ELC N205: Electromagnetics 1 Tutorials

Department of Communications and Computer Engineering

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Agenda

- Smith Chart (What? , Why?)
- Development of Smith Chart
- Mapping on Smith Chart
- Impedance Matching
- Impedance Matching Types

Smith Chart

Definition

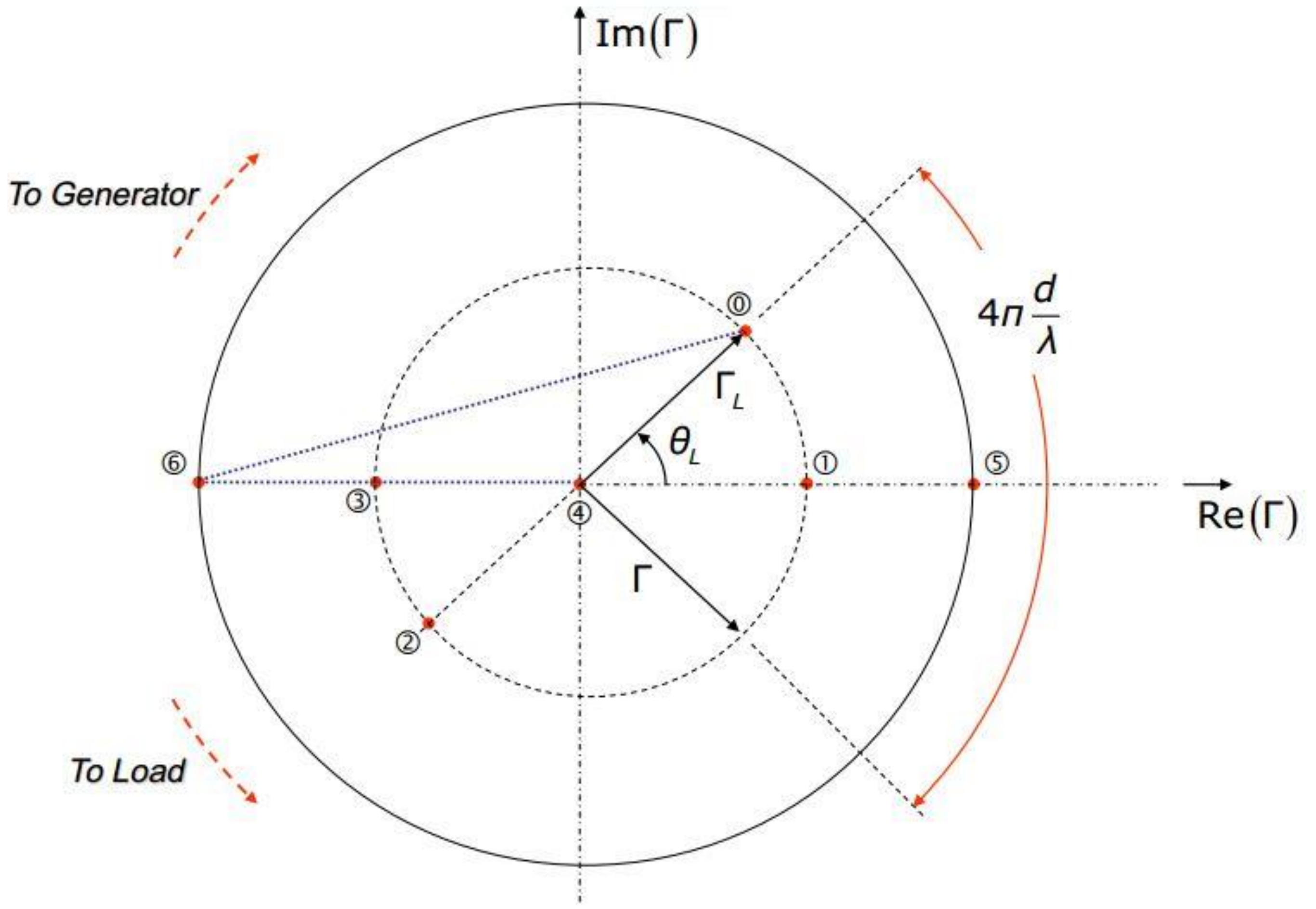
Smith chart is a graphical plot of normalized resistance and reactance functions in the reflection-coefficient complex plane.

Transmission-line calculations—such as the determination of input impedance, reflection coefficient, and load impedance—often involve tedious manipulations of complex numbers. This tedium can be alleviated by using a graphical method of solution. The best known and most widely used graphical chart is the Smith chart

Development of Smith Chart

Important points

0. Load point ((Impedance))
1. Maximum voltage point(R_l > R_o)
   ((z in max = S))
2. Load point ((admittance))
3. Minimum voltage point (R_l < R_o)
   ((z in min = 1/S))
4. r = 1 point
5. Open circuit point
6. Short circuit point



Exercise IIX

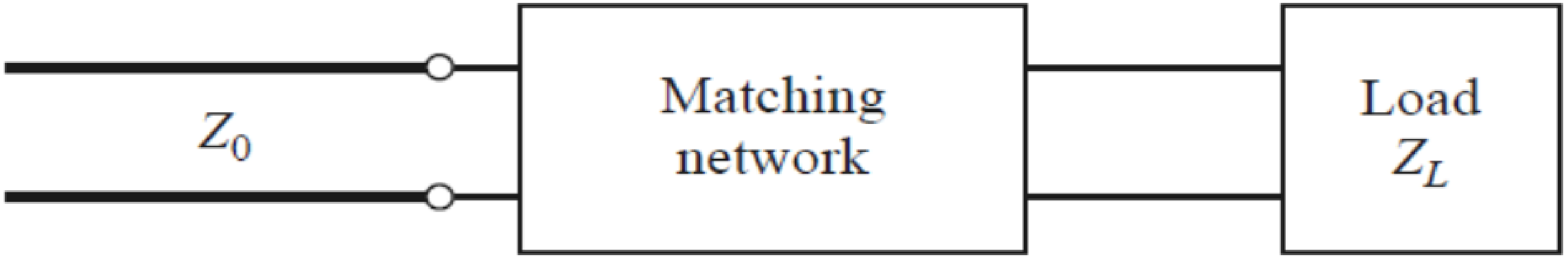
1) **P.9–42** The characteristic impedance of a given lossless transmission line is 75 (Ω). Use a Smith chart to find the input impedance at 200 (MHz) of such a line that is (a) 1 (m) long and open-circuited, and (b) 0.8 (m) long and short-circuited. Then (c) determine the corresponding input admittances for the lines in parts (a) and (b).

2) **P.9–43** A load impedance $30 + j10$ (Ω) is connected to a lossless transmission line of length 0.101λ and characteristic impedance 50 (Ω). Use a Smith chart to find (a) the standing-wave ratio, (b) the voltage reflection coefficient, (c) the input impedance, (d) the input admittance, and (e) the location of the voltage minimum on the line.

3) **P.9–44** Repeat Problem P.9–43 for a load impedance $30 - j10$ (Ω).
(Assignment)

Impedance Matching

Impedance matching is often an important part of a larger design process for a microwave component or system.



The matching network is ideally lossless, to avoid unnecessary loss of power, and is usually designed so that the impedance seen looking into the matching network is Z_o. So, reflections will be eliminated on the transmission line to the left of the matching network, although there will usually be multiple reflections between the matching network and the load.

Impedance Matching

Types

1) Using lumped elements (Using L- Networks)
2) Using single stub tuning (Using TL Transformer + Single Stub)
3) Using TL Transformer + Lumped Element
4) Using TL Transformer only (for any kind of loads)
5) Using Quarter wave Transformer (for real loads only)
6) Using TL Transformer + Quarter wave Transformer

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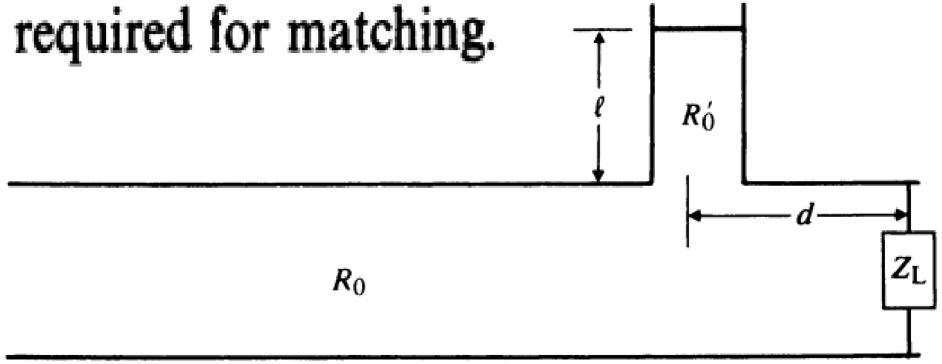
Exercise IIX

4) **P.9–48** The single-stub method is used to match a load impedance $25 + j25\ (\Omega)$ to a $50\ (\Omega)$ transmission line.

a) Find the required length and position of a short-circuited stub made of a section of the same $50\ (\Omega)$ line.

b) Repeat part (a) assuming that the short-circuited stub is made of a section of a line that has a characteristic impedance of $75\ (\Omega)$.

5) **P.9–49** A load impedance can be matched to a transmission line also by using a single stub placed in series with the load at an appropriate location, as shown in Fig. 9–47. Assuming that $Z_L = 25 + j25\ (\Omega)$, $R_0 = 50\ (\Omega)$, and $R_0' = 35\ (\Omega)$, find d and ℓ required for matching.



Exercise IIX

6) **P.9–50** The double-stub method is used to match a load impedance $100 + j100$ (Ω) to a lossless transmission line of characteristic impedance 300 (Ω). The spacing between the stubs is $3\lambda/8$, with one stub connected directly in parallel with the load. Determine the lengths of the stub tuners (a) if they are both short-circuited, and (b) if they are both open-circuited.