UNIVERSITY OF UTAH
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

ECE 5320/6322 **Problems 10-12** Fall 2014

10. The S-matrix of a three-port circuit is given as follows:

$$S = \begin{bmatrix} 0.4 & 0.25j & 0.5 \\ 0.25j & 0.2 & 0.6j \\ 0.5 & 0.6j & 0.2 \end{bmatrix}$$

a. Is it a reciprocal circuit? Give reasons.

b. Is it a lossless circuit? Give reasons.

c. Draw the signal flow graph of the circuit.

d. Calculate the reflection coefficient at port 1 if ports 2 and 3 are connected to loads that are mismatched each with a reflection coefficient of 0.4.

e. Calculate the insertion loss between ports 1 and 2 for the above circuit with mismatched loads connected as in part d.

f. Calculate the power delivered to the load at port 3 as a fraction of the power input to port 1.

11. Following Example 11.1 on p. 539 of the text, calculate the power gains of a microwave amplifier using a transistor (e.g., Fujitsu FHX04FA/LG) with S-parameters at 10 GHz as follows:

$$S_{11} = 0.653\angle -160^\circ; \qquad S_{12} = 0.1\angle -4^\circ$$
$$S_{21} = 3.2\angle 20^\circ; \qquad S_{22} = 0.552\angle -126^\circ$$

a. Calculate the power gain of the amplifier using Eq. 11.8 for $\Gamma_L = 0$.

b. Using Eq. 11.12, the available power gain input and output circuits are approximately conjugate-matched, i.e.

$$\Gamma_s \simeq S_{11}^* \quad \text{and} \quad \Gamma_L \simeq S_{22}^*$$

c. The transducer power gain from Eq. 11.13 when input and output circuits are approximately conjugate matched, i.e.

$$\Gamma_s \simeq S_{11}^* \quad \text{and} \quad \Gamma_L \simeq S_{22}^*$$

d. Using Eq. 11.14, the transducer power gain when both the input and output are matched for zero reflection coefficient $\Gamma_L = \Gamma_s = 0$ (in contrast to conjugate matching).

e. Which of the above gains are the highest?

12. The ABCD parameters of the first entry in Table 4.1 of the Text were derived in Example 4.6. Verify the ABCD parameters of the fifth and sixth entries of Table 4.1.