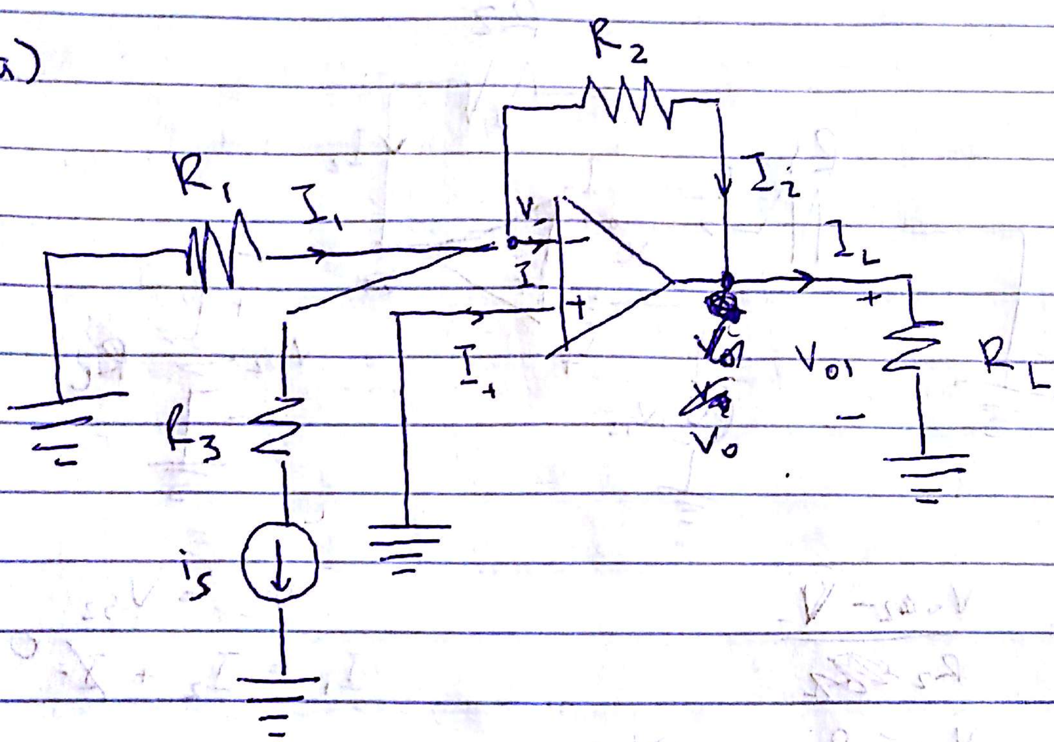
2a)



$I_1 = I_2 + \cancel{\ } i_s + I_{-}$ $\quad V_- = V_+ = 0$

$I_1 = \dfrac{V_- - 0}{R_1} = \dfrac{V_-}{R_1} = 0$ $\quad I_- = I_+ = 0$

$I_2 = -i_s$ $\quad V_{o1} = I_L R_L$

$\cancel{I_2 = \frac{V_{o1} - V_-}{R_2} = \frac{V_{o1}}{R_2}}$ $\quad I_2 = I_L$

$I_1 = \dfrac{V_- - 0}{R_1} = 0$ $\quad I_2 = \dfrac{V_o - V_-}{R_2} = \dfrac{V_o}{R_2}$

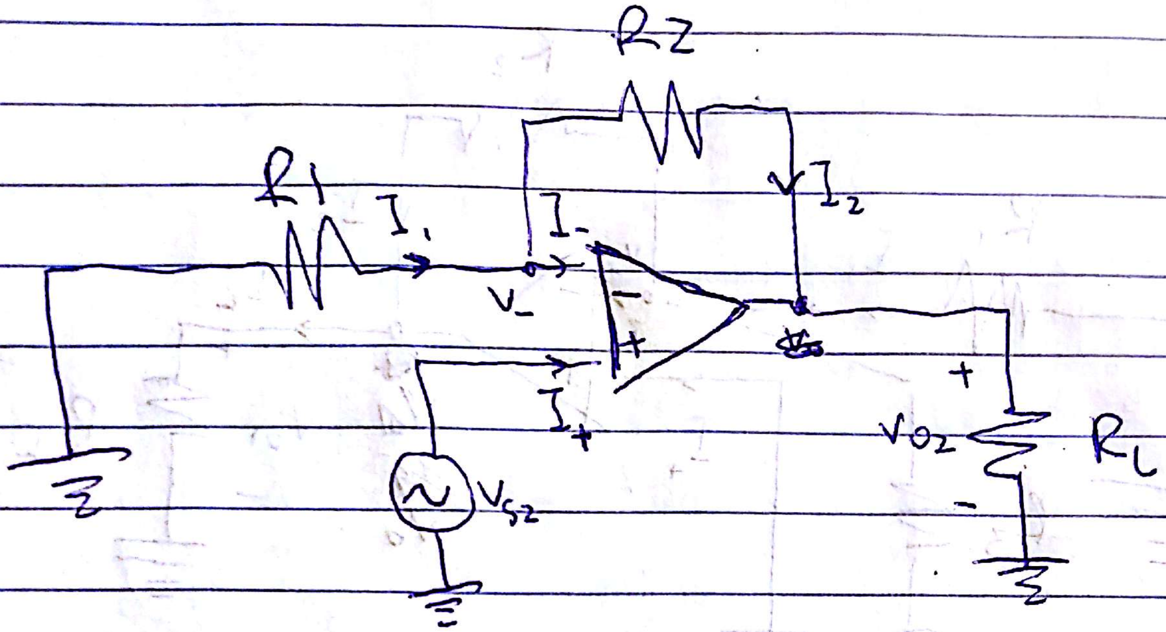
$I_L = \dfrac{0 - V_o}{R_L} = \dfrac{-V_o}{R_L} = \dfrac{V_o}{R_2}$

$V_o = R_2 I_L = -R_2 i_s$

$V_{o1} = -R_2 i_s$

Scanned by CamScanner

b)



$$I_2 = \frac{V_{o2} - V_-}{R_2}$$

$$V_- = V_{S2}$$

$$I_1 = I_2 + \cancel{I_-}^{\,0}$$

$$I_1 = \frac{V_- - 0}{R1} = \frac{V_{S2}}{R1}$$

$$\cancel{V_{o2} = I_2(R_2 + R_2) + R_2\, V_{S2}}$$

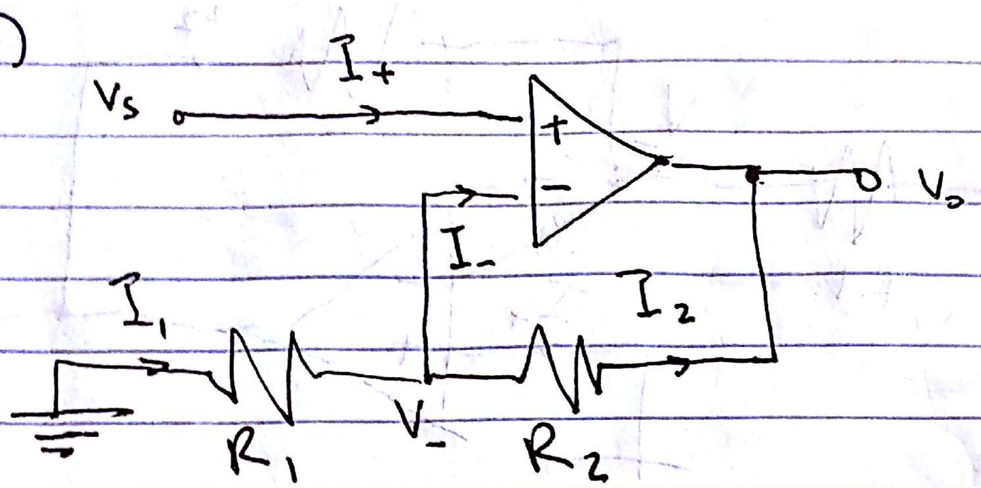
$$\cancel{= R_L(I_2(R_2 + R_L)}$$

$$\cancel{V_{o2} = I_2}$$

$$\frac{V_{O2} - V_{S2}}{R_2} = \frac{V_{S2}}{R1}$$

$$V_{O2} = V_{S2}\left(\frac{R_2}{R_1} + 1\right)$$

1. a)



$I_- = I_+ = 0$ $\quad I_1 = I_- + I_2 \quad I_1 = I_2$

$V_- = V_s$

$$I_2 = \frac{V_- - V_o}{R_2} = \frac{V_s - V_o}{R_2}$$

$$\frac{0 - V_-}{R_1} = I_1 \qquad \frac{-V_-}{R_1} = \frac{V_s - V_o}{R_2}$$

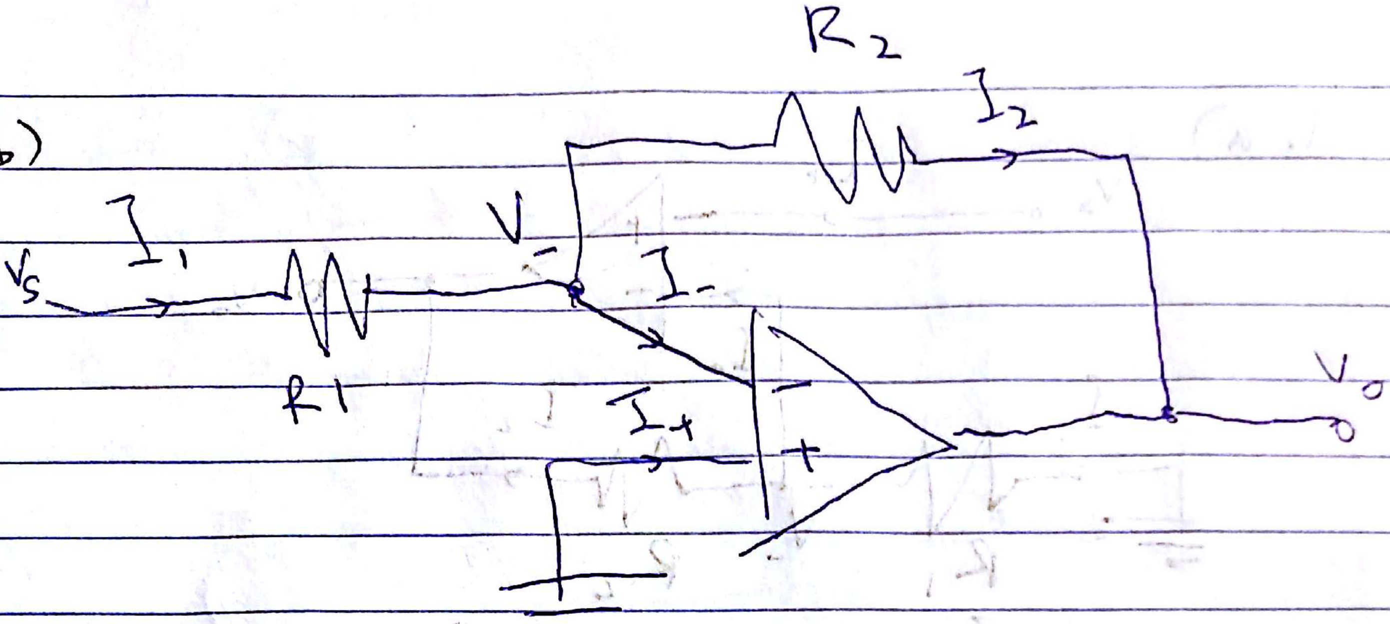
$$\frac{-V_s}{R_1} = \frac{V_s - V_o}{R_2}$$

$$V_s + \frac{V_s R_2}{R_1} = V_o$$

$$V_o = V_s\left(1 + \frac{R_2}{R_1}\right)$$

the amplifier is non inverting because if V_s is positive, V_o stays positive.

b)



$$V_- = V_+ = 0$$

$$I_1 = \underbrace{\cancel{I_-}}_{0} + I_2 \qquad I_1 = I_2$$

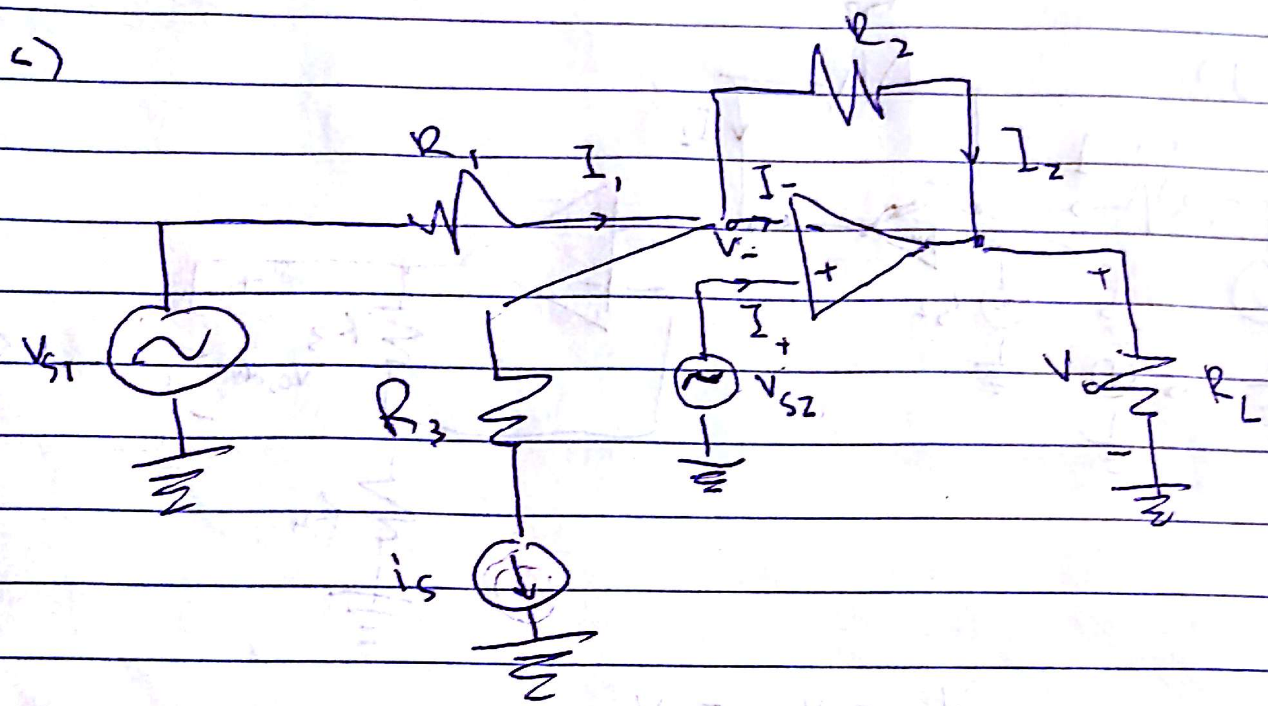
$$I_1 = \frac{V_s - V_-}{R_1} = \frac{V_s}{R_1}$$

$$I_2 = \frac{V_- - V_o}{R_2} = \frac{-V_o}{R_2}$$

$$\frac{V_s}{R_1} = -\frac{V_o}{R_2}$$

$$V_o = -\frac{R_2}{R_1} V_s$$

amplifier is inverting because V_o switches the sign of V_s, therefore inverting it c)



$$I_1 = \cancel{I_-}^{0} + I_2 + i_s \qquad I_1 = I_2 + i_s$$

$$\cancel{V_- = V_+ = V_{s2}}$$

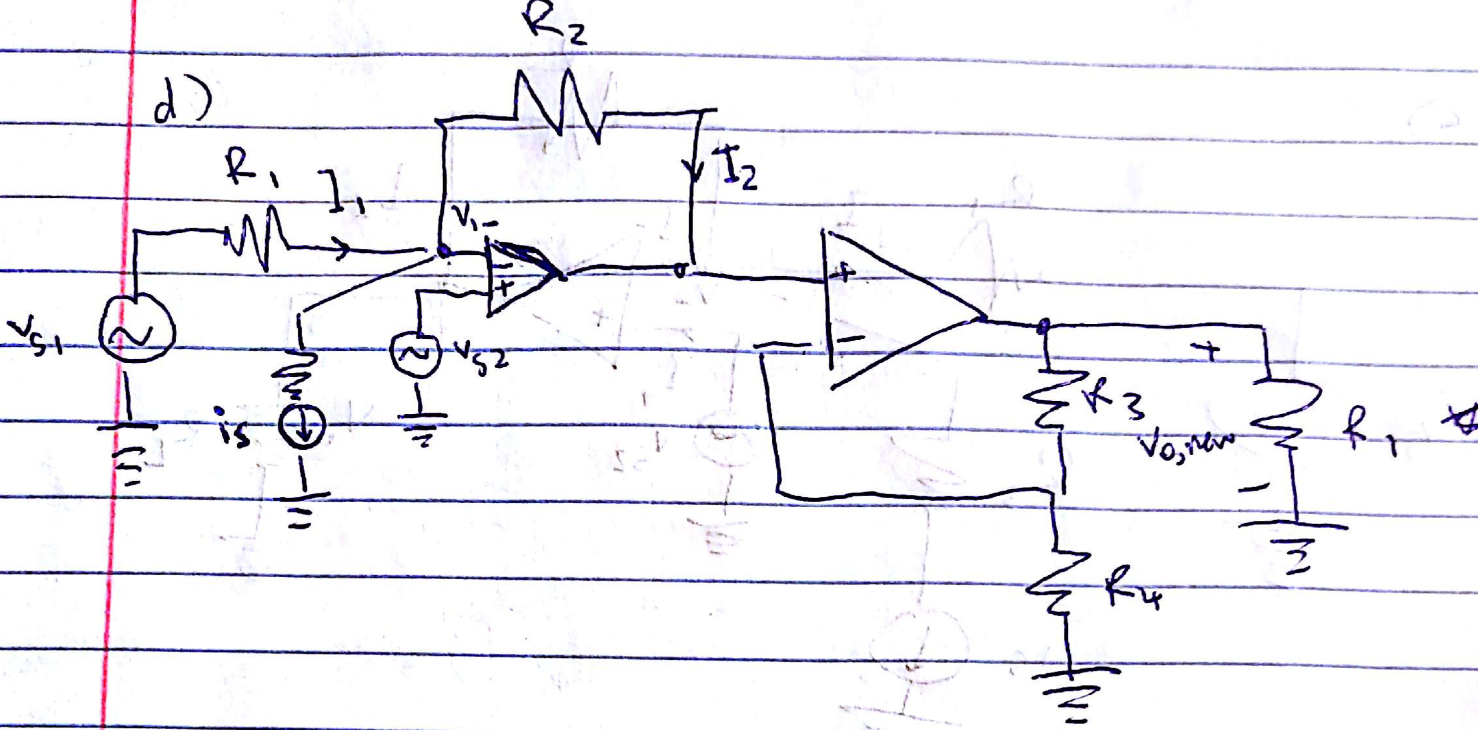
$$I_1 = \frac{V_- - V_{s1}}{R_1} \qquad I_2 = \frac{V_0 - V_-}{R_2}$$

$$\frac{V_0 - V_{s2}}{R_2} = \frac{V_{s2} - V_{s1}}{R_1} + i_s$$

$$\cancel{V_0 = \frac{R_2 (V_{s2} - V_{s1})}{R_1}}$$

$$V_0 = R_2 \left(\frac{V_{s2} - V_{s1}}{R_1} + i_s \right) + V_{s2}$$

d)



$$V_o = V_+ = V_-$$

$$V_- = V_{o,new} \frac{R_3}{R_3 + R_4}$$

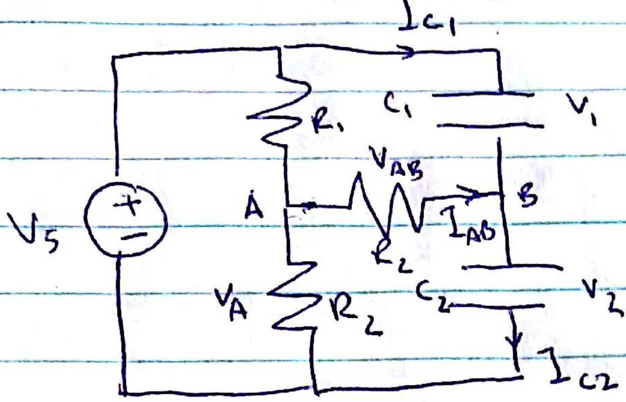
$$V_{o,new} = \frac{V_o (R_3 + R_4)}{R_3}$$

Vo does not change

Vo, new does depend on R_L

3. $R_1 \| (R_2 + R_3) + R_4$

4.



$I_{C1} = 0 \quad I_{C2} = 0$

$I_{AB} = 0$

$V_{AB} = 0 \quad \cancel{AB} \quad V_A = V_B$

$$V_A = \frac{R_2}{R_1 + R_2} V_s$$

$$V_2 = \cancel{R_{AB}}\ V_A - \cancel{V_{AB}}\ 0$$

$$= \frac{R_2}{R_1 + R_2} V_{\cancel{AB}s} = \frac{1}{3} \times 3 = 1$$

$$V_1 = V_S - V_2$$

$$= \frac{R_1}{R_1 + R_2} V_s = \frac{2}{3} \times 3 = 2$$

5. $$\frac{V_A - V_B}{R_1} = \frac{V_1 - V_A}{R_2} + \frac{-V_A}{R_2}$$

$$\frac{V_A}{R_1} - \frac{V_B}{R_1} = \frac{V_1}{R_2} - \frac{V_A}{R_2} \cancel{+} - \frac{V_A}{R_2}$$

$$\frac{V_1}{2} = V_A\left(\frac{1}{2} + \frac{1}{2} + 1\right) - V_B$$

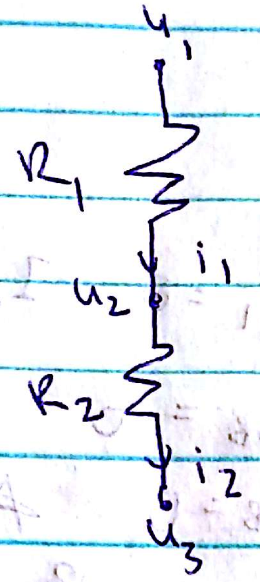
$$V_1/2 = 2V_A - V_B$$

$$\frac{V_2 - V_B}{R_2} = \frac{V_A - V_B}{R_1}$$

$$\frac{V_2}{R_2} + \frac{V_B}{R_2} = \frac{V_A}{R_1} - \frac{V_B}{R_1}$$

$$\frac{V_2}{2} = V_B\left(\frac{1}{2} + 1\right) - V_A$$

6. a)

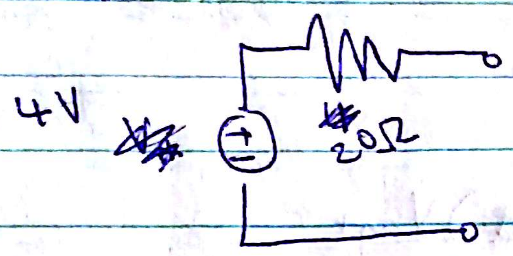


b) $u_1 \xrightarrow{i_1} u_2 \xrightarrow{i_2} u_3$

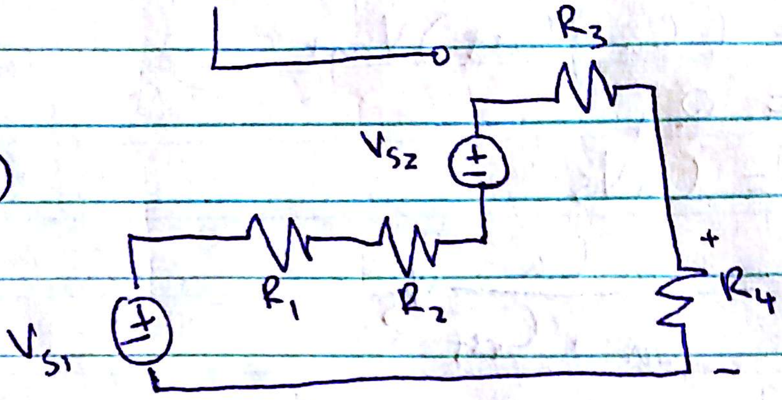
$$\begin{bmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \end{bmatrix}$$

c)
$$\begin{bmatrix} I_{S1} \\ I_{S2} \\ -I_{S1} - I_{S2} \end{bmatrix}$$

7. a) $\frac{1}{5} \times 20 = 4$



b)



$V_{S1} = 30 \times \frac{1}{3} = 10V$

$V_{S2} = \frac{1}{5} \times 20 = 4V$

c) $14 \times \frac{10}{30 + 10 + 20 + 10} = \frac{140}{70} = 2V$

8. $I_{AB} = \frac{R_1}{R_1 + R_2 + (R_3 \| R_4)} I_s$

$V_{Th} = R_2 I_{AB} = \frac{R_1}{R_1 + R_2 + (R_3 \| R_4)} I_s R_2$

$R_{th} = R_2 \| (R_1 + (R_3 \| R_4))$

9. a) $R_y = \frac{\rho_y L}{A}$ $R_x = \frac{\rho_x W}{A}$

10. a) $C = \varepsilon \dfrac{Wx}{d}$

b) $Q_1 = Q_a + Q_{ref} = C_a V_s$

$Q_2 = Q_a + Q_{ref} = (C_a + C_{ref}) V_{out}$

$Q_2 = Q_1$

$(C_a + C_{ref}) V_{out} = C_a V_s$

$$V_{out} = \frac{C_a}{C_a + C_{ref}} V_s$$

c) $\cancel{C_a V_s + C_{ref} V_{out}[k-1] = C_a V_s + C_{ref} V_{out}[k-1]}$

$C_a V_s + C_{ref} V_{out}[k-1] = C_a V_{out}[k] + C_{ref} V_{out}[k]$

$$V_{out}[k] = \frac{C_a V_s + C_{ref} V_{out}[k-1]}{C_a + C_{ref}}$$

11. Bruce Lon 26310857