ECEn 464 (Block 2)
Wireless Communication Circuits

Homework #6
Due Wednesday Dec. 11, 2013 in class (Turn in Problems 2-6 only)

1. Please fill out the online student evaluation for this class for 5 points extra credit on the homework score (be sure to mark the box that allows your name to be released to the instructor).

2. Design a transistor oscillator at 6 GHz using an FET in common source configuration driving a $50\,\Omega$ load on the drain side. The S-parameters are $S_{11} = 0.9\angle -150°$, $S_{21} = 2.6\angle 50°$, $S_{12} = 0.2\angle -15°$, $S_{22} = 0.5\angle -105°$. Design the oscillator using the stability circle method with the terminating network on port 2, and include a $50\,\Omega$ load resistance in the terminating network. Choose Γ_T so that $|\Gamma_{\text{in}}| \gg 1$. The tuning network on port 1 should be a resistor and a length of transmission line.

3. Repeat the previous oscillator design problem using the method in the notes to maximize instability. The terminating network on port 2 should be an open circuit stub (pure reactance), and the tuning network on port 1 should include a $50\,\Omega$ load resistance.

4. The amplitude modulated (AM) signal $v(t) = A[1 + m\cos(2\pi f_m t)]\cos(2\pi f_o t)$ is applied to a diode detector with DC bias V_o. Using the second order expansion $I(v + V_o) \simeq I_o + v/R_j + v^2\alpha/(2R_j)$ of the current through the diode, find the detector output signal. Which portion of this expression is the desired demodulated signal?

5. 13.17 (An undesired signal at an image frequency mixes down to the same IF band as the desired input signal, and if present at the input must be filtered out before mixing.)

6. The input to a single-balanced downconverting mixer is $\sin(2\pi f t)$, where $f = 1.05\,\text{GHz}$. The LO frequency is 1 GHz. Sketch the frequency spectra of (a) the input signal and (b) the mixer output signal up to the second harmonic. Repeat for a double balanced mixer.

7. Calculate the conversion loss of the double balanced mixer shown below, assuming that the diode on-resistance is much less than the load resistance R_L.