EE 481/581 Microwave Engineering
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 92 cm has a measured input reflection coefficient of 0.66∠106° at 2.5 GHz. Calculate the wavelength. Then, using a Smith chart, find the input admittance & impedance, load reflection coefficient, load impedance, standing wave ratio (SWR), return loss (RL), and maximum & minimum impedances along the transmission line. **Show** and **clearly label** all work on the Smith chart (this will be graded).

$\lambda = v_p/f = \frac{2\times10^8}{2.5\times10^9} = 0.08\,m, \quad \frac{\ell}{\lambda} = \frac{92}{8} = 11.5$ ← Integer multiple of λ/2!

→ Plot $\Gamma_{in} = 0.66\angle 106° = \Gamma_L$ on Smith chart

→ Read $z_{in} = z_L = 0.31 + j0.71$ Ω/Ω

$Z_{in} = Z_L = 200(0.31 + j0.71) = 62 + j142\ \Omega$

→ Mark SWR & RL scales w/ compass

SWR = 4.9 & RL = 3.6 dB

→ Draw $|\Gamma| = 0.66$ circle on Smith Chart

read $r_{max} = 4.9 \Rightarrow Z_{max} = 4.9(200) = 980\Omega$

read $r_{min} = 0.21 \Rightarrow Z_{min} = 0.21(200) = 42\Omega$

→ Go 180° around circle to y_{in} point

read $y_{in} = 0.53 - j1.18$ S/S

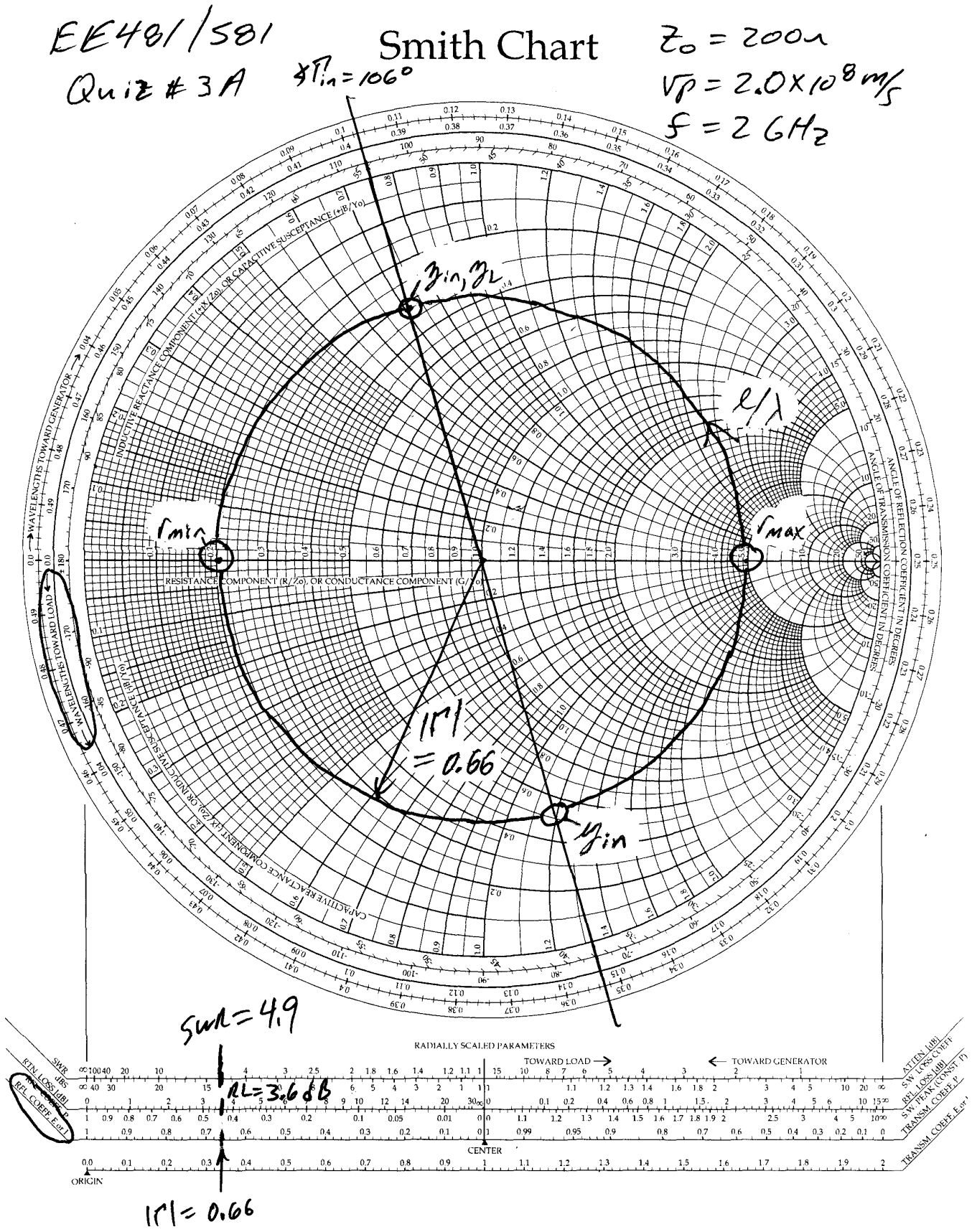
$Y_{in} = \frac{y_{in}}{Z_0} = \frac{0.53 - j1.18}{200} = 2.65 - j5.9\ mS$

wavelength = λ = **8 cm**

Y_{in} = **2.65 – *j* 5.9 mS** Z_{in} = **62 + *j* 142 Ω**

load refl. coeff. = **0.66∠106°** Z_L = **62 + *j* 142 Ω** SWR = **4.9**

RL = **3.6 dB** max. impedance = **980 Ω** min. impedance = **42 Ω**


EE481/581
Quiz #3A
Smith Chart
$Z_0 = 200\Omega$
$V_p = 2.0 \times 10^8$ m/s
$f = 2$ GHz
$\angle\Gamma_{in} = 106°$
z_{in}, z_L
y_{in}
ℓ/λ
r_{min}
r_{max}
$|\Gamma| = 0.66$
SWR = 4.9
RL = 3.6 dB
$|\Gamma| = 0.66$
RESISTANCE COMPONENT (R/Zo), OR CONDUCTANCE COMPONENT (G/Yo)
INDUCTIVE REACTANCE COMPONENT (+jX/Zo), OR CAPACITIVE SUSCEPTANCE (+jB/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo), OR INDUCTIVE SUSCEPTANCE (-jB/Yo)
WAVELENGTHS TOWARD GENERATOR
WAVELENGTHS TOWARD LOAD
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES
RADIALLY SCALED PARAMETERS
TOWARD LOAD →
← TOWARD GENERATOR
SWR
dBS
RTN. LOSS (dB)
REFL. COEFF. E or I
ATTEN. (dB)
SW. LOSS COEFF.
SW. LOSS (dB)
REFL. COEFF. P
SW. PEAK (CONST. P)
TRANSM. COEFF. E or I
CENTER
ORIGIN

EE 481/581 Microwave Engineering
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, standing wave ratio (SWR), return loss (RL), and maximum & minimum impedances along the transmission line. **Show** and **clearly label** all work on the Smith chart (this will be graded).

→ $\lambda = v_p/f = \frac{2.4\times10^8}{2\times10^9} = \underline{0.12\,m}$, $\frac{\ell}{\lambda} = \frac{92}{12} = 7.\overline{6} \to 0.1\overline{66}$

→ Plot $\Gamma_{in} = 0.76\angle{-126°}$ on Smith chart

→ Read $z_{in} = 0.17 - j0.5\ \Omega/\Omega \Rightarrow Z_{in} = 200(0.17 - j0.5) = \underline{34 - j100\,\Omega}$

→ Set compass & draw circle through z_{in}/Γ_{in} point

→ Read $z_{max} = r_{max} = \underline{SWR = 7.3}$, $Z_{max} = 200(7.3) = \underline{1460\,\Omega}$

→ Read $r_{min} = z_{min} = 0.14\ \frac{\Omega}{\Omega}$, $Z_{min} = 0.14(200) = \underline{28\,\Omega}$

→ Use compass on RL scale ⇒ $\underline{RL = 2.4\,dB}$

→ Draw radial line thru circle 180° around and read
$y_{in} = 0.62 + j1.8\ S/S$, $Y_{in} = \frac{y_{in}}{Z_0} = \frac{0.62 + j1.8}{200} = \underline{3.1 + j9\,mS}$

→ Move $0.1\overline{66}$ 'WAVELENGTHS TOWARD LOAD' from z_{in}/Γ_{in}

→ Read $z_L = 6.4 - j2.4\ \frac{\Omega}{\Omega}$, $Z_L = 200(6.4 - j2.4) = \underline{1280 - j480\,\Omega}$

→ Read $\underline{\Gamma_L = 0.76\angle{-6°}}$

wavelength = λ = **12 cm**

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

load refl. coeff. = **0.76∠-6°** Z_L = **1280 - *j* 480 Ω** SWR = **7.3**

RL = **2.4 dB** max. impedance = **1460 Ω** min. impedance = **28 Ω**

EE 481/581
Quiz #3B

Smith Chart

$Z_0 = 200\Omega$
$V_p = 2.4 \times 10^8$ m/s
$f = 2$ GHz