**ECE 6416 Design Project Homework 1**

An RF amplifier designed to operate at a frequency of 2.5 GHz has the following noise parameters:

| Frequency | $NF_{min}$ | $\lvert\Gamma_{opt}\rvert$ | $\angle\Gamma_{opt}$ | $R_n$ |
|---|---|---|---|---|
| 2.5 GHz | 1.82 dB | 0.38 | 94.1° | 15 Ω |

| $\lvert s_{11}\rvert$ | $\angle s_{11}$ | $\lvert s_{21}\rvert$ | $\angle s_{21}$ | $\lvert s_{12}\rvert$ | $\angle s_{12}$ | $\lvert s_{22}\rvert$ | $\angle s_{22}$ |
|---|---|---|---|---|---|---|---|
| 0.63 | −117° | 6.4 | −97° | 0.011 | −144° | 0.21 | 66° |

The characteristic impedance of the transmission lines used to measure the parameter is $Z_c = 50\,\Omega$.

1. (a) Design a two transmission line noise matching network to match a 50 Ω source to the input to the amplifier. Assume that each transmission line has a characteristic impedance $Z_c = 75\,\Omega$.

   (b) Calculate the dB decrease of the operating gain $G_P$ with the noise matching network compared to the operating gain which would be obtained with a conjugate matching network between the source and the amplifier. Note that $\Gamma_{in}$ in the equation for $G_p$ is the reflection coefficient looking into the matching network.

   (c) Use a math program such as Matlab or Mathcad to calculate and plot the noise figure $NF$ as a function of frequency over the band 2.5 GHz ± 10%.

2. Repeat problem (1) for a noise matching network consisting of a series capacitor $C_1$ and a shunt inductor $L_1$.

3. Repeat problem (1) for a noise matching network consisting of a series inductor $L_2$ and a shunt capacitor $C_2$.

4. Which network results in the lowest $NF$ over the band about 2.5 GHz?