EEL-6936; RF & MICROWAVE CIRCUITS II

DESIGN PROJECT (DUE 5/2/03)

The purpose of this project is to provide the student with an opportunity to undertake an independent design assignment. A single-stage microwave amplifier utilizing a silicon bipolar transistor will be designed and simulated. Both technical content and quality of the presentation will have a significant effect on the project grade.

PART 1. Design Requirements

1. Design and evaluate a single-stage microwave amplifier using the Motorola MRF947P silicon bipolar transistor. The design will include a mix of ideal and non-ideal elements as described below. The amplifier must achieve 10 dB available gain at the 1.5 GHz nominal operating frequency while assuring stability over the 0.1 to 3.0 GHz operating range. Obtain the best noise figure that is possible at 1.5 GHz. Evaluate the various combinations of matching networks, loading and feedback to obtain the flattest gain and lowest VSWR's over the frequency range. Data for the transistor are insufficient to evaluate the noise figure over the frequency range. The amplifier must operate from a 50 ohm source and have a 50 ohm load. Data for the MRF947P are available on the course web page.

2. Bias and interconnect elements are to be included. It is assumed that bias will be introduced via shorted stubs. If you don't need a shorted stub for matching, then include an isolation stub (λ/4 at operating frequency) and RF short-circuit (λ/4 at operating frequency). The finished design should look similar to Gonzalez Figure 4.3.11(b) right.

3. The source and load matching networks and all interconnections must be constructed as microstrip from 31mil copper-clad fiberglass-epoxy material specified in CAD assignment #3. You may choose from stub and thruline, stub and λ/4 transformer, or thruline and λ/4 transformer matching. Transition elements for connecting stubs, device, bias resistors and capacitors, changing Z_o, and bends are required. Use size 1206 surface-mount resistors and capacitors. Transition elements for connecting the input/output connectors are not required.

4. Resistors and capacitors should be considered ideal. Do not attempt to account for parasitic effects.

5. A resistive bias supply network must be included. Do not use an active bias network.

PART 2. Procedure

1. Evaluate the device performance and consider stability, GMAX, MSG, etc. Decide how to assure stability and implement the matching networks, including loading and feedback if you use them. This will require you to "experiment" with different combinations of matching networks, loading and feedback to meet the performance objectives. Implement the matching networks utilizing ideal transmission line sections. Simulate network performance and verify expected results for each matching network that you consider. For each

combination of matching networks, loading and feedback, connect the device (including loading and feedback if used) to the matching networks, simulate amplifier performance and verify expected results. When you decide that you have the right combination, arrange for Prof. Gordon to review the design. Save all schematics and plots for every combination that you consider and have them available for the first design review.

2. When your design is approved, begin the next phase by implementing the matching networks as microstrip realizations. Simulate matching network performance including the effect of connections and transitions and verify expected results. Incorporate the device, simulate amplifier performance and verify expected results. Design and add the bias network elements, simulate amplifier performance and verify expected results. When you decide that you are ready to "build" the amplifier, arrange for Prof. Gordon to review your design progress. As before, save all schematics and plots and have them available for the second design review.

3. Begin the final phase by "building" a detailed schematic of the amplifier. The test of completeness for the final schematic is whether the automatic layout generation feature in ADS will produce a layout that can be fabricated. You will have to incorporate every gap, transition, bend, tee, etc. that is required. You must provide the mounting pads for the transistor, resistors and capacitors. Evaluate the amplifier performance, specifically the stability, S-parameters, input and output VSWR's, and available gain as functions of frequency. Provide an evaluation of stability when the input or output is not terminated (particularly open circuit) in 50 ohms. Have Prof. Gordon review and approve your ready-to-build design.

4. Write and submit your report.

PART 3. Report Requirements

1. Your report should be a narrative of your design and evaluation experience. No particular format must be followed, but word-processing with a consistent form and typeface should be used. Include detailed graphs of intermediate results integrated into the text to support your narrative, as well as the required amplifier performance data.