UNIVERSITÀ DEGLI STUDI DI BRESCIA

Microwave Engineering Final Test
June 29, 2020

Student ID:
Name:
Instructions: You have 1.5 hours to complete the test. Please write everything with blue or black ink pen so that all your work can be read easily. You can use your calculator. If you don't have a calculator, you can leave the formulas in expression forms and still get full score for the questions/exercises. Use of course notes or internet resources will invalidate the results of the test. Use of your cell phone is allowed only for scanning test and emailing the file at the end of the exam.
VERY IMPORTANT: Please WRITE YOUR FULL NAME AND STUDENT ID on the first sheet you scan. If you forget to include your name, I will not be able to put your material on record and therefore the test will NOT BE VALID!

Questions:

1. A transmission line of length *l* connects a load to a sinusoidal voltage source with an oscillation frequency *f*. Assuming that the velocity of the wave propagation on the line is *c*, for which of the following situations is reasonable to ignore the presence of the transmission line in the solution of the circuit:
   a. *l* = 30 cm, *f* = 20 KHz
   b. *l* = 50 km, *f* = 60 Hz
   c. *l* = 30 cm, *f* = 600 MHz

2. A four-port network has the scattering matrix shown below.
   a. Is this network lossless?
   b. Is this network reciprocal?
   c. What is the return loss at port 1 when all other ports are terminated with matched loads?
   d. What is the insertion loss and phase delay between ports 2 and 4, when all other ports are terminated with matched loads?
   e. What is the reflection coefficient seen at port 1 if a short circuit is placed at the terminal plane of port 3, and all other ports are terminated with matched loads?

$$[S]=\begin{bmatrix} 0.178\angle 90^\circ & 0.6\angle 45^\circ & 0.4\angle 45^\circ & 0 \\ 0.6\angle 45^\circ & 0 & 0 & 0.3\angle -45^\circ \\ 0.4\angle 45^\circ & 0 & 0 & 0.5\angle -45^\circ \\ 0 & 0.3\angle -45^\circ & 0.5\angle -45^\circ & 0 \end{bmatrix}$$

3. Consider a RHCP plane wave normally incident from free-space (z < 0) onto a half-space (z > 0) consisting of a good conductor. Let the incident electric field be of the form

$$\bar{E}_i = E_0\left(\hat{x} - j\hat{y}\right)e^{-jk_0 z}.$$

   a. Find the electric and magnetic fields in the region z > 0;
   b. Calculate the Poynting vectors for z < 0 and z > 0 and show that complex power is conserved;
   c. What is the polarization of the reflected wave?