EE6320 RF Integrated Circuits Homework 3

1. Impedance transformation networks are widely used in power amplifier designs to enable a specific amount of power to be delivered to a load. Owing to supply voltage limitations, a downward impedance transformation of the antenna resistance is usually necessary. Let us take the example of WiFi, where the PA is required to deliver 1W of power to a 50Ω antenna at 1GHz. Suppose that the power amplifier is able to support a maximum peak-to-peak output swing of 5V across its load resistance.

a) What is the maximum power that can be delivered to the load without a matching network?
b) What impedance should the PA be designed to drive so as to deliver the desired power with the rated voltage swing.
c) Design a high-pass L-match network using ideal passive components to match the antenna impedance to the value from (b) above.
d) Verify the above results of (c) using Eldo or Spectre. Plot S_{11} (magnitude in dB) and Z_{in} (real and imaginary parts in Ω) versus frequency from 500MHz-2GHz. Also, determine the –3dB bandwidth of impedance magnitude from your simulation, and compare the Q derived from the BW definition with the Q that you designed for.
e) Design a high-pass T-match network with a Q=5 using ideal passive components to match the antenna impedance to the value from (b) above.
f) Verify the above results of (e) using Eldo or Spectre. Plot S_{11} (magnitude in dB) and Z_{in} (real and imaginary parts in Ω) versus frequency from 500MHz-2GHz. Also, determine the –3dB bandwidth of impedance magnitude from your simulation, and compare the Q derived from the BW definition with the Q that you designed for.
g) Now, assume that all spiral inductors in this process have a Q of approximately 15. Add an ideal resistor of appropriate value in parallel with the ideal inductor in (d) above and re-run the L-match network simulation to see how the impedance matching has been affected. Again, plot S_{11} (magnitude in dB) and Z_{in} (real and imaginary parts in Ω) versus frequency from 500MHz-2GHz.
h) Ungraded question: See if you can optimize the value of the L-match network components to improve the matching with lossy inductors.