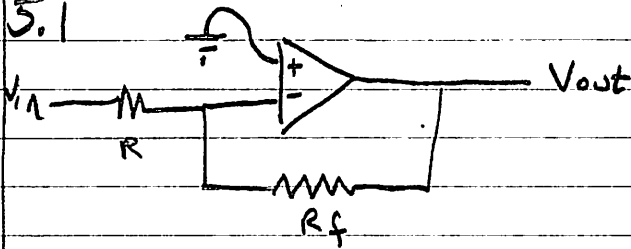


# Final Electronics Homework

5.1, 5.2a, 5.4, 5.7, 5.12, 5.17, 5.20, 6.2,  
6.36, Flash 2 LEDs w/ PIC 16F88 @ 5Hz  
red is 25%, green 75% on.

5.1



$$V_{in} = 5V$$

$$\text{for gain} = 1 = \frac{R_f}{R}$$

$$V_{out} = -V_{in} = -5V$$

$$\text{and } V_- = 0 \text{ so}$$

$$i R_f = 5V \Rightarrow i = \frac{5V}{R_f}$$

$$iV = P$$

$$\frac{5V}{R_f} \cdot 5V = 0.25W$$

$$R_f = 100\Omega, R = 100\Omega$$

$$\text{for gain} = 10 \quad V_{out} = -50, V_- = 0$$

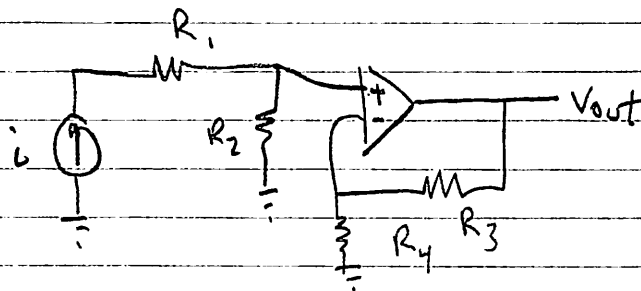
$$\text{so } \frac{50V}{R_f} \cdot 5V = 0.25W$$

$$R_f = 10k\Omega$$

$$\text{and w/ } R = R_f/10$$

$$R = 1k\Omega$$

5.2a



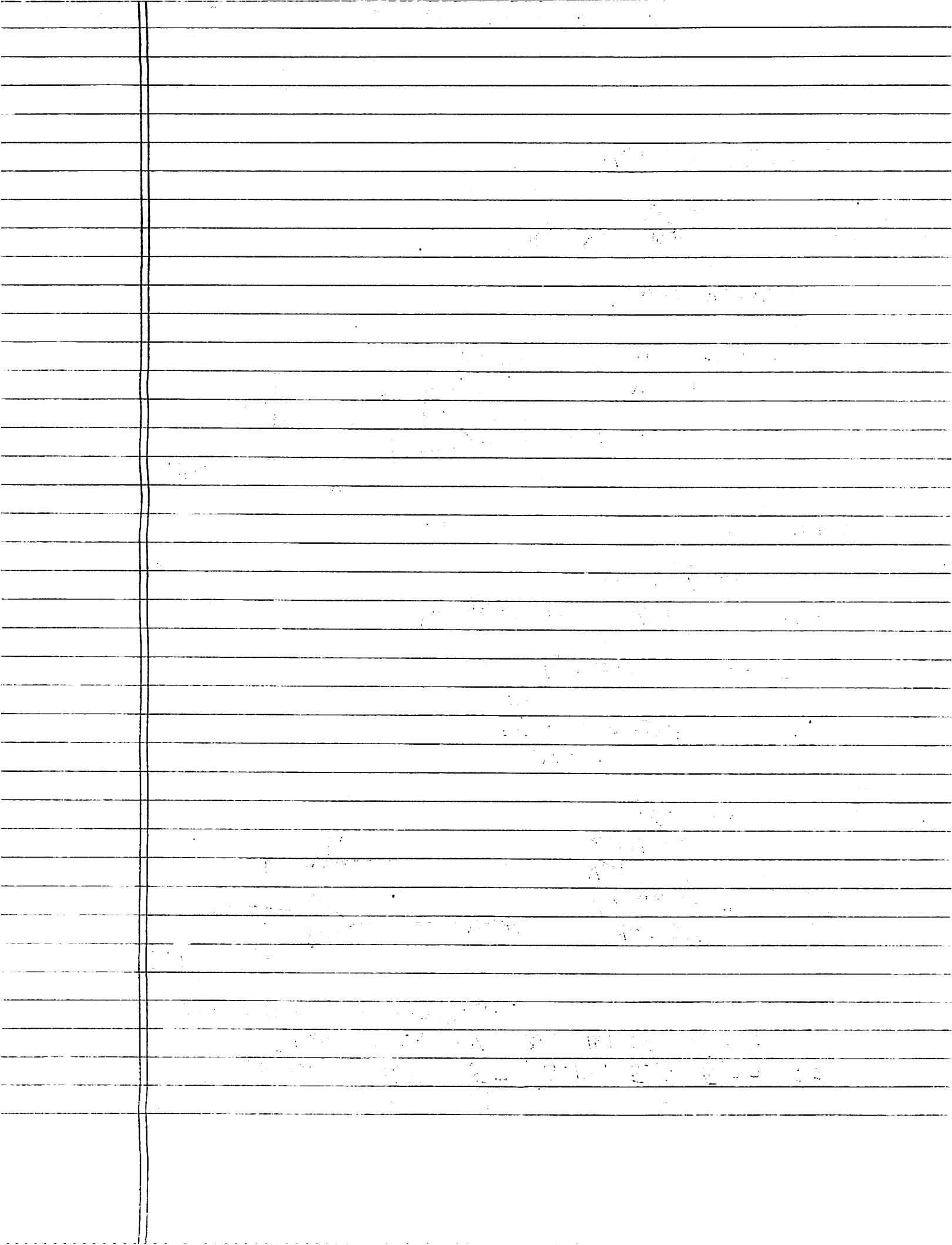
$$V_+ = i R_2$$

$$V_- = V_{out} \frac{R_4}{R_3 + R_4} \quad (\text{voltage divider})$$

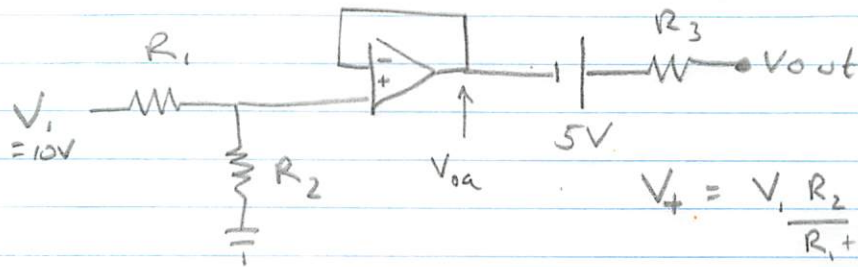
and since  $V_+ = V_-$  for ideal

$$i R_2 = V_{out} \frac{R_4}{R_3 + R_4} \Rightarrow V_{out} = \frac{R_2(R_3 + R_4)}{R_4} i$$

$$V_{out} = R_2 \left( \frac{R_3}{R_4} + 1 \right) i$$



5.4a



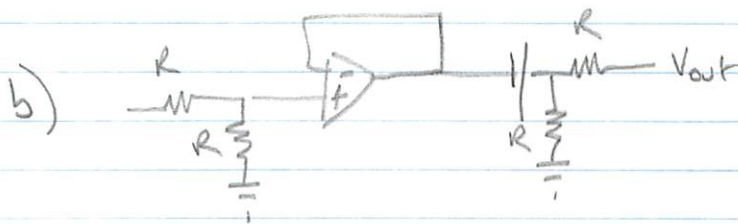
$$V_+ = V_1 \frac{R_2}{R_1 + R_2}$$

$$V_{oa} = V_-$$

$$V_{out} = V_{oa} + 5V - i_3 R_3$$

By ideal opamp

$$V_{out} = V_1 \frac{R_2}{R_1 + R_2} + 5V$$

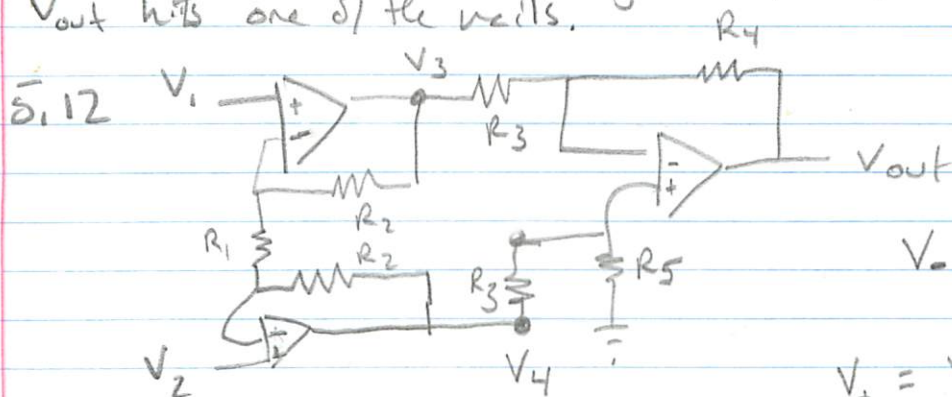


$$= 10V$$

The only thing that has changed is that there is a path for current out of the opamp to go

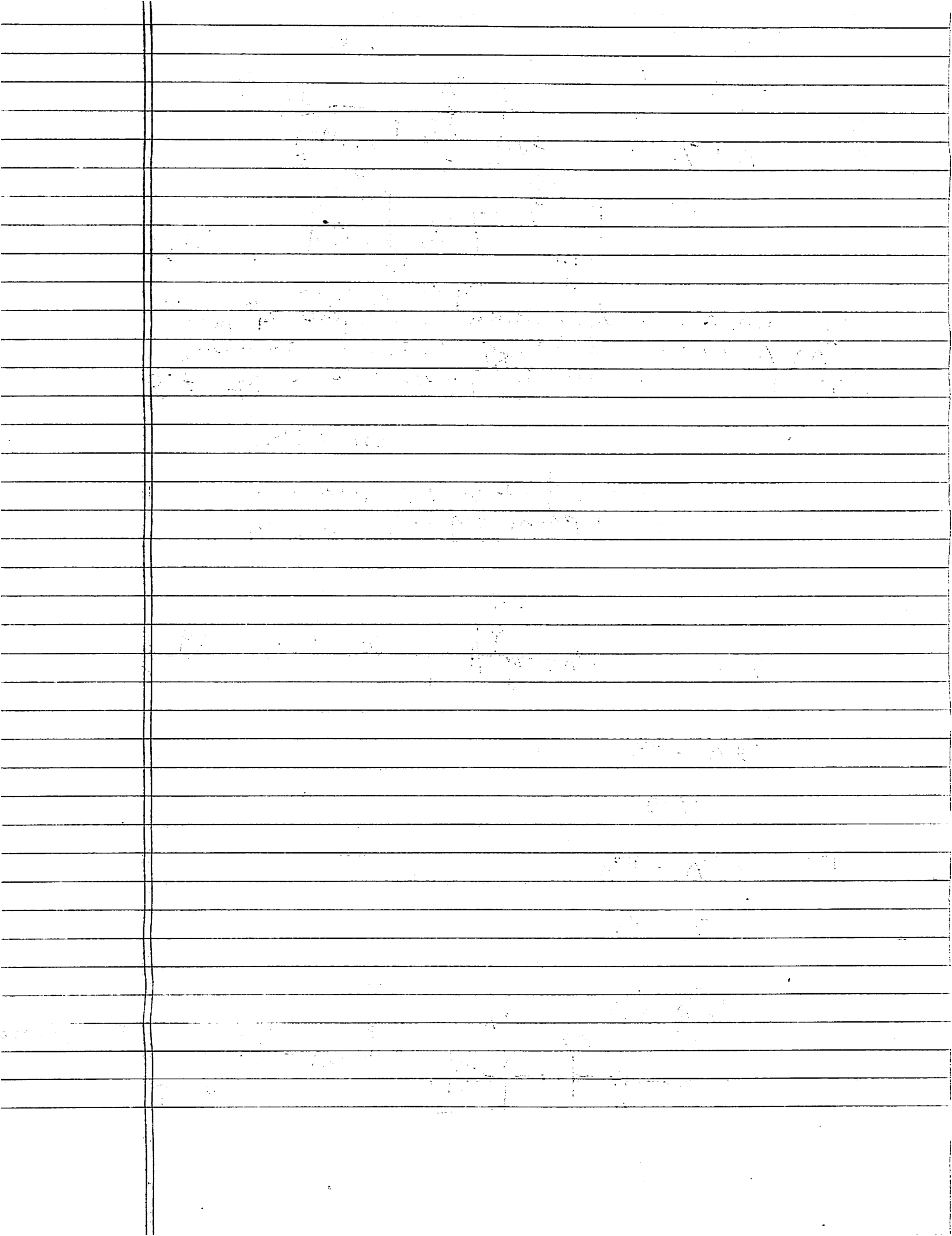
$$V_{out} = 10V$$

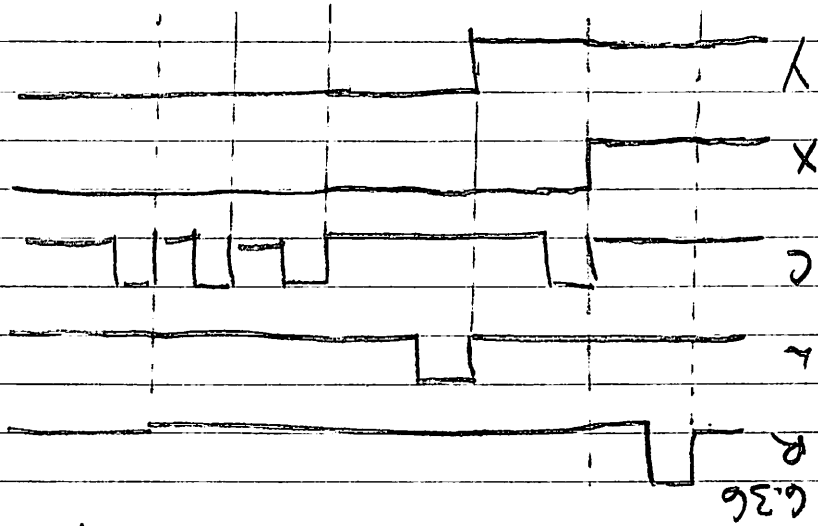
5.7 This op amp circuit has positive feedback instead of negative feedback. Differences between  $V_+$  &  $V_-$  will be amplified to progressively larger values until  $V_{out}$  hits one of the rails.



$$V_- = V_3 = \frac{(V_{out} - V_3)R_3}{R_3 + R_4}$$

$$V_+ = V_4 \frac{R_5}{R_3 + R_5}$$





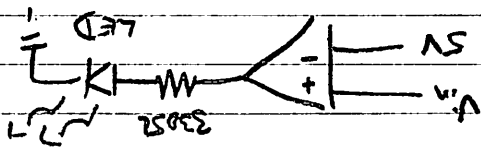
0911111111  
= 091

0910000000 127 = 2<sup>7</sup> - 1 so

0910000000 128 = 2<sup>7</sup> so

from graph open loop gain of 10 is @ 10<sup>5</sup> Hz  
so cut off is 100 kHz.

S.120 Gain =  $\frac{R}{R_f} = \frac{20k\Omega}{2k\Omega} = 10$



S.17

$$V_{out} = \left( \frac{R_3 + R_4}{R_3 + R_5} \right) \frac{R_5}{R_3} V_4 - R_4 V_3$$

$$\left( \frac{R_3 + R_4}{R_3} - R_4 \right) V_3 + V_{out} \frac{R_3}{R_3 + R_4} = V_4 \frac{R_5}{R_3 + R_5}$$

$$V_3 + (V_{out} - V_3) \frac{R_3 + R_4}{R_3} = V_4 \frac{R_5}{R_3 + R_5}$$

for ideal op amp  $V_- = V_+$



Flashing LED - this is a modification of lab 12,

you need 2 output pins that you set in opposite states w/ a delay of  $0.75 \times T$   
 $= 0.75 \times 0.2s = 0.15s$  for green on  
and (Red off)  
 $0.25 \times T$   
 $= 0.25 \times 0.2s = 0.05s$  for green off  
(Red on).

The switching & delays happen inside an infinite loop.

