Matlab Exercise II *

Signals and Systems (ELC 321)
Department of Electrical and Computer Engineering
The College of New Jersey.

Instructions:

1. When using MATLAB to plot signals, scale your time or frequency axis such as to allow sufficient amount of the signal to be plotted. Use subplot to give 3 or 4 plots per page; label the axes of your plots accordingly e.g ime (sec)on the x-axis and (t)on the y-axis; the title should be the problem number, for example a)

2. You must submit all Matlab codes, PSpice and Simulink simulations for this assignment. Append your code at the end of your report and embed your PSpice/Simulink simulation diagrams into your report.

3. **Due Date: March 28, 2016**.

Problem 1 (50 Marks)**.** *The simulation diagram of Fig.3 describes an echo generating system with input $x[n]$ and output $y[n]$. Each successive echo is represented by a delayed and scaled version of the output, which is fed back to the input. The coefficients a and b are attenuation factors while D denotes a unit delay operator.*

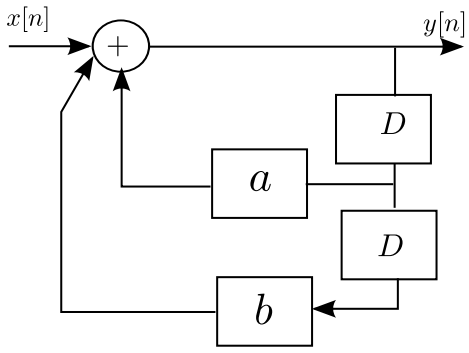

Figure 1: Sequence for Problem 1

a) Suppose that $a = 4$ and $b = 0.15$ and assuming zero initial condition, write a Matlab program that solves for $y[n]$ given that $x[n]$ is a unit step i.e. $x[n] = \mu[n]$. Select an appropriate range for your input and include the plot of $y[n]$ in your report.

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b) Suppose the echo system is realized by analog system represented by the simulation diagram of Figure 2.

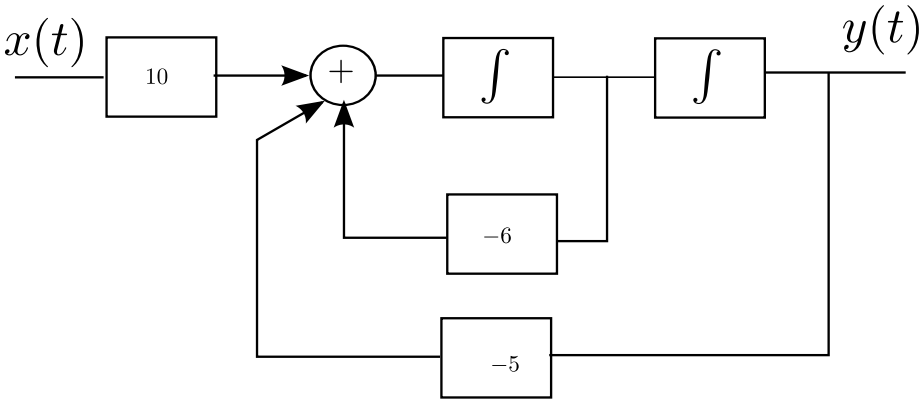

Figure 2: Simulation Diagram for Problem 1

Design an analog computer (using op-amps, resistors and capacitor) to solve the differential equation simulated by Figure 2. Verify the functionality of your developed analog computer in Pspice. Take the input to be unit step i.e. a constant source of $1Volt$ *and assume zero initial conditions.*

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Problem 2 (50 Marks)**.** *The block diagram of Figure 3 is an electronic oscillator for generating pure sinusoidal signal of a particular frequency, say* ω_o*. The block comprises of a square wave generator and a filter. The square wave generator can be realized using the circuit in Figure 4 and the filter using the circuit in Figure 5.*

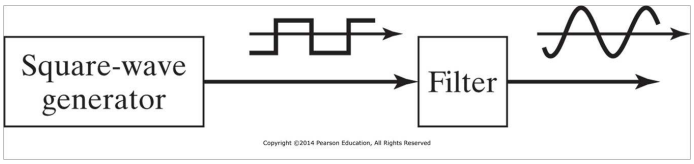

Figure 3: Square Wave Generator

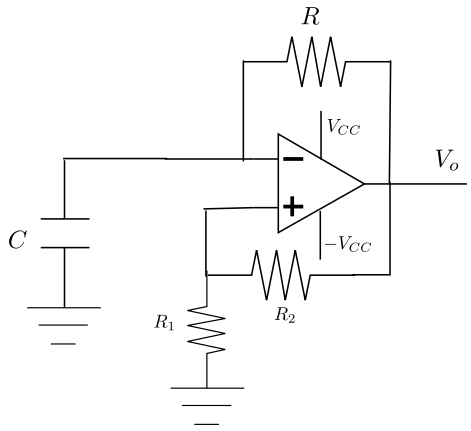

Figure 4: Square Wave Generator

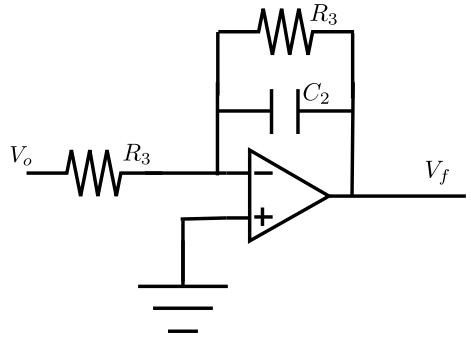

Figure 5: Low Pass Filter

a) *Simulate the square wave generator in Pspice to obtain a square wave output. Set* $V_{CC} = 5V$ *and use appropriate component values to obtain a period of 5 Secs. Include the plots of the capacitor voltage and the output voltage* V_o *in your report. Hint: The period* T *is given by the relation*

$$T = 2RC \ln\left(\frac{1+\alpha}{1-\alpha}\right) \text{ with} \tag{1}$$

$$\alpha = \frac{R_1}{R_1 + R_2} \tag{2}$$

You may fix $\ln\left(\frac{1+\alpha}{1-\alpha}\right) = 1$ *and then compute the values* R_1, R_2, R *and* C *to achieve your desired Period of 5 seconds.*

b) *Cascade the low pass filter to your circuit in Item a and simulate the oscillator in Pspice to obtain a pure tone. Set the time constant* τ *of your filter such that* $w\tau = 1$ *where* w *is the frequecy of your square wave generator. Hint: The time constant of the circuit in Figure 5 is given by* $\tau = R_3 C_2$.

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