Chapter 11 (extra)

11.8 a. $A_V = -\frac{R_2}{R_1} = 10$ $\quad R_{in} = R_1 = 12k$ $\quad R_o = 0$

b. $A_V = 2$ $\quad R_{in} = 150\,k$ $\quad R_o = 0$

c. $A_V = 51.16$ $\quad R_{in} = 4.3k$ $\quad R_o = 0$

11.17 $A_V = -\frac{R_4}{R_3}\left(1 + \frac{R_2}{R_1}\right) = -\frac{10k}{10k}\left(1 + \frac{100k}{2k}\right) = -51$

$V_o = A_V(V_1 - V_2) = -51(2 + 0.1\sin 2000\pi t - 2.1)$

$= 51(0.1)(1 - \sin 2000\pi t) = 51(0.1)\cos 2000\pi t$

$\Rightarrow V_o = 5.1\cos 2000\pi t$

11.21 a. $A_V = -\frac{R_2}{R_1} = 5$, $f_H = \frac{1}{2\pi R_2 C} = 15.9$ kHz

b. $A_V = 20.74$, $f_H = 28.42$ kHz

11.24 $V_o = -RC\frac{dV_i}{dt} = -(100k)(0.02\times10^{-6})\frac{d}{dt}(2\cos 3000\pi t)$

$= +(100k)(0.02\times10^{-6})(2\times3000\pi)\sin 3000\pi t$

$\Rightarrow V_o(t) = 37.7\sin 3000\pi t$

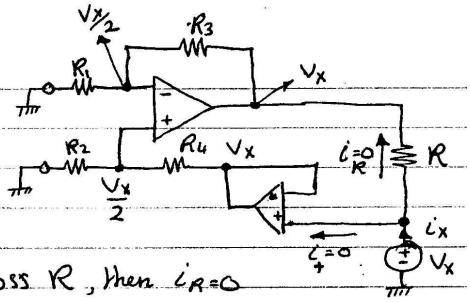
11.34 a. $i_o = \frac{V_5 - V_4}{R}$, but $V_5 = V_1 - \frac{V_1 - V_1}{R_1}R_3 = 2V_1 - V_1$ $(R_1 = R_3)$

$V_1 = V_2 = \frac{V_2 + V_3}{2} = \frac{V_2 + V_4}{2}$ $(V_4 = V_3)$

$\therefore V_5 = V_2 + V_4 - V_1 \Rightarrow i_o = \frac{1}{R}(V_2 + V_4 - V_1 - V_4)$

$\therefore i_o = \frac{V_2 - V_1}{R}$

b. Knowing that $R_1=R_2=R_3=R_4$, we can know that the voltages are as shown in fig.



$\therefore$ There's no voltage drop across R, then $i_R=0$

$$\therefore i_x = i_R + i_+ = 0 \Rightarrow R_{out} = \frac{V_x}{i_x} = \infty$$

11.64 a. $V = \frac{20k}{10k+20k+10k}\,15V = 7.5\,V$

$V_1 = 11.25V$, $V_2 = 3.75\,V \Rightarrow V_{CM} = 7.5\,V$

$CMRR = 0.01\,\% = 10^{-4} = +80\,dB$

b. $V = \frac{200\,\Omega}{10k+0.2k+10k}\,15V = 0.1485\,V$

$V_{CM} = \frac{1}{2}(V_1+V_2) = \frac{15}{2}\left(\frac{10.2}{20.2}+\frac{10}{20.2}\right) = 7.5\,V$

$\frac{V_o)_{CM}}{V_o} = \frac{A_{CM}\cdot V_{CM}}{A_V\cdot V} = CMRR\cdot\frac{V_{CM}}{V} = CMRR\cdot 50.5 = 0.01\,\%$

$\Rightarrow CMRR = 1.98\times10^{-6} \equiv +114\,dB$

11.79 This is a non-inverting amplifier with $V_o = \left(1+\frac{39k}{1k}\right)V_s = 40\,V_s$ as long as $|V_o| \le 15\,V$

a. $V_s = 250\,mV \Rightarrow V_o = 10V < 15V$
$\therefore$ feedback loop is working & $V_{ID}=0$

b. $V_s = 500\,mV \Rightarrow V_o = 20V > 15V$ (not possible)
So V_o saturates at 15V & the feedback loop is broken
$V_{ID} = V_+ - V_- = 0.5V - 15\,\frac{1k}{1k+39k} = 0.125\,V$