



Student ID:

First Name:

Last Name:

Instructions: You have 1.5 hours to complete the test. If you need extra blank sheets to complete the test please ask. Please write everything with blue or black ink pen. You can use your calculator or Matlab. Use of cell phone, course notes or personal computer will invalidate the results of the test.

Questions:

1. Consider a power divider with an input port "1" and two output ports "2", and "3" with the following scattering matrix for a reference characteristic impedance of 50Ω:

$$[S] = \frac{1}{2} \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

- a. Is the device reciprocal?
- b. Is the device lossless?
- c. Is the device matched at all ports?
- d. Are the two output ports 2 and 3 isolated?

Now suppose that the device is driven from port 1 by $V_1 = 10V$ and that the output ports are terminated by matched loads

- e. Calculate the amplitude of the voltage waves at ports 2 and 3;
- f. Calculate the power available at ports 2 and 3;
- g. Calculate the power dissipated in the divider.

2. Consider a resonator composed by a segment of air-filled coaxial cable of length L and characteristic impedance 100Ω. The cable is closed with a short circuit at one end. The operating resonant frequency is $f_0 = 1GHz$ and the phase shift along the cable at resonance should be π .

- a. Calculate the propagation constant β at the resonance frequency f_0 ;
- b. Calculate the value of the cable length L ;
- c. Suppose now to move the operating frequency to a new value f around f_0 as $f = f_0 + \Delta f$ with $|\Delta f| \ll f_0$. Calculate the corresponding phase shift βL in this frequency window.