The University Of Sheffield.

Data Provided: Smith Chart (4 copies)

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2006-2007 (2 hours)

High Speed Electronic Circuit Design 6

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. **a.** List, with the aid of diagrams, three types of transmission lines used to carry RF or microwave signals. List typical applications of each type. **(4)**

b. Explain briefly the difference between a lumped and distributed representation of a circuit element. **(4)**

c. A load impedance of Z_L=80+j20Ω is to be matched to a 100Ω source using a lossless transmission line of characteristic impedance Z_o and length ℓ. Find the required Z_o (real) and ℓ. **(6)**

d. A load impedance of Z_L=75-j50Ω is connected to a lossless transmission line with a 30cm length and Z_o=50Ω at a frequency of 500MHz. Find the input impedance, the impedance and the reflection coefficient at 10cm away from the load. **(6)**

2. **a.** Explain briefly how to calculate reflections on a lossy transmission line using the Smith chart. **(4)**

b. An unknown load impedance is connected to a 0.1λ long 50Ω lossless transmission line. The VSWR and phase of the reflection coefficient measured at the input of the line are 4 and -20° respectively. Determine the input and load impedances by using the Smith Chart. **(6)**

c. For a transmission line with Z_o=50Ω and terminated by Z_L=180+j40Ω, design a double stub matching network to match Z_L to Z_o. The 1st stub is located at the load, and the two stubs are separated by a distance of 0.125λ. The length of each stub should be $\leq 0.25\lambda$. **(10)**

3. **a.** Explain briefly what Signal Flow Diagrams analysis are used to represent, and what are the two basic components of any SFD. **(4)**

b. Find the S parameters for the series and shunt loads shown in Figure 1. Show that $S_{12}+S_{11}=1$ for the series case and $S_{12}-S_{11}=1$ for the shunt case. Assume a characteristic impedance of Z_o in both cases

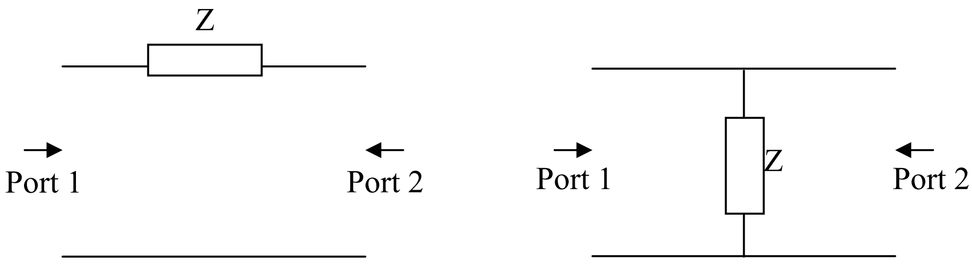

Figure 1 **(8)**

c. Find the transmission, ABCD, parameters for the network shown in Figure 2

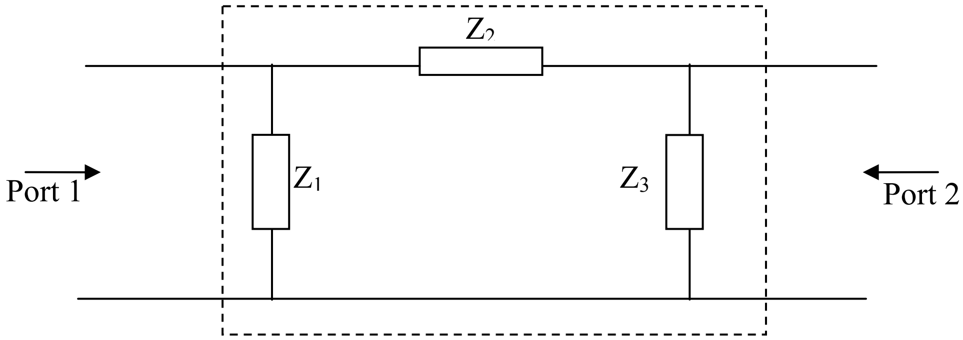

Figure 2

(8)

4. a. Explain why sometimes it is preferable to design an amplifier for less than the maximum obtainable gain? How this can be achieved? **(4)**

b. An amplifier is characterised by the following S-parameters: $S_{11}=0.78\angle-65^\circ$, $S_{21}=2.2\angle78^\circ$, $S_{12}=0.11\angle-21^\circ$, $S_{22}=0.9\angle-29^\circ$. The input side of the amplifier is connected to a source impedance of $Z_s=80\Omega$. The output side is connected to a load of $Z_L=90\Omega$. Assuming that the S parameters are measured with reference to a characteristic impedance of $Z_o=50\Omega$. Determine the stability and the power gains of this amplifier. **(8)**

c. An amplifier has the following scattering and noise parameters

F GHz	S_{11}	S_{21}	S_{12}	S_{22}
6.0	$0.6\angle-60^\circ$	$2.0\angle81^\circ$	0	$0.7\angle-60^\circ$

$Z_o=50\Omega$ $R_N=20\Omega$ $NF_{min}=2dB$ $\Gamma_{opt}=0.62\angle100^\circ$

Design an amplifier having a 2.5dB noise figure with the maximum gain that is compatible with this noise figure. **(8)**

You may find the following information useful:

The constant gain and noise figure circles can be plotted using the following set of equations

$$C_S = \frac{g_S S_{11}^*}{1 - (1 - g_S)|S_{11}|^2}$$

$$r_S = \frac{\sqrt{1 - g_S}\,(1 - |S_{11}|^2)}{1 - (1 - g_S)|S_{11}|^2}$$

$$C_L = \frac{g_L S_{22}^*}{1 - (1 - g_L)|S_{22}|^2}$$

$$r_L = \frac{\sqrt{1 - g_L}\,(1 - |S_{22}|^2)}{1 - (1 - g_L)|S_{22}|^2}$$

$$C_{NF} = \frac{\Gamma_{opt}}{(N + 1)}$$

$$r_{NF} = \frac{\sqrt{N(N + 1 - |\Gamma_{opt}|^2)}}{(N + 1)}$$

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