EGR 261 Due date: _____
Signals and Systems (See Due Dates Table)
File: N261H5

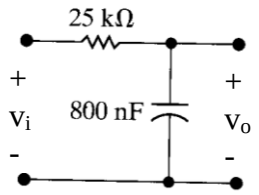
Homework Assignment #5 – Analysis of Systems

Reading Assignment:

Ch. 2, Sect. 1-8 in *Linear Signals & Systems, 2nd Ed.* by Lathi
Ch. 13, Sect. 6 in *Electric Circuits, 9th Ed.* by Nilsson

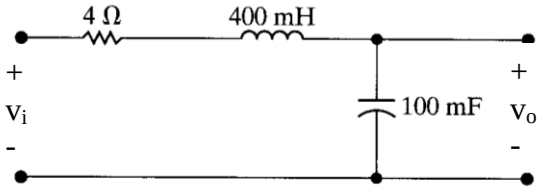
Problem Assignment:

1) For the circuit shown below:



   A) Determine the differential equation that represents the system if $v_i(t)$ is the input voltage and $v_o(t)$ is the output voltage.
   B) Find the unit step response, USR, using the differential equation. Also sketch the USR.
   C) Find the impulse response, h(t), from the USR using h(t) = d/dt(USR). Also sketch h(t).
   D) Find the transfer function $H(s) = V_o(s)/V_i(s)$ from the DE in part A
   E) Find the unit step response, USR, from H(s)
   F) Find the impulse response, h(t), from H(s)

2) Repeat problem 1 for the circuit shown below:



Note: For problems 3, 4, 5, and 6 below use a graphical approach in evaluating the convolution integral. Include sketches to illustrate each part of the solution as well as the related calculations. Sketch the final result as well.

3) Problem 2.4-18, parts a,c,f, and g in the Lathi text (Hint: Invert x_1 rather than x_2 on part g.)
4) Problem 13.60b in the Nilsson text
5) Problem 13.67 in the Nilsson text
6) Problem 13.62 in the Nilsson text
7) Repeat problem 13.62 using Laplace transforms. Specifically, find $H(s) = V_o(s)/V_i(s)$ and then find $v_o(t) = \mathcal{L}^{-1}\{H(s)V_i(s)\}$.

Selected Answers:

1A) $\dfrac{dV_o(t)}{dt} + 50V_o(t) = 50V_i(t)$

1B, E) $USR = V_o(t) = (1 - e^{-50t})u(t)$

1C, F) $h(t) = 50e^{-50t}u(t)$

1D) $H(s) = \dfrac{50}{s+50}$

2A) $\frac{d^2V_o(t)}{dt^2}+10\frac{dV_o(t)}{dt}+25V_o(t)=25V_i(t)$

2B, E) $USR = V_o(t)=(1-5te^{-5t}-e^{-5t})u(t)$

2C, F) $h(t)= 25te^{-5t}u(t)$

2D) $H(s)=\frac{25}{(s+5)^2}$

2.4-18a) $c(t)=\begin{cases} 0 & t\le -1 \\ AB(t+1) & -1\le t\le 0 \\ AB & 0\le t\le 1 \\ AB(2-t) & 1\le t\le 2 \\ 0 & 2\le t \end{cases}$

2.4-18c) $c(t)=\begin{cases} 0 & t\le -4 \\ t+4 & -4\le t\le -1 \\ 3 & t\ge -1 \end{cases}$

2.4-18f) $c(t)=\begin{cases} 0 & t\le 0 \\ 1-e^{-t} & 0\le t\le 3 \\ e^{-(t-3)}-e^{-t} & t\ge 3 \end{cases}$

2.4-18g) $c(t)=\begin{cases} 0 & t\le -1 \\ 0.5(1-t)^2 & -1\le t\le 0 \\ 0.5 & t\ge 0 \end{cases}$

13.62) $y(t)=\begin{cases} 0 & t\le 0 \\ (1-e^{-t}) & 0\le t\le 1 \\ (e-1)e^{-t} & t\ge 1 \end{cases}$

13.60b) $y(t)=\begin{cases} 0 & t\le 0 \\ 312.5t & 0\le t\le 10 \\ 3125 & 10\le t\le 20 \\ 312.5(30-t) & 20\le t\le 30 \\ 0 & t\ge 30 \end{cases}$

13.67) $v_o=\begin{cases} 0 & t\le -1 \\ 5t^2+10t+5 & -1\le t\le 4 \\ 50t-75 & 4\le t\le 9 \\ -5t^2+140t-480 & 9\le t\le 14 \\ 500 & 14\le t\le 19 \\ -5t^2+190t-1305 & 19\le t\le 24 \\ -50t+1575 & 24\le t\le 29 \\ 5t^2-340t+5780 & 29\le t\le 34 \\ 0 & 34\le t \end{cases}$