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**ECE 5317/6351**

**Microwave Engineering**

**Exam 1**

**Fall 2019**

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 (30 pts)**

A lossless transmission line with a load and a practical source connected to it is shown below.

a) Assume that we know  and . Determine what the current  is in terms of these two known quantities, and then find an expression for the load impedance  in terms of these two known quantities.

b) Assume now that the transmission line is 1/4 of a guided wavelength long. That is, . Derive an expression for the power (in watts) going into the load in terms of , ,  and .



**Room for additional work**

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**Problem 2 (30 pts)**

A current source is connected to a CPS (coplanar strips) transmission line as shown below, without using a balun. 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 .

For the characteristic impedance *Z*o*d* , the voltage is the voltage between the two strips (with the + conductor being the left one and the - conductor being the right one), while the current is the current flowing in the *z* direction on the + strip (the left strip). For the characteristic impedance *Z*o*c*, the voltage is the voltage between the strips (which are now at the same voltage) and the ground, while the current is the total current flowing in the *z* direction on both strips.

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

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



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**Problem 3 (40 pts)**

A 2.4 GHz wireless system consists of two identical coaxial cables and two half-wavelength dipole antennas. A 20 meter long coaxial cable delivers a signal from a transmitter to a dipole antenna. The dipole antenna transmits the signal to another dipole antenna that is 1 km away. The receive dipole then delivers the received signal through another 20 meter length of coax to a receiver. Assume that the coaxial cables are matched to the dipole antennas (with baluns), so is there is a perfect match seen by the coaxial cables.

a) Calculate the dB of loss through each of the coaxial cables.

b) Calculate the dB of loss through the wireless link between the two dipoles.

c) Calculate the total dB of loss in going from the transmitter to the receiver.

The parameters of the coaxial cables are as follows:

*a* = 0.635 [mm]

*b* = 2.13 [mm]

*εr* = 2.1

tan*δ* = 0.001

*σ* = 3.0 ×107 [S/m]

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