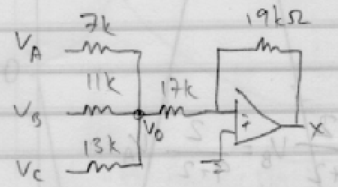
EE100 Midterm Review Problems Solutions.

1. $V_A = 10V$ (Voltage Follower)

$V_B = (1+\frac{2}{3})10V = 16.7V$ (non-inverting amp)

$V_C = -\frac{7k}{25k} \cdot 10V = -2.8V$ (inverting amp)



$$\frac{V_A - V_0}{7k} + \frac{V_B - V_0}{11k} + \frac{V_C - V_0}{13k} = \frac{V_0}{17k}$$

$$\frac{V_A}{7k} + \frac{V_B}{11k} + \frac{V_C}{13k} = V_0\left(\frac{1}{17k} + \frac{1}{7k} + \frac{1}{11k} + \frac{1}{13k}\right)$$

$$= \frac{V_0}{2.7k} \Rightarrow V_0 = 7.4V$$

$$\frac{V_0 - 0}{17k} = \frac{0 - V_x}{19k\Omega} \qquad V_x = \frac{-19k}{17k} V_0$$

$$\boxed{V_x = -8.3V}$$

2. ~~Inverting~~ Non Inverting Amp: $V_0 = (1 + \frac{R_F}{5k}) \cdot 10V$

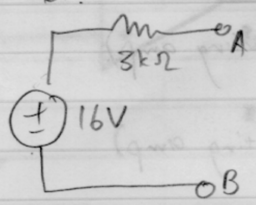
$$(1+\frac{R_F}{5k}) \cdot 10 > 16 \Rightarrow \boxed{R_F > 3k\Omega}$$

$(1+\frac{R_F}{5k}) \cdot 10 < -16$ will never occur with $R_F > 0$.

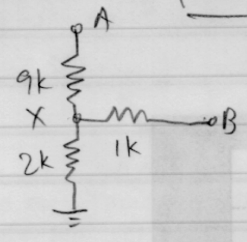
b) Non-inverting amp: $V_o = (1 + \frac{6}{4}) \cdot 8 = 20V$

saturated at 16V.

equiv ckt.



3. (a) ideal op-amp, $\boxed{V_B = V_{IN}}$



$V_x = \frac{2}{1+2} V_B = \frac{2}{9+2} V_A$

$V_A = \frac{11}{3} V_B$

$\boxed{V_A = \frac{11}{3} V_{IN}}$

(b) Same as (a) because input voltages are equal in an ideal op-amp.

4. Prob. 5.36: $V_p = \frac{1.5}{9.0}(-18V) = -3V = V_n$

$\frac{-18 - (V_n)}{1.6k} = \frac{V_n - V_o}{R_f} \Rightarrow V_o = \frac{R_f}{1.6k}(15) - 3$

$V_+ = 9V \quad V_- = -9V$

$R_f > 0$: +ve sat is limit

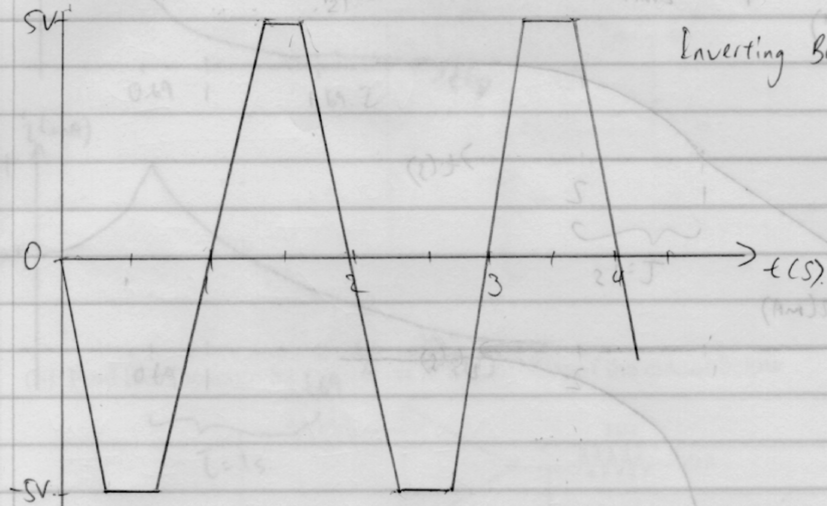
$9 = \frac{R_f}{1.6k} 15 - 3$

$\hookrightarrow \boxed{R_f = 1.28k\Omega}$

5. Prob. 5.47:

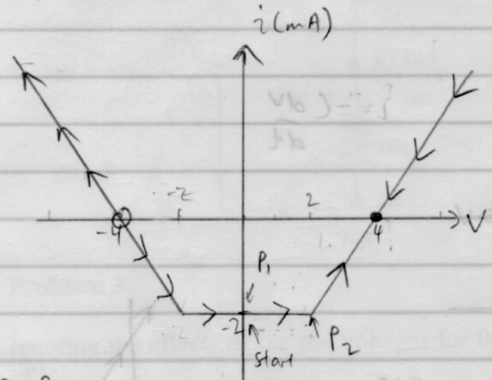
Inverting amp: $v_o = -\frac{120k}{7.5k} v_{in} = -16 v_{in}$

Clips when $|V_{in}| = 0.03125$ V.



Inverting Behavior.

6.



$i = -C\frac{dV}{dt}$

$P_1 - P_2$

$V_i = 0$ V $\quad V_f = 2$V $\quad i = \text{constant} = -C\frac{dV}{dt} \Rightarrow V$ is linear.

$$\frac{dV}{dt} = \frac{+2mA}{1mF} = +2 \Rightarrow V(t) = 2t + C$$

$v(0) = 2(0) + C = 0 \Rightarrow C = 0$

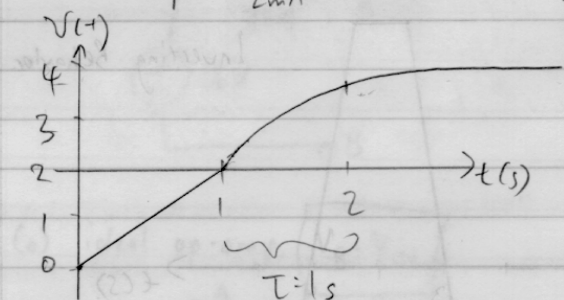
$V(t) = 2t = 2 \Rightarrow t = 1s$

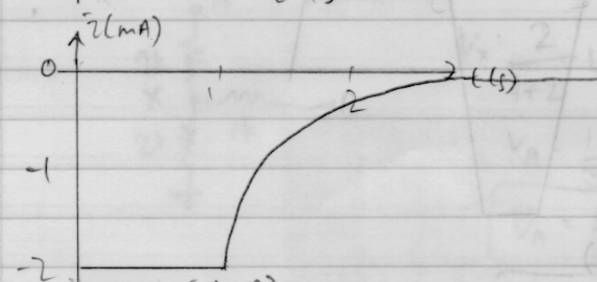
P_2 onwards.

$v_i = 2V \qquad v_{final} = 4V.$

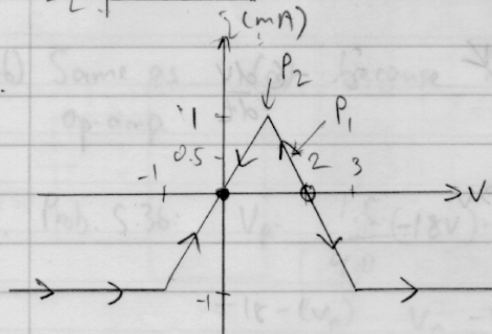
$R = \frac{1}{slope} = \frac{2V}{2mA} = 1k\Omega \qquad \tau = RC = 1k \cdot 1m$

$= 1s.$

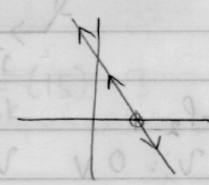




7.



$i = -C\frac{dV}{dt}$



$P_1 - P_2 \quad v_{initial} = 1.5V \quad v_{final} = 2V$

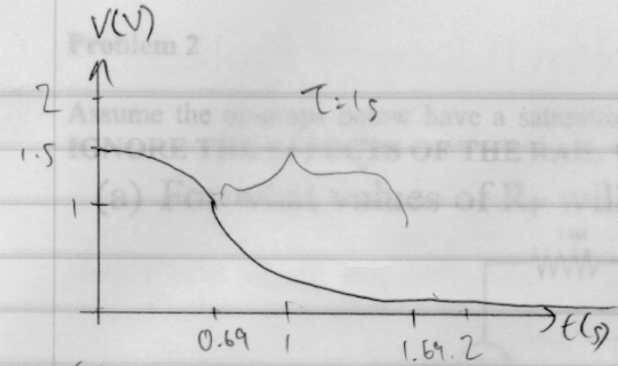
$R = \frac{1}{slope} = \frac{-1V}{1mA} = -1k\Omega \qquad \tau = -1s.$

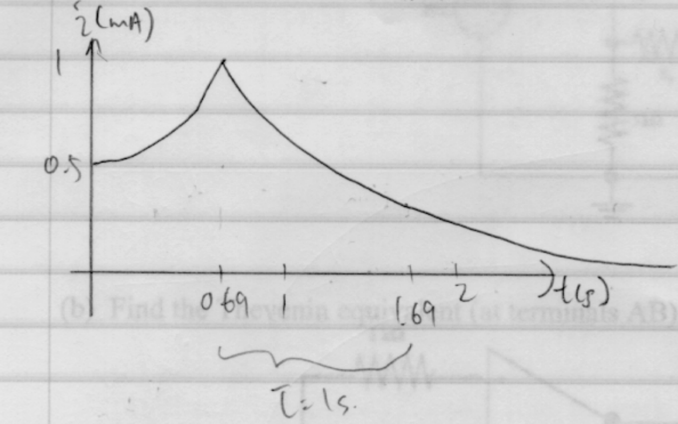
$v(t) = v_{final} - (v_{final} - v_{initial})\, e^{\frac{t}{1s}}\ V$

$= 2 - 0.5\, e^{+\frac{t}{s}}\ V$

$v(t) = 1V = 2 - 0.5\, e^{+\frac{t}{s}} \Rightarrow t = 0.69s.$ arrive at P_2

P_2 onwards: $\tau = 1s \quad v_{final} = 0V.$


V(V)
2
1.5
1
τ=1s
0.69
1
1.69
2
t(s)


i(mA)
1
0.5
0.69
1
1.69
2
t(s)
τ=1s.