Name_____

EGR 220, Circuit Theory
Exam 2 Nov. 16, 2009

2nd order circuit response – equation parameters

$\alpha \equiv \frac{R}{2\mathrm{L}}$ for series RLC circuits

$\alpha \equiv \frac{1}{2\mathrm{RC}}$ for parallel RLC circuits

$\omega_0 \equiv \frac{1}{\sqrt{LC}}$

2nd order circuit response expressions

$x(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$

$x(t) = (A_1 + A_2 t) e^{-\alpha t}$

$x(t) = e^{-\alpha t}\left(A_1 \cos \omega_d t + A_2 \sin \omega_d t\right)$

… where x(t) can represent any i(t) or v(t) in the circuit.

Quadratic Expression

The roots of a quadratic equation $ax^2 + bx + c = 0$ can be found with

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

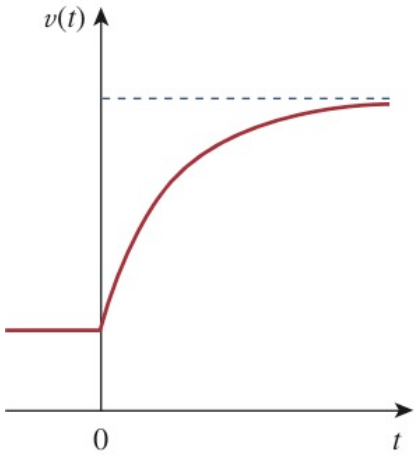
Problem 1a: Discuss the source of phase shifting (6 points)

Briefly state one or two fundamental, physical (as in 'physics') phenomena or causes of voltage and current signal phase shifts relative to each other, in electrical circuits. (One phrase or sentence is fine, **do not use more than two sentences**.)

Problem 1b **(7 points)**

Qualitatively describe any circuit that could produce the output shown below. There is more than one answer – you only need to provide one example.
Include, for example,

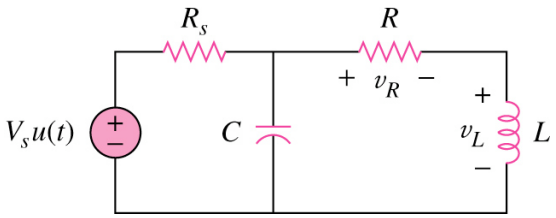
- The number and type of source(s) the circuit could have (do not worry about numerical values, but if you identify more than one source, indicate their *relative* values)
- The number and type of element(s) (resistor, capacitor, inductor, …) the circuit could have
- *Briefly* state the reasoning for the selections you made (a phrase or two is fine)
- **Note that** this question is only looking for a qualitative statement or list of what could be part of the circuit – ***you do NOT need to draw a circuit diagram***

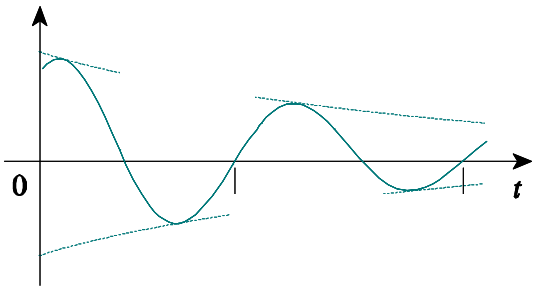


Problem 1c **(7 points)**

A circuit and its response are shown below. The output is oscillating, and it is your task to reduce this oscillatory behavior. State what would you do to reduce this oscillation, and explain why. There is more than one possible answer to this question – you only need to provide one.

i) Which element(s) would you select to change (other than the source)?
ii) Would you increase or decrease the value(s) of the selected element(s)?
iii) *Briefly* explain your answers to parts (i) and (ii) (a phrase or two is fine).

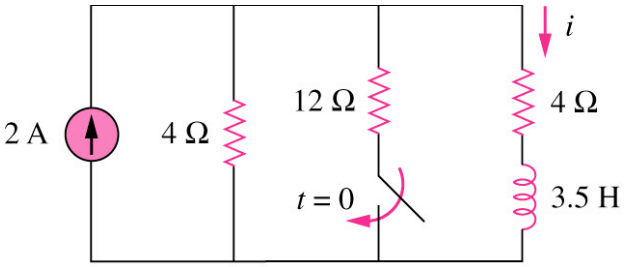




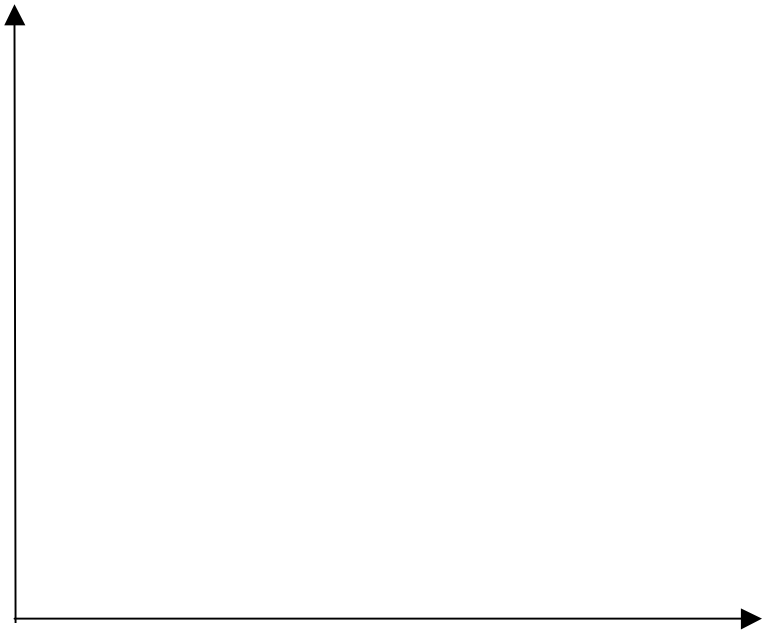
Problem 2: **(20 points)**

Assume the switch in the circuit below has been open for a long time before time t = 0.

a) Find *i(t)*, the current through the inductor, for t > 0 (12 points)
b) Sketch *i(t)* and label relevant parts and points on the graph (next page). (8 points)

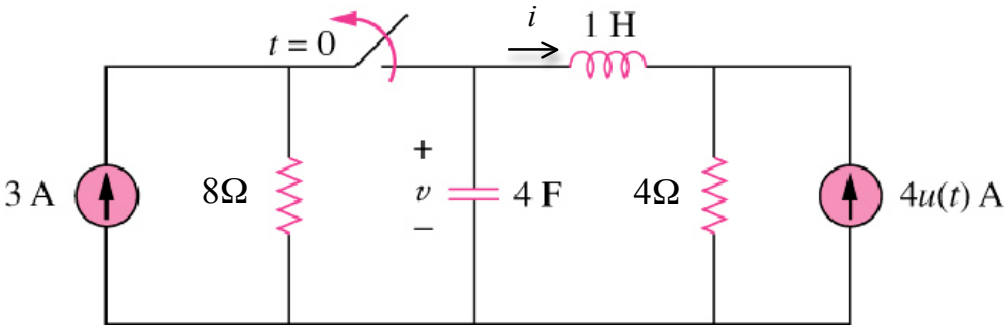


Problem 2 extra space



Problem 3: **(20 points)**

Find the initial conditions, $i_L(0)$, $v_c(0)$, **and** **EITHER** $di_L(0)/dt$ **OR** $dv_c(0)/dt$



Problem 4: **(20 points)**

Find $i(t)$, ***given that***: $di(0)/dt = 0$A/s.