UNIVERSITI SAINS MALAYSIA

Semester I Examination
Academic Session 2010/2011

November 2010

EEE 532 – MICROWAVE CIRCUIT DESIGN

Time: 3 Hours

INSTRUCTION TO CANDIDATE:

Please ensure that this examination paper contains **SIX** printed pages including **(TWELVE)** Appendices and **SIX** questions before answering.

Answer **FIVE** questions.

Distribution of marks for each question is stated accordingly.

All questions must be answered in English.

1.

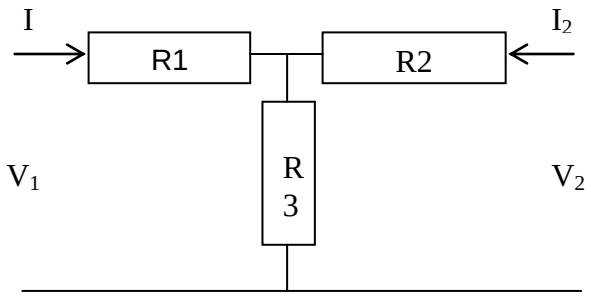

Figure 1

(a) A two port network for Z-parameter is shown in Figure 1. The network can be expressed as

..Equation 1

(i) Write the matrix representation of 2-port Z-parameter

(ii) Determine the representation of Z_{11},Z_{12},Z_{21},Z_{22} using R_1,R_2 and R_3.

(30 marks)

(b) Given that $V_1=20\angle 0^o$ $V_2=4\angle -90^o$
$I_1=0.4\angle 90^o$ $I_2=0.08\angle 0^o$

Assuming that $Z_o = 50\Omega$

(i) Draw a 2-port network and Label the diagram using the information given. Use the information used in a (ii)

(ii) Calculate the input impedance for both port. Note that $V=IZ_{in.}$

(iii) Using the equation given in equation 1, calculate the reflection coefficient.

(iv) Discuss the result obtained in b(iii) by providing your analysis.

(70 marks)

2. (a) Matching Network an important design technique to ensure maximum power transfer within the system. Given that you are to design a matching circuit using 2 elements. Design 2 possible example using 2 elements matching section for normalized z_L=2.0 - j0.3. The design will centre at Z_o = 50Ω and f_o=500MHz. Additional information are as follows: Substrate FR4 dielectric constant of 4.5 and height of 1.5mm. Assume Z_{oL} =100Ω and Z_{oC}=20Ω.

(i) State the configuration and its circuit model.

(ii) Determine the value of jX and jB solutions and show the workings on the given Smith Chart.

(iii) Calculate the width and the leghth of the microstrip line elements using the given equation in table 1.

(iv) Sketch and label the microstrip line elements.

(80 Marks)

(b) If the design requires the use of only one element, using figure 2, disscuss the type of load impedance that can be matched with the single element (jX) and Z_o.

(20 marks)

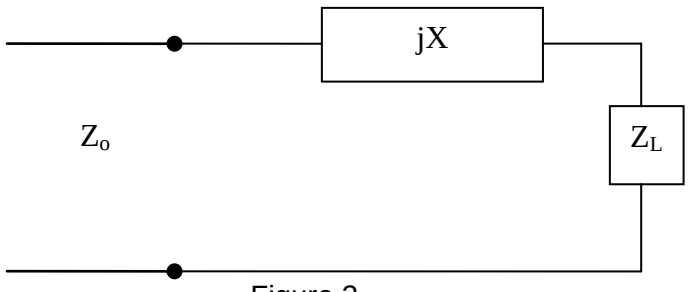

Figure 2

Table 1: Related Equations

Length for inductor:	Length for capacitor:

3. (a) Design a high ass composite filter using image filter method with the following specification:
Z_o=75Ω ; f_c = 50 MHz ; f_∞= 48 MHz. Use Table 2 for guide.

(60 marks)

(b) Figure 3 below shows the result for the result for the low pass composite filter. Analyze the result and discuss the cause of sharp drop at Point A and attenuation at Point B.

(30 marks)

(c) State the disadvantage of composite filter method.

(10 marks)

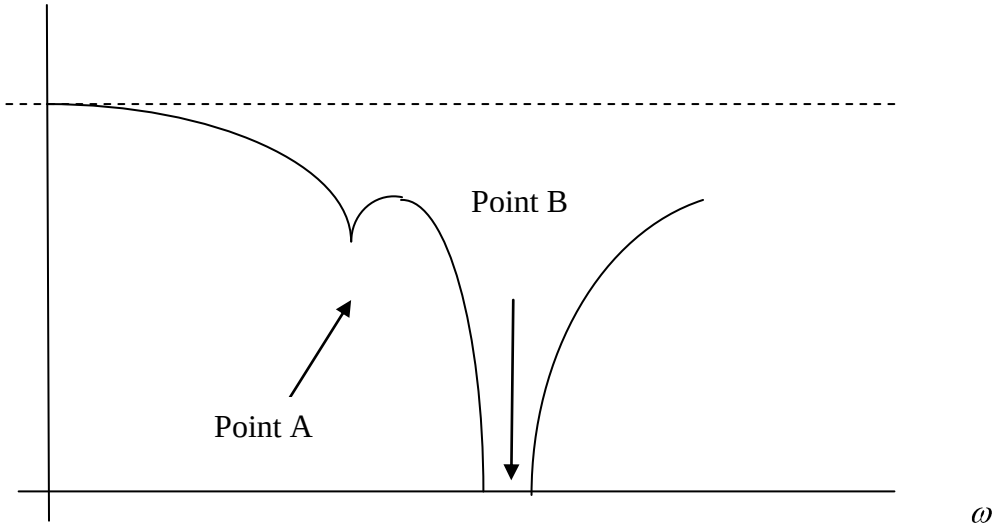

Figure 3

4. Design a low noise amplifier operating at a frequency of 4 GHz having a noise figure of 0.5 dB. The device need to be used is the PHEMT ATF 36077. Use a stub matching for the input and for the output. Choose Γ_{in} at a point of C_{in}. The data for the ATF 36077 is in Appendix 1. Use a Duroid printed circuit board with the thickness of 0.8 mm and the dielectric constant, ε_r = 2.5. The power supply for the amplifier is 3 V, finish your design with a complete power supply biasing.

(100 marks)

5. (a) Design a diode mixer operating at a frequency of 8 GHz. Use a rat-race coupler. Use a FR4 printed circuit board with the thickness of 1.5 mm and the dielectric constant of 4.5.

(80 marks)

(b) Explain what is the conversion loss of the mixer.

(20 marks)

6. (a) Explain the concept of a feedback oscillator. What are the important criteria for the oscillator to oscillate?

(40 marks)

(b) Design a 10 GHz downconverter circuit using the components datasheet as in Attachment(****). RF input signal to the low noise amplifier is -90 dBm. The Intermediate Frequency (IF) output is 1 GHz with the output power of -10 dBm.

(60 marks)

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