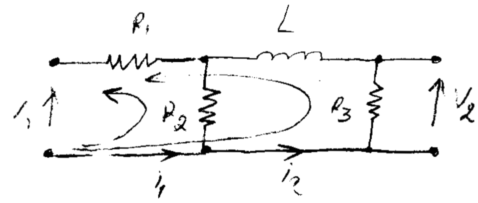
2)



$G(s) = \frac{V_2(s)}{V_1(s)} = ?$ ③

applying Cramer's rule

loop 1: $-V_1 = R_1 i_1 + R_2(i_1 - i_2)$

loop 2: $-V_1 = R_1 i_1 + (R_3 + Ls) i_2$

$$\Rightarrow \begin{bmatrix} R_1 + R_2 & -R_2 \\ R_1 & R_3 + Ls \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} -V_1 \\ -V_1 \end{bmatrix} \Rightarrow i_2 = \frac{\begin{vmatrix} R_1 + R_2 & -V_1 \\ R_1 & -V_1 \end{vmatrix}}{\begin{vmatrix} R_1 + R_2 & -R_2 \\ R_1 & R_3 + Ls \end{vmatrix}} =$$

$$= \frac{-R_2 V_1}{L_1 (R_1 + R_2) s + R_1 R_3 + R_2 R_3 + R_1 R_2} \Rightarrow -V_1 = \frac{L_1 (R_1 + R_2) s + R_1 R_3 + R_2 R_3 + R_1 R_2}{R_2} i_2$$

$V_2 = -R_3 i_2$

$$\Rightarrow G(s) = \frac{-V_2(s)}{-V_1(s)} = \frac{R_3 \cdot R_2}{L_1 (R_1 + R_2) s + R_1 R_3 + R_2 R_3 + R_1 R_2}$$

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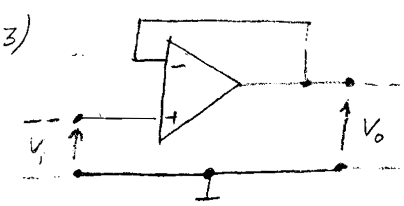
3)



$G(s) = \frac{V_o(s)}{V_i(s)} = ?$ ①

$V_+ = V_i$, $V_+ = V_-$ (for op-amp), $\Rightarrow$

$\Rightarrow V_- = V_i$, $V_o = V_- \Rightarrow V_o = V_i \Rightarrow$

$$G(s) = \frac{V_o}{V_i} = \frac{V_i}{V_i} = 1$$

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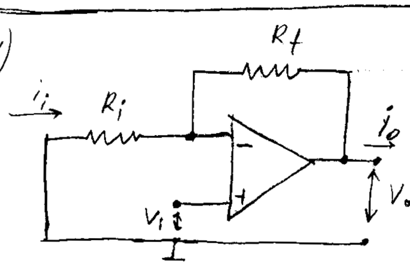
4)



$G(s) = \frac{V_o}{V_i} = ?$ ①

$V_+ = V_i$

$V_o = V_- - i_o R_f$, $V_- = -R_i \cdot i_i \Rightarrow$

$V_o = -R_i i_i - R_f i_o$

for op-amp $i_o = i_i$, $V_+ = V_-$ $\Rightarrow G(s) = \frac{V_o}{V_i} = \frac{-R_i i - R_f i}{-R_i i} = 1 + \frac{R_f}{R_i}$