UNIVERSITÀ DEGLI STUDI DI BRESCIA

Microwave Engineering Test
June 14, 2019

Student ID:
First Name:
Last Name:

Instructions: You have 2 hours to complete the test. If you need extra blank sheets or additional Smith's charts 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:

Question 1:

Consider a plane wave normally incident on a half space of gold ($\sigma = 4.098 \times 10^7$ S/m). If the wave frequency is f = 4 GHz, calculate:

(a) the propagation constant;
(b) the intrinsic impedance;
(c) the skin depth for the conductor;
(d) Reflection and transmission coefficients.

Hint: free space magnetic permeability $\mu_0 = 4\pi \times 10^{-7}$ H/m

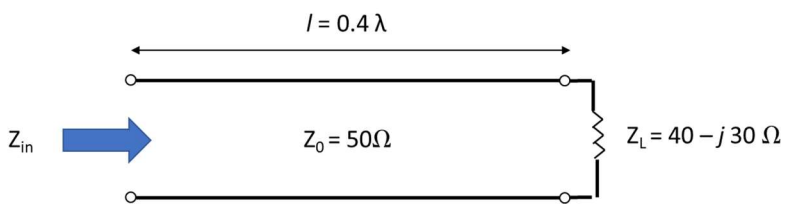
Question 2:

For a purely reactive load impedance of the form $Z_L = jX$, show that the reflection coefficient magnitude $|\Gamma|$ is always unity. Assume the characteristic impedance Z_0 is real.

Question 3:

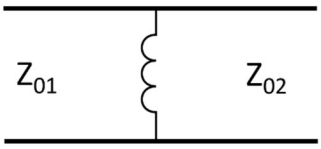
Use the Smith's chart to find the following quantities for the transmission line circuit below:

(a) The SWR on the line;
(b) The reflection coefficient at the load;
(c) The load admittance;
(d) The input impedance of the line;
(e) The distance from the load to the first voltage minimum;
(f) The distance from the load to the first voltage maximum.



Question 4:

Consider the microwave circuit in figure:



Discuss (equations are not required) how this circuit can be used as an equivalent model. Optional: sketch a possible implementation based on rectangular waveguides.

Question 5:

Consider a N-port device described by the NxN scattering matrix [S] referred to a common characteristic impedance Z_0. Suppose that at port 1 we add a segment of transmission line of length L (characteristic impedance Z_0, propagation constant β), so that there is a shift in the terminal plane of the N-port device. The other ports are left unchanged.

Calculate the new scattering matrix S' as a function of β, L and [S]