HA # 5

In this assignment, you will design and test **three** matching networks:

a) A Quarter-wave transformer
b) A 4-section Binomial transformer
c) A 4-section Chebychev transformer

Assignment Scope

In this design, you will attempt to match a real load of $R_L = 20\Omega$ to a transmission line with a 50Ω characteristic impedance at a frequency of 6.0 GHz.

The **bandwidth** of the 4-section transformers is defined by $\Gamma_m = 0.1.1$. Assume TEM wave propagation in the transmission lines, and the transmission line dielectric constant is ε_r = 9.0.

Assignment Tasks

1) **Design** each of the three matching networks, determining both the **characteristic impedance** and **physical length** (in cm) of each section.
2) Use the design equations in your notes/book to **determine** the **expected bandwidth** for each design.
3) **Implement** each design on **ADS** software. **Analyze** the circuit by evaluating $\Gamma_{in}(\omega)$ from **0 to 12 GHz**. **Display** the results as (make sure you use **enough frequency points—at least 100—**in the analysis!):
   a. Smith Chart plot of $\Gamma_{in}(\omega)$. Note this is a **parametric** plot of reflection coefficient in Γ as a function of **frequency**—not as a function position (i.e., **not** $\Gamma(z)$!).
   b. Cartesian plot of $\Gamma_{in}(\omega)$ (i.e., **linear** scale) versus frequency, with a vertical scale from 0 to 1.0.

Q1: Do the plots indicate that your designs are correct? **Explain why** you think so. **Give** specific **numerical** examples!

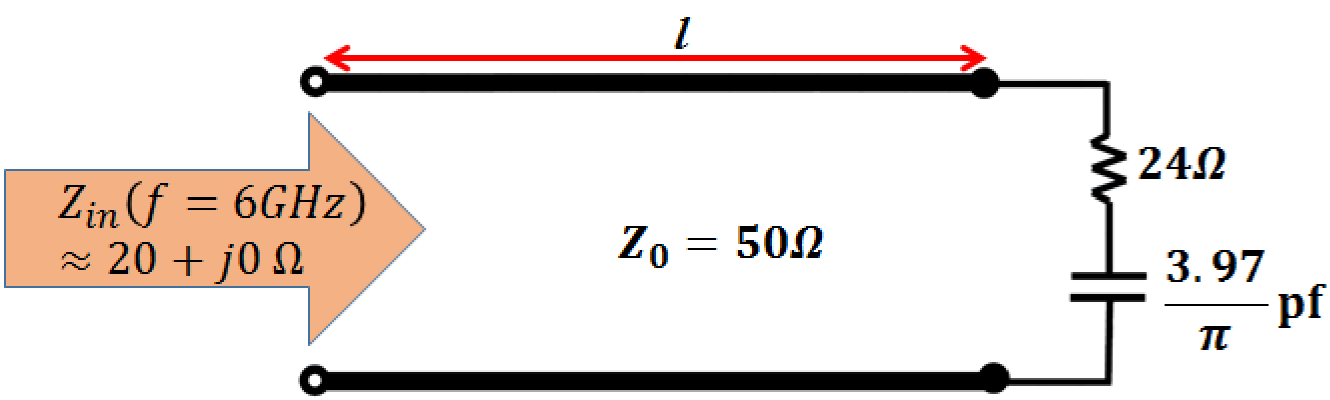
Q2: **Observe** the parametric plot $\Gamma_{in}(\omega)$ on the Smith Chart. Use the adjustable markers to **determine** at what **frequencies** the curve is **far** from the center of the chart, and at what **frequencies** the curve is **near** the center. Use your knowledge of the Smith Chart and matching networks to **explain why** this result makes sense.

Q3: Likewise **precisely determine** the **specific frequencies** at which the parametric Smith Chart plot of $\Gamma_{in}(\omega)$ is **precisely** at the center of the chart (i.e., the curve intersects the center point). **Explain why** this result makes sense. **Locate** these **same** specific frequencies on the **Cartesian** plot. **What** is the **values** of $\Gamma_{in}(\omega)$ at these frequencies? **Explain why** this result makes sense.

4) Use the adjustable **markers** on the plots to **determine** the **bandwidth** of each design, using the criterion $\Gamma_m = 0.1.$.

Q4: You will find that the bandwidths of your design will not be exactly the bandwidths predicted by the design equations. Explain why that is. Hint: It is not because "ADS has errors"!

5) You will find that at f = 6 GHz , the following device has an input impedance of approximately $Z_{in} \approx 20 + j0\ \Omega$ if the length l is properly determined:



6) Determine the proper value for line length l. Now replace the 20 Ω resistor with this 20 Ω "load" shown above, and reanalyze (with ADS) each matching transformer design.

7) **Display** the results of this new load on the same two plots (with the same scale!) as described in step 3.

Q5: **Compare** and **contrast** these results with the 20 Ohm resistor plots. **How** are the results different? **Determine** the **specific** frequencies where the value of $\Gamma_{in}(\omega)$ is **precisely** the same for the two cases. **Explain why** this is true.