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**ECE 5317/6351**

**Microwave Engineering**

**Exam 1**

**Fall 2018**

Instructions

1. This exam is open book and notes. Calculators and Smith chart tools (e.g. compasses and rulers) may be used. Laptops and any devices that may be used for communication are not allowed.
2. Please show *all of your work* and *write neatly* in order to receive credit. No credit will be given if the work required to obtain the solution is not shown, or if it is not easily readable.
3. Put all of your answers in terms of the parameters given in the problems, unless otherwise noted.
4. Please circle your final answers.
5. Include units with all numerical answers in order to receive full credit.
6. Perform all of your work on the paper provided. If you need more space, you may write on the backs of the pages.

**Problem 1 (35 pts)**

A lossless transmission line with a (real) load and a practical source connected to it is shown below. Assume that the transmission line is 1/4 of a guided wavelength long. That is, .

a) Derive formulas for the following quantities:



b) Assume now that the Thévenin impedance  is real, and that the line is designed as a quarter-wave transformer so that the input impedance seen looking into the line by the source is . Find the ratio of the output to input voltages. That is, determine the ratio *R*, where

.



**Room for additional work**

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**Problem 2 (35 pts)**

A coaxial cable is connect to a CPS (coplanar strips) transmission line as shown below, without using a balun. (Three different views are shown.) Assume that the CPS line supports an even mode and an odd mode. The even mode (common mode) has a characteristic impedance of  and a phase constant of . The odd mode (differential mode) has a characteristic impedance of and a phase constant of .

a) Find the voltages  and  on the two microstrip lines that make up the CPS.

b) Find the currents  and  on the two microstrip lines that make up the CPS.

c) Find the input impedance seen by the source (feed) .







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**Problem 3 (30 pts)**

A rectangular waveguide of dimensions *a* × *b* operates in the TE10 mode. The waveguide is filled with a lossy (nonmagnetic) Teflon material. Calculate the attenuation in dB/m at a frequency of 9 GHz.

The parameters of the waveguide are as follows:

*Dimensions*

*a* = 2.0 [cm]

*b* = 1.0 [cm]

*Metal wall*

*σ* = 3.0 ×107 [S/m]

*Teflon*

*εr* = 2.1

tan*δ* = 0.001

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