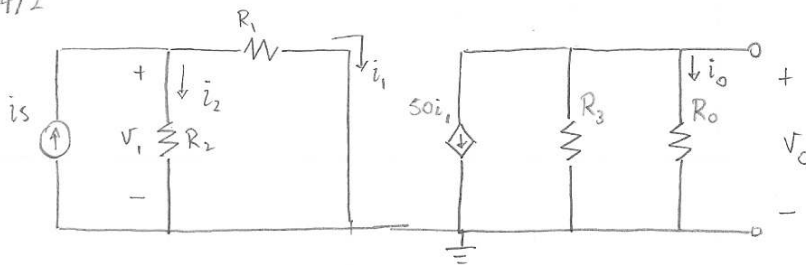


4/2



$$R_1 = R_2 = 100 \, \Omega$$

$$R_3 = R_0 = 2 \, \text{k}\Omega$$

$$i_1 = i_s \frac{R_2}{R_1 + R_2} = \frac{i_s}{2}$$

$$v_1 = i_2 R_2$$

$$= (i_s - i_1) R_2$$

$$= 50 i_s$$

$$i_o = (-50 i_1) \frac{R_3}{R_3 + R_0}$$

$$= -25 i_1$$

$$= -\frac{25}{2} i_s$$

$$v_o = i_o R_0$$

$$= -\frac{25}{2} i_s R_0$$

$$= -500 v_1$$

$$v_o/v_1 = -500$$

$$i_o/i_s = -25/2$$

$$\text{If } i_s = 2 \, \text{mA}$$

$$v_1 = 50 i_s = 0.1 \, \text{V}$$

$$P_s = i_s v_1 = 0.2 \, \text{mW}$$

$$v_o = -50 \, \text{V}$$

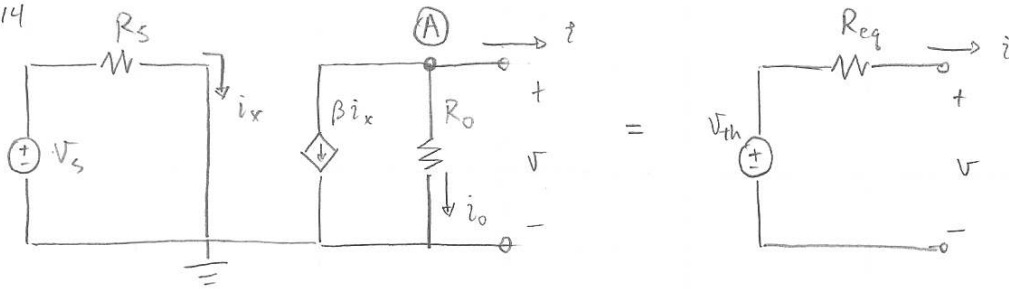
$$i_o = -25 \, \text{mA}$$

$$P_o = v_o i_o = 1.25 \, \text{W}$$

$$P_s = 0.2 \, \text{mW}$$

$$P_o = 1.25 \, \text{W}$$

4/14



$$i_x = \frac{V_s}{R_s}$$

OC test  $i = 0$   
 $\Rightarrow v = v_{th}$

$$\begin{aligned} v &= i_o R_o \\ &= -\beta i_x R_o \\ &= -\frac{\beta V_s R_o}{R_s} \end{aligned}$$

SC test  $v = 0$   
 $i = \frac{v_{th}}{R_{eq}}$

$$\Rightarrow R_{eq} = v_{th}/i$$

$$\begin{aligned} i &= -i_o - \beta i_x \\ &= -\beta i_x \end{aligned}$$

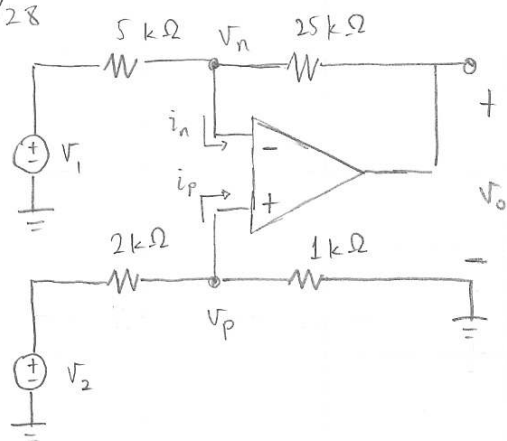
$$R_{eq} = \frac{v_{th}}{-\beta i_x}$$

$$= \frac{-\beta i_x R_o}{-\beta i_x}$$

$$= R_o \quad (\text{not surprisingly})$$

$$\boxed{v_{th} = -\beta V_s \frac{R_o}{R_s}, \quad R_{eq} = R_o}$$

4/28



$$(1) V_p = V_n, (2) i_p = i_n = 0$$

$$2 \Rightarrow \frac{V_2}{2+1} = \frac{V_p}{1}$$

$$\Rightarrow V_p = \frac{V_2}{3}$$

$$1 \Rightarrow V_n = \frac{V_2}{3}$$

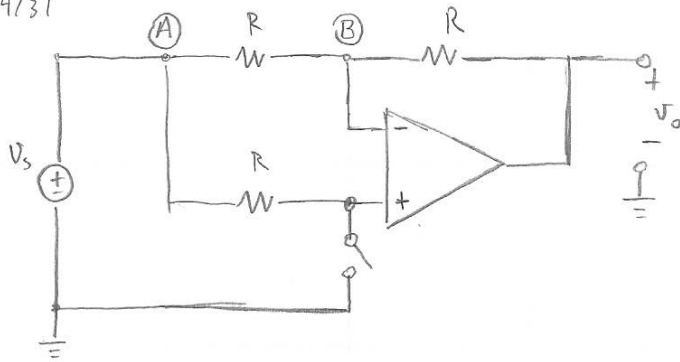
$$\frac{1}{5}(V_1 - V_n) = \frac{1}{25}(V_n - V_o)$$

$$5V_1 - 5V_n = V_n - V_o$$

$$5V_1 - \frac{5}{3}V_2 = \frac{V_2}{3} - V_o$$

$$\boxed{V_o = 2V_2 - 5V_1}$$

4/31



Switch open

$$V_n = V_p, \quad i_p = i_n = 0$$

$$\Rightarrow V_A = V_B = V_s$$

$$\frac{V_B - V_o}{R} = 0$$

$$V_B - V_o = 0$$

$$\Rightarrow \boxed{V_s = V_o}$$

Switch closed

$$\Rightarrow V_p = V_n = V_B = 0$$

$$\frac{V_A - V_B}{R} = \frac{V_B - V_o}{R}$$

$$V_s - 0 = 0 - V_o$$

$$\boxed{V_s = -V_o}$$

9/17 (a)

$$F_1(s) = \frac{2(s+5)}{s(s+10)}$$

$$= \frac{K_1}{s} + \frac{K_2}{s+10}$$

$$K_1 = \lim_{s \rightarrow 0} \frac{2(s+5)}{s(s+10)} \times s \Rightarrow$$

$$K_1 = 1$$

$$K_2 = \lim_{s \rightarrow -10} \frac{2(s+5)}{s(s+10)} \times (s+10)$$

$$= \frac{2(-5)}{-10} \Rightarrow$$

$$K_2 = 1$$

$$F_1(s) = \frac{1}{s} + \frac{1}{s+10}$$

$$\boxed{f_1(t) = u_t (1 + e^{-10t})}$$

9/17 (b)

$$F_2(s) = \frac{s^2}{(s+5)(s+10)}$$

$$\begin{array}{r} s^2 + 15s + 50 \overline{) s^2} \\ \underline{-s^2 - 15s - 50} \\ -15s - 50 \end{array}$$

$$F_2(s) = 1 - \frac{15s+50}{(s+5)(s+10)}$$

$$= 1 - \left( \frac{K_1}{s+5} + \frac{K_2}{s+10} \right)$$

$$K_1 = \lim_{s \rightarrow -5} \frac{15s+50}{(s+5)(s+10)} (s+5) \Rightarrow$$

$$K_1 = -5$$

$$K_2 = \lim_{s \rightarrow -10} \frac{15s+50}{(s+5)(s+10)} (s+10) \Rightarrow$$

$$K_2 = 20$$

$$F_2(s) = 1 + \frac{5}{s+5} - \frac{20}{s+10}$$

$$\boxed{f_2(t) = \delta_t + u_t (5e^{-5t} - 20e^{-10t})}$$

9/31 (a)

$$50 \dot{y}_t + 250 y_t = 0 ; y_{0-} = 10$$

$$\Rightarrow 50(s y_s - y_{0-}) + 250 y_s = 0$$

$$(50s + 250) y_s = 500$$

$$y_s = \frac{500}{50(s+5)}$$

$$= \frac{10}{s+5}$$

$$\Rightarrow \boxed{y_t = 10 u_t e^{-5t}}$$

9/31 (b)

$$\dot{y}_t + 20 y_t = 40 u_t ; y_{0-} = -10$$

$$\Rightarrow s y_s - y_{0-} + 20 y_s = 40 \left( \frac{1}{s} \right)$$

$$(s+20) y_s + 10 = \frac{40}{s}$$

$$y_s = -\frac{10}{s+20} + \frac{40}{s(s+20)}$$

$$= -\frac{10}{s+20} + \frac{K_1}{s} + \frac{K_2}{s+20}$$

$$K_1 = \lim_{s \rightarrow 0} \frac{40}{s(s+20)} \times s \Rightarrow$$

$$K_1 = 2$$

$$K_2 = \lim_{s \rightarrow -20} \frac{40}{s(s+20)} \times (s+20)$$

$$K_2 = -2$$

$$y_s = -\frac{12}{s+20} + \frac{2}{s}$$

$$\Rightarrow \boxed{y_t = u_t (1 - 12 e^{-20t})}$$