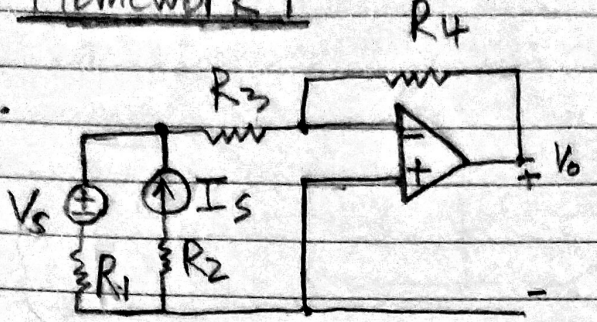
Nathan Donaldson

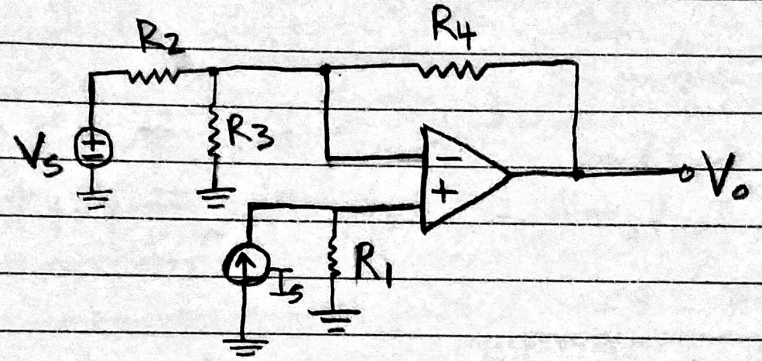
Homework 9

1.



$$V_o = \frac{-(V_s + I_s(R_1))R_4}{R_3 + R_4}$$

2.



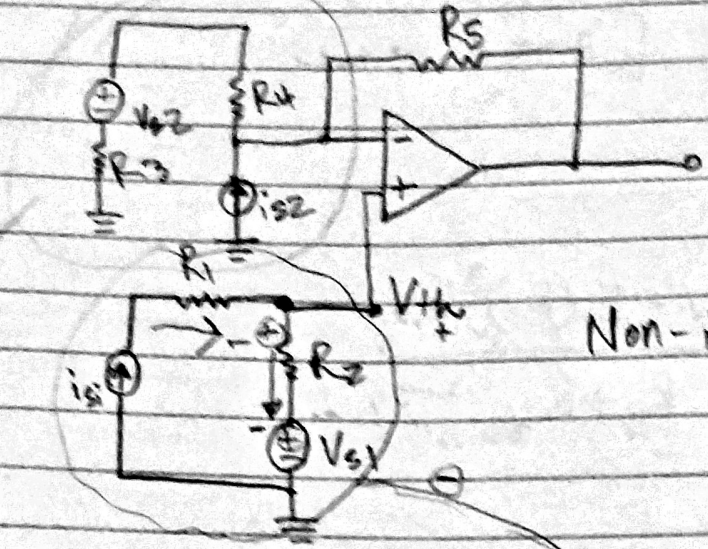
$$V_n = V_p = I_s R_1$$

$$\frac{V_n - V_o}{R_4} + \frac{V_n - R_2}{V_s} + \frac{V_n}{R_3} = 0$$

$$\frac{I_s R_1 - V_o}{R_4} + \frac{I_s R_1 - R_2}{V_s} + \frac{I_s R_1}{R_3} = 0$$

$$V_o = I_s R_1 + \frac{R4 I_s R_1 - R_4 R_2}{V_s} + \frac{R_4 I_s R_1}{R_3}$$

3.



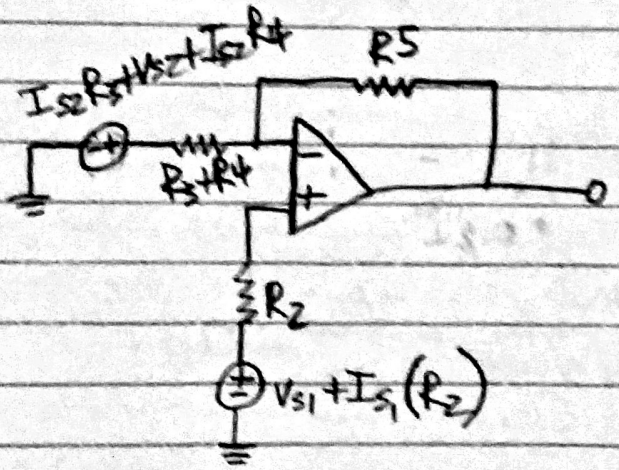
Non-inverting

$R_{Th} = R_3 + R_4$

$V_{Th} = I_{s2}R_3 + V_{s2} + I_{s2}R_4$

$R_{th} = R_2$

$V_{th} = V_{s1} + I_{s1}(R_2)$



$V_n = V_p = V_{s1} + I_{s1}(R_2)$

$$0 = \frac{V_n - (I_{s2}R_3 + V_{s2} + I_{s2}R_4)}{R_3 + R_4} + \frac{V_n - V_o}{R_5}$$

$$V_o = \frac{R_5 V_n - R_5 I_{s2} R_3 - R_5 V_{s2} + R_5 I_{s2} R_4}{R_3 + R_4} + R_5 V_n$$

$$V_o = \left(\frac{(V_{s1} R_5 + I_{s1} R_2 R_5) - (R_5 I_{s2} R_3 - R_5 V_{s2} + R_5 I_{s2} R_4)}{R_3 + R_4} \right.$$

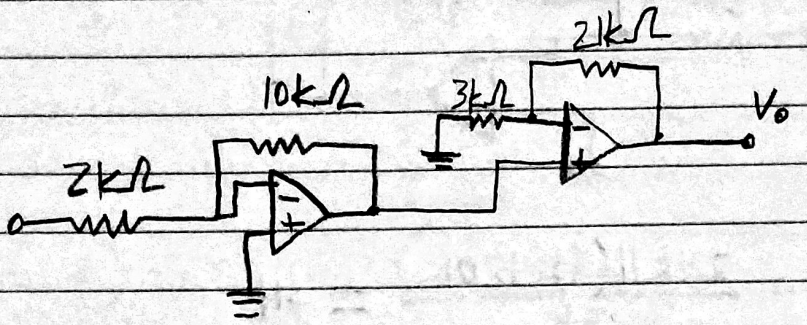
$$\left. \times R_5 V_{s1} + R_5 I_{s1} R_2 \right)$$

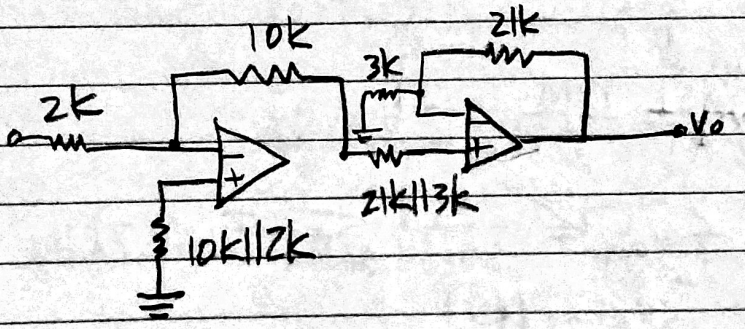
4.

a) noninverting amplifier

b) inverting amplifier

5.

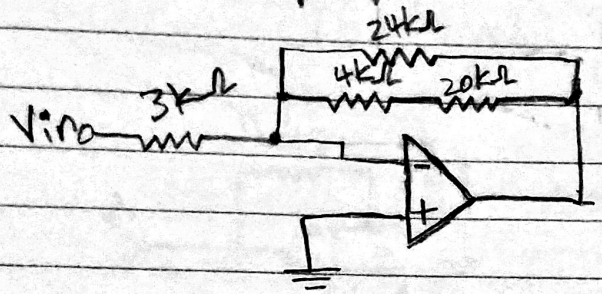




6.

input offset voltage: $V_{ios} = 5mV$
input resistance: $R_i = 1M\Omega$
unity-gain bandwidth: $f_T = 12MHz$
output swing limits: within 2V of power supply
slew rate: $SR = 4\ V/\mu sec$

Op Amp powered at $\pm 12V$



a) $\frac{24k \| (4k+20k)}{3k} = -4$

b) $f_c = \frac{12M}{5} = 2.4MHz$

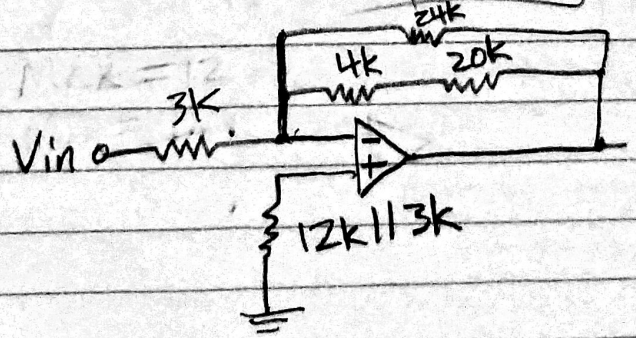
c) $S_{max} = \frac{4}{1M} \cdot \frac{1}{12\pi} = 63.7kHz$

d) $2(1m)(4) = 8mV$

e) $(2m)(5) = offset = 10mV$

$10mv \pm 5mV$ **16mV**

f)



7.

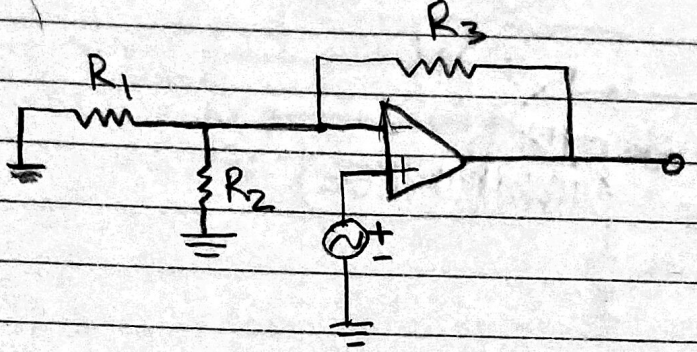
$V_{ios} = 4mV$

$R_i = 2M\Omega$

$f_T = 10MHz$

Swing = within 2 volts of power supply $\pm 12V$

$SR = 5\frac{V}{\mu sec}$



a)

$V_n = V_p = V_s$

$$\frac{V_{in} - V_o}{R_3} + \frac{V_{in}}{R_2} + \frac{V_{in}}{R_1} = 0$$

$$V_o = R_3 V_{in} + \frac{R_3 V_{in}}{R_2} + \frac{R_3 V_{in}}{R_1}$$

$$V_o = \left(\frac{R_3}{R_1} \| R_2 + 1\right) V_{in}$$

b)

$$\frac{V_o}{V_{in}} = \frac{100k}{5k} = 20 + 1 = 21$$

$$f_c = \frac{10MHz}{21} = 476190.5$$

$$f_{max} = \frac{5}{1\lambda} \cdot \frac{1}{20 \cdot \pi} = 80kHz$$

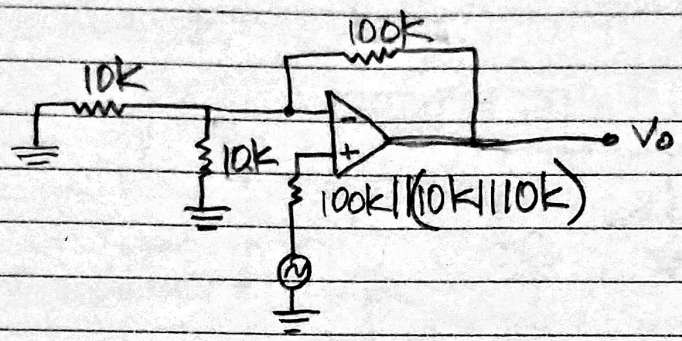
c)

$4m(21) = 84m$

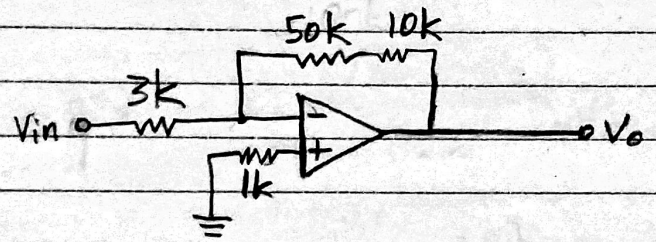
$V_{op} = -21(1m \sin(2\pi 90kt)) + 84m$

$V_{peak} = 105mV$

d)



8.



$V_{ios} = 3mV$

$R_i = 2M\Omega$

$f_T = 80MHz$

swing: within 2 volts of supply

$SR = 3\ V/\mu sec$

a)

$$\frac{V_o}{V_i} = \frac{60k}{3k} = -20$$

b)

$$f_c = \frac{80MHz}{21} = \boxed{3,809523.81}$$

$$f_{max} = \frac{3}{1\mu} \cdot \frac{1}{20\pi} = 471238.898$$

9.

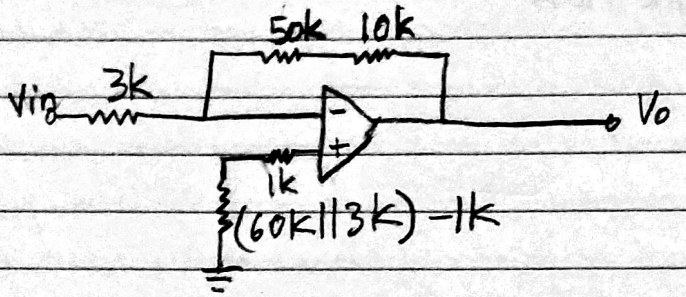
a)

$V_{tot} = 3m(20) + 20(1m)$

Max = 83 mV

Min = 43 mV

b)



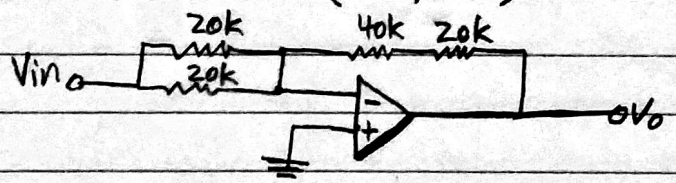
10.

a) $V_{ios} = 5mV$

~~f_T~~ = 12MHz

$SR = 4 \frac{V}{\mu sec}$

$Vin = 1m \sin(2\pi 90kt)$

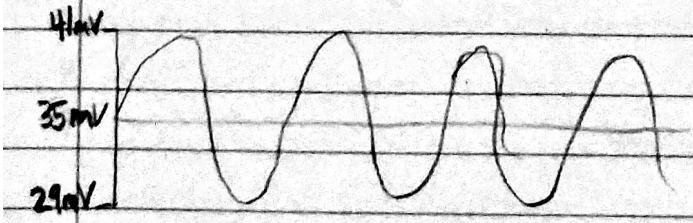


$\frac{Vo}{Vin} = \frac{60k}{10k} = -6$

g)

$f_c = \frac{12MHz}{7} = 1.7MHz$

h) 5mv(7) = ~~offset~~ = 35mV 1m(6) = 6m



i)