EE301: Electromagnetic Waves
Tutorial 6 - Part B

October 11, 2018

Problem 1: Smith chart

A lossless line having an air dielectric has a characteristic impedance, Z_0 of 400Ω. The line is operating at $200MHz$ and input impedance, $Z_{in} = (200 - j200)\Omega$. Use analytic methods and the Smith chart to find:

(a) Input admittance

(b) Input VSWR

(c) Load impedance if the line is $1m$ long

(d) VSWR at the load

(e) The distance from the load to nearest voltage maximum

Problem 1a: Analytical solution

(a) Input admittance

$Y_{in} = \frac{1}{Z_{in}}$

$\implies Y_{in} = \frac{1}{200-j200} = (2.5 \times 10^{-3} + j2.5 \times 10^{-3})\mho$

Problem 1a: Solution

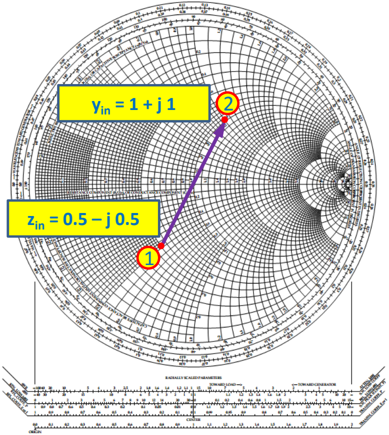

Figure: Input admittance calculation using Smith chart

Problem 1b: Analytical solution

(b) Input *VSWR*

Input reflection coefficient, $\Gamma_{in} = \frac{Z_{in} - Z_0}{Z_{in} + Z_0}$

$$\implies \Gamma_{in} = -0.2 + j0.4 = 0.447\angle 116.56^o$$

Input VSWR, $VSWR_{in} = \frac{1 + |\Gamma_{in}|}{1 - |\Gamma_{in}|}$

$$\implies VSWR_{in} = 2.617$$

Problem 1b: Solution

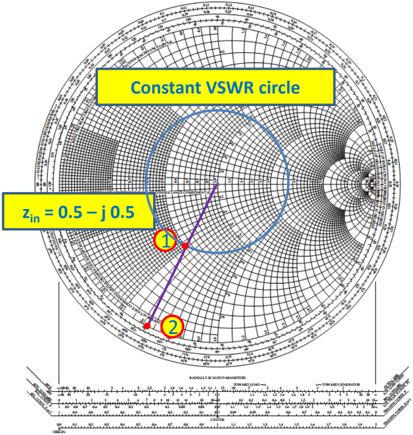

Figure: Input VSWR calculation using Smith chart

Problem 1c: Analytical solution

(c) Load impedance

Input impedance, $Z_{in} = Z_0 \frac{Z_L + jZ_0 tan(\beta l)}{Z_0 + jZ_L tan(\beta l)}$

$\implies$ Load impedance, $Z_L = Z_0 \frac{Z_{in} - jZ_0 tan(\beta l)}{Z_0 - jZ_{in} tan(\beta l)}$

$Z_L = (1040 + j69.8)\Omega$

Problem 1c: Solution

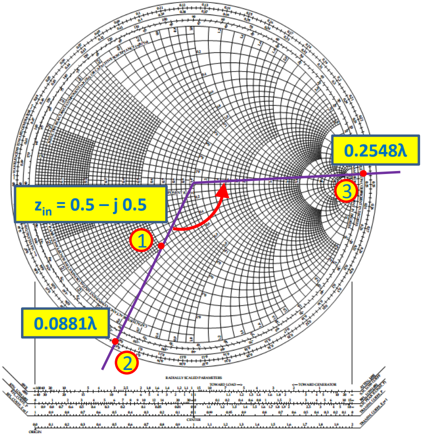

Figure: Load impedance calculation using Smith chart

Problem 1c: Solution

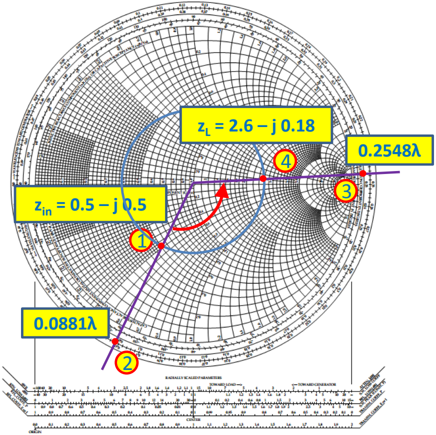

Figure: Load impedance calculation using Smith chart

Problem 1d: Analytical solution

(d) $VSWR$ at the load

Load reflection coefficient, $\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0}$

$\implies \Gamma_L = 0.446 - j0.268 = 0.447\angle 3.45^o$

Load VSWR, $VSWR_L = \frac{1+|\Gamma_L|}{1-|\Gamma_L|}$

$\implies VSWR_L = 2.617$

Problem 1e: Analytical solution

(e) Nearest voltage maximum

$$l_{max} = -\frac{\phi}{2\beta} = -\frac{\lambda\phi}{4\pi} = -7.2mm$$

Note: ϕ should be in radian

Problem 1e: Solution

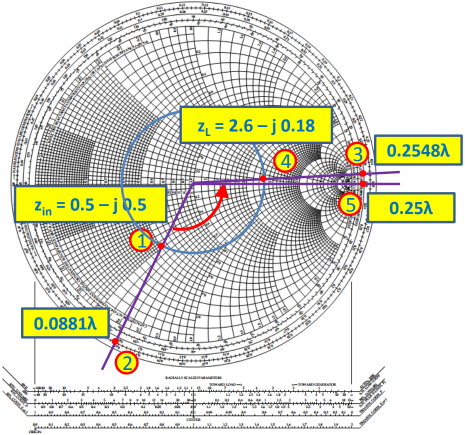

Figure: Distance to the nearest voltage maximum

THANK YOU