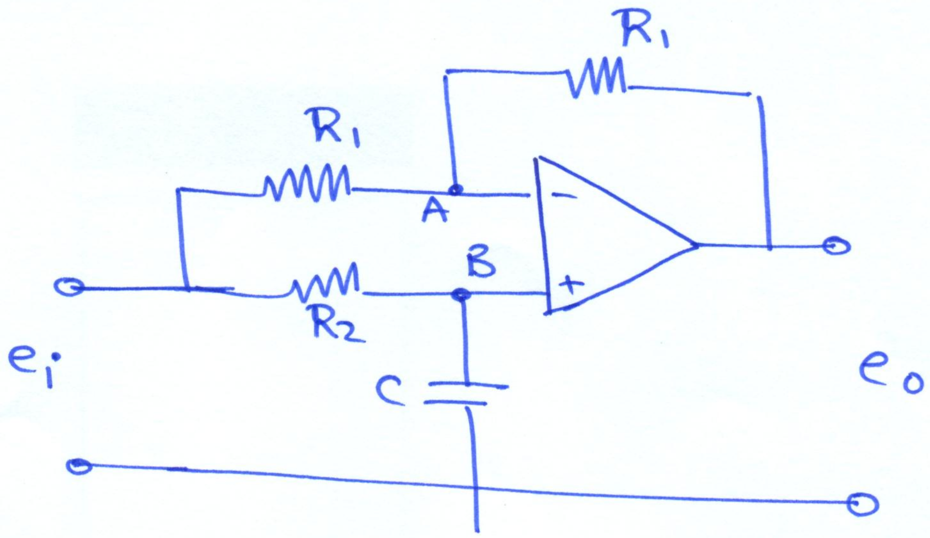
Find $\dfrac{E_o(s)}{E_i(s)}$

Sol.

$E_A = E_B$



$$\frac{E_i - E_A}{R_1} = \frac{E_A - E_o}{R_1}$$

$$\therefore \; E_i - E_A = E_A - E_o$$

$$E_A = \frac{1}{2}(E_i + E_o)$$

$$E_B = E_i \times \frac{1/sC}{R_2 + 1/sC}$$

$$= E_i \, \frac{1}{R_2Cs + 1}$$

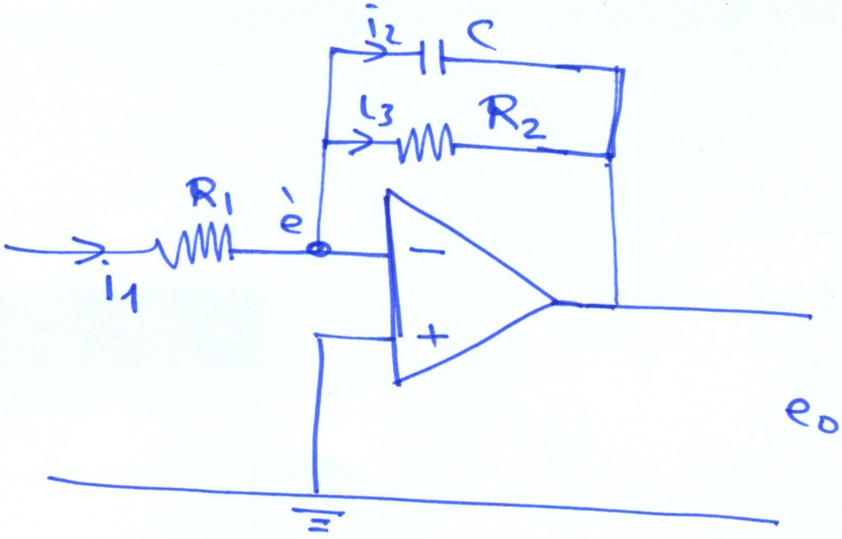
$$\therefore \; E_A = E_B$$

$$\therefore \; \frac{1}{2}(E_i + E_o) = E_i \, \frac{1}{R_2Cs + 1}$$

$$E_o = E_i \left(\frac{2}{R_2Cs + 1} - 1 \right)$$

$$E_o = E_i \left(\frac{1 - R_2Cs}{1 + R_2Cs} \right) \Rightarrow \frac{E_o}{E_i} = \frac{s - \frac{1}{R_2C}}{s + \frac{1}{R_2C}}$$

Find $\frac{E_o(s)}{E_i(s)}$



Sol.

$\therefore V^- = V^+$

$\therefore V^+ = 0$

$\therefore V^- = 0$

$\therefore V^- = \grave{e} = 0$

$\therefore i_1 = i_2 + i_3$

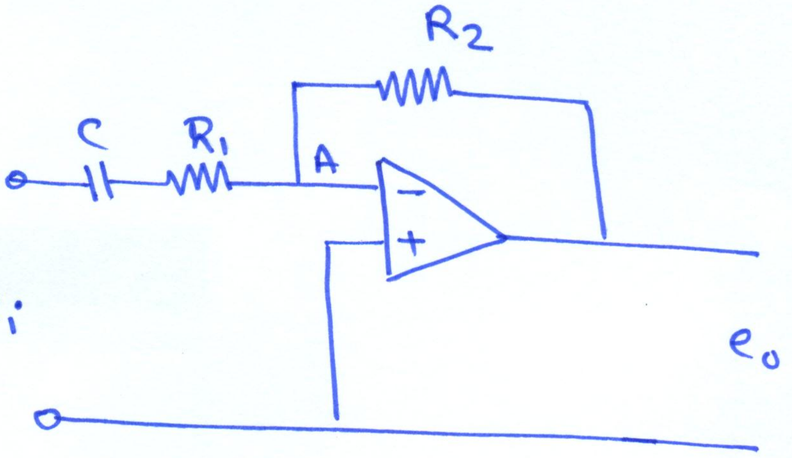
$$\frac{E_i}{R_1} = \frac{-E_o}{R_2} - CSE_o$$

$$\frac{E_i}{R_1} = -E_o\left(\frac{1}{R_2} + CS\right) = -E_o\left(\frac{1 + CR_2 S}{R_2}\right)$$

$$\therefore \frac{E_o}{E_i} = \frac{-R_2}{R_1} \frac{1}{1 + R_2 CS}$$

Prob. Find $\frac{E_o(s)}{E_i(s)}$

Sol.



$$E_A = 0$$

$$\frac{E_i - E_A}{R_1 + 1/sC} = \frac{E_A - E_o}{R_2}$$

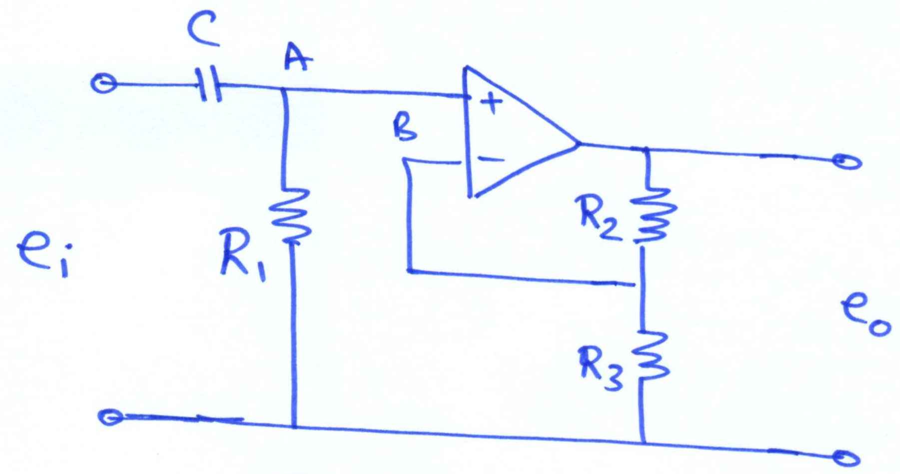
$$\because E_A = 0$$

$$\therefore \frac{E_i}{R_1 + 1/sC} = \frac{-E_o}{R_2}$$

$$\therefore \frac{E_o}{E_i} = \frac{-R_2}{R_1 + 1/sC} = \frac{-R_2 C s}{1 + R_1 C s}$$

Prob.

Find $\frac{E_o}{E_i}$



Sol.

$$E_A = E_B$$

$$E_A = E_i \frac{R_1}{R_1 + 1/sC} = E_i \frac{R_1 C s}{1 + R_1 C s}$$

$$E_B = E_o \frac{R_3}{R_2 + R_3}$$

$$\therefore \; E_i \frac{R_1 C s}{1 + R_1 C s} = E_o \frac{R_3}{R_2 + R_3}$$

$$\therefore \; \frac{E_o}{E_i} = \frac{R_1 C s}{1 + R_1 C s} * \frac{R_2 + R_3}{R_3}$$

$$\frac{E_o}{E_i} = \frac{R_1 (R_2 + R_3)}{R_3} * \frac{C s}{1 + R_1 C s}$$

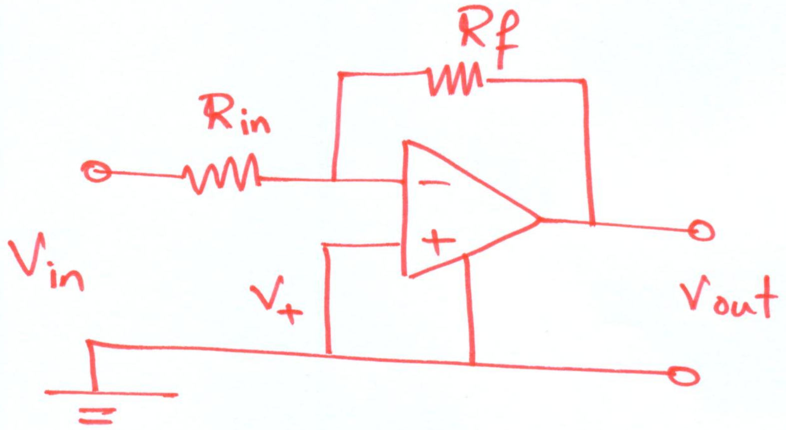
Prob.

A First step toward a realistic model of an op-amp is given by the following equations and is shown in fig. below

$$V_{out} = \frac{10^7}{s+3}(V_+ - V_-)$$

$$I_+ = I_- = 0$$

Find the transfer function of the simple amplification circuit shown using this model



Sol.

$$\frac{V_{in} - V_-}{R_{in}} = \frac{V_- - V_{out}}{R_f}$$

$$V_{in} - V_- = \frac{R_{in}}{R_f}(V_- - V_{out})$$

$$V_{in} + \frac{R_{in}}{R_f} V_{out} = V_- \left(\frac{R_{in}}{R_f} + 1 \right)$$

$$= V_- \left(\frac{R_{in} + R_f}{R_f} \right)$$

$$\therefore V_- = R_f/(R_{in} + R_f) * \left(V_{in} + \frac{R_{in}}{R_f} V_{out} \right)$$

$$\therefore V_- = \left(\frac{R_f}{R_{in}+R_f}\right) * \left(V_{in} + \frac{R_{in}}{R_f} V_{out}\right)$$

$$V_- = \frac{R_f}{R_{in}+R_f} V_{in} + \frac{R_{in}}{R_{in}+R_f} V_{out}$$

$$\therefore V_{out} = \frac{10^7}{S+3}\left(V_+ - V_-\right)$$

$$\because V_+ = 0$$

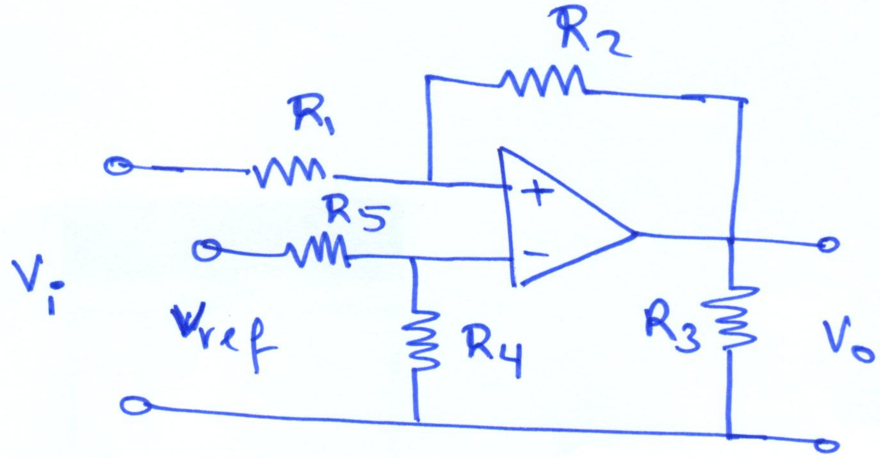
$$\therefore V_{out} = -\frac{10^7}{S+3}\left(\frac{R_f}{R_{in}+R_f} V_{in} + \frac{R_{in}}{R_{in}+R_f} V_{out}\right)$$

$$V_{out}\left(1 + \frac{10^7}{S+3} * \frac{R_{in}}{R_{in}+R_f}\right) = \frac{-10^7}{S+3} \frac{R_f}{R_{in}+R_f} V_{in}$$

$$V_{out}\left(\frac{(S+3)(R_{in}+R_f) + 10^7 R_{in}}{(S+3)(R_{in}+R_f)}\right) = \frac{-10^7 R_f}{(S+3)(R_{in}+R_f)} V_{in}$$

$$\therefore \frac{V_{out}}{V_{in}} = \frac{-10^7 R_f}{(S+3)(R_{in}+R_f) + 10^7 R_{in}}$$

Prob.



$$\frac{V_i - V^+}{R_1} = \frac{V^+ - V_o}{R_2} = \frac{V_o}{R_3}$$

$$\frac{V_i - V^+}{R_1} = \frac{V^+ - V_o}{R_2}$$

$$V_i - V^+ = \frac{R_1}{R_2}\left(V^+ - V_o\right)$$

$$\left(V_i + \frac{R_1}{R_2} V_o\right) = V^+\left(\frac{R_1}{R_2} + 1\right)$$

$$= V^+ \frac{R_1 + R_2}{R_2}$$

$$\therefore V^+ = \frac{R_2}{R_1 + R_2} V_{in} + \frac{R_1}{R_1 + R_2} V_o$$

$$\therefore V^- = V_{ref} \frac{R_4}{R_4 + R_5}$$

$$\therefore V_{ref} \frac{R_4}{R_4 + R_5} = \frac{R_2}{R_1 + R_2} V_{in} + \frac{R_1}{R_1 + R_2} V_o$$

$$\therefore V_o = -\frac{R_2}{R_1} V_{in} + \frac{R_4(R_1 + R_2)}{R_1(R_4 + R_5)} V_{ref}$$