EECE301 NETWORK ANALYSIS II **Dr. Charles J. Kim**

Class Note 03: **s-Domain Analysis: Example Problems**

A. s-domain circuit

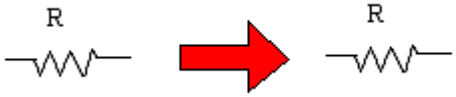
Related operation transformations for inductor/capacitor:

$$L\{f'(t)\} = sF(s) - f(0^-) \text{ and } L\{\int_0^t f(x)dx\} = \frac{F(s)}{s}$$

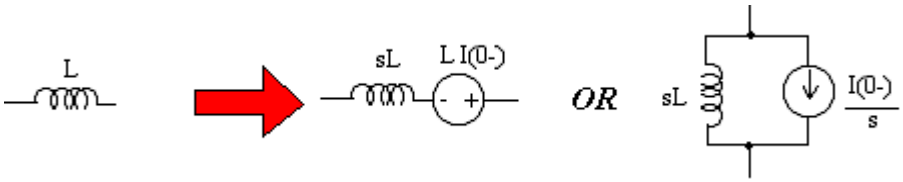
(ex) From $v = L\frac{di}{dt}$, $V(s) = L\{sI(s) - i(0-)\} = sLI(s) - Li(0-)$

Time Domain **S – Domain**

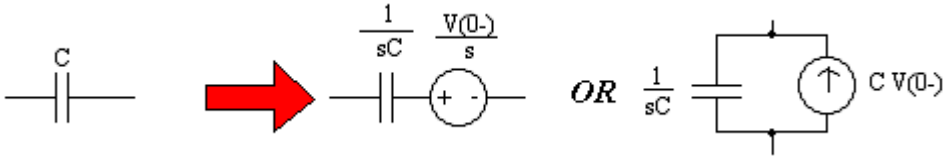
Resistor:



Inductor:

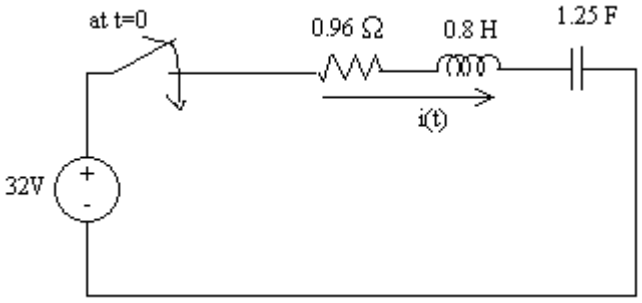


Capacitor:



B. EXAMPLE PROBLEMS:

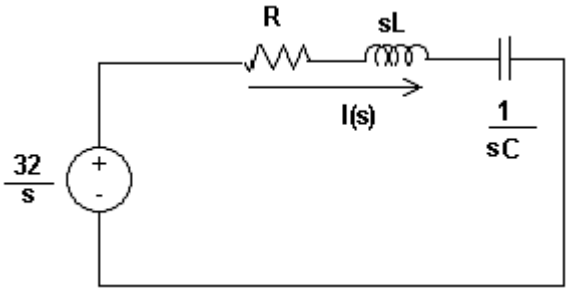
1. The switch in the circuit closed at t=0. Find current i(t) at t>0 using s-domain analysis



SOLUTION

t<0: No initial charge

s-domain circuit:



Equation for I(s): $I(s) = \dfrac{32/s}{R + sL + \dfrac{1}{sC}}$ with R=0.96, L=0.8, and C=1.25, then

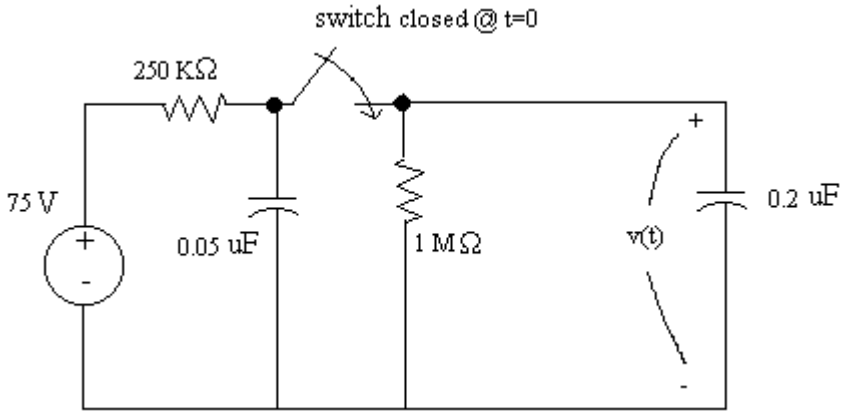
$$I(s) = \frac{32/s}{0.96 + 0.8s + \dfrac{1}{1.25s}} = \frac{40}{s^2 + 1.25s + 1}$$

Now let's change to an entry form:

$$I(s) = \frac{40}{s^2 + 1.2s + 1} = \frac{40}{(s+0.6)^2 + 0.8^2} = \frac{50 \cdot (0.8)}{(s+0.6)^2 + 0.8^2}$$

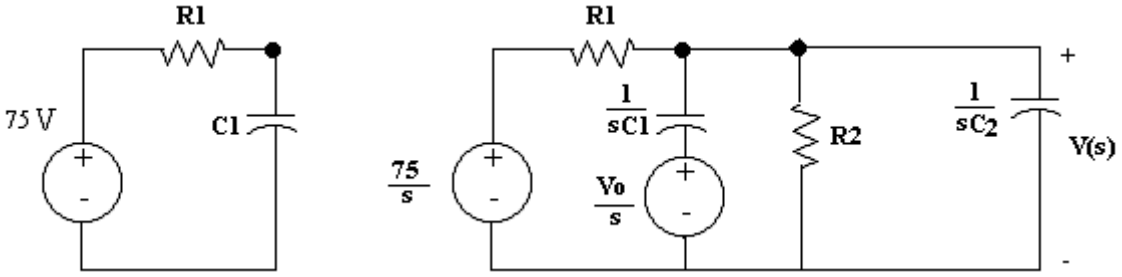
i(t): $i(t) = 50e^{-0.6t} \sin 0.8t$, t>0

2. The switch in the circuit has been opened for a long time. At t = 0 the switch closes. Find voltage v(t) by using s-domain analysis.



SOLUTION

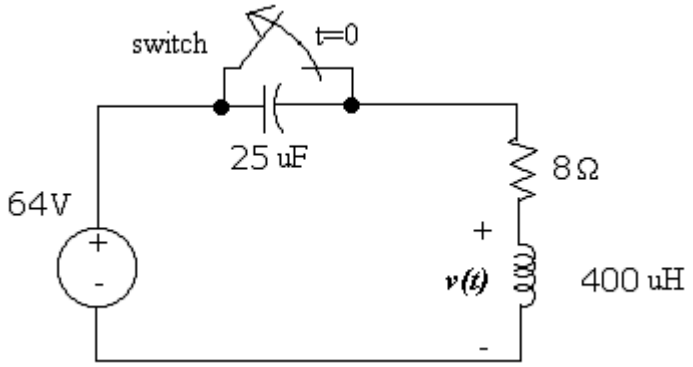
(a) t<0: Initial voltage across the capacitor C1 is, then, 75 [V]. V_o=75.



(b) t>0: s-domain circuit: (See above right)

ANSWER: $v(t) = 60u(t) - 45e^{-20t}$, t>0

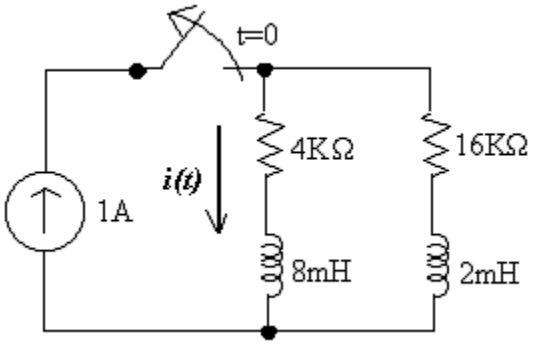
3. The switch in the circuit shown below has been closed for a long time. At t=0, the switch is opened. Find $v(t)$ by inverse Laplace transformation of $V(s)$.



SOLUTION:

ANSWER: $v(t) = -32\times10^{4}\cdot t\cdot e^{-10^{4}t}$, t>0

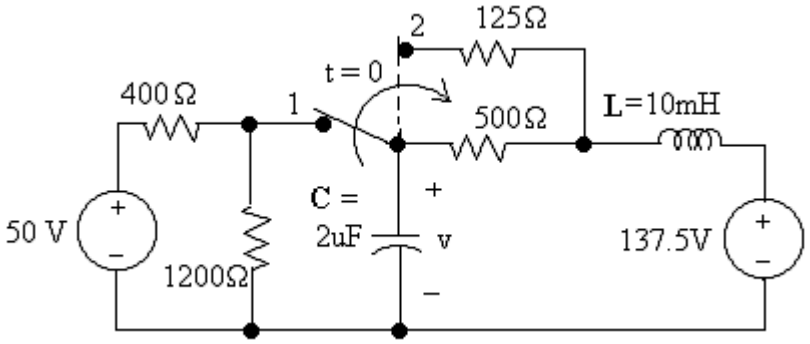
4. The switch below has been closed for a long time. At $t = 0$ the switch opens. Find i(t) by inverse Laplace transformation of I(s).



SOLUTION:

ANSWER $i(t) = 0.6e^{-2\times10^{-6}t}$, t>0

5. The switch in the circuit seen in the figure below has been in position 1 for a long time. At t = 0 it moves instantaneously from 1 to 2 position. Find v(t) by inverse transformation of s-domain voltage $V(s)$



SOLUTION

ANSWER

$$v(t) = 137.5u(t) - 62.5e^{-5000t}\cos 5000t - 50e^{-5000t}\sin 5000t$$

$$= 137.5u(t) - \sqrt{62.5^2 + 50^2}\,e^{-5000t}\cos(5000t - \arctan\frac{50}{62.5})$$

$$= 137.5u(t) - 80e^{-5000t}\cos(5000t - 38^\circ)$$

for t>0