EGR 261 Due date: _____
Signals and Systems (See Due Dates Table)
File: N261H3

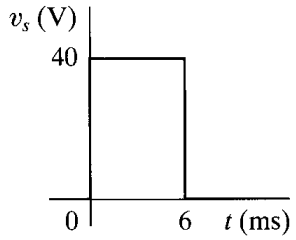
Homework Assignment #3 – Analyzing Circuits with Laplace Transforms

Reading Assignment:

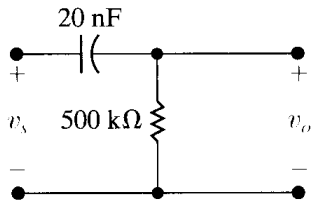
Ch. 13, Sect. 1-5, 7 in *Electric Circuits,9th Edition* by Nilsson
Ch. 4, Sect. 4 in *Linear Signals & Systems, 2nd Ed.* by Lathi
Handout: Laplace Transform Properties and Common Laplace Transform Pairs
Lecture notes

Problem Assignment:

1) Work the following problems from Ch. 13 of *Electric Circuits, 9th Edition* by Nilsson:
   9, 10, 11, 29(a & c only), 46, 50, 57a, 70a (find H(s) then the impulse response, h(t))
2) The voltage waveform is Figure (a) below is applied to the input of the circuit shown in Figure (b) below. The initial voltage on the capacitor is zero.
   A) Write an expression for $v_s(t)$ using unit step functions
   B) Use Laplace transforms to solve for $v_o(t)$
   C) Sketch $v_o(t)$ versus t.

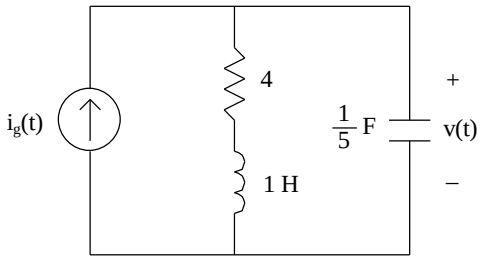


(a)



(b)

3) Work problem 4.4-7 in *Linear Signals & Systems, 2nd Ed.* by Lathi:
4) A) Determine the transfer function H(s) = V(s)/I_g(s) for the circuit shown below.
   B) Determine the impulse response [i.e., find v(t) if $i_g(t) = \delta(t)$ A].
   C) Determine the unit step response [i.e., find v(t) if $i_g(t) = u(t)$ A].



MATLAB Problems (Extra Credit):

Put all problems in a single MATLAB program with an initial block of comments (name, course assignment number, etc) and add a comment identifying each part. Include a printout of the program and the output. Check your results to make sure that they are correct.

1) Solve problem 13-9 using MATLAB. In particular, enter the s-domain equation(s) used to analyze the circuit and solve the equation(s) using ***solve( )***. Use ***ilaplace( )*** to find the corresponding time domain expressions.
2) Repeat for problem 13-10.

Selected Answers:

13.10) $v_o(t) = 137.5 + 80.04e^{-5{,}000t}\cos(5{,}000t + 141.34°)u(t)$ V
or $v_o(t) = 137.5 - e^{-5{,}000t}[62.5\cos(5{,}000t) + 50\sin(5000t)]u(t)$ V

13.11) a) $i_L(0^-) = 5$A, $v_C(0^-) = -70$V b) $V_o(s) = -70(s + 20/7)/(s^2 + 10s + 50)$
c) $v_o(t) = 76.2e^{-5t}\cos(5t - 156.8°)u(t)$ V
or $v_o(t) = e^{-5t}[-70\cos(5t) - 30\sin(5t)]u(t)$ V

13.46) $v_o(t) = 40e^{-5{,}000t}\cos(10{,}000t + 90°)u(t)$ mV $= -40e^{-5{,}000t}\sin(20{,}000t)u(t)$ mV

13.57a) $H(s) = \dfrac{I_o(s)}{I_g(s)} = \dfrac{s^2}{s^2 + 2000s + 5x10^7}$

13.70) a) $H(s) = \dfrac{0.8}{s+1}$, $h(t) = 0.8e^{-t}u(t)$

2) $v_o(t) = 40e^{-100t}u(t) - 40e^{-100(t-0.006)}u(t - 0.006)$ V

4.4-7) $y(t) = e^{-2t}[1.5\cos(3t) - 5/6\sin(3t)]u(t)$ V $= 1.716e^{-2t}\cos(3t + 29.1°)u(t)$ V

3) a) $H(s) = \dfrac{V(s)}{I_g(s)} = \dfrac{5s + 20}{s^2 + 4s + 5}$
b) $v(t) = h(t) = e^{-2t}[5\cos t + 10\sin t]u(t)$ V
c) $v(t) = 4 - e^{-2t}[4\cos t + 3\sin t]u(t)$ V