Data Provided: Smith Chart (4 copies)

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2008-2009 (2 hours)

High Speed 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.** Explain briefly what is meant by a conjugate impedance matching. **(3)**

b. A lossless transmission line with an electrical length of 0.15λ and a real characteristic impedance of 50Ω is terminated with complex load impedance of 70-j30Ω. Find the reflection coefficient at the load, the VSWR on the line and the input impedance. **(4)**

c. Consider a lossless transmission line which has a characteristic impedance of Z_o and terminated by a load impedance of Z_L. Show that the voltage reflection coefficient at the load is given by $\Gamma = (Z_L - Z_o)/(Z_L + Z_o)$. **(7)**

d. A lossless quarter wavelength transformer with Z_o=100Ω is terminated by a load impedance of Z_L=210Ω. Calculate the impedance and voltage at the sending end when the voltage at the receiving end is 80V. **(6)**

2. **a.** Explain briefly how the Smith chart can be used to solve transmission line problems. **(4)**

b. A lossy line with attenuation of 15 dB/m at 300 MHz, is terminated by a load with a normalized impedance of z=2.5+j0. Use the Smith chart to find the VSWR at a distance of 20cm from the load. **(6)**

c. For a transmission line with Z_o=50Ω and terminated by Z_L=110+j50Ω, 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 $\leq$ 0.25λ. **(10)**

Note: Find one possible solution for each design.

3. **a.** List and explain briefly the decomposition rules of a signal flow diagram (SFD). **(4)**

b. Find the transmission, ABCD, parameters of the transmission line shown in Figure 1

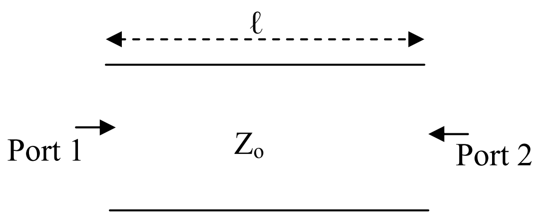

Figure 1 **(8)**

c. Calculate the scattering parameters of the two-port network shown in Figure 2. Assume the characteristic impedances for the input and output ports are equal (Z_{o1}=Z_{o2}).

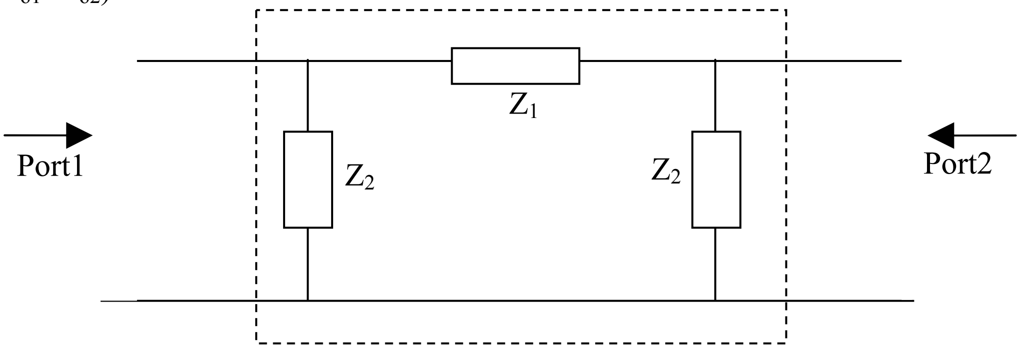

Figure 2 **(8)**

4. **a.** Explain with the aid of diagrams what is meant by the unconditional stability of an amplifier. **(4)**

b. An amplifier has the following S-parameters: $S_{11} = 0.7\angle\text{-}70°$, $S_{21} = 5.5\angle 85°$, $S_{12} = 0.2\angle\text{-}10°$,, $S_{22} = 0.7\angle\text{-}45°$. Determine the stability of this transistor and plot the corresponding stability circles. **(8)**

c. Design an amplifier for maximum gain at 4.0 GHz. Use a GaAs FET with the following parameters (Z_o=50Ω): $S_{11} = 0.72\angle\text{-}116°$, $S_{21} = 2.6\angle 76°$, $S_{12} = 0.03\angle 57°$, $S_{22} = 0.73\angle\text{-}54°$. **(8)**

You may find the following information useful:

The equations of input and output stability circles are

$$r_{in} = \left| \frac{S_{12}S_{21}}{|S_{11}|^2 - |\Delta|^2} \right|$$

$$C_{in} = \frac{\left(S_{11} - \Delta S_{22}^*\right)^*}{|S_{11}|^2 - |\Delta|^2}$$

$$r_{out} = \left| \frac{S_{12}S_{21}}{|S_{22}|^2 - |\Delta|^2} \right|$$

$$C_{out} = \frac{\left(S_{22} - \Delta S_{11}^*\right)^*}{|S_{22}|^2 - |\Delta|^2}$$

SKK/AT