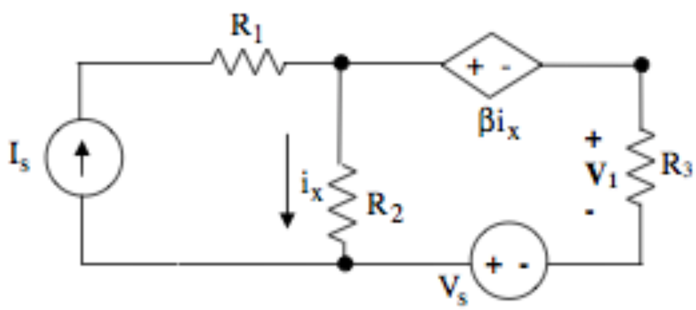
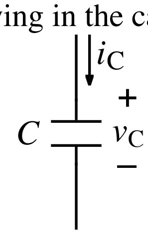
Homework 7

1.



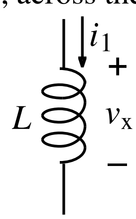
Using superposition, derive an expression for v_1 that contains no circuit quantities other than i_s, v_S, R_1, R_2, R_3, and β, where $\beta < 0$.

2. In (a)-(c), the voltage $v_C(t)$ across a 0.2 μF capacitor is listed. Find the current, $i_C(t)$, flowing in the capacitor in each case as a function of time:



a) $v_C(t) = 3$ V
b) $v_C(t) = 1000t$ V/s
c) $v_C(t) = 1 - e^{-t/4\text{ms}}$ V

3. In (a)-(c), the current $i_L(t)$ flowing into a 0.5 mH 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) $i_L(t) = 5t$ mA/s
c) $i_L(t) = 5\sin(2\pi \cdot 100t)$ mA

4. The following equation describes the voltage, v_C, across a capacitor as a function of time. Find the time, t, at which v_C is equal to 2 V.

$$v_C(t) = 1 + 3(1 - e^{-t/8\text{ms}})\text{ V}$$

5. The following equation describes the voltage, v_L, across an inductor as a function of time. Find an expression for the current, $i_L(t)$, through the inductor as a function of time. Assume that $i_L(t = 0) = 0$ A and $L = 10$ mH.

$$v_L(t) = 2 + 6(1 - e^{-t/12.5\mu s})\ \text{kV}$$

Answers:

1. $v_1 = \left(1 - \frac{\beta}{R_2}\right)\frac{i_s R_2 R_3}{R_2 + R_3 - \beta} + \frac{v_s R_3}{R_2 + R_3 - \beta}$

2.c. $i_C = 50\ \mu\text{A}\ e^{-t/4\text{ms}}$

3.c. $v_L = \frac{\pi}{2}\cos(2\pi \cdot 100t)\ \text{mV}$

4. $t = 3.24\ \text{ms}$

5. Hint: $i_L(t) = \frac{1}{L}\int_0^t \left[2 + 6(1 - e^{-t/12.5\mu\text{s}})\text{kV}\right] dt + 0A$ and compute the integral