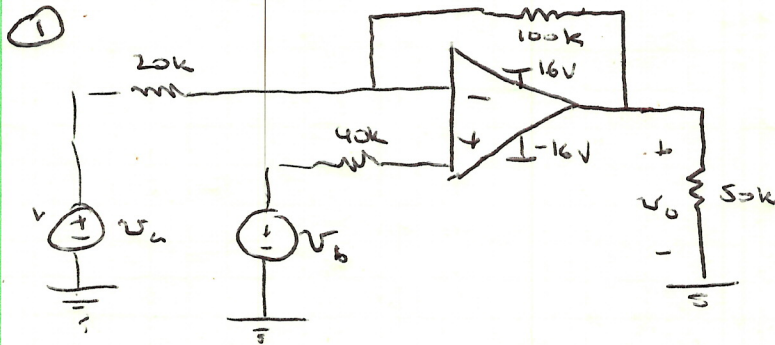


ENGR 2910  
HOMEWORK 6 SOLUTIONS



$$\frac{v_a - v_b}{20k} + \frac{v_o - v_b}{100k} = 0$$

$$v_o = 6 \cdot v_b - 5v_a$$

a)  $v_a = 4V, v_b = 0V \Rightarrow v_o = -16V$  (saturated)

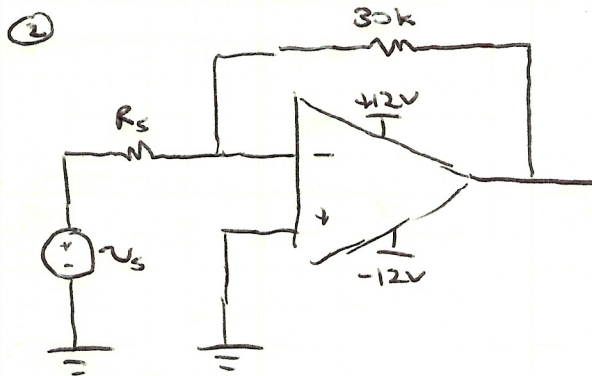
b)  $v_a = 2V, v_b = 0V \Rightarrow v_o = -10V$

c)  $v_a = 2V, v_b = 1V \Rightarrow v_o = -4V$

d)  $v_a = 1V, v_b = 2V \Rightarrow v_o = 7V$

e)  $v_b = 1.6V \Rightarrow v_{o, sat} = 9.6 - 5v_a = \pm 16V$

$$\Rightarrow -1.25V \leq v_a \leq 5.12V$$



a)  $R_s \leq \frac{30k}{4} = 7.5k$

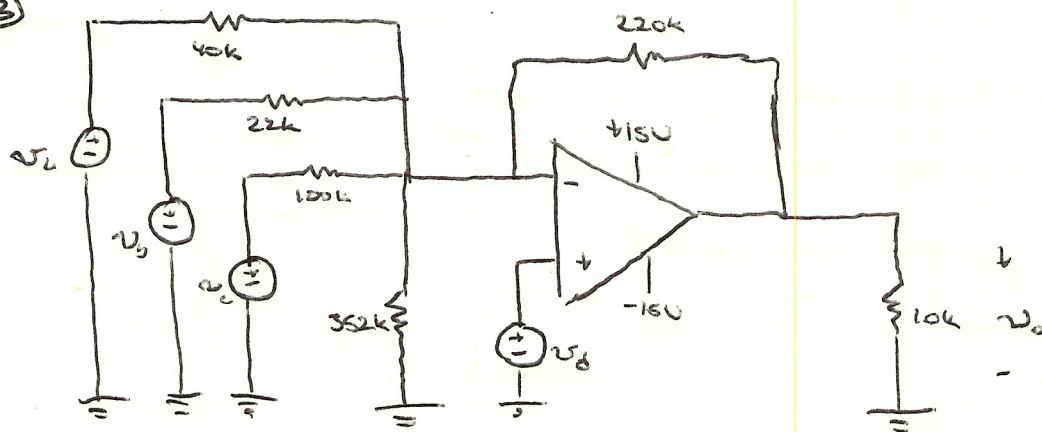
b)  $v_o = 4v_s \Rightarrow -3V \leq v_o \leq 3V$

c)  $-\frac{R_f}{R_g}(2) = -12V$

$$R_f = 45k$$

$$\left| \frac{v_o}{v_s} \right| = \frac{R_f}{R_s} = \frac{45k}{7.5k} = 6$$

③



$$\textcircled{a} \quad KCL: \frac{(v_a - v_d)}{40k} + \frac{(v_b - v_d)}{22k} + \frac{(v_c - v_d)}{100k} + \frac{v_d}{352k} + \frac{v_o - v_d}{220k} = 0$$

$$v_o = -220k \left[ \frac{v_a - v_d}{40k} + \frac{v_b - v_d}{22k} + \frac{v_c - v_d}{100k} + \frac{v_d}{352k} + \frac{-v_d}{220k} \right]$$

$$= -220k \left[ \frac{-4}{40k} + \frac{1}{22k} + \frac{5}{100k} + \frac{-8}{352k} - \frac{-8}{220k} \right]$$

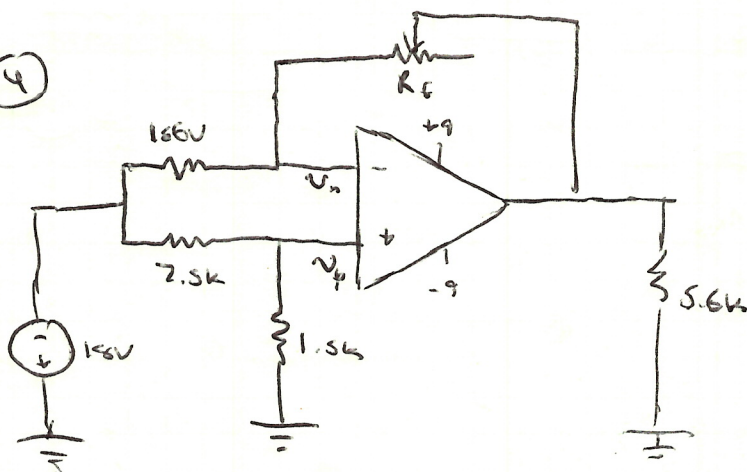
$$\boxed{v_o = 14k}$$

$$\textcircled{b} \quad \frac{v_a - 8}{40k} + \frac{1}{22k} + \frac{5}{100k} - \frac{8}{352k} - \frac{v_o - 8}{220k} = 0$$

$$v_o = 36 - 5.5v_a = \pm 15V$$

$$3.818V \leq v_a \leq 9.273V$$

④



$$v_p = \frac{1.5k}{1.5k + 2.5k} (-15V) = -3V$$

$$v_n = v_p = -3V$$

$$\frac{-15V - (-3V)}{1600} + \frac{v_o - (-3V)}{R_f} = 0$$

$$v_o = (0.009375)R_f - 3$$

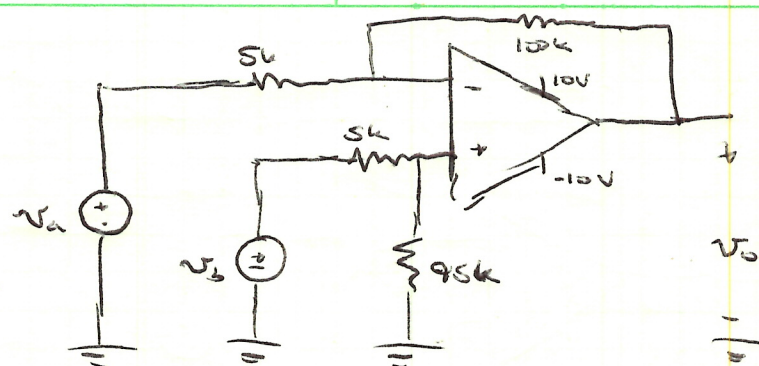
$$v_o = 9 \Rightarrow 1280\Omega$$

$$v_o = -9 \Rightarrow -640\Omega$$

$$R_f > 0 \Rightarrow R_f = 1280\Omega$$



5)



$$a) A_{dm} = \frac{95(100+5) + 100(5+95)}{2(5)(5+95)} = 19.975$$

$$b) A_{cm} = \frac{(5)(95) - (5)(100)}{(5)(5+95)} = -0.05$$

$$c) CMRR = \left| \frac{19.975}{-0.05} \right| = 399.5$$