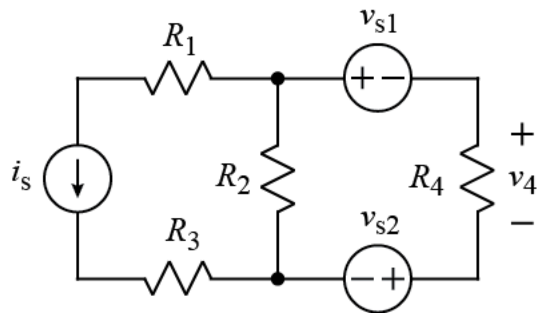
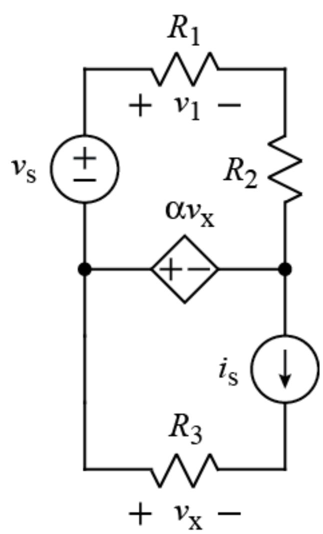
Homework 7

1.



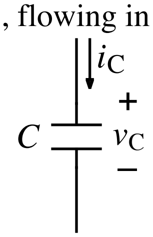
Using superposition, derive an expression for v_4 that contains no circuit quantities other than i_s, v_{s1}, v_{s2}, R_1, R_2, R_3, and R_4.

2.



Using superposition, derive an expression for v_1 that contains no circuit quantities other than i_s, v_s, R_1, R_2, R_3, and α, where $\alpha > 0$.

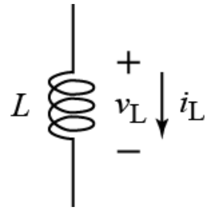
3. In (a) and (b), the voltage $v_C(t)$ across a 30 nF capacitor is listed. Find the current, $i_C(t)$, flowing in the capacitor in each case as a function of time:



a) $v_C(t) = 0 \text{ V}$

b) $v_C(t) = 4\text{ V} + \dfrac{5\text{ Vs}}{1\text{ s} + t}$

4. In (a) and (b), the current $i_L(t)$ flowing into a 20 μH inductor is listed. Find the voltage, $v_L(t)$, across the inductor in each case as a function of time:



a) $i_L(t) = 5$ mA

b) $i_L(t) = 5e^{-t/20\,\text{ms}}$ mA

5. a) The following equation describes the current, i_C, through a capacitor as a function of time. Find an expression for the voltage, $v_C(t)$, across the capacitor as a function of time. Assume that $v_C(t = 0) = 2$ V and $C = 1$ μF.

$$i_C(t) = 5e^{-t/8\,\text{ms}} \text{ mA}$$

b) Using your answer to (a), find the time, t, at which v_C is equal to 40 V.

Answers:

1. $v_4 = \dfrac{-i_s R_2 R_4 - (v_{s1} + v_{s2}) R_4}{R_2 + R_4}$ 2. $v_1 = \dfrac{v_s R_1 - \alpha i_s R_1 R_3}{R_1 + R_2}$

3.a) $i_C = 0\,\text{A}$ b) $i_C = -\dfrac{150}{(1 + t/\text{s})^2}\,\text{nA}$

4.a) $v_L = 0$ V b) $v_L = -5e^{-t/20\,\text{ms}}$ μV

5.a) $v_C(t) = 1\,\text{M/F} \int_0^t 5e^{-t/8\,\text{ms}} \text{mA } dt + 2\,\text{V}$ (compute the integral) b) $t \approx 24\,\text{ms}$