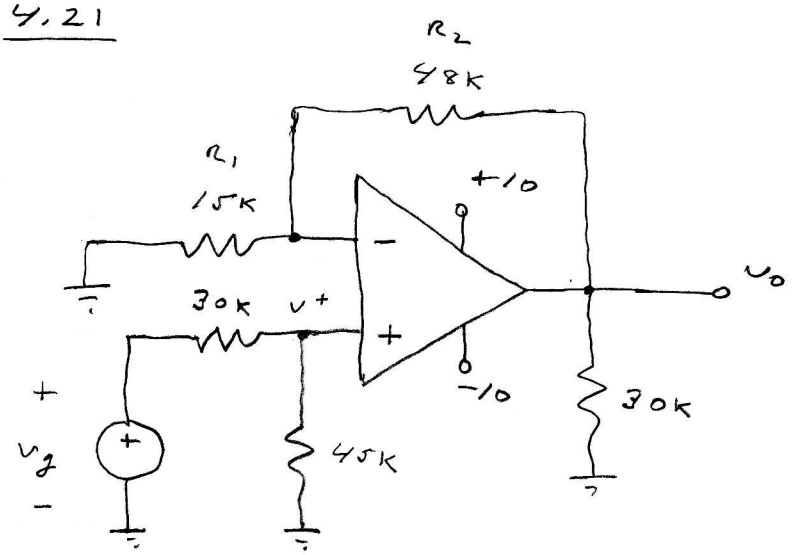
4.21



a) $v^+ = v_g\left(\frac{45K}{45K + 30K}\right) = \frac{3}{5} v_g$

But $v_o = v^+\left(1 + \frac{R_2}{R_1}\right)$

(recall the non-inverting amplifier)

$\rightarrow v_o = \left(1 + \frac{48K}{15K}\right)\left(\frac{3}{5}\right) v_g = 2.52\, v_g$

so if $v_g = 3V$, $v_o = 7.56\ V$

b) For linear mode, $-10 \le v_o \le +10$

$\rightarrow v_g \le \frac{10}{2.52} = 3.97$

$\rightarrow v_g \ge \frac{-10}{2.52} = -3.97$

c) $v_g = 5V$, $48K \rightarrow R_2$

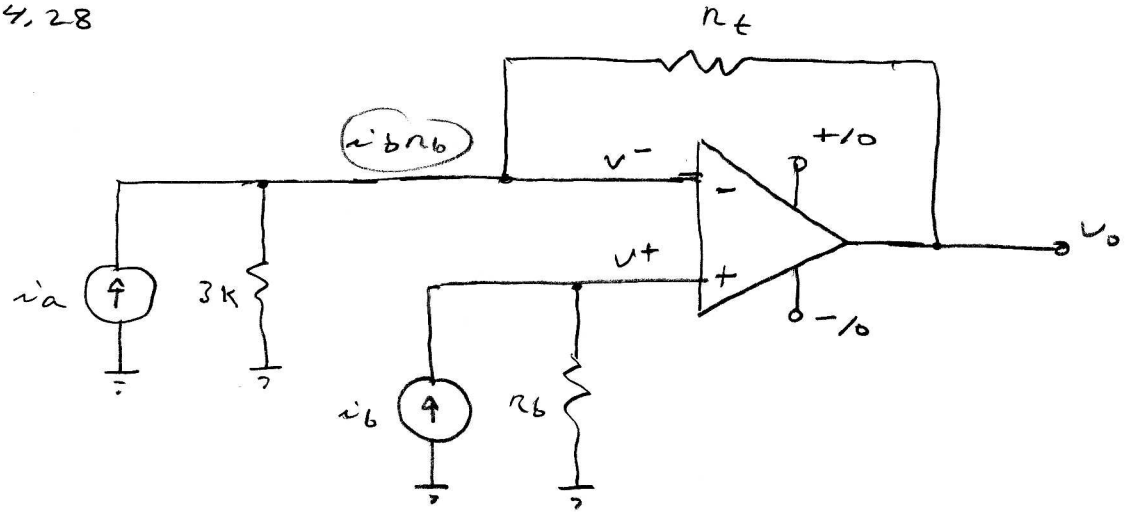
$v_o = \frac{3}{5}(5)\left(1 + \frac{R_2}{15}\right) < 10$

$\left(1 + \frac{R_2}{15}\right) < \frac{10}{3}$

$\frac{R_2}{15} < \frac{7}{3}$

$\rightarrow R_2 < 35K$

4.28



Want $v_o = 2000\,(i_b - i_a)$

↑ Ω

$v^+ = i_b R_b = v^-$

so at the v^- node,

$$i_a - \frac{i_b R_b}{3} + \frac{v_o - i_b R_b}{R_t} = 0 \quad \text{(KCL)}$$

$$\hookrightarrow \quad v_o = R_t \left\{ \frac{R_b}{R_t}\left(1 + \frac{R_t}{3}\right) v_b - i_a \right\}$$

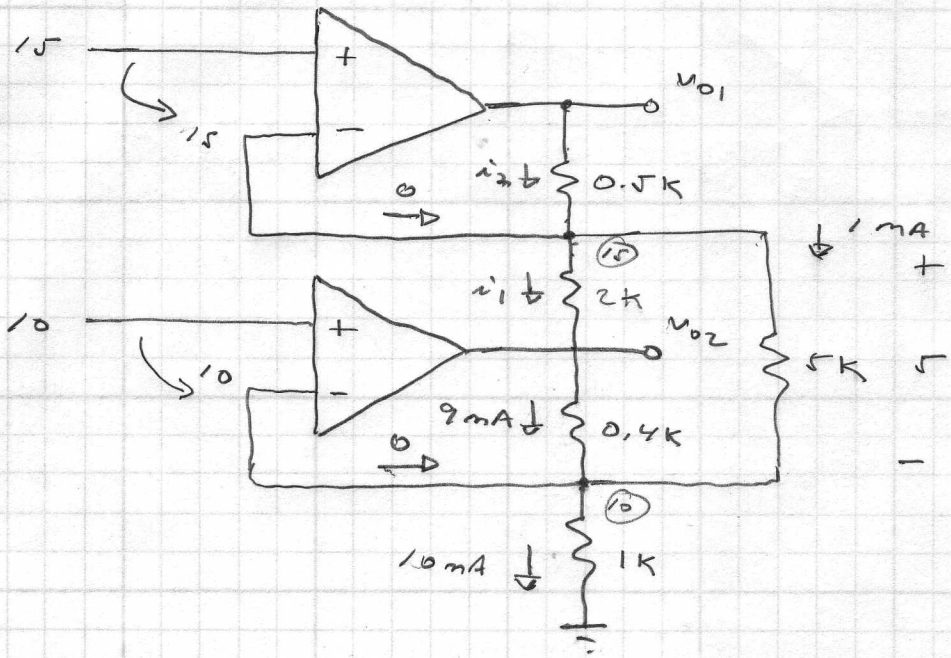
$R_t = 2K \quad (2000\,\Omega)$

$$\frac{R_b}{R_t}\left(1 + \frac{R_t}{3}\right) = \frac{R_b}{2}\left(1 + \frac{2}{3}\right) = 1$$

$$\hookrightarrow \quad R_b = 1.2\,K$$

4.31

mark up diagram



$$v_{o2} = 10 + 9(0.4) = 13.6\ V$$

$$i_1 = \frac{15 - 13.6}{2} = 0.7\ mA$$

$$i_2 = 1\ mA + 0.7\ mA = 1.7\ mA$$

$$v_{o1} = 15 + 1.7(0.5) = 15.85\ V$$