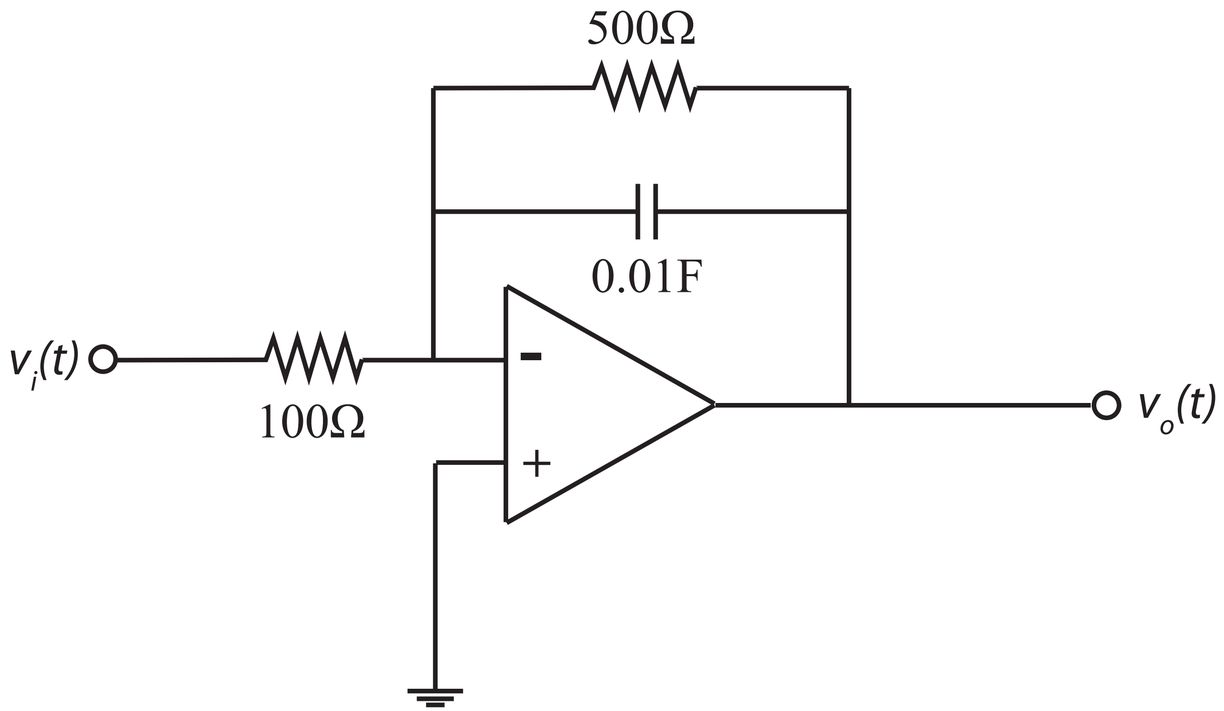
First Order OPAMP Circuits

- Let $v_i(t) = 10\ u(t)$ V, then determine $v_o(t)$



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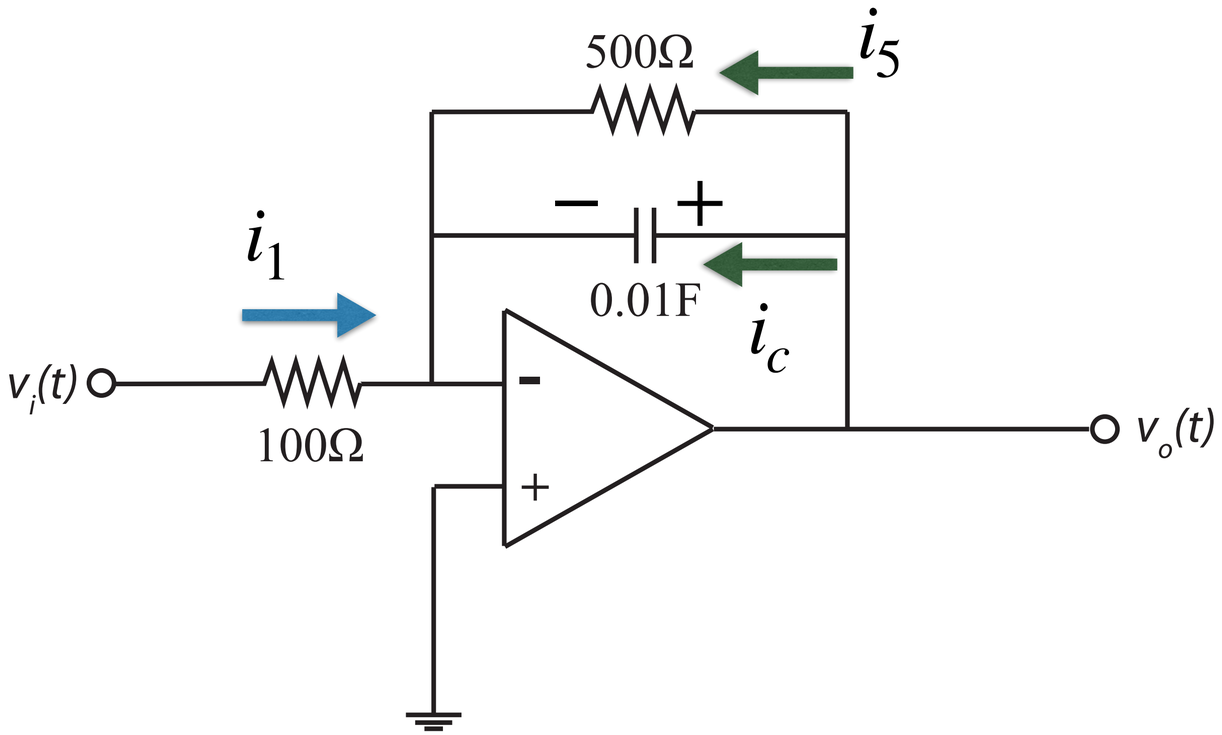

$$V_o = V_c$$

$$i_1 + i_5 + i_c = 0$$

$$\frac{v_i}{R_i} + \frac{v_c}{R_o} + C\frac{dv_c}{dt} = 0$$

$$\frac{dv_c}{dt} + \frac{1}{R_o C}v_c = \frac{-v_i}{CR_i}$$

$$\tau = R_o C = 5s$$

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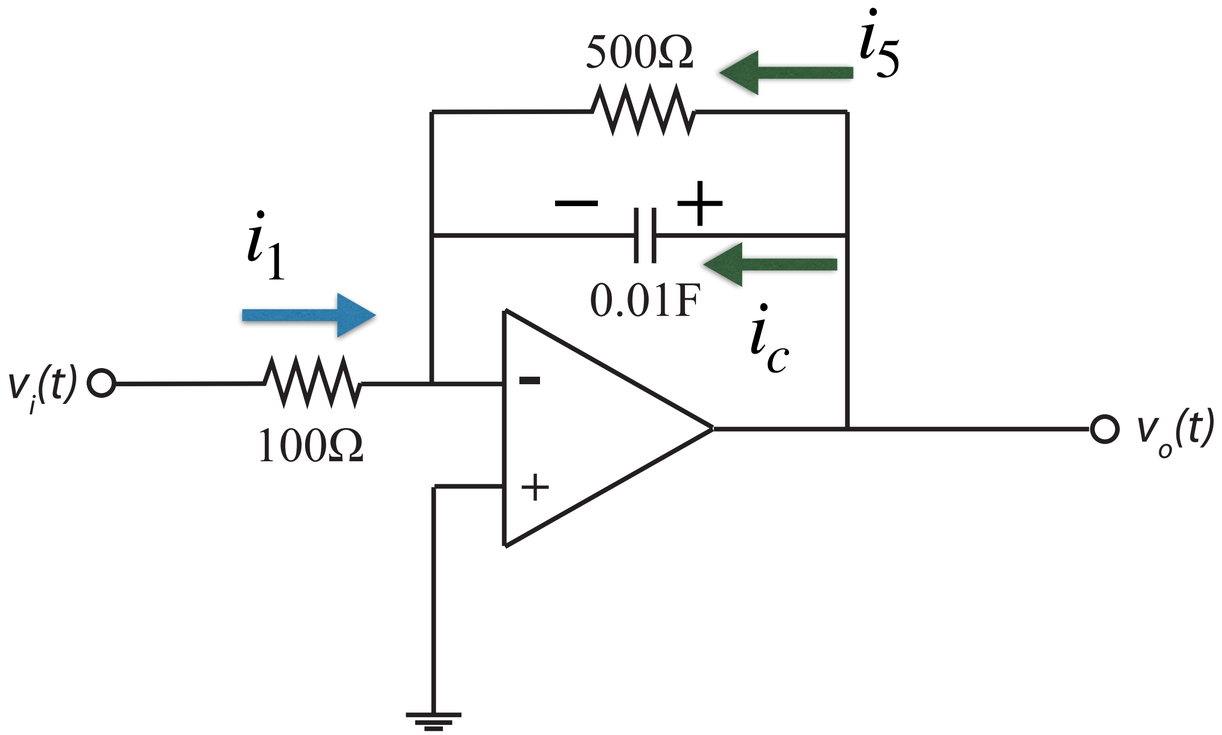

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$$\tau = R_o C = 5s$$

$$V_\infty = 10\frac{-500}{100}V = -50V$$

$$V_o(t) = V_\infty\left(1 - e^{-t/\tau}\right) = 50\left(e^{-t/5} - 1\right)$$

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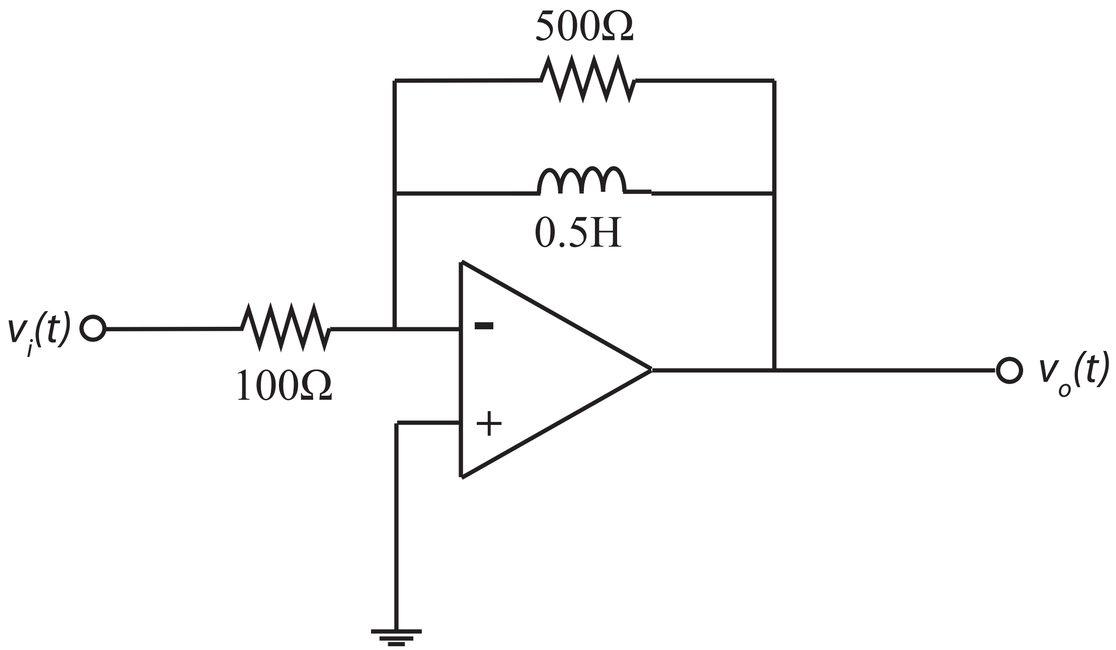

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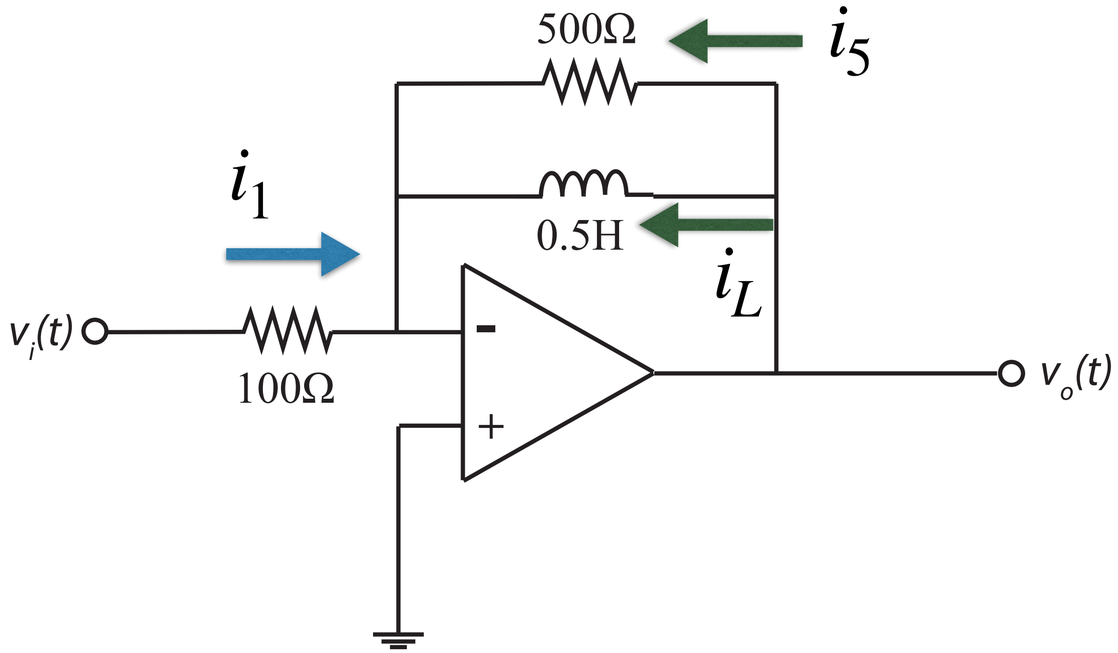

$$V_o = V_L$$

$$i_1 + i_5 + i_L = 0$$

$$\frac{v_i}{R_i} + \frac{v_L}{R_o} + i_L = 0$$

$$\frac{di_L}{dt} + \frac{R_o}{L} i_L = \frac{-v_i \cdot R_o}{R_i \cdot L}$$

$$\tau = \frac{L}{R_o} = \frac{0.5}{500} s = 0.001 s$$

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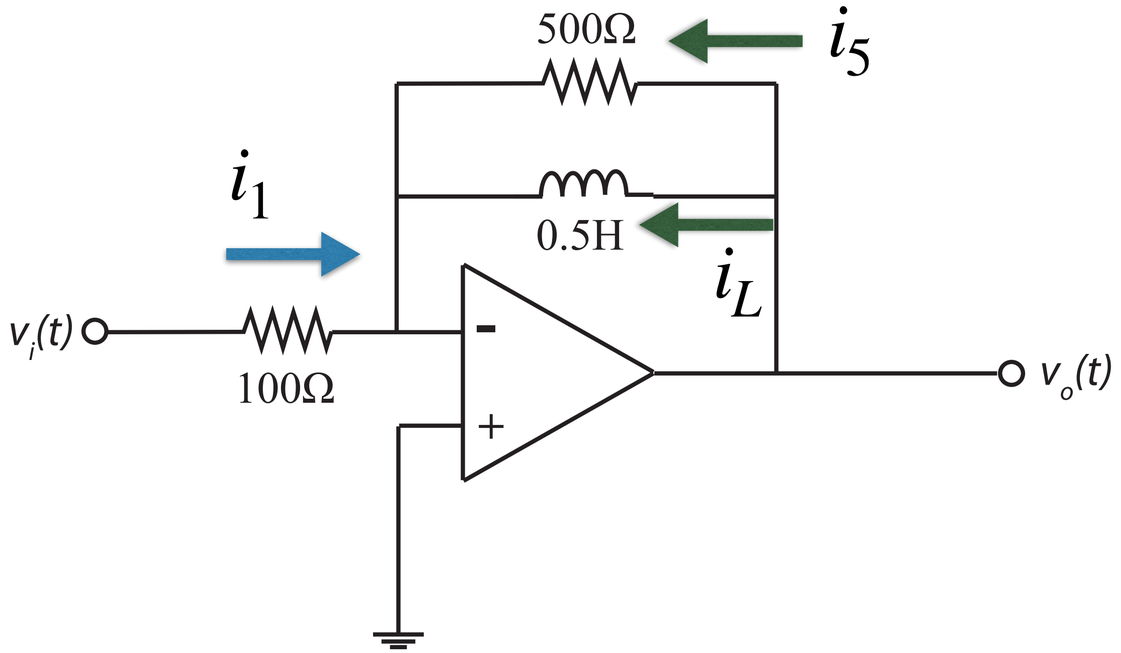

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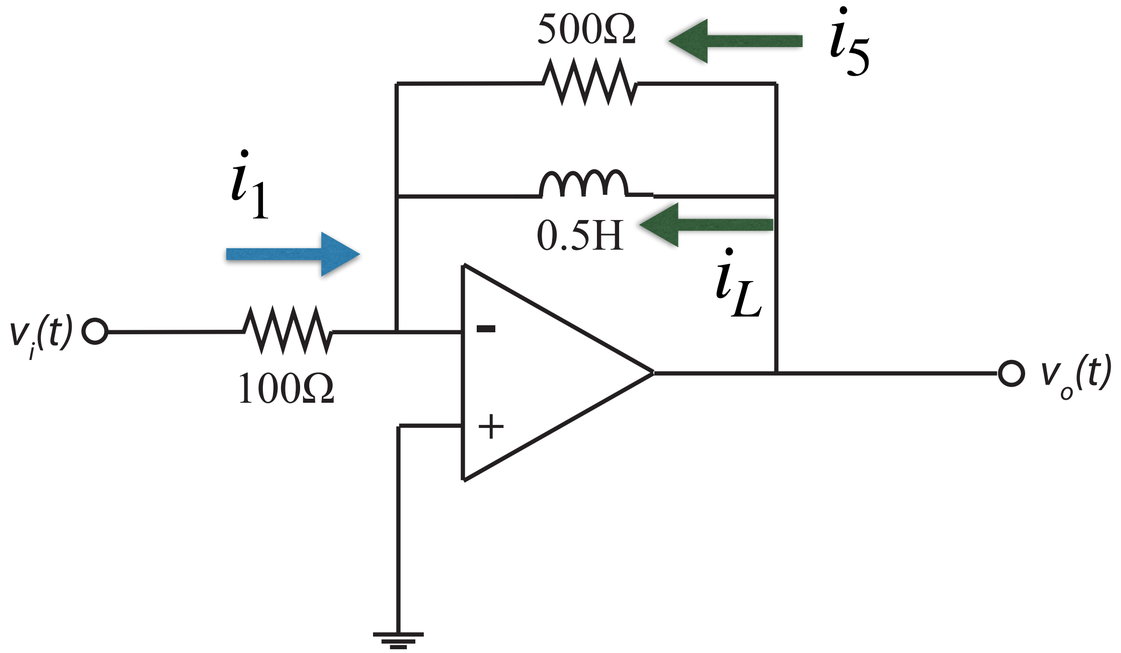

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$$I_L(t) = I_\infty \left(1 - e^{-t/\tau}\right) = 0.1 \left(e^{-1000 \cdot t} - 1\right)$$

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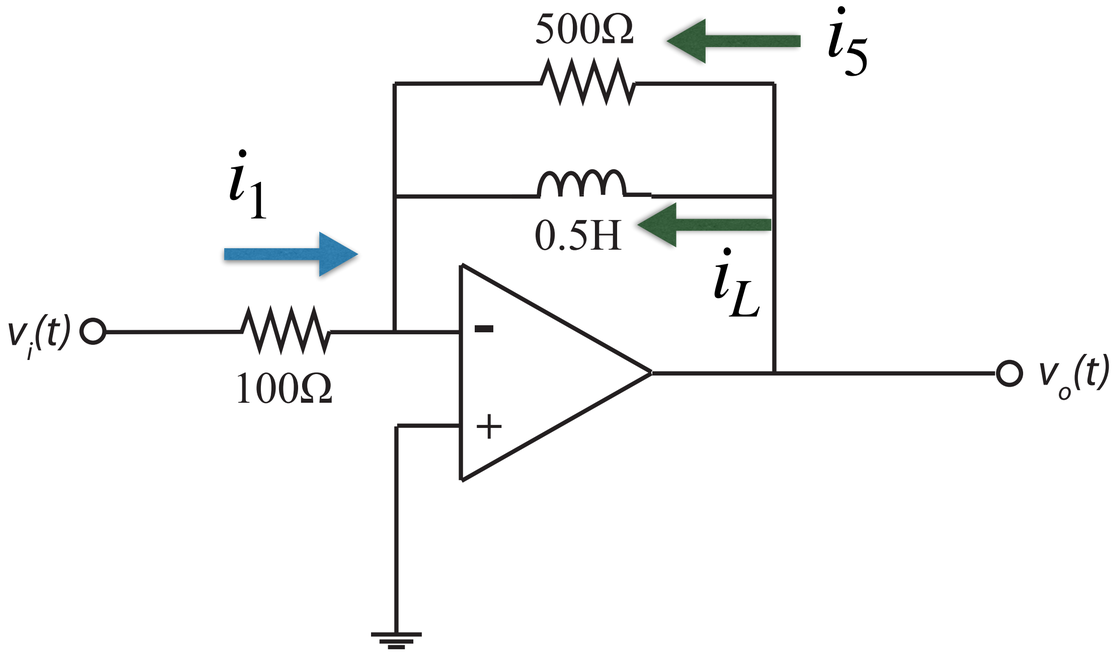

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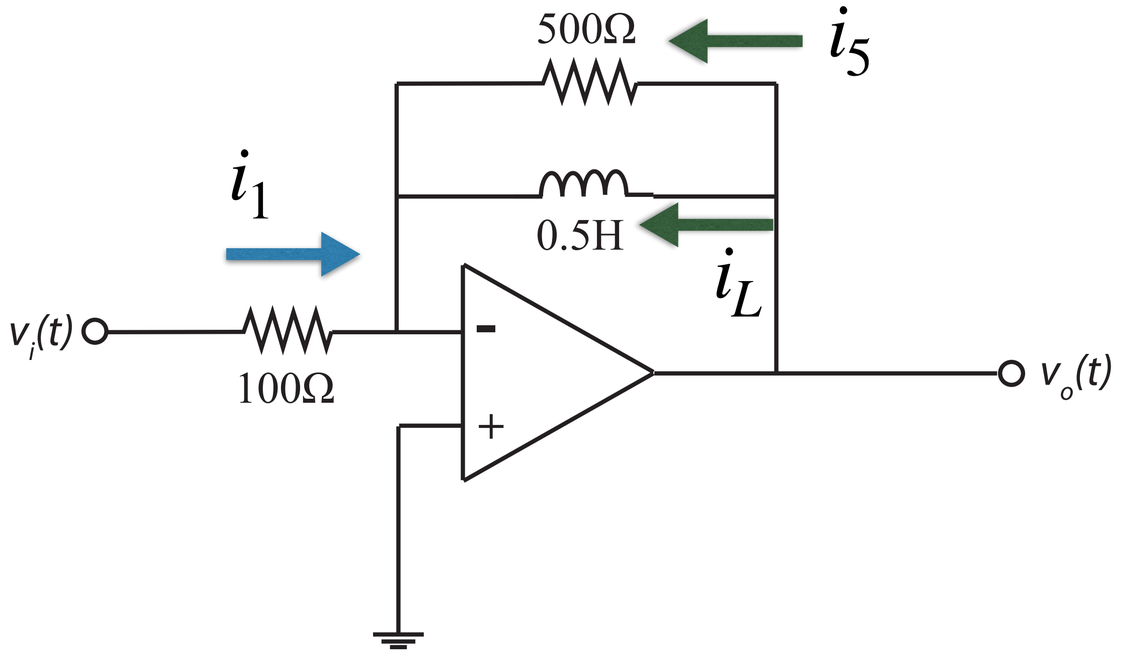

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$$V_o(t) = V_L(t) = L\frac{d}{dr}I_L(t)$$

$$V_o(t) = -50e^{-1000 \cdot t}\, V$$