

# ECE 435

## DESIGN OF MICROSTRIP CIRCUITS

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### I. Introduction

In this lab you will design a microstrip circuit, a branch line coupler and patch antenna.

A branch line coupler is a type of directional coupler often used for power-splitting purposes. It is simple to design and easy to fabricate as a microstrip circuit. In this lab you will design a 3-dB branch-line coupler and lay out the coupler using Sonnet. In a later lab you will measure its characteristics with the network analyzer.

A simple antenna to design and build is a patch antenna. Based on Chapter 14 in Balanis and the appropriate sections of the course notes, you will design a microstrip fed patch antenna.

### II. Design

**BEFORE** coming to lab, your group is to design:

1. A 3-dB (equal power split) branch line coupler for operation at 1 GHz. Use the attached sheets to determine the necessary impedances of the coupler arms. See the attached design sheets.
2. A patch antenna that will resonate at 3 GHz. The antenna should be linearly polarized and feed by a 50 Ohm microstrip transmission line. Feel free to choose a substrate other than GML-1000. Look on the web for available boards (e.g. Rogers Corp., GIL Laminates, etc.)

Your design must include the physical lengths and widths of the microstrip elements. These depend on the properties of the board you are using. Your group must turn in a copy of these designs to your lab instructor before the beginning of class.

### III. Layout

You will lay out your designs using Sonnet during the regularly scheduled lab period. In order to lay out the circuit you will need to know the parameters of the circuit board. For the branch line coupler use:

Size:	15.25 cm x 4.2 cm
Substrate thickness:	1.65 mm
Dielectric constant:	3.91
Layout type:	microstrip

Lay the circuit and get a printout of  $S_{11}$ ,  $S_{21}$ ,  $S_{31}$  and  $S_{41}$  for the branch-line. Since the circuit is symmetric, the other S-parameters can be determined from these. For the branch line coupler plot the S-parameters in the range 0.5-1.5 GHz.

Now for the second circuit design, layout a 50 Ohm transmission line and verify its properties. Then, use that line to feed your patch antenna model. Adjust the layout to obtain the best match properties you can (e.g. lowest  $S_{11}$  at the design frequency). Generate a Smith chart (from 2 GHz to 4 GHz) and radiation patterns for the principal plane cuts at the design frequency.

### IV. Report

Comment on the results and on any discrepancies between theory (the ideal designs) and simulation. How can you reduce error and what is your wag on the lowest obtainable error. Be sure to include all plots and the artwork.