MS Exam: ECE166 (Fall 2012)

(a) Design a single-stub network at 12 GHz for maximum power transfer between a source with an impedance of $Z_g = 20 + j50 \, \Omega$ and a load with an impedance of $Z_L = 70 \, \Omega$. Use a single Smith Chart. Calculate all the t-line lengths for one solution (open stub or short stub – all stub lengths must be lower than lambda/4). All t-lines and stub impedances are 50 $\Omega$. Write your name on the Smith Chart.

(b) Consider the following 4-port networks with scattering parameters $[S_A]$ and $[S_B]$. The networks are passive and linear. All ports are matched except for $S_{11}$ ($S_m = 0$ except for $S_{11}$). Also, $S_{13} = 0$ and $S_{24} = 0$ for both A and B networks. Calculate $S_{11}$, $S_{21}$ for the combined network.
Consider the amplifier shown below to the left. Under the conditions shown below, you are told that the amplifier has a noise figure of 7 dB and an IIP3 of 10 dBm and operates at room temperature. Assume that IIP2 is infinity.

a. A 3-dB attenuator is placed between the source and the amplifier. What is the noise figure of the cascade of the attenuator and amplifier?

b. What is the linearity of the combination of the attenuator and amplifier?

c. What is the SFDR of the new combination? Has it improved over the first case?

d. If the input frequency is 1 GHz and a jammer is located at 1.1 GHz, at what frequencies will we observe intermodulation products?

e. Instead of an attenuator, consider the notch filter shown below. If the notch is located at 1.1 GHz and has a depth of 20 dB but the filter provides no attenuation at 1 GHz, how much is the IM3 product at 900 MHz reduced.

f. What is the SFDR of the receiver with the notch?