Quiz #16 EE 221 Spring 2019   Name:_____
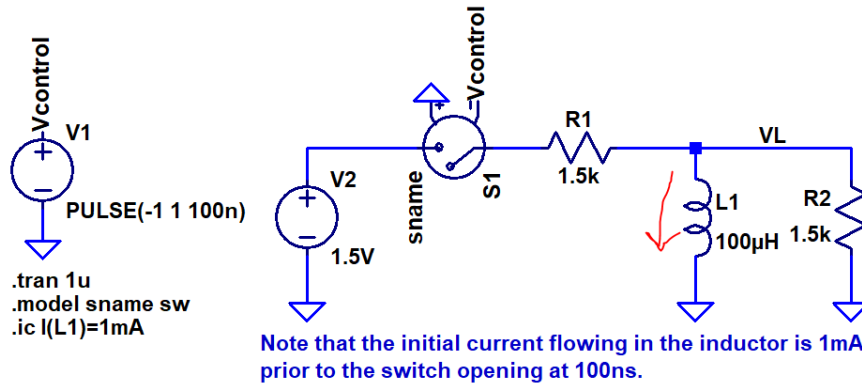Closed book and notes.

Show your work for credit and place a box around each of your answers. Note the information on the back of the quiz!

1. At 100 ns the switch seen below opens. Using the Laplace transform determine, and sketch, the voltage across the inductor from 0 to 1 us. (5 points)

Vcontrol

V1

PULSE(-1 1 100n)

.tran 1u
.model sname sw
.ic I(L1)=1mA

V2

1.5V

sname

S1

-Vcontrol

R1
1.5k

VL

L1
100µH

R2
1.5k

Note that the initial current flowing in the inductor is 1mA prior to the switch opening at 100ns.

12-2.1 Definition of the Laplace Transform

The symbol $\mathcal{L}[f(t)]$ is a short-hand notation for "the Laplace transform of function $f(t)$." Usually denoted $\mathbf{F}(s)$, the Laplace transform is defined by

$$\mathbf{F}(s) = \mathcal{L}[f(t)] = \int_{0^-}^{\infty} f(t)\, e^{-st}\, dt, \qquad (12.10)$$

Table 12-2: Examples of Laplace transform pairs for $T \geq 0$. Note that multiplication by $u(t)$ guarantees that $f(t) = 0$ for $t < 0^-$.

	Laplace Transform Pairs	
	$f(t)$	$\mathbf{F}(s) = \mathcal{L}[f(t)]$
1	$\delta(t)$	1
1a	$\delta(t-T)$	e^{-Ts}
2	1 or $u(t)$	$\dfrac{1}{s}$
2a	$u(t-T)$	$\dfrac{e^{-Ts}}{s}$
3	$e^{-at} u(t)$	$\dfrac{1}{s+a}$
3a	$e^{-a(t-T)} u(t-T)$	$\dfrac{e^{-Ts}}{s+a}$
4	$t\, u(t)$	$\dfrac{1}{s^2}$
4a	$(t-T)\, u(t-T)$	$\dfrac{e^{-Ts}}{s^2}$
5	$t^2\, u(t)$	$\dfrac{2}{s^3}$
6	$t e^{-at} u(t)$	$\dfrac{1}{(s+a)^2}$
7	$t^2 e^{-at} u(t)$	$\dfrac{2}{(s+a)^3}$
8	$t^{n-1} e^{-at} u(t)$	$\dfrac{(n-1)!}{(s+a)^n}$
9	$\sin \omega t\, u(t)$	$\dfrac{\omega}{s^2 + \omega^2}$
10	$\sin(\omega t + \theta)\, u(t)$	$\dfrac{s \sin\theta + \omega \cos\theta}{s^2 + \omega^2}$
11	$\cos \omega t\, u(t)$	$\dfrac{s}{s^2 + \omega^2}$
12	$\cos(\omega t + \theta)\, u(t)$	$\dfrac{s \cos\theta - \omega \sin\theta}{s^2 + \omega^2}$
13	$e^{-at} \sin \omega t\, u(t)$	$\dfrac{\omega}{(s+a)^2 + \omega^2}$
14	$e^{-at} \cos \omega t\, u(t)$	$\dfrac{s+a}{(s+a)^2 + \omega^2}$
15	$2e^{-at} \cos(bt - \theta)\, u(t)$	$\dfrac{e^{j\theta}}{s+a+jb} + \dfrac{e^{-j\theta}}{s+a-jb}$
16	$\dfrac{2t^{n-1}}{(n-1)!} e^{-at} \cos(bt - \theta)\, u(t)$	$\dfrac{e^{j\theta}}{(s+a+jb)^n} + \dfrac{e^{-j\theta}}{(s+a-jb)^n}$

Note: $(n-1)! = (n-1)(n-2)\ldots 1.$