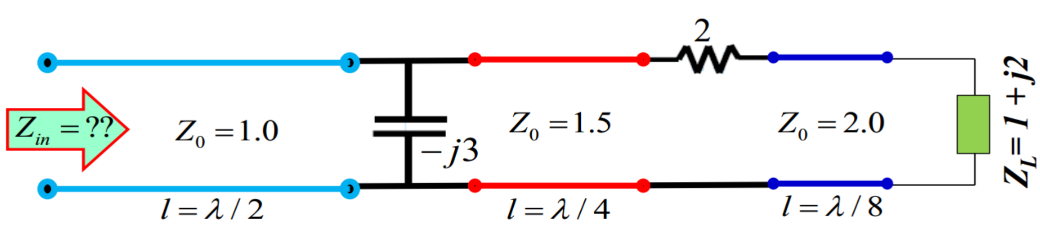


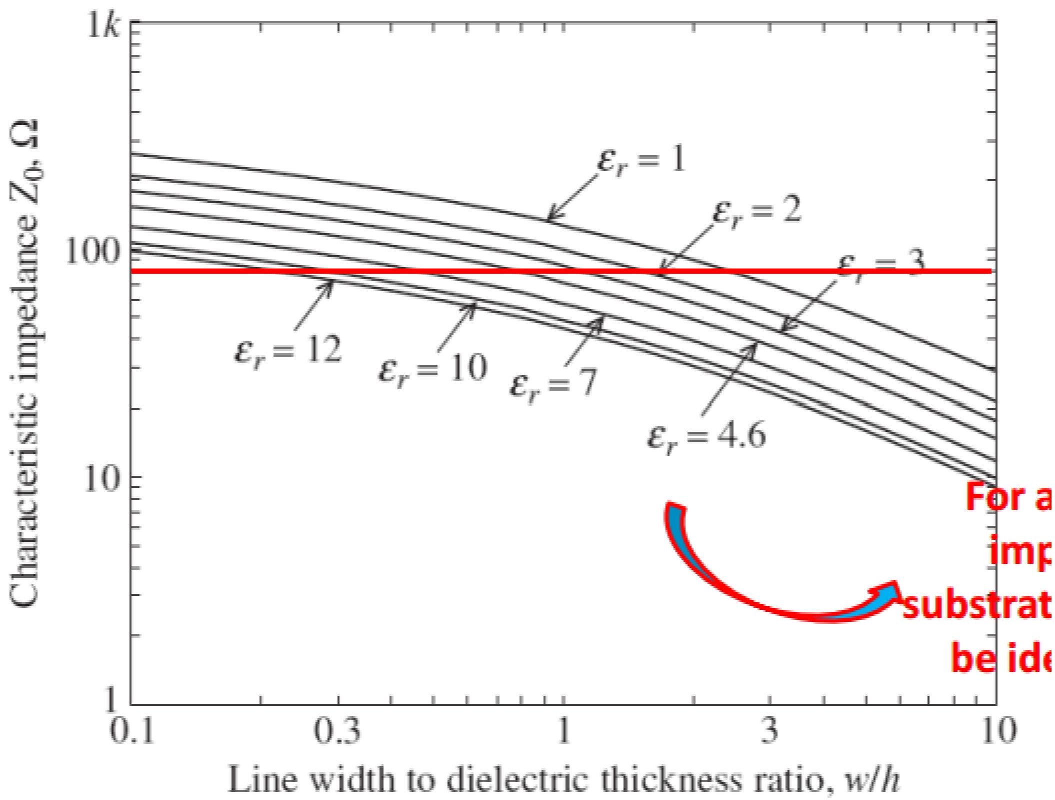
Figure 2

$$\boxed{\therefore Z_{in} = Z_4 = 0.22 + j0.028}$$

Solution> See Lecture Slides

4. (a) what happens to the width of microstrip line with the decrease in ε_r for a given value of characteristic impedance and the substrate height?

Solution> It Increases.



(b) A certain transmission line (T-line) is known to obey following relationship:

$$Z_{in}(d) = Z_0 \frac{Z_L + jZ_0 \tan(\beta d)}{Z_0 + jZ_L \tan(\beta d)}$$

You have already learned in RFCD how to realize capacitor and Inductor using this type of T-line. Can you suggest a way to realize a resistor using such a T-line? Explain.

Solution> Any Tline following above expression must be lossless (with R=G=0), thus realization of resistor from such a line is NOT possible.