Data Provided: Smith Chart (4 copies)

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2007-2008 (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. Explain briefly the difference between return and insertion losses. **(2)**

b. Explain with the aid of diagrams what is meant by a quarter wavelength transformer. **(4)**

c. A lossless coaxial transmission line with a length of 3cm and a characteristic impedance of 50Ω is terminated with a complex load impedance of 50+j80Ω at a frequency of 3GHz. Find the reflection coefficient at the load, the input impedance, the return loss and insertion loss of the line. **(6)**

d. Consider a 50Ω lossless transmission line with a VSWR of 3 and a load impedance of Z_L. The distance between successive minima has been measured as 2.1cm and the distance of the first voltage minimum from the load is 0.9cm. Find the load impedance. **(8)**

2. a. Explain briefly how the Smith chart can be used for admittance transformation. **(4)**

b. Design a double stub matching network to match a load impedance of Z_L=150+j30Ω to a transmission line with a characteristic impedance of Z_o=50Ω. The 1^{st} 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 ≤ 0.25λ. **(8)**

c. Repeat (2.b) when the first stub is located at a distance of 0.1λ from the load. **(8)**

Note: Find one possible solution for each design.

3. a. Explain with the aid of diagrams what is meant by the ABCD network representation. **(4)**

b. Explain briefly the difference between the available power gain and the transducer power gain. **(4)**

c. Find the transmission parameters for the network shown in Figure 1

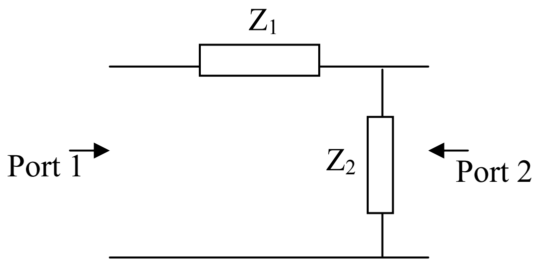

Figure 1

(6)

d. Find the scattering parameters of the two ports network shown in Figure 2. The characteristic impedance of each port is 50Ω.

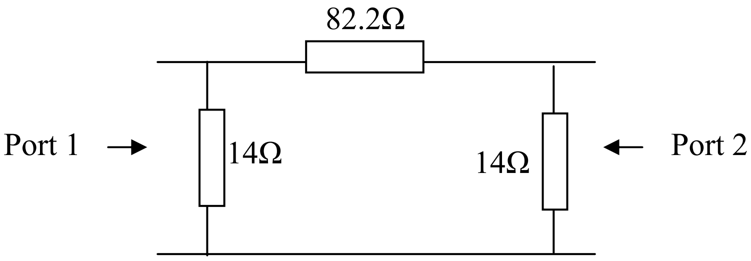

Figure 2

(6)

4. a. Explain the difference between conditional and unconditional stability **(2)**

b. Explain briefly what is meant by constant gain circles. **(2)**

c. An amplifier is characterised by the following S-parameters: $S_{11} = 0.72 \angle\text{-}116°$, $S_{21} = 2.60 \angle 76°$, $S_{12} = 0.03 \angle 57°$, $S_{22} = 0.73 \angle\text{-}54°$. The input side of the amplifier is connected to a source impedance of Z_s=75Ω. The output side is connected to a load of Z_L=100Ω. Assuming that the S parameters are measured with reference to a characteristic impedance of Z_o=50Ω, find the power gains of this amplifier. **(6)**

d. An amplifier has the following S-parameters measured at 4GHz with a 50Ω reference characteristics impedance: $S_{11} = 75\angle\text{-}120°$, $S_{21} = 2.5\angle 80°$, $S_{12} = 0.0$, $S_{22} = 0.6 \angle\text{-}70°$. Design the input and output matching networks of the amplifier so that an overall gain of 11dB is achieved. Plot constant gain circles for G_s=2dB and 3dB, and G_L=0dB and 1dB. **(10)**

You may find the following information useful:

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

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

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

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

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

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