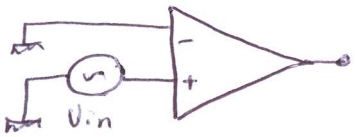
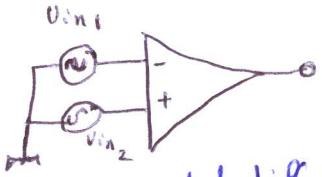
3

(a)



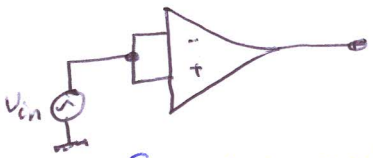
Single-ended differential input mode

(b)



Double-ended differential input mode

(c)



Common-mode

4

$$CMRR_{dB} = 20 \log_{10}(CMRR)$$

$$\therefore CMRR_{dB} = 20 \log(250000)$$

$$\simeq 108 \text{ dB}$$

5 $A_{ol} = 175000$, $A_{cm} = 0.18$, $CMRR_{dB} = ??$

$$CMRR_{dB} = 20 \log\left(\frac{A_{ol}}{A_{cm}}\right)$$

$$= 20 \log\left(\frac{175000}{0.18}\right) = 119.76$$

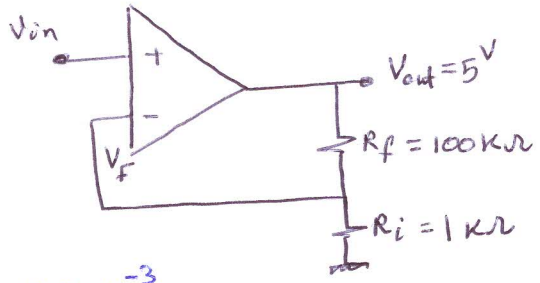
$$\simeq 120 \text{ dB}$$

6 $CMRR = 300000$, $A_{ol} = 90000$, $A_{cm} = ??$

$$\because CMRR = \frac{A_{ol}}{A_{cm}}$$

$$\therefore A_{cm} = \frac{A_{ol}}{CMRR} = \frac{90000}{300000} = 0.3$$

12

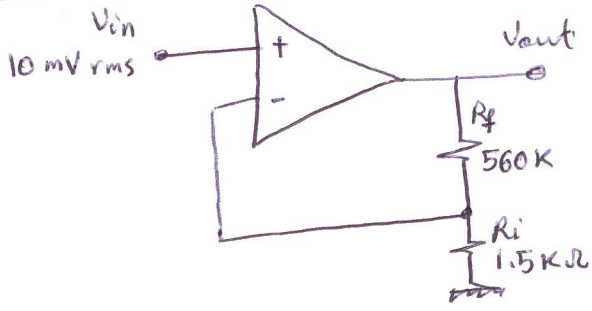


$V_F = B V_{out}$

$\therefore B = \frac{R_i}{R_i + R_f} = \frac{1K}{(100+1)K} = 9.9 * 10^{-3}$

$\therefore V_F = 9.9 * 10^{-3} * 5$ $\therefore$ **$V_F = 49.5$ mV**, **$B = 9.9 * 10^{-3}$**

13



⇐ NI amplifier

a) $A_{cl(NI)} \simeq \frac{1}{B}$; $B = \frac{R_i}{R_i + R_f} = \frac{1.5}{1.5+560} \simeq 2.674 * 10^{-3}$

$\therefore$ **$A_{cl(NI)} = 374.33$**

b) $V_{out} = A_{cl(NI)} V_{in} = 374.33 * 10$ mV rms $= 3743.3$ mV rms

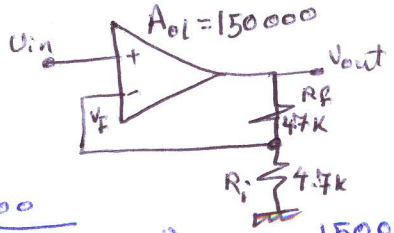
$\therefore$ **$V_{out} = 3.743$ V rms**

c) $V_f = B V_{out} = 2.674 * 10^{-3} * 3.743 = 9.994 * 10^{-3}$ V rms

$\therefore$ **$V_f = 9.994$ mV rms**

14

a) $B = \frac{R_i}{R_f + R_i} = \frac{4.7}{47+4.7} = 90.9 * 10^{-3}$



$\therefore A_{cl} = \frac{A_{ol}}{1 + B A_{ol}} = \frac{150000}{1 + (90.9 * 10^{-3} * 150000)} = \frac{150000}{136.36} = 11$

OR

$A_{cl} \simeq \frac{1}{B} = 11$

14

b) $B = \frac{R_i}{R_i + R_f} = \frac{10 * 10^3}{10 * 10^3 + 1 * 10^6} = 9.9 * 10^{-3}$

$\therefore A_{cl(NI)} = \frac{A_{ol}}{1 + B A_{ol}} = \frac{100000}{1 + 9.9 * 10^{-3} * 100000} = \frac{100000}{991} = 100.91$

OR

$A_{cl(NI)} \simeq \frac{1}{B} = 101$

c) $B = \frac{R_i}{R_i + R_f} = \frac{4.7}{4.7 + 220} = 20.92 * 10^{-3}$

$\therefore A_{cl(NI)} = \frac{A_{ol}}{1 + B A_{ol}} = \frac{200000}{1 + 20.92 * 10^{-3} * 200000} = \frac{200000}{4185} = 47.79$

OR

$A_{cl(NI)} \simeq \frac{1}{B} = 47.8$

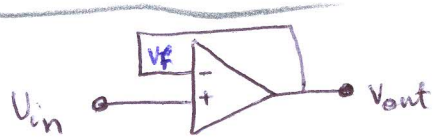
d) $B = \frac{R_i}{R_i + R_f} = \frac{1}{1 + 22} = 43.48 * 10^{-3}$

$A_{cl} = \frac{A_{ol}}{1 + B A_{cl}} = \frac{185000}{1 + 43.48 * 10^{-3} * 185000} = \frac{185000}{8044.8} = 22.996$

OR

$A_{cl} \simeq \frac{1}{B} = 22.999 \simeq 23$

16 a)



← Voltage Follower

$V_f = V_{out}$ $\quad \therefore B = 1$

$\therefore V_{out} = A_{ol}(V_{in} - V_F)$

$= A_{ol}(V_{in} - V_{out})$

$\therefore V_{out}(1 + A_{ol}) = A_{ol} V_{in}$

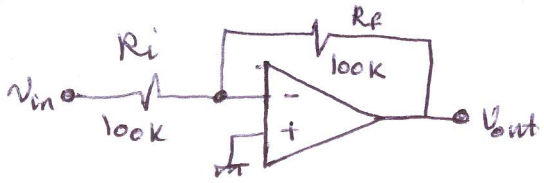
$\therefore A_{cl(VF)} = \frac{V_{out}}{V_{in}} = \frac{A_{ol}}{1 + A_{ol}}$

$\because A_{ol} >> 1$

$\therefore A_{cl(VF)} \simeq 1$

$A_{cl} = 1$

16. b)

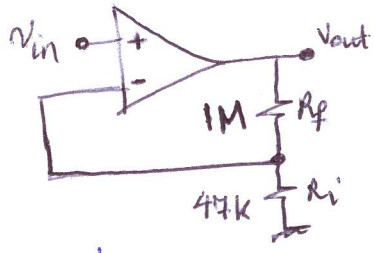


← Inverting Amplifier

$$A_{cl(I)} = -\frac{R_f}{R_i}$$

$$= -\frac{100K}{100K} \quad \therefore \boxed{A_{cl} = -1}$$

c)



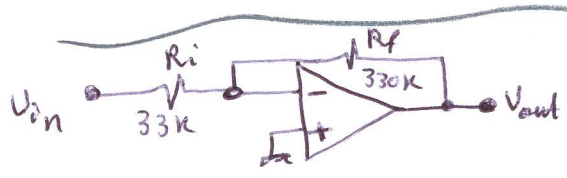
← Noninverting Amplifier

$$A_{cl(NI)} \simeq \frac{1}{B} = \frac{1}{\frac{R_i}{R_i+R_f}}$$

$$\therefore A_{cl} = \frac{R_i + R_f}{R_i} = 1 + \frac{R_f}{R_i}$$

$$\therefore A_{cl} = 1 + \frac{1*10^6}{47*10^3} \quad \therefore \boxed{A_{cl} = 22.3}$$

d)



$$A_{cl(I)} = -\frac{R_f}{R_{in}}$$

$$= -\frac{330K}{33K} = -10 \quad \therefore \boxed{A_{cl} = -10}$$