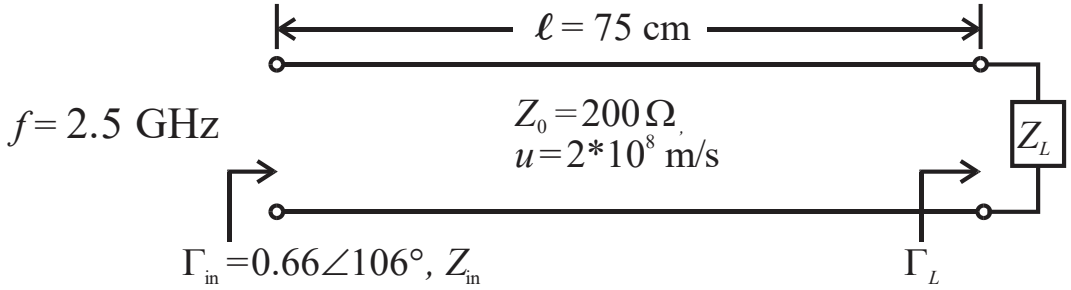
EE 381 Electric and Magnetic Fields Quiz #3 (Fall 2024)

Name ____KEY A_____

Instructions: Closed book & notes. Place answers in indicated spaces and show all work for credit.

A lossless transmission line (200 Ω, 2×10^8 m/s) of length 75 cm has a measured input reflection coefficient of $0.66\angle 106°$ at 2.5 GHz. Calculate the wavelength. Then, using a Smith chart, find the input admittance & impedance, load reflection coefficient, load impedance, and standing wave ratio (SWR) along the transmission line. **Show** and **clearly label** all work on the Smith chart (this will be graded).



- Wavelength $\lambda = u/f = 2\times10^8/2.5\times10^9 \Rightarrow$ **$\lambda = 0.08$ m = 8 cm**.

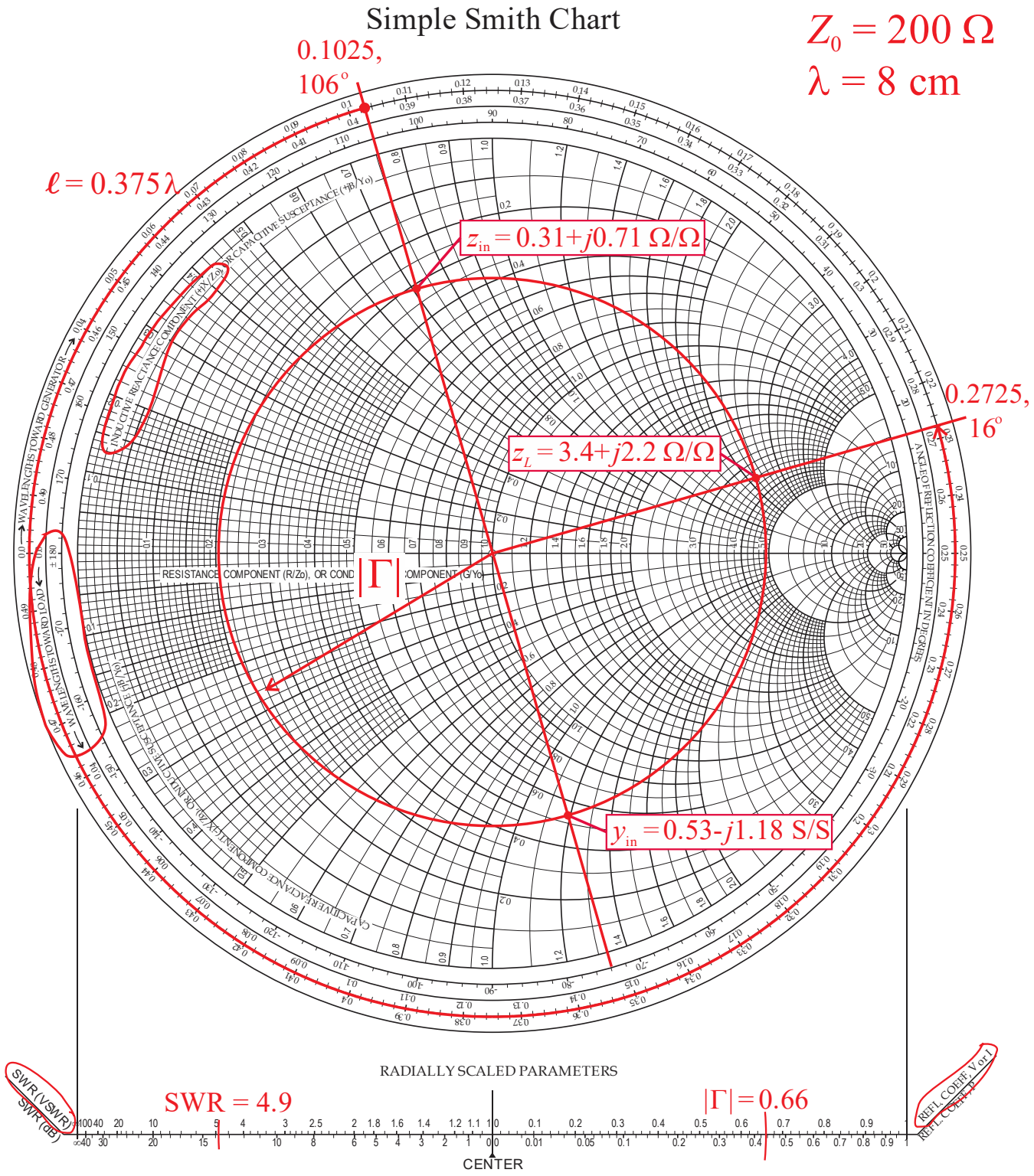
Steps

1) Plot $\Gamma_{in} = 0.66\angle 106°$ by drawing circle, centered on Smith chart, of radius 0.66 (use "REFL. COEFF, V or I" scale at bottom of Smith chart) and radial line from center of Smith chart to 106° on "ANGLE OF REFLECTION COEFFICIENT" scale.
2) Read normalized input impedance $z_{in} = 0.31 + j\ 0.71$ Ω/Ω. Compute the input impedance $Z_{in} = Z_0\ z_{in} = 200\ (0.31 + j\ 0.71) \Rightarrow$ **$Z_{in} = 62 + j\ 142$ Ω**.
3) Draw arc of radius 0.66 on "SWR (VSWR)" scale. Read SWR = 4.9.
4) To find the normalized input admittance, go 180° around $\Gamma = 0.66$ circle and draw a radial line. Read $y_{in} = 0.53 - j\ 1.18$ S/S off Smith chart. Compute the input admittance $Y_{in} = y_{in}/Z_0 = (0.53 - j\ 1.18)/200 \Rightarrow$ **$Y_{in} = 2.65 - j\ 5.9$ mS**.
5) To get to the load point, we must go $\ell/\lambda = 75/8 = 9.375 \Rightarrow 0.375 = 0.1025 + 0.2725$ in the "WAVELENGTHS TOWARD LOAD" direction along the $\Gamma = 0.66$ circle from $z_{in}/\ \Gamma_{in}$ point.
6) Read the normalized load impedance $z_L = 3.4 + j\ 2.2$ Ω/Ω. Compute the load impedance $Z_L = Z_0\ z_{in} = 200\ (3.4 + j\ 2.2) \Rightarrow$ **$Z_L = 680 + j\ 440$ Ω**.
7) Read $\angle\Gamma_L = 16°$"ANGLE OF REFLECTION COEFFICIENT" scale. Already know that $\Gamma = 0.66$ on a lossless transmission line. $\Rightarrow$ **$\Gamma_L = 0.66\angle 16°$**.

wavelength = **$\lambda = 0.08$ m = 8 cm**

Y_{in} = **$2.65 - j\ 5.9$ mS** Z_{in} = **$62 + j\ 142$ Ω**

load refl. coeff. = **$\Gamma_L = 0.66\angle 16°$** Z_L = **$680 + j\ 440$ Ω** SWR = 4.9

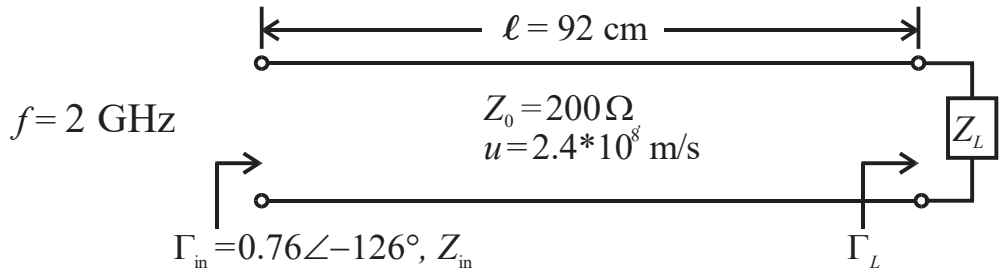

Simple Smith Chart
$Z_0 = 200\ \Omega$
$\lambda = 8$ cm
0.1025, 106°
$\ell = 0.375\lambda$
$z_{in} = 0.31 + j0.71\ \Omega/\Omega$
0.2725, 16°
$z_L = 3.4 + j2.2\ \Omega/\Omega$
$y_{in} = 0.53 - j1.18$ S/S
RESISTANCE COMPONENT (R/Zo), OR COND
$|\Gamma|$
OMPONENT (G/Yo)
WAVELENGTHS TOWARD GENERATOR
WAVELENGTHS TOWARD LOAD
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
INDUCTIVE REACTANCE COMPONENT (+jX/Zo)
OR CAPACITIVE SUSCEPTANCE (+jB/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo) OR INDUCTIVE SUSCEPTANCE (-jB/Yo)
RADIALLY SCALED PARAMETERS
SWR (VSWR)
SWR (dB)
SWR = 4.9
$|\Gamma| = 0.66$
REFL. COEFF. V or I
REFL. COEFF. P
CENTER

EE 381 Electric and Magnetic Fields Quiz #3 (Fall 2024)

Name __KEY B__

Instructions: Closed book & notes. Place answers in indicated spaces and show all work for credit.

A lossless transmission line (200 Ω, 2.4×10^8 m/s) of length 92 cm has a measured input reflection coefficient of 0.76∠-126° at 2 GHz. Calculate the wavelength. Then, using a Smith chart, find the input admittance & impedance, load reflection coefficient, load impedance, and standing wave ratio (SWR) along the transmission line. **Show** and **clearly label** all work on the Smith chart (this will be graded).



- Wavelength $\lambda = u/f = 2.4\times10^8/2\times10^9 \Rightarrow$ **$\lambda = 0.12$ m = 12 cm**.

Steps

1) Plot $\Gamma_{in} = 0.76\angle$-126° by drawing circle, centered on Smith chart, of radius 0.76 (use "REFL. COEFF, V or I" scale at bottom of Smith chart) and radial line from center of Smith chart to -126° on "ANGLE OF REFLECTION COEFFICIENT" scale.
2) Read normalized input impedance $z_{in} = 0.17 - j\ 0.5$ Ω/Ω. Compute the input impedance $Z_{in} = Z_0\ z_{in} = 200\ (0.17 - j\ 0.5) \Rightarrow$ **$Z_{in} = 34 - j\ 100$ Ω**.
3) Draw arc of radius 0.76 on "SWR (VSWR)" scale. Read **SWR = 7.3**.
4) To find the normalized input admittance, go 180° around $\Gamma = 0.76$ circle and draw a radial line. Read $y_{in} = 0.62 + j\ 1.8$ S/S off Smith chart. Compute the input admittance $Y_{in} = y_{in}/Z_0 = (0.62 + j\ 1.8)/200 \Rightarrow$ **$Y_{in} = 3.1 + j\ 9$ mS**.
5) To get to the load point, we must go $\ell/\lambda = 92/12 = 7.6667 \Rightarrow 0.16667$ in the "WAVELENGTHS TOWARD LOAD" direction (0.075 + 0.1666 = 0.2417) along the $\Gamma = 0.66$ circle from z_{in}/Γ_{in} point.
6) Read the normalized load impedance $z_L = 6.4 - j\ 2.4$ Ω/Ω. Compute the load impedance $Z_L = Z_0\ z_{in} = 200\ (6.4 - j\ 2.4) \Rightarrow$ **$Z_L = 1280 - j\ 480$ Ω**.
7) Read $\angle\Gamma_L = -6°$ on "ANGLE OF REFLECTION COEFFICIENT" scale. Already know that $\Gamma = 0.76$ on a lossless transmission line $\Rightarrow$ **$\Gamma_L = 0.76\angle$-6°**.

wavelength = **$\lambda = 0.12$ m = 12 cm**

Y_{in} = **$3.1 + j\ 9$ mS** Z_{in} = **$34 - j\ 100$ Ω**

load refl. coeff. = **$\Gamma_L = 0.76\angle$-6°** Z_L = **$1280 - j\ 480$ Ω** SWR = **7.3**

Simple Smith Chart

$Z_0 = 200\ \Omega$

$\lambda = 12$ cm