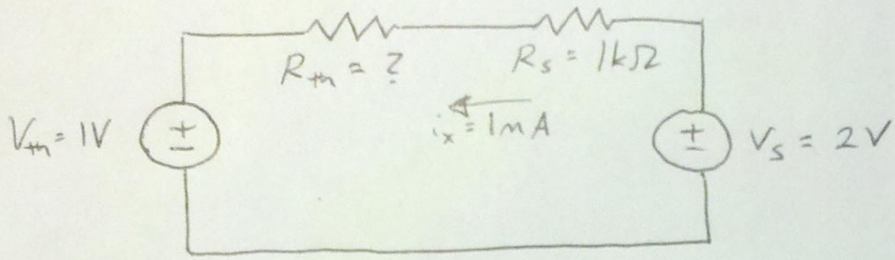
Problem 1

$$\boxed{V_{th} = V_{oc} = 1\,V}$$



KVL : $2 - (1mA)(1k\Omega) - (1mA)R_{th} - 1 = 0$

$2 - 1 - 1 - i_x R_{th} = 0 \longrightarrow \therefore \boxed{R_{th} = 0}$

$$\boxed{\begin{aligned} V_{th} &= 1V \\ R_{th} &= 0\,\Omega \end{aligned}}$$

Problem 2

7 nodes & 2 unknown variables (v_x, v_y)

$\longrightarrow$ 9 equations total

① $V_x = V_4 - V_5$

② $V_y = V_7 - V_6$

KCL for rest!

③ Node 1: $$\frac{V_1 - V_5 - V_7}{R_1} + \frac{V_1 - V_2}{R_2} + \frac{V_1 - V_3}{R_3} = 0$$

④ Supernode 2/4: $$\frac{V_2 - V_1}{R_2} + \frac{V_2 - V_3}{R_4} + \frac{V_4 - V_3}{R_5} + \frac{V_4 - V_5}{R_6} = 0$$

$\rightarrow$ auxiliary eqn needed: ⑤ $V_2 - V_4 = \beta V_y$

⑥ Node 3: $$\frac{V_3 - V_1}{R_3} + \frac{V_3 - V_2}{R_4} + \frac{V_3 - V_4}{R_5} - \alpha V_x = I_s$$

⑦ Node 5: $$-\frac{V_x}{R_6} + \alpha V_x + \frac{V_5 - V_6}{R_7} = 0$$

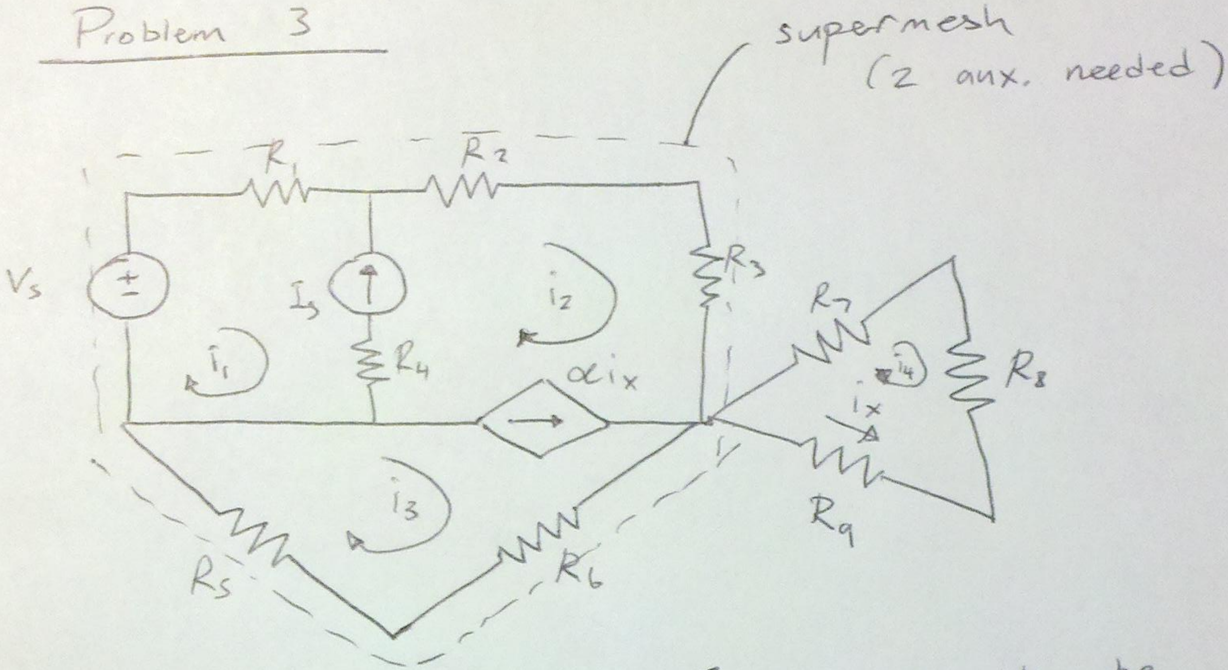
⑧ Node 6: $$\frac{V_6 - V_5}{R_7} + I_s - \frac{V_y}{R_8} = 0$$

⑨ Node 7: $$\frac{V_7 - V_6}{R_8} + \frac{V_5 - V_1}{R_1} = 0$$

OK if you plugged in ground, but set of equations must be same if we set above equations with same ground.

OK if you plugged in with V_x, V_y, but only if you ~~stated~~ what V_x & V_y equal in terms of nodes.

Problem 3



4 meshes & i_x $\longrightarrow$ 5 equations to be complete.

① $\boxed{i_4 = -i_x}$ (Mesh 4)

② $\boxed{i_x = 0}$ since $-i_x(R_7 + R_8 + R_9) = 0$ (Mesh 4)

③ (supermesh 1/2/3)

$$\boxed{-V_s + R_1 i_1 + R_2 i_2 + R_3 i_2 + R_6 i_3 + R_5 i_3 = 0}$$

2 aux: $\alpha i_x = i_2 - i_3 \longrightarrow \therefore \boxed{i_2 = i_3}$ ④

Also, $\boxed{I_s = i_2 - i_1}$ ⑤

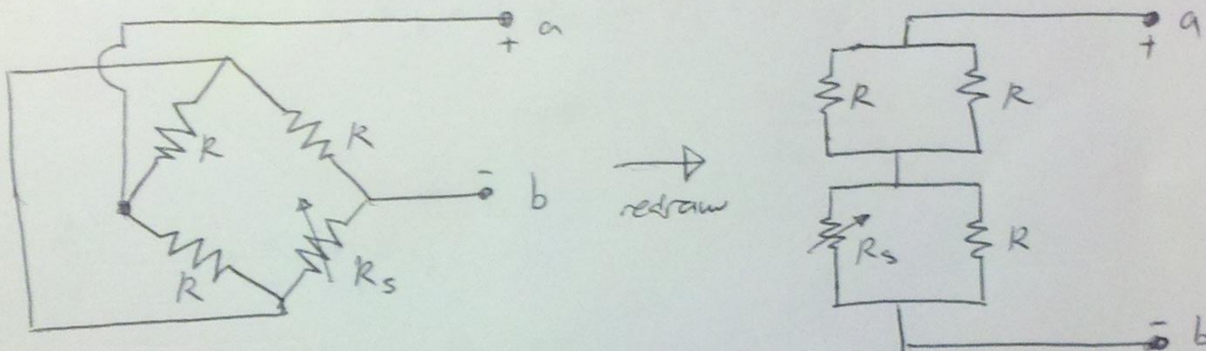
Probem 4

(a) Voltage divides in parallel :

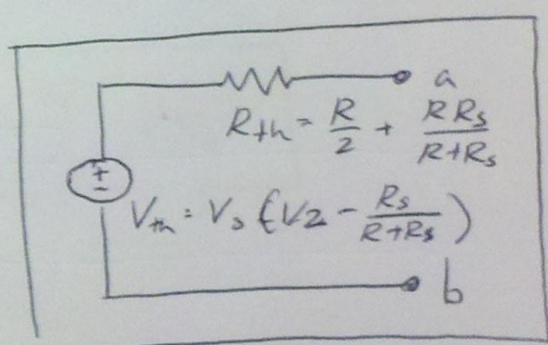
$$V_a = V_s/2 \qquad V_b = V_s \frac{R_s}{R+R_s}$$

$$V_{th} = V_{oc} = V_a - V_b \qquad \therefore \boxed{V_{th} = V_s\left(\frac{1}{2} - \frac{R_s}{R+R_s}\right)}$$

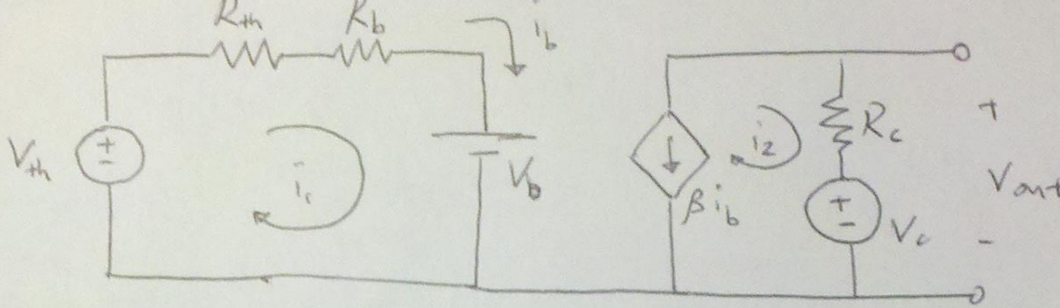
Equivalent resistance :



$$\therefore \boxed{R_{th} = \frac{R}{2} + \frac{RR_s}{R+R_s}}$$



(b)



$i_1 = i_b$

Mesh 1: $\quad -V_{th} + i_b R_b + i_b R_{th} + V_b = 0$

$$\longrightarrow \quad i_b = \frac{V_{th} - V_b}{R_{th} + R_b}$$

Mesh 2: $\quad i_2 = -\beta i_b$

$$V_{out} = i_2 R_c + V_c$$

$$\therefore \quad \boxed{V_{out} = -\beta R_c \frac{V_{th} - V_b}{R_{th} + R_b} + V_c}$$