ECE 100 Assignment 6 Systems Analysis and Design Fall 2011

This assignment is to be done individually. The problems are to provide practice in systems analysis and design. They include the use of the system simulator Simulink which is part of the Matlab package.

1. Dual-Integrator Analysis:

Consider a transfer function $H(s) = 1/(1 + 0.4*s + s^2)$ which is to be realized with a dual-integrator system. You are interested in the step response, in particular the overshoot in the step response.

Find the overshoot analytically (use the formula from Assignment 1).

Enter the system in matlab using the "tf" routine and find the overshoot using "step".

Simulate the step response in Simulink using the dual integrator topology and plot the output with "scope".

2. Dual-Integrator Realization:

Show how to realize a general second order LP or BP function with three opamps.

Show how to realize a general second order HP, BR, or AP function with four opamps.

3. Wien Bridge Oscillator:

Simulate the oscillator in Simulink with a gain block of 3.1 and a feedback transfer function of $s/(1+3s+s^2)$. Include a saturation element and limit the amplitude at 10v peak to peak. To get the oscillation to start in Simulink, add a small step of amplitude 0.1v to the amplifier input. Plot the output on the scope.

4. Negative Feedback System with Time Delay:

The transfer function of the forward path is $A(s) = 2/(1+2s+s^2)$. There is also a delay of T seconds in the forward path. The transfer function of the delay is $D(s) = \exp(-sT)$. The feed back gain is B=1 and the sense is negative.

Use Matlab to make a Nyquist plot for T=0.1s. It should show no poles in the RHP. Then increase T until the Nyquist plot just loops around –1. What T is required? Use Matlab to make a Bode plot for this value of T.

Use Simulink to make simulate the step response of the system. Plot the step response with T=0.1s and again with T that you found was unstable. Use the block called "transport delay".

5. Signal Flow Graph of a Ladder Network:

The LC ladder is a very popular filter structure because it is not sensitive to component values. Here we will consider one with two inductive series branches and two capacitive shunt branches.

Define the series branches as impedances Z_1 and Z_2 and the shunt branches as admittances Y_1 and Y_2. Calculate the transfer function H. Replace Z_N with sL_N and Y_N with sC_N for N=1,2 and write H(s) as a rational function of s.

Draw the signal flow graph to represent the equations of the circuit. Use Mason's Rule to find the transfer function H(s).

Show how to realize the signal flow graph representation with four opamp integrators and two opamp inverters (6 opamps in total).