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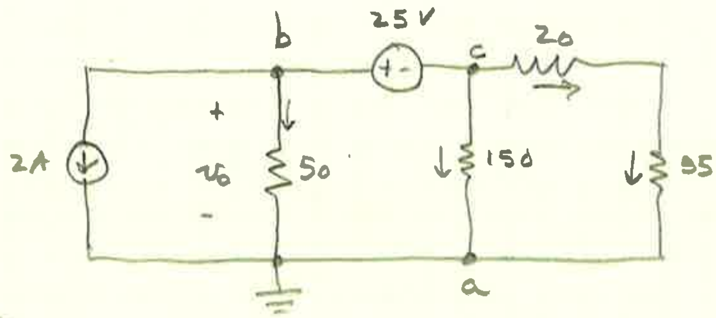
a) FIND V_o + P_{2A}. use node a as the reference



with node a as the reference, this becomes a super-node problem.

① $V_b = V_c + 25$

② $\Sigma i_{IN} = \Sigma_{out}$ (super node)

$$0 = 2 + \frac{V_b}{50} + \frac{V_c}{150} + \frac{V_c}{75}$$

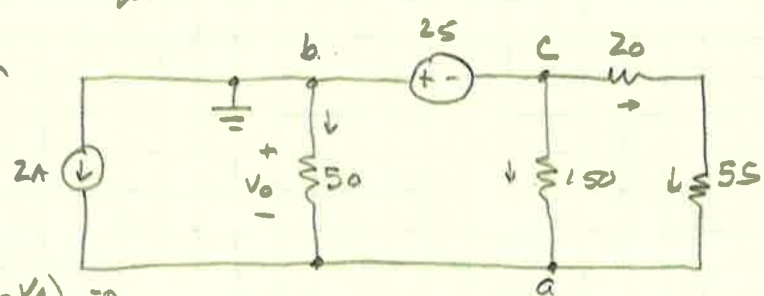
Solving : $V_b = V_o = -37.5V$
$V_c = -62.5V$

$P_{2A} = (-37.5)(2) = -75W$

b) Solve using node b as the reference.

Not a super-node problem
$V_b = 0V$
$V_c = -25V$

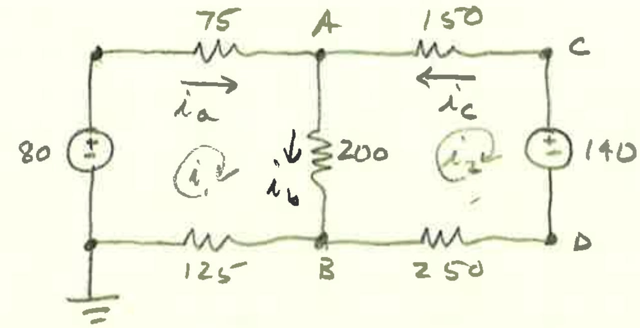
Node a: $\Sigma i_{IN} = \Sigma i_{out}$



$$2 + \frac{0 - V_A}{50} + \frac{(-25 - V_A)}{150} + \frac{(-25 - V_A)}{75} = 0$$

$V_A = 37.5V$
$V_o = -V_A = -37.5V$
$P_{2A} = (-37.5)(2) = -75W$

c) which is better? - b, because it only requires 1 equation.



a) use node-voltage method to find i_a, i_b, i_c

1) assign reference node
2) Super node problem

Node A : $i_a + i_c = i_b$

$$\frac{80 - V_A}{75} + \frac{V_C - V_A}{150} = \frac{V_A - V_B}{200} \quad ①$$

Node V_B : $i_b = i_a + i_c$

$$\frac{V_A - V_B}{200} = \frac{V_B}{125} + \frac{V_B - V_D}{250} \quad ②$$

super node : $i_c = i_c$

$$\frac{V_B - V_D}{250} = \frac{V_C - V_A}{150} \quad ③$$

Super node equation : $V_C = V_D + 140$ ④

Solving, $V_A = 72.5V$
$V_B = 12.5V$
$V_C = 102.5V$
$V_D = -37.5V$

b) Solve using mesh currents

mesh i_1 : $-80 + 75 i_1 + 200(i_1 - i_2) + 125 i_1 = 0$

$140 + 250(i_2) + 200(i_2 - i_1) + 150 i_2) = 0$

$$400 i_1 - 200 i_2 = 80$$
$$-200 i_1 + 600 i_2 = -140$$

$i_1 = 0.1A$
$i_2 = -0.2A$

So, $V_A = 80 - 75 i_1 = 72.5V$
$V_B = 0 + 125 (i_1) = 12.5V$
$V_C = V_A + (-i_2)(150) = 102.5V$
$V_D = V_C - 140 = -37.5V$
also, $V_D = V_B + (i_2)(250) = -37.5V$

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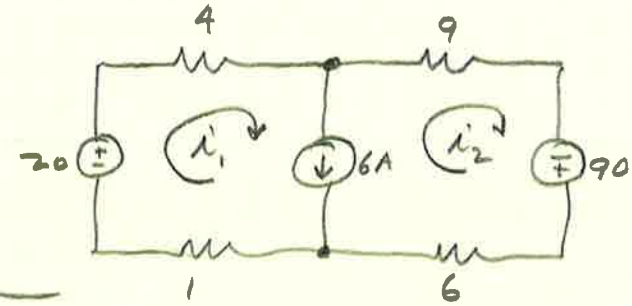
use the mesh current method to solve for total power dissipated.



Super-mesh problem

$i_1 - i_2 = 6$

$-20 + 4i_1 + 9i_2 - 90 + 6i_2 + 1i_1 = 0$

$i_1 - i_2 = 6$

$5i_1 + 15i_2 = 110$

solving : $i_1 = 10\,A$

$i_2 = 4\,A$

$P_{20V} = -(20)(10) = -200\,W$

$P_{90V} = -(90)(4) = -360\,W$

$P_{6A} = (-1i_1 + 20 - 4i_1)(6) = -180\,W$

} 740 W generated

$P_4 = i^2 R = (10)^2 4 = 400\,W$

$P_1 = (10)^2 1 = 100\,W$

$P_9 = (4)^2 9 = 144\,W$

$P_6 = (4^2)(6) = 96\,W$

} 740 W dissipated

✓

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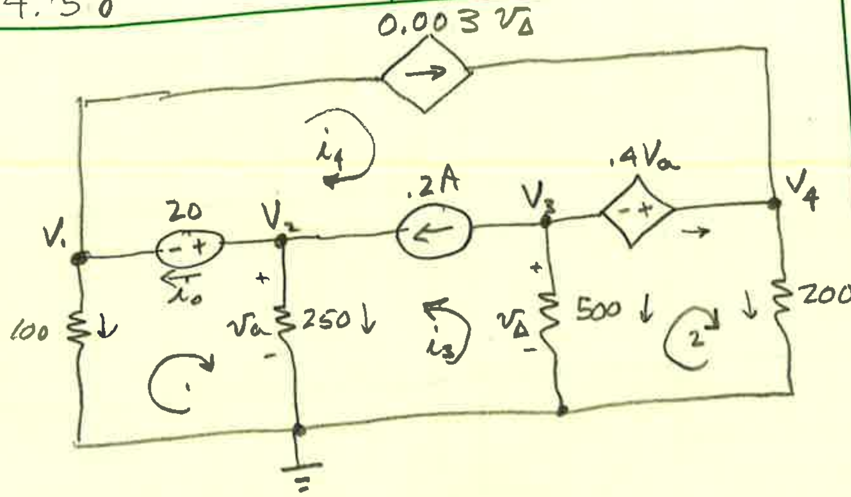
Find P_{20V} source



NODAL ANALYSIS

note: Both voltage sources are super nodes

nodes $V_1 + V_2$: $\Sigma i_{IN} = \Sigma_{OUT}$

$$.2 = \frac{V_2}{250} + \frac{V_1}{100} + .003 v_\Delta$$

Super node $V_1 + V_2$: $V_2 = V_1 + 20$

also: $V_\Delta = V_3$

nodes $V_3 + V_4$: $\Sigma i_{IN} = \Sigma i_{OUT}$

$$.003 v_\Delta = .2 + \frac{V_3}{500} + \frac{V_4}{200}$$

also $v_4 = v_3 + .4 V_a$ $\qquad v_a = V_2$

Solving: $V_1 = 24V$
$V_2 = 44V = V_A$
$V_3 = -72V = V_\Delta$
$V_4 = -54V$

$i_1 = -240mA$ ✓
$i_2 = -272mA$ ✓
$i_3 = 416mA$ ✓
$i_4 = -216mA$ ✓

$$i_o = .2 - \frac{V_2}{250} = 24mA$$

$\therefore$ $P_{20V} = (20)(24mA) =$ **480 mW absorbed**

mesh technique

mesh 1: $100i_1 - 20 + 250(i_1 + i_3) = 0$ ✓ $350i_1 \quad +250i_3$
mesh 2: $-.4V_A + 200i_2 + 500(i_2 + i_3) = 0$ ✓ $-100i_1 + 700i_2 + 400i_3$
mesh 3: $i_3 + i_4 = .2$ ✓ → $1.5i_2 + 1.5i_3 + i_3 + i_4$
$V_A = 250(i_1 + i_3) = .003(500)(i_3 + i_2)$ ✓
mesh 4: $i_4 = .003 V_\Delta$
Solving: $i_1 = -240 mA$
$i_2 = -272 mA$
$i_3 = 416 mA$
$i_4 = -216 mA$