Name Solutions UW ID#: _____ Section: ___ Version A

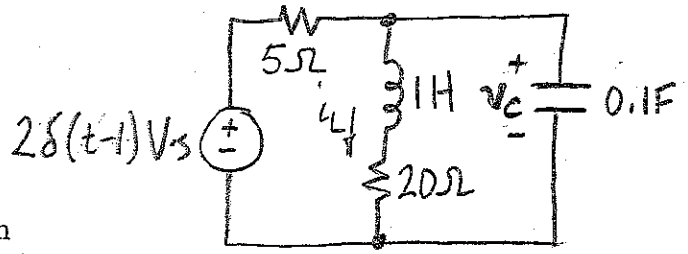
Final Exam — EE 233

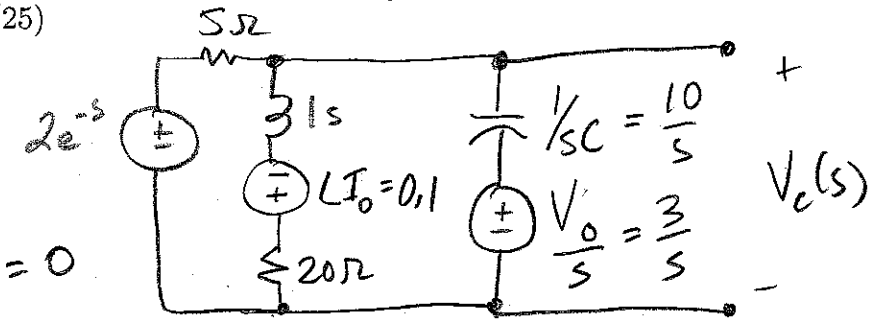
Fall 2006

The test is closed book, with two sheets of 8.5 by 11 inch notes and standard (non-graphing) calculators allowed. Show all work. Be sure to state all assumptions made and **check** them when possible. The number of points per problem are indicated in parentheses. Total of 150 points in 6 problems on 6 pages. A table of Laplace transform pairs are attached as page 7.

1. In the circuit to the right, $v_C = 3\,\text{V}$ and $i_L = 0.1\,\text{A}$ at $t = 0^-$.

   Draw the s-domain circuit valid for $t > 0$ and determine $V_C(s)$. Check your result with the Initial Value Theorem. (25)





$\mathcal{L}\{2\delta(t-1)\} = 2e^{-s}$

$$\frac{V_c - 2e^{-s}}{5} + \frac{V_c + 0.1}{s+20} + \frac{V_c - 3/s}{10/s} = 0$$

$$\frac{(V_c - 2e^{-s})(s+20)(2) + 10(V_c + 0.1) + (sV_c - 3)(s+20)}{10(s+20)} = 0$$

$$V_c\left[2s + 40 + 10 + s^2 + 20s\right] = (4s + 80)e^{-s} - 1 + 3s + 60$$

$$V_c = \frac{(4s+80)e^{-s} + 3s + 59}{s^2 + 22s + 50}$$

$$\lim_{s\to\infty} sV_c(s) = \lim_{s\to\infty}\left[\frac{(4s^2+80s)e^{-s} + 3s^2 + 59s}{s^2 + 22s + 50}\right] = \frac{3s^2}{s^2} = 3 \quad \text{checks}$$

4. Find the time-domain behavior of the following s-domain functions:

(a) $V_1(s) = \dfrac{2s+1}{s+3}$ (10)

$$\frac{2s+1}{s+3} = 2 - \frac{5}{s+3}$$

$$\mathcal{L}^{-1}\left(2 - \frac{5}{s+3}\right) = 2\delta(t) - 5e^{-3t}u(t) = v_1(t)$$

(b) $V_2(s) = \dfrac{10s+5}{s^2+9s+13}$. (15)

roots of $s^2+9s+13$ are $\dfrac{-9 \pm \sqrt{9^2-4(13)}}{2}$

$= -\frac{9}{2} \pm \frac{\sqrt{29}}{2} = -1.81, -7.19$

$$V_2(s) = \frac{K_1}{s+1.81} + \frac{K_2}{s+7.19}$$

$$K_1 = \left.\frac{10s+5}{s^2+9s+13}(s+1.81)\right|_{s=-1.81} = \left.\frac{10s+5}{s+7.19}\right|_{s=-1.81}$$

1.73

$$= \frac{-18.1+5}{-1.81+7.19} = -2.43$$

Check: $s=0$

$$\frac{-2.43}{1.81} + \frac{12.43}{7.19} = 0.38 = \frac{5}{13}$$

$$K_2 = \left.\frac{10s+5}{s+1.81}\right|_{s=-7.19} = \frac{-71.9+5}{-7.19+1.81} = 12.43$$

$$v_2(t) = -2.43e^{-1.81t} + 12.43e^{-7.19t}$$

Check w/ IVT: $\lim_{s\to\infty} sV_2(s) = 10 = v_2(0)$ ✓