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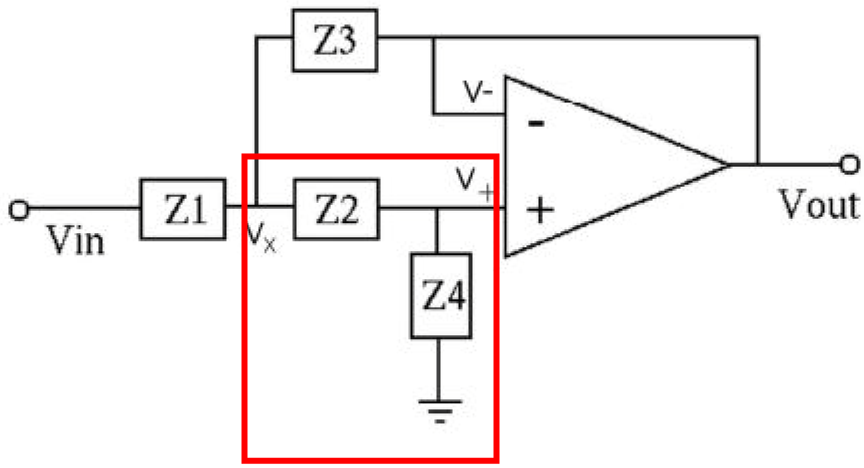
Problem1

a) Consider the circuit below.



from the negative feedback, we know $V_+ = V_- = V_{out}$
KCL at V_x node

$$\frac{V_{in} - V_x}{Z_1} = \frac{V_x - V_{out}}{Z_3} + \frac{V_x - V_{out}}{Z_2} \qquad \text{(5pts)}$$

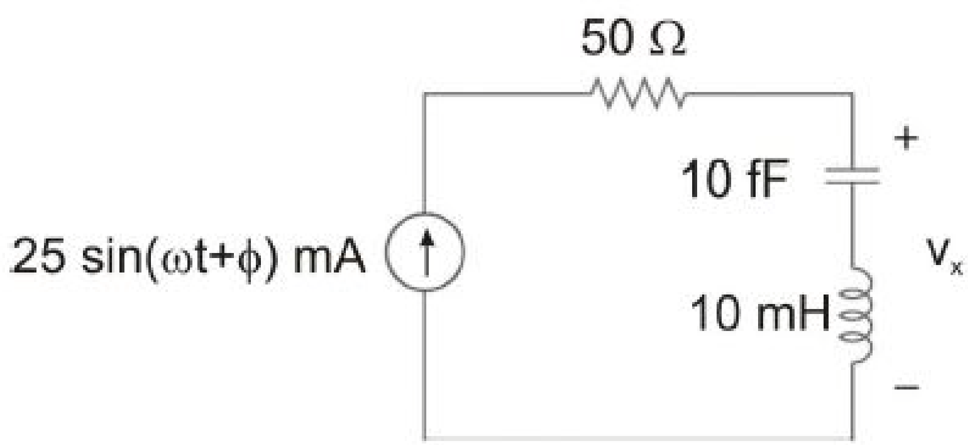
Voltage divider in the red box above with Z_2 & Z_4

$$V_{out} = \left(\frac{Z_4}{Z_2 + Z_4}\right) V_x$$

$$V_x = \frac{Z_2 + Z_4}{Z_4} V_{out} \text{ or}$$

$$V_x = \left(1 + \frac{Z_2}{Z_4}\right) V_{out} \qquad \text{(5pts)}$$

(b) Find ω such that $v_x = 0$ for this circuit at $t = \infty$. *(5 points)*



In order to have

$V_x = 0$, we need to have impedence across V_x should be zero.

$$Z_x(\omega) = Z_c(\omega) + Z_L(\omega) = 0$$

$$Z_x(\omega) = \frac{1}{j\omega C} + j\omega L = 0$$

$$Z_x(\omega) = \frac{-j}{\omega C} + j\omega L = 0$$

$$Z_x(\omega) = j\left(\frac{-1}{\omega C} + \omega L\right) = 0$$

$$Z_x(\omega) = 0 \text{ when } \left(\frac{-1}{\omega C} + \omega L\right) = 0$$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10 \times 10^{-15} \times 10 \times 10^{-3}}} = \frac{1}{\sqrt{1 \times 10^{-16}}}$$

$$\omega = 1 \times 10^{8}\, \frac{rad}{s}$$ (5pts)