1. The exam is take-home. No collaboration or discussion of any type about the exam is allowed.

2. Electronic resources, including calculators and Mathcad, may be used to assist in the completion of the exam. Electronic communication regarding the exam with anyone other than the instructor or teaching assistant is strictly prohibited.

3. You must circle or box your answers to get full credit.

4. All work and steps toward a solution must be clearly shown to obtain credit.

5. Partial credit may be given provided that the grader can clearly follow your work to the extent that an understanding of the problem is demonstrated.

6. No collaboration is allowed on this examination. Only Dr. Baylis or the teaching assistant may be consulted for clarification.

7. Please attach all hand calculations, Mathcad sheets, and Smith Charts to the exam. Mathcad sheets should contain appropriate comments to allow the grader to follow your work. Each page should contain your name, the problem number, and the page number for that problem.

Please sign the statement below. YOU MUST SIGN THE STATEMENT OR YOU WILL GET A ZERO FOR THIS EXAMINATION!!

I hereby testify that I have neither provided or received information from unauthorized sources during the test and that this test is the sole product of my effort.

Signed ____________________________ Date ____________________
**PROBLEM 1 (25 points):** A Si BJT has the following S-parameters at 1.5 GHz:

\[
S_{11} = 0.08 \angle 35^\circ \\
S_{12} = 0.02 \angle 45^\circ \\
S_{21} = 6.1 \angle 98^\circ \\
S_{22} = 0.15 \angle -23^\circ 
\]

(a) (5 points) Is the device unconditionally stable at 1.5 GHz? Why or why not?

(b) (15 points) Design a stable amplifier with \( G_T = 15 \) dB. Use the approach of designing for \( G_A = 15 \) dB and then setting \( \Gamma_L = \Gamma_{OUT}^* \). Clearly give your design values of \( \Gamma_s \) and \( \Gamma_L \).

(c) (5 points) Determine \((VSWR)_\text{in}\) and \((VSWR)_\text{out}\).

**PROBLEM 2 (30 points):** A SiGe HBT has the following S-parameters at 1.2 GHz:

\[
S_{11} = 0.8 \angle 35^\circ \\
S_{12} = 0.07 \angle -32^\circ \\
S_{21} = 7.6 \angle -25^\circ \\
S_{22} = 0.51 \angle 103^\circ 
\]

(a) (5 points) Is the device unconditionally stable at 1.2 GHz? Why or why not?

(b) (5 points) If the device is potentially unstable, plot the source and load stability circles on two separate Smith charts. Indicate clearly the stable and unstable regions. Identify the Smith charts clearly as the \( \Gamma_s \) and \( \Gamma_L \) Smith charts, appropriately.

(c) (15 points) Design a stable amplifier with \( G_T = 10 \) dB. Use the approach of designing for \( G_P = 10 \) dB and then setting \( \Gamma_s = \Gamma_{IN}^* \). Clearly give your design values of \( \Gamma_L \) and \( \Gamma_s \). For purposes of this problem, you are not required to check the \( \Gamma_s \) value for stability. Simply set \( \Gamma_s = \Gamma_{IN}^* \) and move on.

(d) (5 points) Determine \((VSWR)_\text{in}\) and \((VSWR)_\text{out}\).
**PROBLEM 3 (20 points):** The S-parameters and the noise parameters of a Si BJT at \( f = 2.4 \text{ GHz} \) and a certain bias condition are given as follows. Assume \( Z_0 = 50 \Omega \).

\[
\begin{align*}
S_{11} &= 0.18 \angle 25^\circ \\
S_{12} &= 0.02 \angle -28^\circ \\
S_{21} &= 4.6 \angle 52^\circ \\
S_{22} &= 0.02 \angle -14^\circ \\
F_{\text{min}} &= 1.3 \text{ dB} \\
\Gamma_{\text{opt}} &= 0.23 \angle -49^\circ \\
R_n &= 12 \Omega
\end{align*}
\]

(a) (5 points) Is the device unconditionally stable at 2.4 GHz? Why or why not?

(b) (15 points) Design a microwave transistor amplifier to obtain the highest transducer gain possible while achieving the minimum noise figure \( F_{\text{min}} \). Do this by first designing for the value of \( \Gamma_s \) and then designing for the value of \( \Gamma_L \). Indicate clearly your noise figure \( F = F_{\text{min}} \) as achieved by your design, as well as your values of \( \Gamma_s, \Gamma_L, \) and transducer gain \( G_T \).

**PROBLEM 4 (25 points):** A GaN HEMT in the common-gate configuration with feedback has the following S-parameters:

\[
\begin{align*}
S_{11} &= 0.65 \angle -28^\circ \\
S_{12} &= 0.37 \angle -49^\circ \\
S_{21} &= 0.83 \angle 121^\circ \\
S_{22} &= 0.89 \angle 14^\circ \\
\end{align*}
\]

Using the configuration with the terminating network connected to the device port 2 (load connected to device port 1), design an oscillator using the methods of Sections 5.3 and 5.4 in your book. Choose \( \Gamma_{T,o} \) as your terminating reflection coefficient, and then use the method of Section 5.3 to choose the load impedance (for port 1), assuming that the real part of the load impedance producing maximum power is given by one-third of the magnitude of the small-signal input resistance. Give your values for \( \Gamma_T \) and \( Z_L \) (in ohms) and attach all work necessary for your design. Use \( Z_0 = 50 \Omega \).