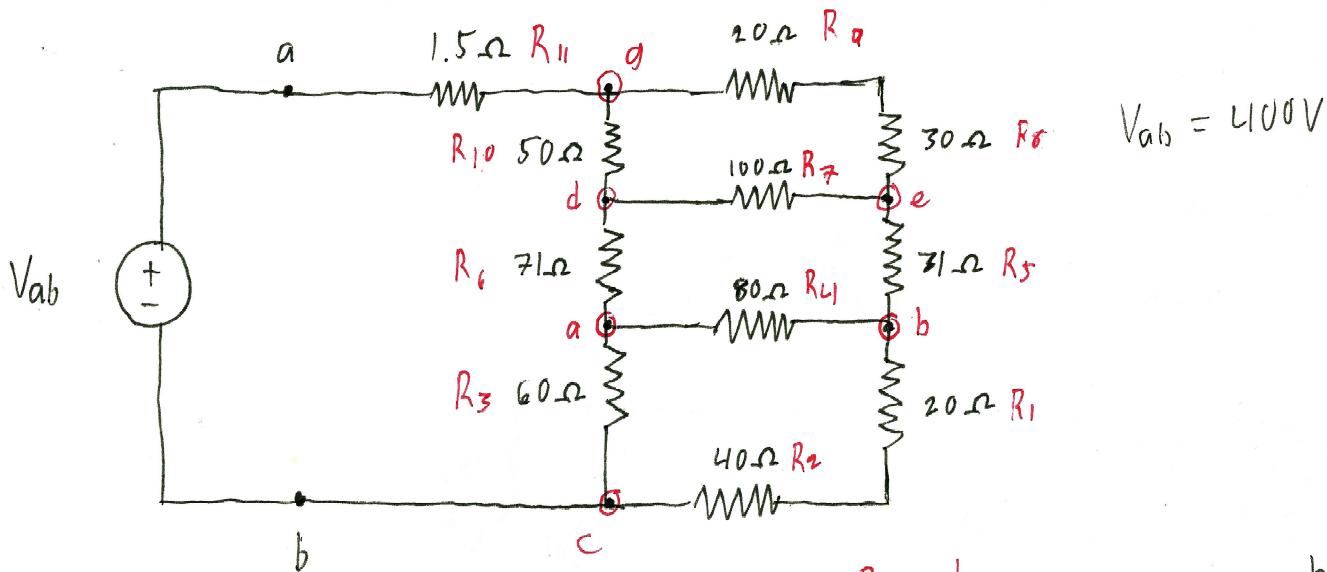


1)



L R₁ and R₂ are in series

$$R_{12} = R_1 + R_2 = 60 \Omega$$

L R₁₂, R₃, and R₄ from Δ-to-Y

$$R_a = \frac{R_3 R_4}{R_{12} + R_3 + R_4} = 24 \Omega$$

$$R_b = \frac{R_{12} R_4}{R_{12} + R_3 + R_4} = 24 \Omega$$

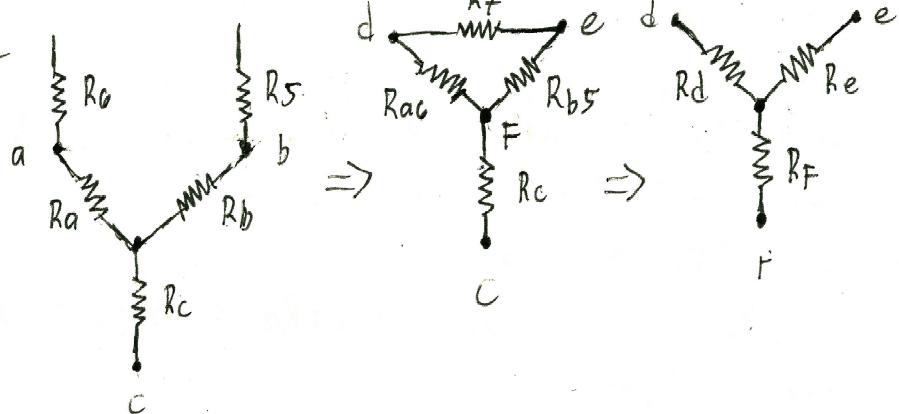
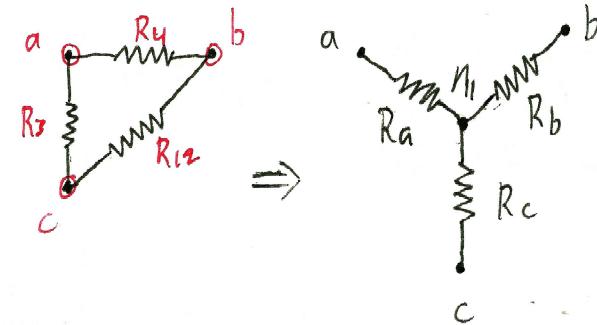
$$R_c = \frac{R_{12} R_3}{R_{12} + R_3 + R_4} = 18 \Omega$$

L R_a and R_c are series

$$R_{ac} = R_a + R_c = 42 \Omega$$

L R_b and R₅ are series

$$R_{b5} = R_b + R_5 = 55 \Omega$$



L R₇, R_{ac}, and R_{b5} from Δ-to-Y * → R_d and R₁₀ in series

$$R_d = \frac{R_7 R_{ac}}{R_7 + R_{ac} + R_{b5}} = 38 \Omega$$

$$R_e = \frac{R_7 R_{b5}}{R_7 + R_{ac} + R_{b5}} = 22 \Omega$$

$$R_f = \frac{R_{ac} R_{b5}}{R_7 + R_{ac} + R_{b5}} = 20.9 \Omega$$

L R_a and R_f are series

$$R_{af} = R_f + R_a = 50 \Omega$$

L Go to *

$$R_{d10} = R_d + R_{10} = 88 \Omega$$

↳ R_e and R_{8a} in series

$$R_{e8a} = R_e + R_{8a} = 72 \Omega$$

↳ R_{d10} and R_{e8a} in Parallel

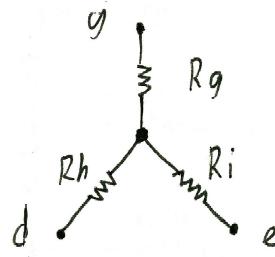
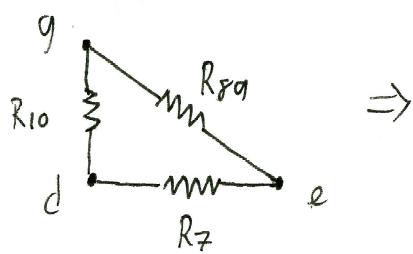
$$R_{de8a10} = \frac{R_{d10} R_{e8a}}{R_{d10} + R_{e8a}} = 39.6 \Omega$$

↳ R_H, R_{dc8a10}, R_F, and R_c in series

a)
$$[R_{eq} = R_{11} + R_{de8a10} + R_c + R_F = 80 \Omega]$$

L R_g and R_h are series

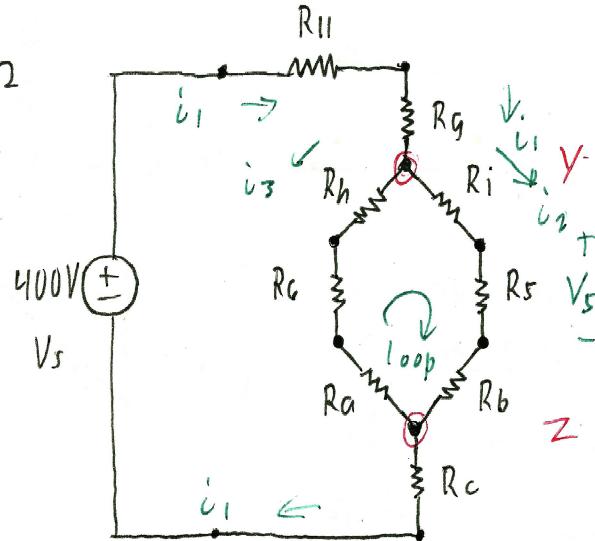
$$R_{hg} = 50 \Omega$$



$$R_g = \frac{R_{hg} R_{10}}{R_7 + R_{hg} + R_{10}} = 12.5 \Omega$$

$$R_h = \frac{R_7 R_{10}}{R_7 + R_{hg} + R_{10}} = 25 \Omega$$

$$R_i = \frac{R_7 R_{hg}}{R_7 + R_{hg} + R_{10}} = 25 \Omega$$



L Find i_1

$$i_1 = \frac{V_s}{R_{hg}} = 5 A$$

L Use KCL @ node Y

$$i_1 - i_2 - i_3 = 0 \quad (1)$$

L Use KVL @ loop

$$-i_2 R_i - i_2 R_5 - i_2 R_b + i_3 R_a + i_3 R_6 + i_3 R_h = 0 \quad (2)$$

L Solve (2) for i_3

$$-i_2 (R_i + R_5 + R_b) + i_3 (R_a + R_6 + R_h) = 0$$

$$i_3 (120 \Omega) = i_2 (80 \Omega) \Rightarrow i_3 = i_2 \frac{2}{3} \quad (3)$$

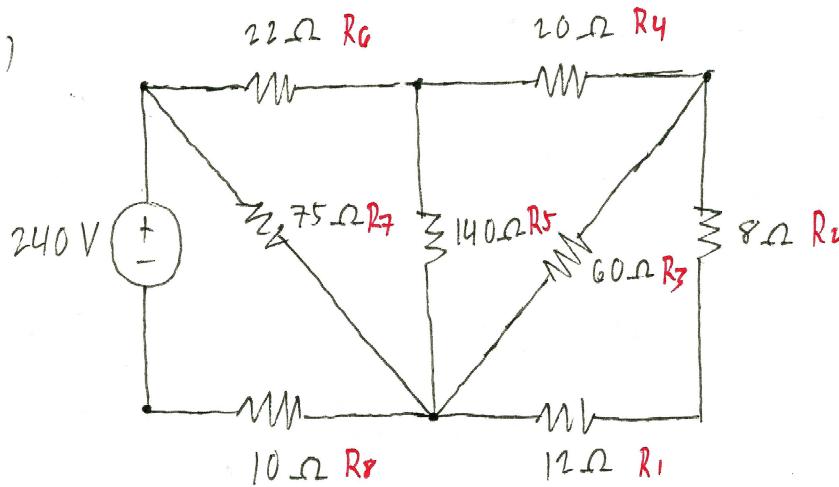
L Use (3) in (1), solve for i_2

$$i_1 - i_2 - i_2 \frac{2}{3} = 0 \Rightarrow \frac{5}{3} i_2 = 5 \Rightarrow i_2 = 3 A$$

L Find Power @ R_{312}

$$\left[P_{312} = -i_2^2 R_{312} = -279 W \right] b)$$

2)



L R_1 and R_2 in series

$$R_{12} = R_1 + R_2 = 20\Omega$$

L R_{12} , and R_3 in parallel

$$R_{123} = \frac{R_{12} \cdot R_3}{R_{12} + R_3} = 15\Omega$$

L R_{123} and R_4 in series

$$R_{1-4} = R_{123} + R_4 = 35\Omega$$

L R_{1-4} and R_5 in parallel

$$R_{1-5} = \frac{R_{1-4} \cdot R_5}{R_{1-4} + R_5} = 28\Omega$$

L R_{1-5} and R_6 in series

$$R_{1-6} = R_{1-5} + R_6 = 50\Omega$$

L R_{1-6} and R_7 in parallel

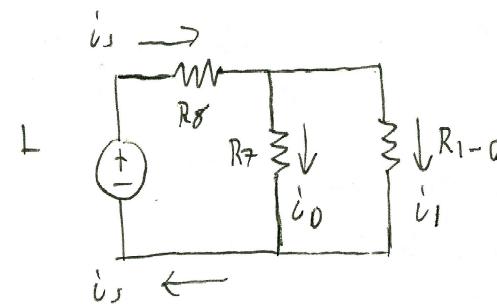
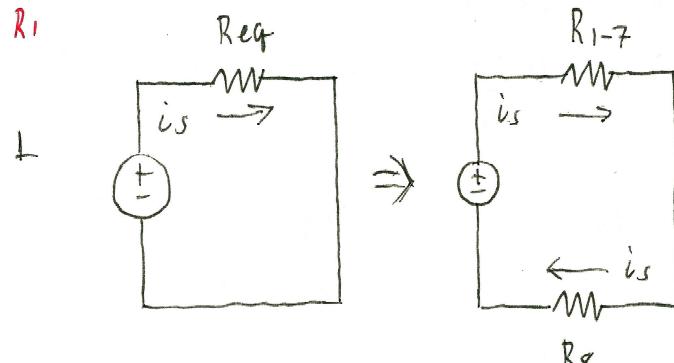
$$R_{1-7} = \frac{R_{1-6} \cdot R_7}{R_{1-6} + R_7} = 30\Omega$$

L R_{1-7} and R_8 in series

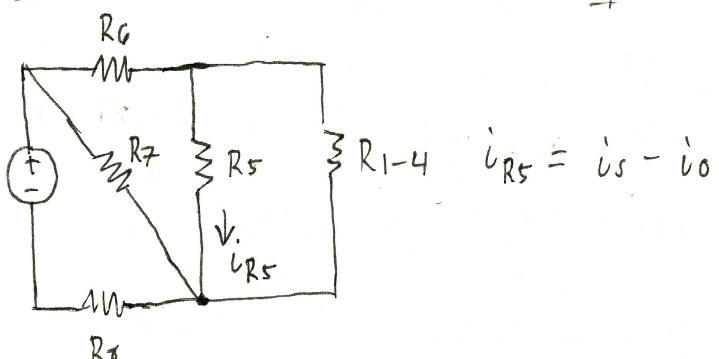
$$R_{\text{Req}} = R_{1-7} + R_8 = 40\Omega$$

L find i_s

$$V_s = i_s R_{\text{Req}} \Rightarrow i_s = \frac{240}{40} = 6A$$

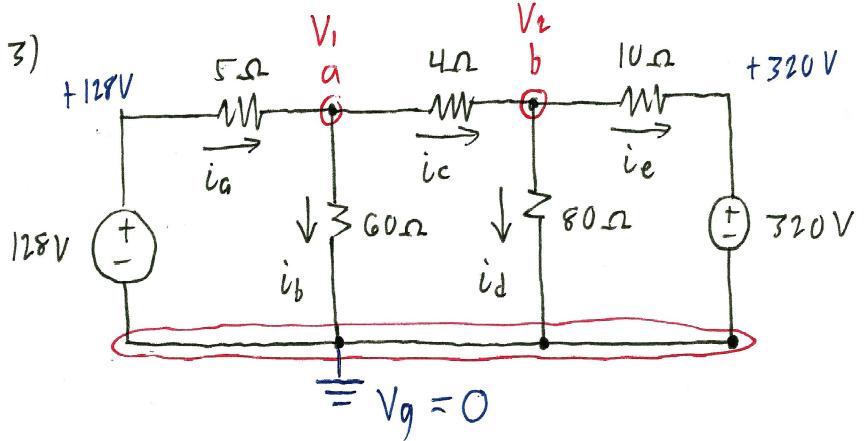


$$a) [i_0 = i_s \left(\frac{R_{1-6}}{R_{1-6} + R_7} \right) = 2.4 A]$$



$$i_{R5} = (i_s - i_0) \left(\frac{R_{1-4}}{R_{1-4} + R_5} \right) = 0.72A$$

$$b) [P_{140\Omega} = i_{R5}^2 R_5 = 72.576 W]$$



a)

L Use KCL @ node a

$$\left[\frac{V_1 - 128}{5} + \frac{V_1 - 0}{60} + \frac{V_1 - V_2}{4} = 0 \right] 60$$

$$12V_1 - 1536 + V_1 + 15V_1 - 15V_2 = 0$$

$$28V_1 - 15V_2 = 1536 \quad (1)$$

L Use KCL @ node b

$$\left[\frac{V_2 - V_1}{4} + \frac{V_2 - 0}{80} + \frac{V_2 - 320}{10} = 0 \right] 80$$

$$20V_2 - 20V_1 + V_2 + 8V_2 - 2560 = 0$$

$$-20V_1 + 29V_2 = 2560 \quad (2)$$

$$i_a = \frac{V_1 - 128}{5} = -6.8 \text{ A}$$

$$i_b = \frac{V_1}{60} = 2.7 \text{ A}$$

$$i_c = \frac{V_1 - V_2}{4} = -9.5 \text{ A}$$

$$i_d = \frac{V_2}{80} = 2.5 \text{ A}$$

$$i_e = \frac{V_2 - 320}{10} = -12 \text{ A}$$

$$P_{128V} = -i_a V_{128} = 870.4 \text{ W}$$

$$b) [P_{320V} = i_e V_{320} = -3840 \text{ W}]$$

L Find V_2 in (2)

$$V_2 = \frac{2560}{29} + \frac{20}{29}V_1 \quad (3)$$

L Use (3) in (1), find V_1

$$28V_1 - 15\left(\frac{2560}{29} + \frac{20}{29}V_1\right) = +1536$$

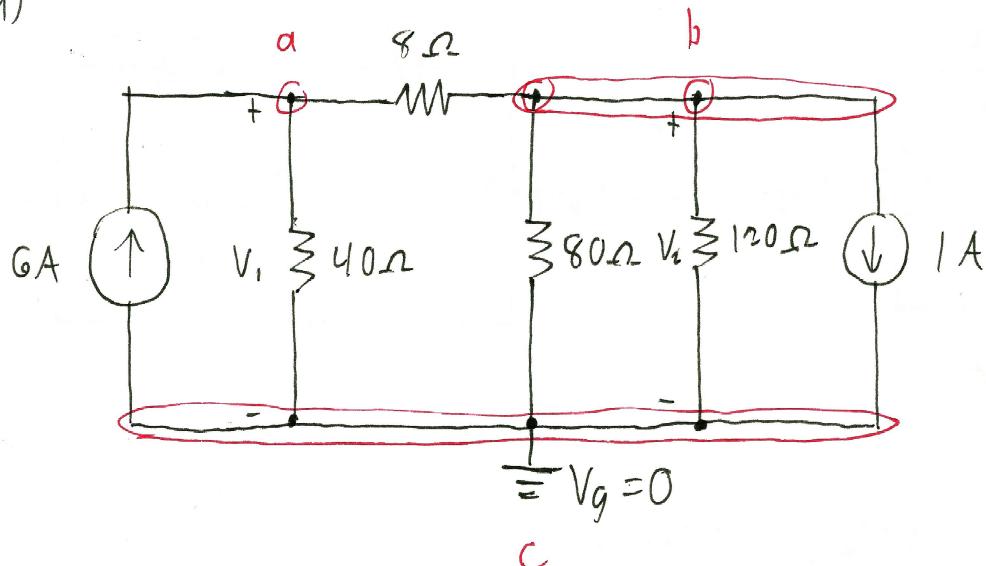
$$28V_1 - \frac{300}{29}V_1 = \frac{38400}{29} + 1536$$

$$\frac{512}{29}V_1 = \frac{82944}{29} \Rightarrow V_1 = 162 \text{ V}$$

L Find V_2 in (1) with V_1

$$28(162) - 1536 = 15V_2 \rightarrow V_2 = 200 \text{ V}$$

4)



L Use KCL @ a

$$\left[-6 + \frac{V_1 - 0}{40} + \frac{V_1 - V_2}{8} = 0 \right] 40$$

$$-240 + V_1 + 5V_1 - 5V_2 = 0$$

$$6V_1 - 5V_2 = 240 \quad (1)$$

L Use KCL @ b

$$\left[\frac{V_2 - V_1}{8} + \frac{V_2 - 0}{80} + \frac{V_2 - 0}{120} + 1 = 0 \right] 120$$

$$15V_2 - 15V_1 + 1.5V_2 + V_2 + 120 = 0$$

$$-15V_1 + 17.5V_2 = -120 \quad (2)$$

L Find V_2 in (2)

$$17.5V_2 = -120 + 15V_1 \Rightarrow V_2 = \frac{-120}{17.5} + \frac{15}{17.5}V_1 \quad (3)$$

L Use (3) in (1), find V_1

$$6V_1 - 5\left(\frac{-120}{17.5} + \frac{15}{17.5}V_1\right) = 240$$

$$6V_1 + \frac{240}{7} - \frac{30}{7}V_1 = 240$$

$$\frac{12}{7}V_1 = \frac{1440}{7}$$

$$[V_1 = 120V] \text{ a)}$$

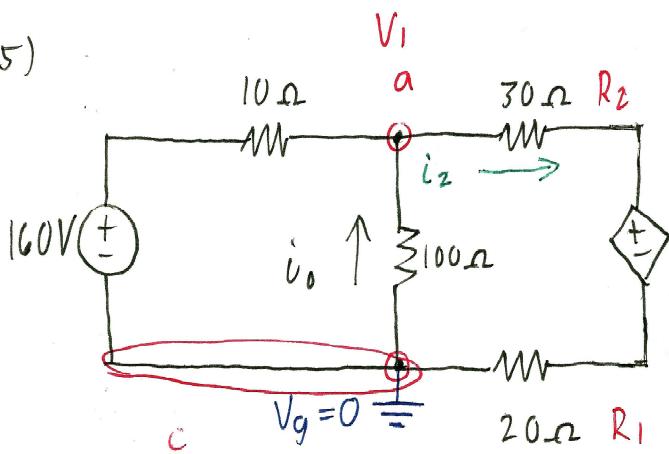
L Find V_2 in (1) with V_1

$$6(120) - 5V_2 = 240$$

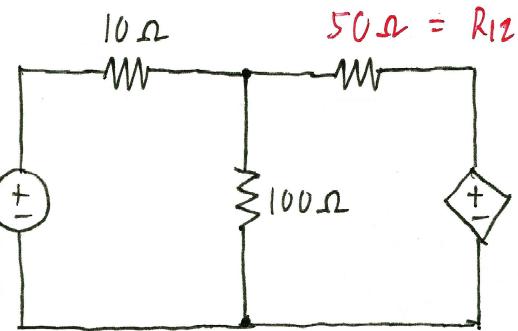
$$5V_2 = 480$$

$$[V_2 = 96V] \text{ b}$$

5)



$$150i_0 = V_2 \Rightarrow 160$$



L Use KCL @ a

$$\left[\frac{V_1 - 160}{10} + \frac{V_1 - 0}{100} + \frac{V_1 - 150i_0}{50} = 0 \right] 300$$

$$30V_1 - 4800 + 3V_1 + 6V_1 - 900i_0$$

$$39V_1 - 900i_0 = 4800$$

$$P_0 = i_2 V_2 = 5(-150) = -750 \text{ W}$$

L The current i_0 depends on

$$-\frac{V_1}{100} = i_0 \quad (2)$$

+ Use (2) in (1), find V_1

$$39V_1 - 900\left(\frac{-V_1}{100}\right) = 4800$$

$$V_1 = \frac{4800}{48} = 100 \text{ V}$$

+ Find i_0 in (2) with V_1

$$i_0 = -\frac{100}{100} = -1 \text{ A}$$

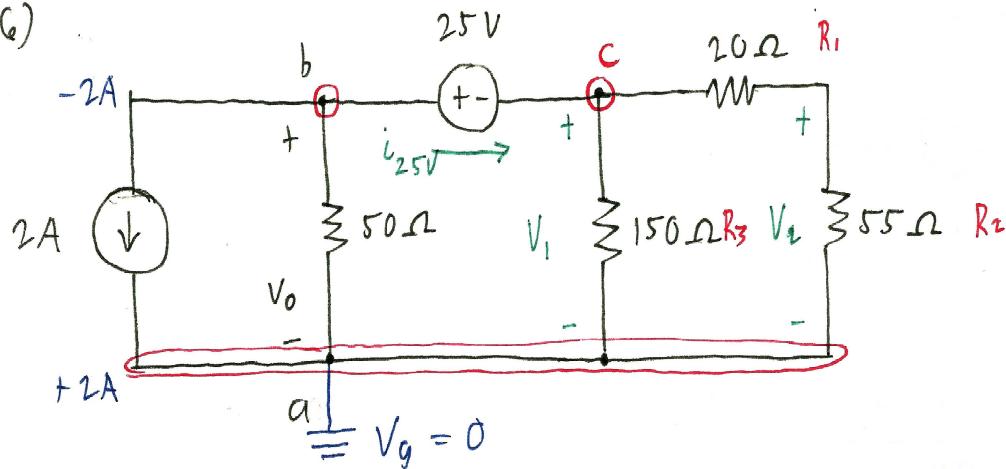
L Find V_2 with i_0

$$V_2 = 150(-1) = -150 \text{ V}$$

L Find i_2

$$i_2 = \frac{V_1 - V_2}{50} = \frac{100 - (-150)}{50} = 5 \text{ A}$$

6)

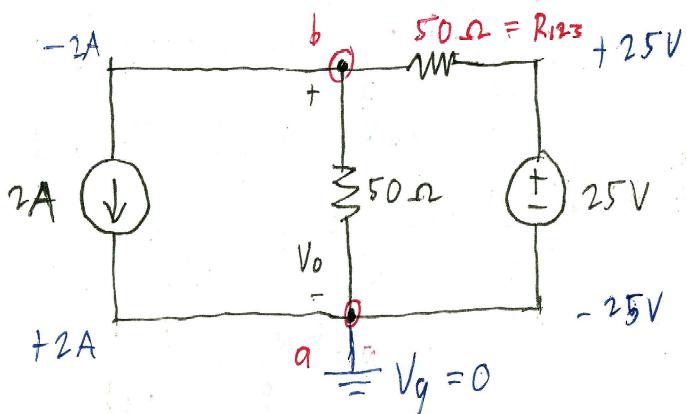


L R_1 and R_2 in series

$$R_{12} = R_1 + R_2 = 75\Omega$$

L R_{12} and R_3 in parallel

$$R_{123} = \frac{R_{12}R_3}{R_{12} + R_3} = 50\Omega$$



L Use KCL @ b, find V_o

$$\left[-(-2) + \frac{V_o - 0}{50} + \frac{V_o - 25}{50} = 0 \right] 50$$

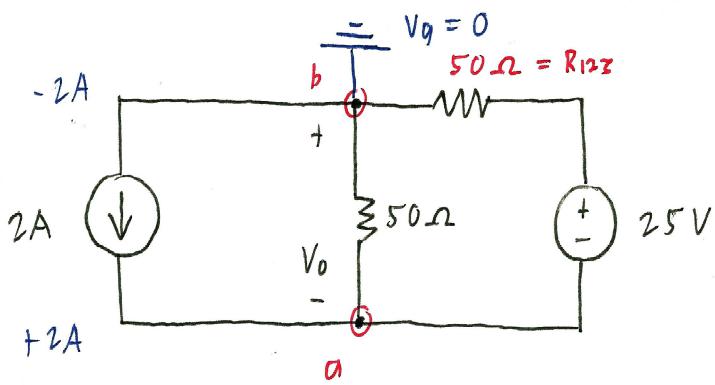
$$100 + V_o + V_o - 25 = 0$$

$$2V_o = -75$$

$$\left[V_o = \frac{-75}{2} = -37.5V \right] 1a)$$

L Find P_{2A}

$$\left[P_{2A} = -i_{2A} V_o = -(2)(-37.5) = 75W \right] 2a)$$



L Use KCL @ a

$$\left[-2 + \frac{(-V_o - 0)}{50} + \frac{(-V_o - (-25))}{50} = 0 \right] 50$$

$$-100 + V_o - V_o + 25 = 0$$

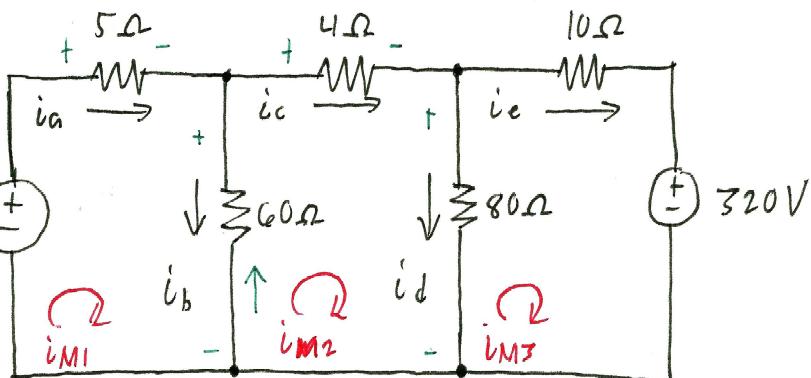
$$2V_o = -75$$

$$\left[V_o = \frac{-75}{2} = -37.5 \text{ V} \right] 1(b)$$

L Find P_{2A}

$$\left[P_{2A} = -i_{2A} V_o = 75 \text{ W} \right] 2(b)$$

7)

L Use KVL @ i_{M1}

$$-128 + 5i_{M1} + 60(i_{M1} - i_{M2}) = 0$$

$$65i_{M1} - 60i_{M2} = 128 \quad (1)$$

L Use KVL @ i_{M2}

$$60(i_{M2} - i_{M1}) + 4i_{M2} + 80(i_{M2} - i_{M3}) = 0$$

$$-60i_{M1} + 144i_{M2} - 80i_{M3} = 0 \quad (2)$$

L Use KVL @ i_{M3}

$$80(i_{M3} - i_{M2}) + 10i_{M3} + 320 = 0$$

$$-80i_{M2} + 90i_{M3} = -320 \quad (3)$$

L Find i_{M3} in (3)

$$90i_{M3} = 80i_{M2} - 320$$

$$i_{M3} = \frac{8}{9}i_{M2} - \frac{32}{9} \quad (4)$$

L Use (4) in (2)

$$-60i_{M1} + 144i_{M2} - 80\left(\frac{8}{9}i_{M2} - \frac{32}{9}\right) = 0$$

$$\left[-60i_{M1} + 144i_{M2} - \frac{640}{9}i_{M2} + \frac{2560}{9} = 0 \right] 9$$

$$-540i_{M1} + 656i_{M2} = -2560 \quad (5)$$

L Multiply (1) by $\frac{164}{15}$ then add to (5), Find i_{M1}

$$\frac{512}{3}i_{M1} = -\frac{17408}{15} \Rightarrow i_{M1} = -6.8 \text{ A}$$

L Find i_{M2} in (5) With i_{M1}

$$656i_{M2} = -2560 - 3672 \Rightarrow i_{M2} = -9.5 \text{ A}$$

L Go to *

* Find i_{M3} in (3) with i_{M2}

$$90i_{M3} = -320 - 760$$

$$i_{M3} = -12 \text{ A}$$

L Relationship between currents

a)

$i_a = i_{M1} = -6.8 \text{ A}$
$i_b = (i_{M1} - i_{M2}) = 2.7 \text{ A}$
$i_c = i_{M2} = -9.5 \text{ A}$
$i_d = (i_{M2} - i_{M3}) = 2.5 \text{ A}$
$i_e = i_{M3} = -12 \text{ A}$

b) $[P_{320V} = i_e V_{320V} = -3840 \text{ W}]$