

4. a) single-ended

b) differential

c) common mode.

5. a) unity gain buffer

b) non-inverting

c) inverting

6. a) $A_{cl} = 1 + \frac{R_f}{R_{in}} = 1 + \frac{47k\Omega}{4.7k\Omega} = 11$

b) $A_{cl} = 1 + \frac{1000k\Omega}{10k\Omega} = 101$

c) $A_{cl} = 1 + \frac{220k\Omega}{4.7k\Omega} = 47.8$

d) $A_{cl} = 1 + \frac{22k\Omega}{1k\Omega} = 23$

7. a) $A_{cl} = 1 + \frac{R_f}{R_i} = 50$

$$R_f = R_i (A_{cl} - 1)$$

$$= 1k\Omega (50 - 1) = 49k\Omega$$

b) $A_{cl} = -\frac{R_f}{R_i} = -300$

$$R_f = 300 R_i = 300 (10k\Omega) = 3M\Omega$$

8. a) $V_{in} = 10mV$

find V_{out} , ϕ

$$A_{cl} \approx 1 \rightarrow V_{in} \approx V_{out}$$

$$V_{out} = 10mV$$

$$\phi = 0^\circ$$

b) $A_{cl} = -\frac{R_f}{R_i} = -1$

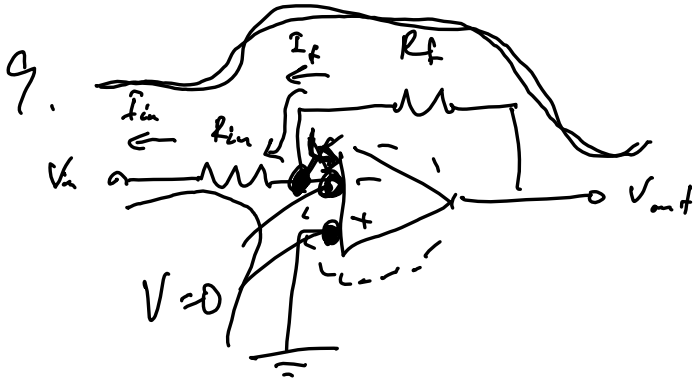
$$V_{out} = A_{cl} \cdot V_{in} = -10mV$$

$$\phi = 180^\circ$$

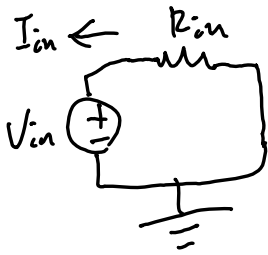
c) $A_{cl} = 1 + \frac{1000k\Omega}{47k\Omega} = 22.3$

$$V_{out} = 22.3 \cdot 10mV = 223mV$$

$$\phi = 0^\circ$$



a) find I_{in}



$$V_{in} = -I_{in} \cdot R_{in}$$

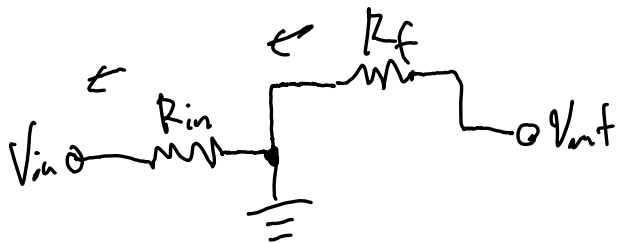
$$I_{in} = -\frac{V_{in}}{R_{in}} = -\frac{1V}{2.2k\Omega}$$

$$= \boxed{-0.45mA}$$

b) find I_f

$$I_f = I_{in} = -0.45mA$$

c) find V_{out}



$$V_{out} - i_f \cdot R_f - i_{in} \cdot R_{in} = V_{in}$$

$$V_{out} = V_{in} + i(R_f + R_{in})$$

$$= 1V - 0.45mA (2.2k\Omega + 2.2k\Omega)$$

$$= \boxed{-10V}$$

a) find A_{cl}

$$V_{out} = A_{cl} \cdot V_{in}$$

$$A_{cl} = \frac{V_{out}}{V_{in}} = \boxed{-10} = -\frac{R_f}{R_i}$$