EE 481/581 Microwave Engineering
Quiz #2 (Fall 2025)

Name **KEY A**

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

A lossless transmission line (35 Ω, 2.2×10^8 m/s) is 0.64λ long at 1.6 GHz. First, find the phase constant and length ℓ (cm) of the line. If the line is terminated with a load of $70 + j30$ Ω, determine the SWR, load reflection coefficient (polar format w/ angle in degrees), and input impedance (rectangular format).

Per (2.16), $v_p = \dfrac{\omega}{\beta} \Rightarrow \beta = \dfrac{\omega}{v_p} = \dfrac{2\pi(1.6\times10^9)}{2.2\times10^8}$ ⇒ **β = 45.695893 rad/m.**

Per (2.15), $\lambda = \dfrac{2\pi}{\beta} = \dfrac{2\pi}{45.695893} = 0.1375$ m.

Therefore, the TL length is $\ell = 0.64\lambda = 0.64(13.75 \text{ cm})$ ⇒ **ℓ = 8.8 cm.**

Per (2.35), $\Gamma = \Gamma_L = \dfrac{Z_L - Z_0}{Z_L + Z_0} = \dfrac{(70 + j30) - 35}{(70 + j30) + 35}$ ⇒ **$\Gamma_L = 0.422134\angle 24.6559°$.**

Per (2.41), $\text{SWR} = \dfrac{1+|\Gamma|}{1-|\Gamma|} = \dfrac{1+0.422134}{1-0.422134}$ ⇒ **SWR = 2.461.**

Per (2.44), $Z_{in} = Z_0 \dfrac{Z_L + jZ_0 \tan(\beta\ell)}{Z_0 + jZ_L \tan(\beta\ell)} = 35\dfrac{(70 + j30) + j35\tan(2\pi 0.64)}{35 + j(70 + j30)\tan(2\pi 0.64)}$

⇒ **Z_{in} = 29.47006 - j29.39467 Ω.**

phase constant = **β = 45.696 rad/m** ℓ = **8.8 cm** SWR = **2.461**

load refl. coeff. = **$\Gamma_L = 0.4221\angle 24.656°$** input imp. = **$Z_{in}$ = 29.47 - j29.395 Ω**

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Name **KEY B**

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

A lossless transmission line (65 Ω, 2.4×10^8 m/s) is 0.68λ long at 1.4 GHz. First, find the phase constant and length ℓ (cm) of the line. If the line is terminated with a load of $30 + j70$ Ω, determine the SWR, load reflection coefficient (polar format w/ angle in degrees), and input impedance (rectangular format).

Per (2.16), $v_p = \dfrac{\omega}{\beta} \Rightarrow \beta = \dfrac{\omega}{v_p} = \dfrac{2\pi(1.4\times10^9)}{2.4\times10^8} \Rightarrow$ **β = 36.65191 rad/m.**

Per (2.15), $\lambda = \dfrac{2\pi}{\beta} = \dfrac{2\pi}{36.65191} = 0.171429 \text{ m} = 17.1429 \text{ cm}$.

Therefore, the TL length is $\ell = 0.68\lambda = 0.68(17.1429 \text{ cm}) \Rightarrow$ **ℓ = 11.6571 cm.**

Per (2.35), $\Gamma = \Gamma_L = \dfrac{Z_L - Z_0}{Z_L + Z_0} = \dfrac{(30 + j70) - 65}{(30 + j70) + 65} \Rightarrow$ **$\Gamma_L = 0.663217\angle 80.1807°$.**

Per (2.41), $\text{SWR} = \dfrac{1+|\Gamma|}{1-|\Gamma|} = \dfrac{1+0.663217}{1-0.663217} \Rightarrow$ **SWR = 4.9385.**

Per (2.44), $Z_{\text{in}} = Z_0 \dfrac{Z_L + jZ_0\tan(\beta\ell)}{Z_0 + jZ_L\tan(\beta\ell)} = 65\dfrac{(30 + j70) + j65\tan(2\pi 0.68)}{65 + j(30 + j70)\tan(2\pi 0.68)}$

$\Rightarrow$ **Z_{in} = 63.1025 – j113.4893 Ω.**

phase constant = **β = 36.652 rad/m** ℓ = **11.657 cm** SWR = **4.9385**

load refl. coeff. = **$\Gamma_L = 0.6632\angle 80.181°$** input imp. = **$Z_{in}$ = 63.103 – j113.489 Ω**