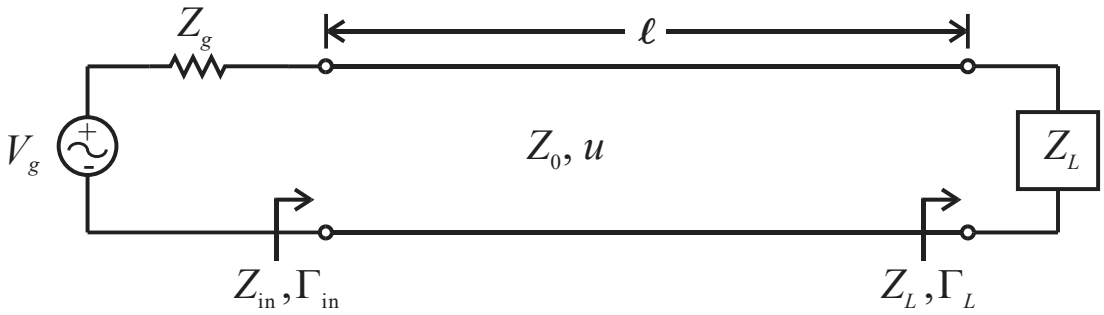
EE 381 Electric and Magnetic Fields Quiz #3 (Fall 2025)

Name KEY A

Instructions: Closed book & notes. Show all work for credit. Clearly label all points/work on Smith chart. Put reflection coefficients in polar format w/ angles in degrees. Express impedances in rectangular format.

Consider a lossless transmission line circuit where $Z_0 = 80\,\Omega$, $f = 400$ MHz, $u = 2.2 \times 10^8$ m/s, $\ell = 69.47$ cm, and the **input** impedance is measured to be $48 - j88\ \Omega$. Using a **Smith Chart, compass, & straight edge**, find the input & load reflection coefficients, load impedance, and SWR.



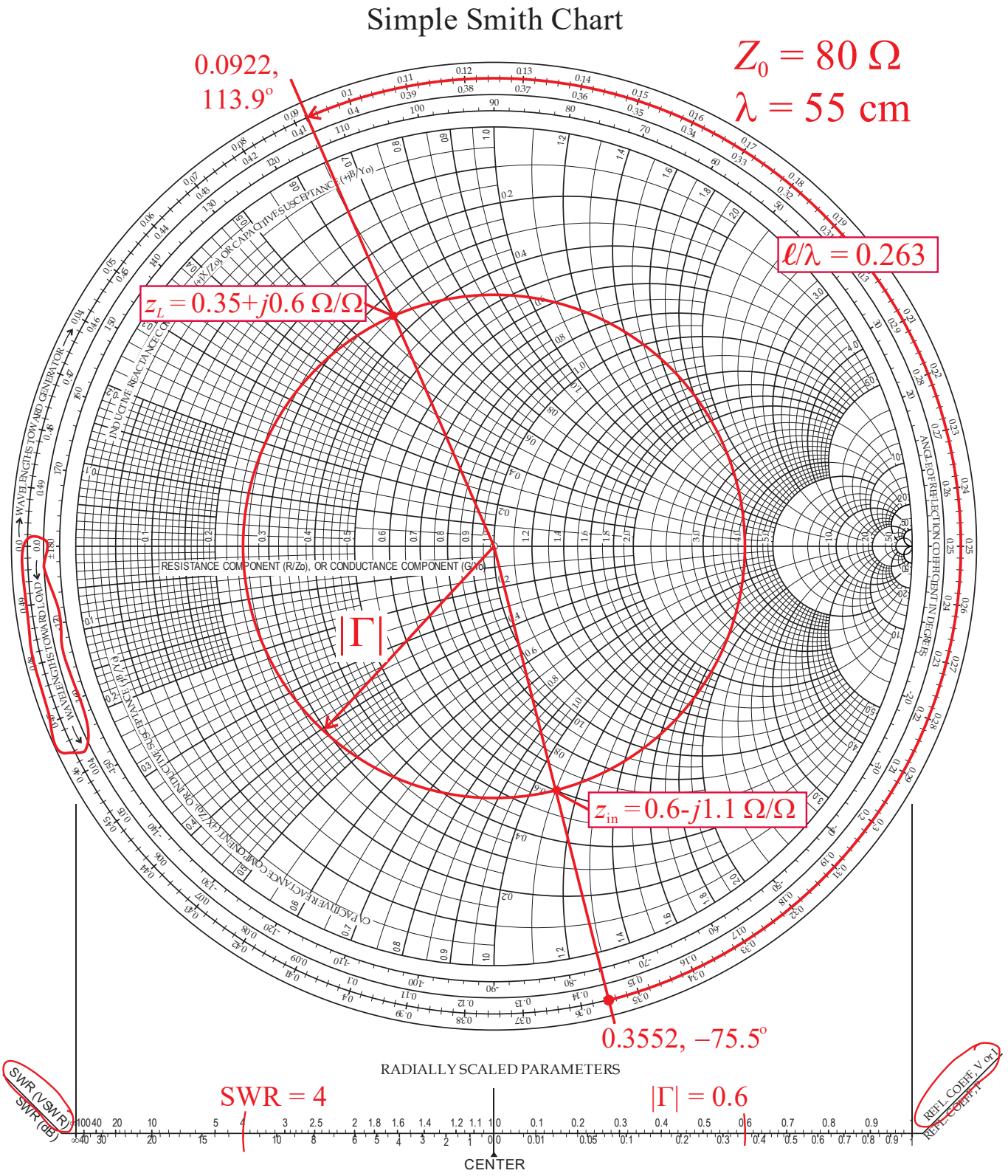
- Normalize $z_{in} = Z_{in} / Z_0 = (48 - j\,88) / 80 \Rightarrow$ **$z_{in} = 0.6 - j\,1.1\ \Omega/\Omega$.**
- Plot z_{in} on Smith chart by finding intersection of $r = 0.6$ circle with $x = -1.1$ arc.
- Set compass to distance from center of Smith chart to z_{in} point. Draw circle, centered on Smith Chart, through z_{in} point.
- Use compass to make marks on 'RFL COEFF, E or I' and 'SWR' scales. Read off **$|\Gamma| = 0.6$** and **SWR = 4**.
- Use straightedge to draw radial line through z_{in} from center of Smith chart. Use "ANGLE OF REFLECTION COEFFICIENT IN DEGREES" scale to read **$\angle\Gamma_{in} = -75.5°$**. Put magnitude & angle together to get input reflection coefficient **$\Gamma_{in} = 0.6\angle -75.5°$.**
- Calculate wavelength to be $\lambda = u / f = 2.2 \times 10^8 / 400 \times 10^6 = 0.55$ m = 55 cm. The TL length in wavelengths is $\ell/\lambda = 69.47 / 55 = 1.263$. Subtract $2(0.5) = 1$ (i.e., remove integer multiples of $n\lambda/2$) to get **$\ell/\lambda = 0.263$**.
- Move **$\ell/\lambda = 0.263$** in the "WAVELENTHS TOWARD LOAD" direction on arc of constant $|\Gamma|$ from input point (0.3552) to load point (0.3552 - 0.263 = 0.0922) and draw radial line from center of Smith chart. The intersection of line & circle is location of z_L.
- At load point, read **$\angle\Gamma_L = 113.9°$** on "ANGLE OF REFLECTION COEFFICIENT IN DEGREES" scale and **$z_L = 0.35 + j\,0.6\ \Omega/\Omega$**. The load reflection coefficient is then **$\Gamma_L = 0.6\angle 113.9°$** and load impedance is $Z_L = z_L Z_0 = (0.35 + j\,0.6)\,80 \Rightarrow$ **$Z_L = 28 + j\,48\ \Omega$**.

input refl. coeff. = **$\Gamma_{in} = 0.6\angle -75.5°$** load refl. coeff. = **$\Gamma_L = 0.6\angle 113.9°$**

load impedance = **$Z_L = 28 + j\,48\ \Omega$** SWR = **4**

Exact answers- input refl. coeff. = $\Gamma_{in} = 0.603\angle -75.475°$ load refl. coeff. = $\Gamma_L = 0.603\angle 113.95°$

load impedance = $Z_L = 27.49 + j\,47.57\ \Omega$ SWR = 4.036

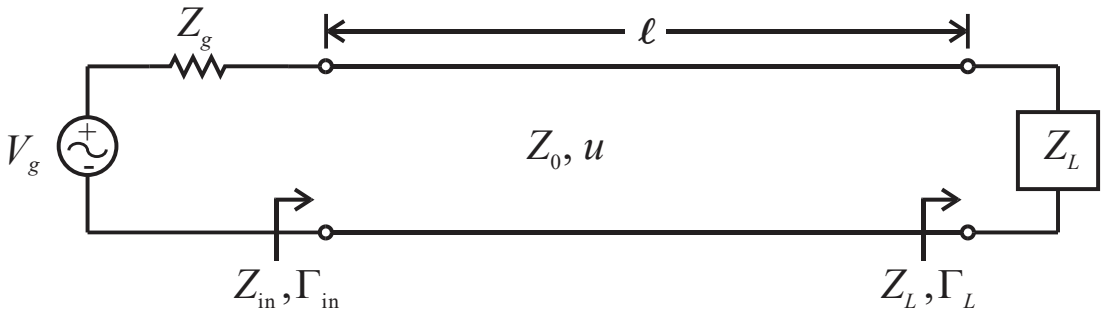


EE 381 Electric and Magnetic Fields Quiz #3 (Fall 2025)

Name KEY B

Instructions: Closed book & notes. Show all work for credit. Clearly label all points/work on Smith chart. Put reflection coefficients in polar format w/ angles in degrees. Express impedances in rectangular format.

Consider a lossless transmission line circuit where $Z_0 = 60\,\Omega$, $f = 500$ MHz, $u = 2.4 \times 10^8$ m/s, $\ell = 53.26$ cm, and the **input** impedance is measured to be $54 + j102\ \Omega$. Using a **Smith Chart, compass, & straight edge**, find the input & load reflection coefficients, load impedance, and SWR.



- Normalize $z_{in} = Z_{in} / Z_0 = (54 + j\,102)/60 \Rightarrow$ **$z_{in} = 0.9 + j\,1.7\ \Omega/\Omega$.**
- Plot z_{in} on Smith chart by finding intersection of $r = 0.9$ circle with $x = 1.7$ arc.
- Set compass to distance from center of Smith chart to z_{in} point. Draw circle, centered on Smith Chart, through z_{in} point.
- Use compass to make marks on 'RFL COEFF, E or I' and 'SWR' scales. Read off **$|\Gamma| = 0.67$** and **SWR = 5**.
- Use straightedge to draw radial line through z_{in} from center of Smith chart. Use "ANGLE OF REFLECTION COEFFICIENT IN DEGREES" scale to read **$\angle\Gamma_{in} = 51.6°$**. Put magnitude & angle together to get input reflection coefficient **$\Gamma_{in} = 0.67\angle 51.6°$.**
- Calculate wavelength to be $\lambda = u / f = 2.4 \times 10^8 / 500 \times 10^6 = 0.48$ m = 48 cm. The TL length in wavelengths is $\ell/\lambda = 53.26 / 48 = 1.11$. Subtract $2(0.5) = 1$ (i.e., remove integer multiples of $n\lambda/2$) to get **$\ell/\lambda = 0.11$**.
- Move **$\ell/\lambda = 0.263$** in the "WAVELENTHS TOWARD LOAD" direction on arc of constant $|\Gamma|$ from input point (0.1782) to load point (0.1782 - 0.11 = 0.0682) and draw radial line from center of Smith chart. The intersection of line & circle is location of z_L.
- At load point, read **$\angle\Gamma_L = 130.6°$** on "ANGLE OF REFLECTION COEFFICIENT IN DEGREES" scale & **$z_L = 0.24 + j\,0.44\ \Omega/\Omega$**. The load reflection coefficient is then **$\Gamma_L = 0.67\angle 130.6°$** & load impedance is $Z_L = z_L Z_0 = (0.24 + j0.44)60 \Rightarrow$ **$Z_L = 14.4 + j26.4\,\Omega$**.

input refl. coeff. = **$\Gamma_{in} = 0.67\angle 51.6°$** load refl. coeff. = **$\Gamma_L = 0.67\angle 130.6°$**

load impedance = **$Z_L = 14.4 + j\,26.4\ \Omega$** SWR = **5**

Exact answers- input refl. coeff. = $\Gamma_{in} = 0.668\angle 51.55°$ load refl. coeff. = $\Gamma_L = 0.668\angle 130.45°$

load impedance = $Z_L = 14.37 + j\,26.37\ \Omega$ SWR = 5.023