Problem Set 2
Due Monday March 2, 2009

1. Assume that the third port of a three port circuit is terminated in a load $\Gamma_3$. Calculate the resulting two-port parameters directly using scattering parameters.

2. Derive a transformation between the $S$ and $T$ matrix (both ways). The $T$ matrix is defined to allow cascading of two-port parameters (similar to the $ABCD$ matrix) when using forward/reverse waves $a$ and $b$.

3. Derive the scattering parameters of a “pad” or a resistive II and $T$ attenuator. Derive design equations for a given attenuation for a matched system.

4. Consider the composite S-parameters of a cascade of amplifiers. Show that if $S_{12} = 0$ for one of one components, then the overall system is unilateral.

5. Design an amplifier using the raw S-parameter measurements provided. Your goal is to realize a power gain of 12 dB at 5 GHz when driven and loaded by a 50$\Omega$ environment.

(a) Plot the maximum stable gain, maximum available gain, and unilateral gain curves for the device.

(b) Draw the load stability and power gain circles and comment on various choices for the load impedance.

(c) Draw the source stability and available gain circles and comment on various choices for the source impedance.

(d) Design the input and output matching network to realize stable gain. Use ideal matching networks (inductors, capacitors, transmission lines). Design for a reasonable input match but assume the output match is not needed.

(e) Design a two-stage amplifier that is unconditionally stable over all frequencies 12 dB power gain. The input and output match should be better than -15 dB. You may use any topology and any elements, including resistors.