13. KCL: \[ I_- + I_s + I_f = 0 \quad +0.5 \]

\[ V_A = V_{\text{ref}} \quad +0.5 \]

\[ V_- = V_+ \]

\[ \frac{V_{\text{ref}} - V_{\text{in}}}{R_s} + \frac{V_{\text{ref}} - V_{\text{out}}}{R_f} = 0 \]

\[ \frac{V_{\text{ref}} - V_{\text{out}}}{R_f} = \frac{V_{\text{in}} - V_{\text{ref}}}{R_s} \]

\[ V_{\text{ref}} - V_{\text{out}} = \frac{R_f}{R_s} (V_{\text{in}} - V_{\text{ref}}) \]

\[ V_{\text{out}} = V_{\text{ref}} - \frac{R_f}{R_s} (V_{\text{in}} - V_{\text{ref}}) \]

\[ V_{\text{out}} = V_{\text{ref}} \left[ 1 + \frac{R_f}{R_s} \right] - \frac{R_f}{R_s} \cdot V_{\text{in}} \]

14. If \( V_{\text{ref}} = 0 \), \( V_{\text{out}} = -\frac{R_f}{R_s} \cdot V_{\text{in}} \quad +0.5 \)

So use \( + \cos \omega t = + \frac{R_f}{R_s} \cdot 0.1 \cdot \cos \omega t \)

\[ R_s = 0.1 \cdot R_f \quad +1 \]

\[ R_s = 10 \text{ M} \Omega \]

\[ R_f = 100 \text{ k} \Omega \]
15. Use full eqn. from #13

\[- \cos \omega t = V_{\text{ref}} \left[ 1 + \frac{100 \text{ k}\Omega}{10 \text{ k}\Omega} \right] - \frac{100 \text{ k}\Omega}{10 \text{ k}\Omega} \left[ 0.1 \cos \omega t + 1.8 \right] \]

\[- \cos \omega t = V_{\text{ref}} \left[ 1 + 10 \right] - 10 \left[ 0.1 \cos \omega t + 1.8 \right] \]

\[- \cos \omega t = 11 \ V_{\text{ref}} - \cos \omega t - 18 \]

\[11 \ V_{\text{ref}} = 18 \]

\[V_{\text{ref}} = \frac{18}{11} = 1.64 \ \text{V} \]

16.

\[\frac{I_1}{10 \text{ k}\Omega} \to \frac{I_2}{100 \text{ k}\Omega} \to V_- \to I_{\text{amp}} \to 1 \text{ MR} \to I_3 \to 10 \\text{T} \to 10,000 \ V_{\text{amp}} \]

17. \[V_+ = 0 \]

KCL at \( V_- \) \( \Rightarrow \) \( I_{\text{amp}} + I_1 + I_2 = 0 \)

at \( V_{\text{out}} \) \( \Rightarrow \) \( I_2 = I_3 \)

\[\frac{0 - V_-}{10^6} + \frac{10 - V_-}{10,000} + \frac{V_{\text{out}} - V_-}{100,000} = 0 \]

\[\frac{V_{\text{out}} - V_-}{100,000} = \frac{10,000 (0 - V_-) - V_{\text{out}}}{10} \]
\[ -V_- + 100(10 - V_-) + 10(V_{out} - V_-) = 0 \]

\[ V_{out} - V_- = 10,000 \left[ -10,000 V_- - V_{out} \right] \]

\[ V_{out} = V_- - 10^8 V_- - 10,000 V_{out} \]

\[ 10,000 V_{out} = -10^8 V_- \]

\[ V_{out} = -9.999 \times 10^3 V_- \]

So

\[ -V_- + 1000 - 100 V_- + 10 \left( -9.999 \times 10^3 V_- \right) - 10 V_- = 0 \]

\[ -111 V_- - 9.999 \times 10^4 V_- = -1000 \]

\[ -1.001 \times 10^5 V_- = -1000 \]

\[ V_- = 9.9899 \times 10^{-3} = 10 \text{ mV} \]

So \( V_t - V_- = 0 - 9.9899 \times 10^{-3} = -10 \text{ mV} \)

\[ I_{amp} = \frac{-9.9899 \times 10^{-3}}{10^6} = -10 \text{ nA} \]

as expected \( I_{amp} \approx 0 \)

\( V_t \approx V_- \approx 0 \)