ECE 202: Linear Circuit Analysis II – Fall 2013

HOMEWORK SET 1: DUE TUESDAY, AUGUST 27, 5 PM IN MSEE 180

ALWAYS CHECK THE ERRATA on the web.

1. (Signal representation and Laplace transforms) Recall that $u(t)$ denotes the unit step function, $r(t) = tu(t)$ the ramp function, and $K\delta(t)$ the so-called delta function with weight or area K. (The delta-function is NOT really a function, but rather a so-called distribution.)

(a) Draw the indicated signals on graph paper or in MATLAB. What do you observe in case (ii)?

(i) $f_1(t) = 4r(t-2) - 2r(t) - r(t-4)$

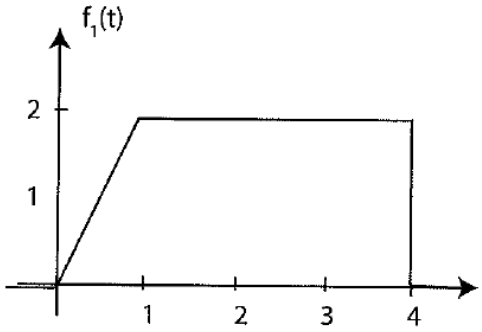
(ii) $f_2(t) = 5u(t+3) - 5u(t-2)$ and $\widetilde{f}_2(t) = 5u(t+3)u(2-t)$

(iii) $f_3(t) = 4r(t+2)u(t+1) - 2r(t+1) + 2u(t)$

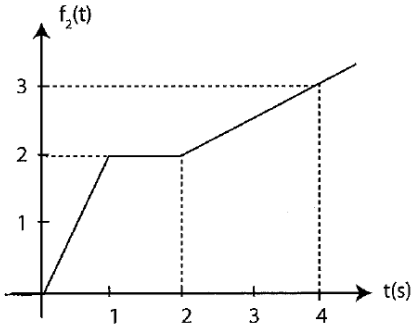
(iv) $f_4(t) = 2\delta(t) - \delta(t-2) - \delta(t+1)$ Hint: delta's are represented by arrows pointing up or down with a parenthetical expression indicating the weight or area of the delta function next to the arrow head.

(b) Represent each of the following signals using (sums of) steps, ramps, *etc*.

(i)

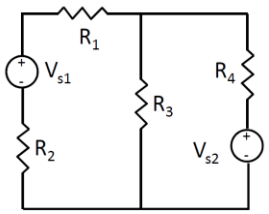


(ii)



2. Using your knowledge of the Laplace transforms of the step and ramp functions in conjunction with linearity and the time shift property, compute the Laplace transforms of each of the signals set forth in problem 1(a) above.

3. **(Laplace transforms with Circuits--A Review)** For the circuit below, find the Laplace transforms of $V_{R1}(s) = \mathcal{L}[v_{R1}(t)]$, where $R_1 = 10\ \Omega$, $R_2 = 5\ \Omega$, $R_3 = 30\ \Omega$, $R_4 = 40\ \Omega$, and the inputs $v_{s1}(t) = 3u(t) - 3u(t-2)$V and $v_{s2}(t) = 109e^{-2t}r(t-2)$ V. This is tricky—you need to make a modification at least one input in order to find the Laplace transforms.



Hint: write a single node equation and solve for the voltage across R_3. With that voltage, $v_{R_1}(t)$ is computed by V-division.

4. Using properties and previously (in class) computed transforms, find the Laplace transform of each of the following signals, USING ONLY THE TABLES AND PROPERTIES:
   (a) $f_1(t) = 3\sin t\, u(t-\pi) - 3\cos t\, u(t-2\pi)$.

   (b) $f_2(t) = 3\delta(t) - 2\delta(t-2)$
   (c) $f_3(t) = \sinh(2t)\, u(t+1)\delta(t) + 10t\delta(2t+4) - 2tu(t)\delta(t-2)$ (Hint: What is the lower limit of the Laplace transform integral, and would that affect the result?)
   (d) $f_4(t) = 12e^{4t}u(t) + 4te^{-3t}u(t-1)$ (Be careful: "t" is NOT "t-1" or "t-2" in the exponential terms. Use properties wherever possible, such as $e^1e^{-1} = 1$)