8.4

nominal gain = 4

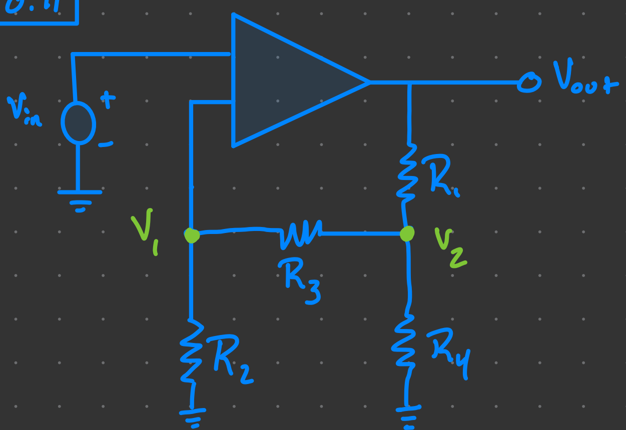
gain error = 0.1%

minimum required

$$\text{op-Amp Gain} = 4\left(1 - \frac{0.1}{100}\right)$$

$$= 3.996$$

8.11



$$\text{Node 1: } \frac{V_1 - 0}{R_2} + \frac{V_1 - V_2}{R_4} \Rightarrow V_2 = V_{in}\left(1 + \frac{R_4}{R_2}\right)$$

$$\text{Node 2: } \frac{V_2 - 0}{R_4} + \frac{V_2 - V_1}{R_3} + \frac{V_2 - V_{out}}{R_1} = 0$$

$$V_2\left(\frac{1}{R_4} + \frac{1}{R_3} + \frac{1}{R_1}\right) - V_{in} \cdot \frac{1}{R_3} = \frac{V_{out}}{R_1}$$

$$V_{out} = V_2\left(1 + \frac{R_1}{R_3} + \frac{R_1}{R_4}\right) - V_{in} \cdot \frac{R_1}{R_3}$$

$$V_{out} = V_{in}\left[\frac{(R_2 + R_4)(R_3 \cdot R_4 + R_1 \cdot R_4 + R_1 \cdot R_3)}{R_2 \cdot R_3 \cdot R_4} - \frac{R_1}{R_3}\right]$$

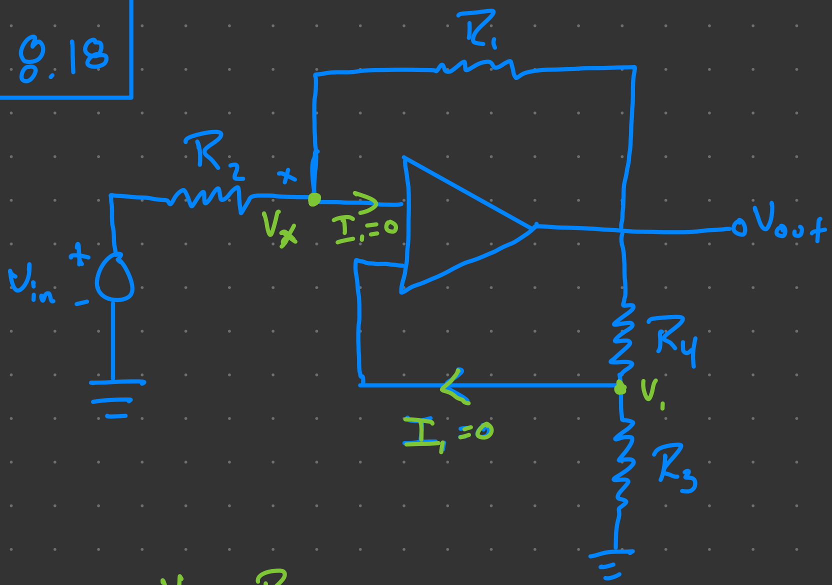
$$\boxed{\frac{V_{out}}{V_{in}} = \frac{R_1 \cdot R_2 \cdot R_3 + R_4\left[R_2 R_3 + R_1 R_3 + R_1 \cdot R_4 + R_3 R_4\right]}{R_2 R_3 R_4}}$$

① $R_1 \to 0$

$$\frac{V_{out}}{V_{in}} = \frac{R_4 \, R_2 \cdot R_3 + R_3 \cdot R_4 \cdot R_4}{R_2 \cdot R_3 \cdot R_4} = \frac{R_2 + R_4}{R_2}$$

② $R_3 \to 0$ $\quad \frac{V_{out}}{V_{in}} = \infty$

8.18



$$V_1 = \frac{V_{out} \cdot R_3}{R_4 + R_3}$$

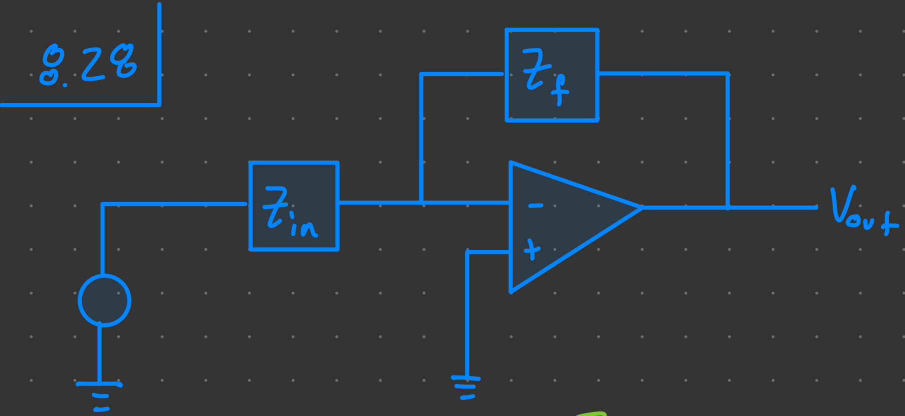
$$\frac{V_x - V_{in}}{R_2} + \frac{V_x - V_{out}}{R_1} = 0$$

$$V_x \left[\frac{1}{R_2} + \frac{1}{R_1} \right] - \frac{V_{in}}{R_2} - \frac{V_{out}}{R_1} = 0$$

$$V_{out} \left[\frac{R_3}{R_4 + R_3} \left(\frac{R_1 + R_2}{R_1 R_2} \right) - \frac{1}{R_1} \right] = \frac{V_{in}}{R_2}$$

$$\frac{V_{out}}{V_{in}} = \frac{\frac{1}{R_2}}{\frac{R_3}{R_4 + R_3} \left[\frac{R_1 + R_2}{R_1 \cdot R_2} \right] - \frac{1}{R_1}} = \boxed{\frac{R_1 \left[R_4 + R_3 \right]}{R_1^2 R_3 - R_1 R_2 R_4}}$$

8.28



$$\frac{V_{out}}{V_{in}} = \frac{-Z_f}{Z_{in}} = \frac{-R_2}{j\omega R_2 C_2 + 1} \cdot \frac{j\omega R_1 C_1 + 1}{R_1}$$

$$\left|\frac{V_{out}}{V_{in}}\right| = \frac{R_2}{R_1} \cdot \frac{\sqrt{(\omega R_1 C_1)^2 + 1}}{\sqrt{(\omega R_2 C_2)^2 + 1}}$$

$$\frac{\sqrt{(\omega R_1 C_1)^2 + 1}}{\sqrt{(\omega R_2 C_2)^2 + 1}} = 1 \quad \& \quad \frac{R_2}{R_1} = 1$$

$$\boxed{R_2 = R_1}$$

$$(\omega R_1 C_1)^2 + 1 = (\omega R_2 C_2)^2 + 1$$

$$\boxed{R_1 C_1 = R_2 C_2}$$

8.59

$$\left|\frac{dV_o}{dt}\right| > \text{Slew Rate}$$

$$V_o = V_{om} \sin W_o t$$

$$\frac{dV_o}{dt} = V_{om} \sin W_o t \cdot W_o$$

$$\left|\frac{dV_o}{dt}\right| = V_{om} W_o$$

$$V_{om} = G\, V_{in}$$

$$G V_{in} \cdot W_o < {}^{1V}/_{10^{-9}}$$

$$W_o < {}^{10^{-9}}/_{4 \times 0.5}$$

$$\boxed{f = \frac{10^{-9}}{4\pi} = 7.96 \times 10^{7}\, Hz}$$