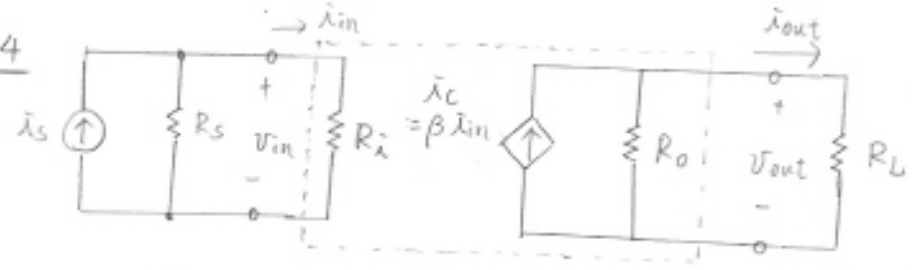
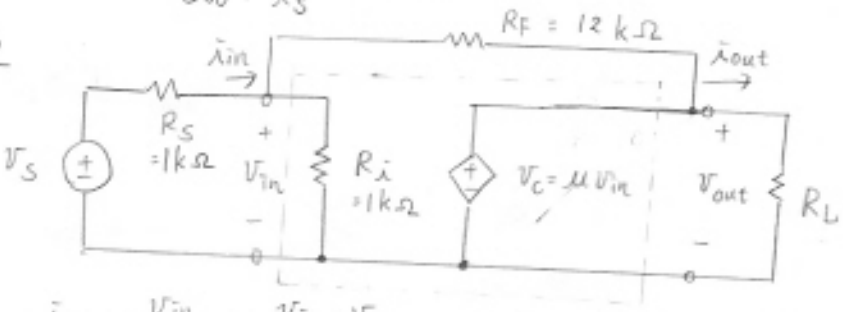
3.14



$$A_i = \frac{300}{500}\,\beta\,\frac{5k}{6k} = 60 \Rightarrow \beta = 120$$

$$A_v = \frac{1k \cdot i_{out}}{300 \cdot i_S} = \frac{10}{3} A_i = 200$$

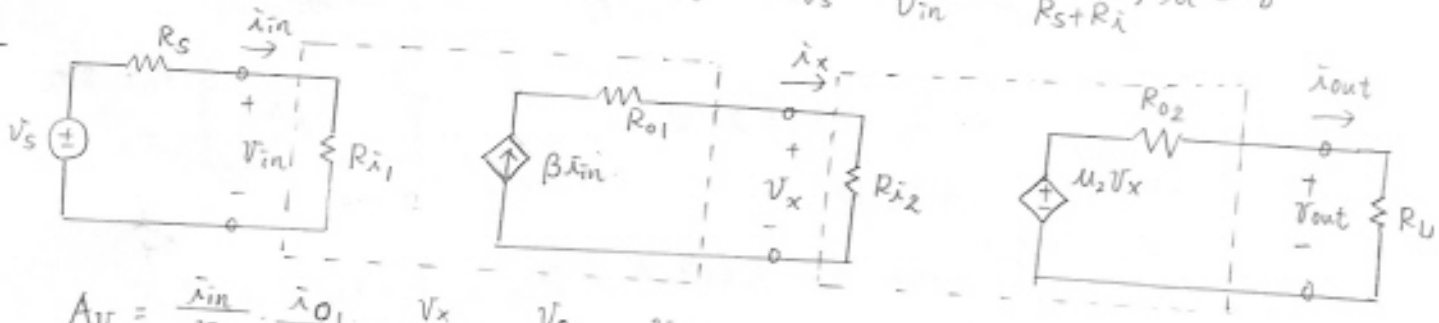
3.16



$$i_{in} = \frac{v_{in}}{R_i} + \frac{v_{in} - v_C}{R_F} = \left(\frac{1}{R_i} + \frac{1-\mu}{R_F}\right) v_{in} = \left(\frac{1}{1k} - \frac{9}{12k}\right) v_{in} = \frac{1}{4k} v_{in}$$

$$R_i' = v_{in}/i_{in} = 4\,k\Omega, \quad A_v = v_{out}/v_S = \frac{v_{in}}{v_S} \times \frac{v_o}{v_{in}} = \frac{R_i'}{R_S + R_i'}, \quad \mu = 8$$

3.20

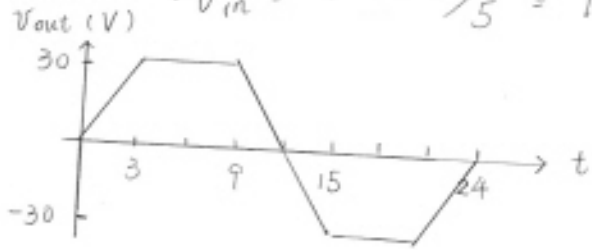


$$A_v = \frac{i_{in}}{v_S} \cdot \frac{i_{o1}}{i_{in}} \cdot \frac{v_x}{i_{o1}} \cdot \frac{v_{o2}}{v_x} \cdot \frac{v_{out}}{v_{o2}} = \frac{1}{500} \times 25 \times (1k \parallel 1k) \times \mu_2 \times \frac{8}{8+2}$$

$$= 20\,\mu_2 = -300, \quad \mu_2 = -15$$

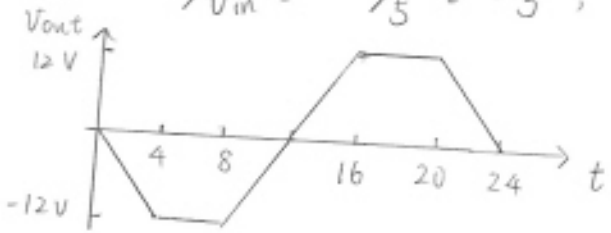
3.23

$v_{out}/v_{in} = (5+45)/5 = 10$. for $|v_{out}| < 30\,V$, $|v_{in}| < 30/10 = 3\,V$



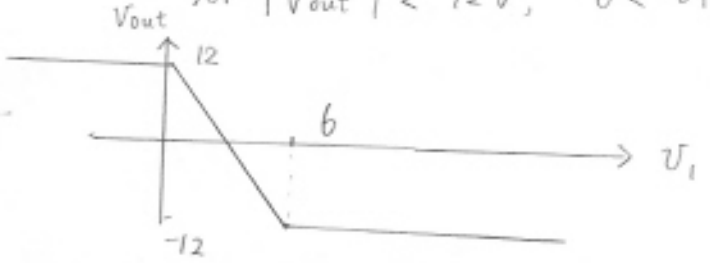
3.25

$v_{out}/v_{in} = -15/5 = -3$, for $|v_{out}| < 12\,V$, $|v_{in}| < 12/3 = 4\,V$



3.27 $V_{out} = -(16/4)(V_1 - 3) = -4V_1 + 12$

for $|V_{out}| < 12V$, $0 < V_1 < 24/4 = 6V$



3.29

$V_{out}/V_{in} = -1 \Rightarrow$ inverting amplifier with $R_F/R_1 = 1$

take $R_F = R_1 = 2R$

pin connection : 1-6, 2-4, 3-9, 5-7

$V_{out}/V_{in} = 3 \Rightarrow$ noninverting amplifier wit $R_F/R_1 = 2$

take $R_F = 2R$, $R_1 = R$

pin connection : 1-4, 2-8, 3-9, 5-6

$V_{out}/V_{in} = -3 \Rightarrow$ inverting amplifier with $R_F/R_1 = 3$

take $R_F = 2R$, $R_1 = R \| 2R = 2R/3$

pin connection : 1-7-8, 2-4, 3-9, 5-6

3.32

$V_{out} = -[2V_a + 10(10V_b)]$

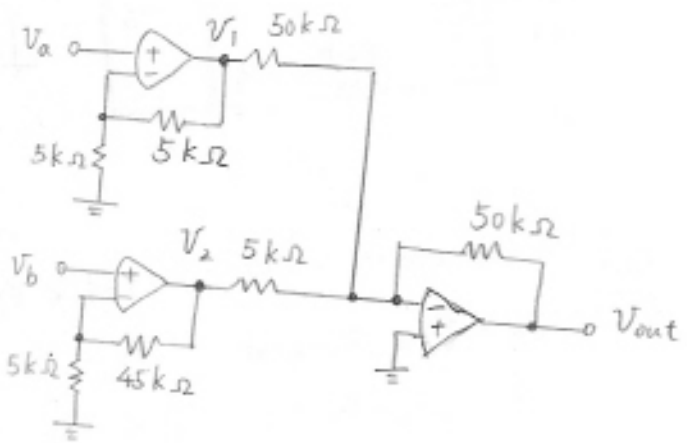
$= -2V_a - 100V_b$

$V_{ps} > 2 \times 1.5 + 100 \times 0.05 = 8V$

$V_1 = \frac{5+5}{5} V_a = 2V_a$

$V_2 = \frac{5+45}{5} V_b = 10V_b$

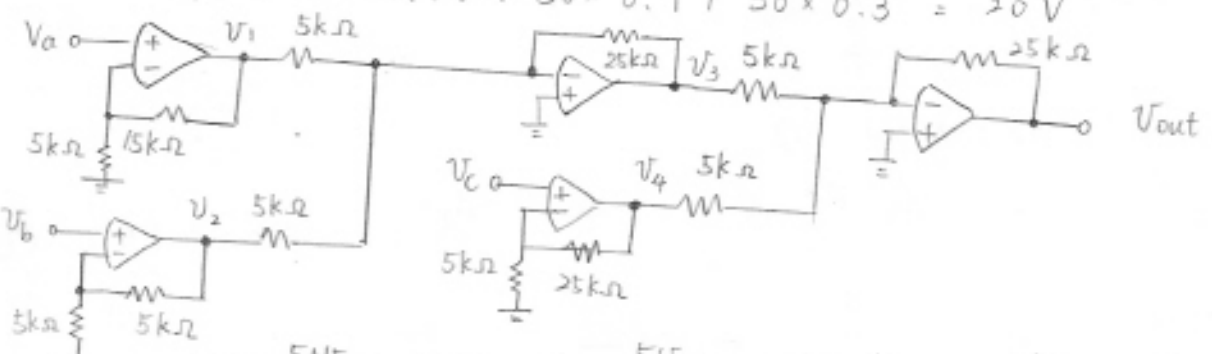
$V_{out} = -\frac{50}{50} V_1 - \frac{50}{5} V_2 = -2V_a - 100V_b$



3.36

$V_{out} = -5[(-20V_a - 10V_b) + 6V_c] = 100V_a + 50V_b - 30V_c$

$V_{ps} > 100 \times 0.06 + 50 \times 0.1 + 30 \times 0.3 = 20V$



$V_1 = \frac{5+15}{5} V_a = 4V_a$, $V_2 = \frac{5+5}{5} V_b = 2V_b$, $V_3 = -\frac{25}{5} V_1 - \frac{25}{5} V_2 = -20V_a - 10V_b$

$V_4 = \frac{5+25}{5} V_c = 6V_c$, $V_{out} = -\frac{25}{5} V_3 - \frac{25}{5} V_4 = 100V_a + 50V_b - 30V_c$

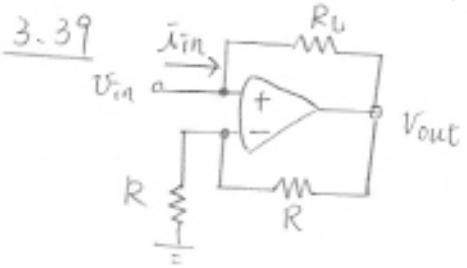
3.37 $V_1 = 1,\ V_2 = V_3 = 0 \Rightarrow V_{out} = -(R_F/R_1)\times 1 = -1 \Rightarrow R_1 = R_F$

$V_2 = 1,\ V_1 = V_3 = 0 \Rightarrow V_{out} = -(R_F/R_2)\times 1 = -2 \Rightarrow R_2 = R_F/2$

$V_3 = 1,\ V_1 = V_2 = 0 \Rightarrow V_{out} = -(R_F/R_3)\times 1 = -4 \Rightarrow R_3 = R_F/4$

$V_{out} = -R_F(V_1/R_1 + V_2/R_2 + V_3/R_3) = -(V_1 + 2V_2 + 4V_3)$

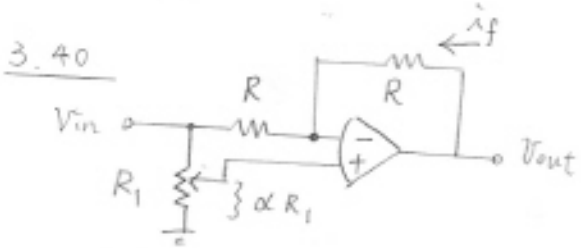
3.39



$V_n = \frac{R}{R+R} V_{out} = \frac{1}{2} V_{out}$, $V_{in} = V_p = V_n \Rightarrow V_{out} = 2V_{in}$

$i_{in} = \frac{V_{in} - V_{out}}{R_L} = \frac{-V_{in}}{R_L} \Rightarrow \frac{V_{in}}{i_{in}} = -R_L$

3.40



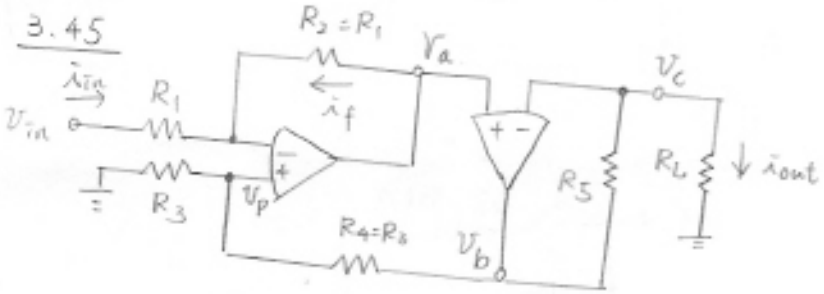
$V_n = V_p = (\alpha R_1/R_1) V_{in} = \alpha V_{in}$

$(V_{in} - V_n)/R = -i_f$

$V_{out} = V_n + R i_f = \alpha V_{in} + \alpha V_{in} - V_{in}$

$= (2\alpha - 1) V_{in} = \begin{cases} V_{in}, & \alpha = 1 \\ -V_{in}, & \alpha = 0 \end{cases}$

3.45



(a) $V_p = R_4 V_b/(R_4 + R_3) = \frac{1}{2} V_b$

$i_{in} = (V_{in} - V_p)/R_1$, $i_f = -i_{in}$

$V_a = V_p + R_2 i_f = \frac{V_b}{2} - R_2 (V_{in} - \frac{V_b}{2})/R_1$

$= V_b - V_{in}$

$V_c = V_a = V_b - V_{in}$

$i_{out} = (V_b - V_c)/R_5 = V_{in}/R_5$

$\Rightarrow i_{out} = g V_{in} = V_{in}/R_5 \Rightarrow g = 1/R_5$

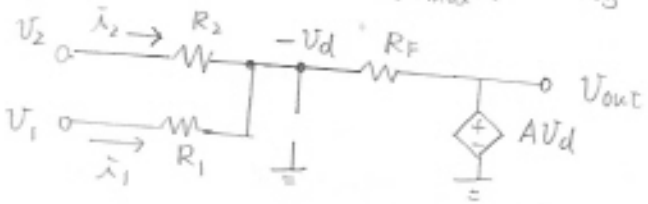
(b) For linear region : $|V_a| < V_{ps}$ and $|V_b| < V_{ps}$

$V_a = V_c = R_L \cdot i_{out}$, $V_b = V_c + R_5 \cdot i_{out} = (R_L + R_5) \cdot i_{out}$

$\Rightarrow |(R_L + R_5) \cdot i_{out}| < V_{ps} \Rightarrow (R_L + R_5) \cdot i_{out}|_{max} < V_{ps}$

$\Rightarrow R_L < (V_{ps}/i_{out}|_{max}) - R_5$

3.48



$AV_d + R_F(i_1 + i_2) + V_d = 0$

$i_1 = \frac{V_1 + V_d}{R_1}$, $i_2 = \frac{V_2 + V_d}{R_2} \Rightarrow \left(A + \frac{R_F}{R_1} + \frac{R_F}{R_2} + 1\right) V_d = -\frac{R_F}{R_1} V_1 - \frac{R_F}{R_2} V_2$

$V_{out} = AV_d = \frac{-A}{A + R_F/R_1 + R_F/R_2 + 1} \left(\frac{R_F}{R_1} V_1 + \frac{R_F}{R_2} V_2\right)$