EE 202 (122) – HW3 – Solution

Due Monday March 11, 2013

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Question 1:

For the circuit shown in Figure 1, use source transformation to find the current i_o.

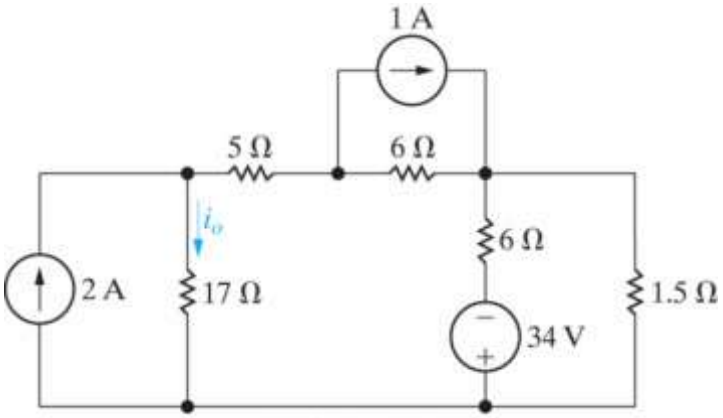
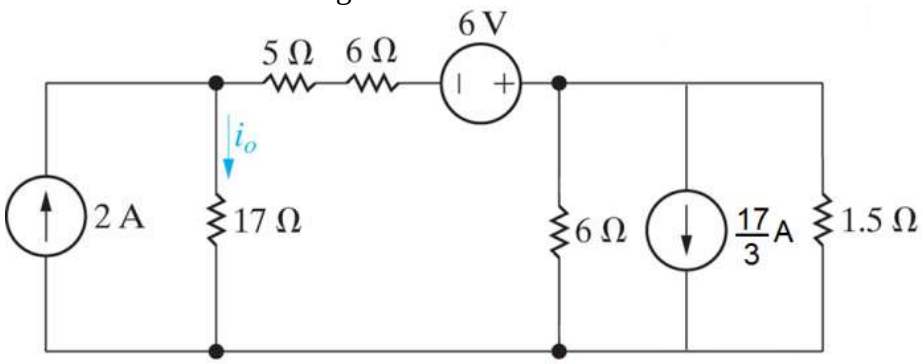


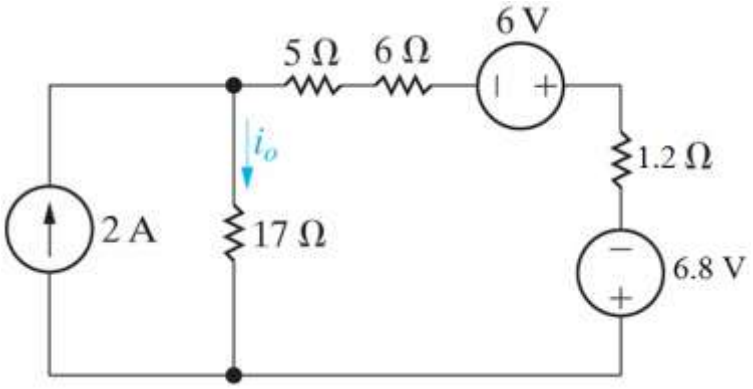
Figure 1

Solution:

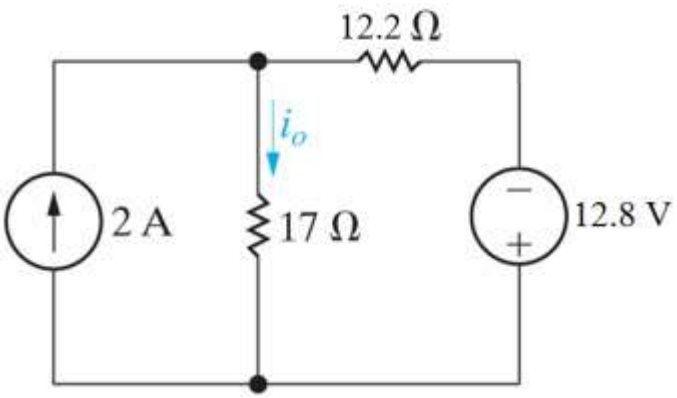
a) Two source transformations to get:



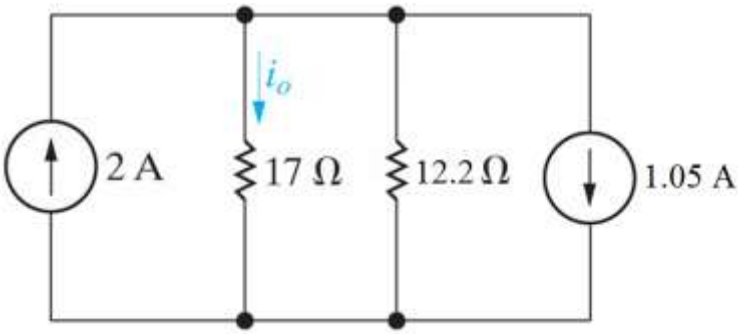
b) Combine two parallel resistors and one source transformation to get:



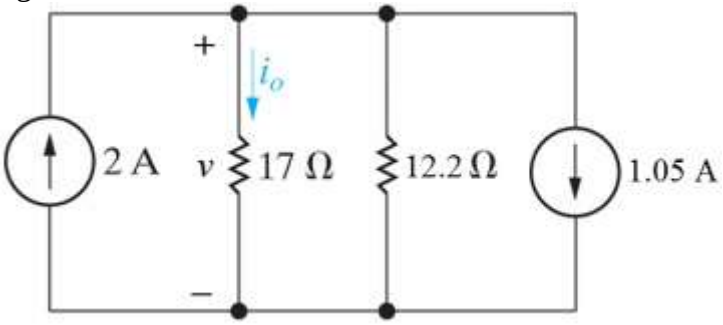
c) Combine three resistors and two voltage sources to get:



d) Once source transformation to get:



e) Assign a voltage v as follows:



Apply KCL to get
-2 +v/17 +v/12.2 + 1.05 = 0
v = 6.75 V

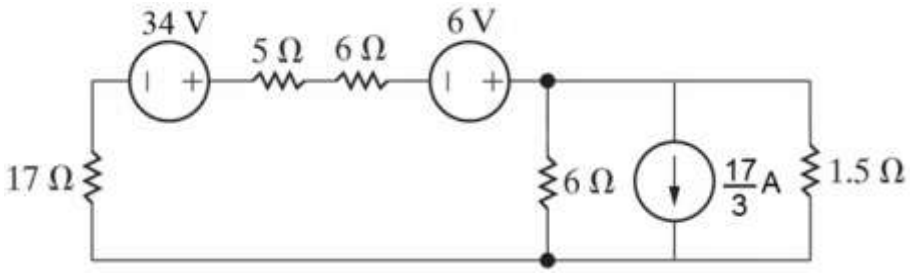
i_o = 6.75 /17 = 0.397 A

Question 2:

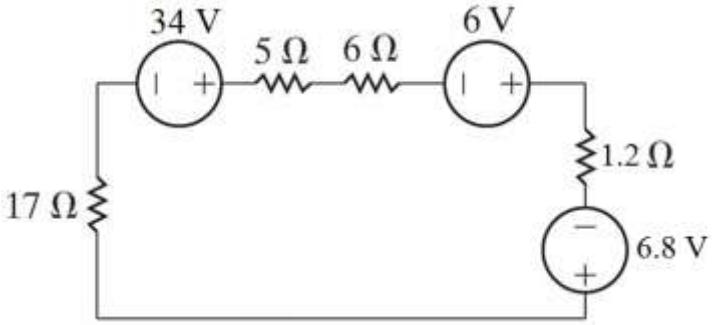
For the circuit shown in Figure 1, use source transformation to find the power dissipated by the 5 Ω resistor.

Solution:

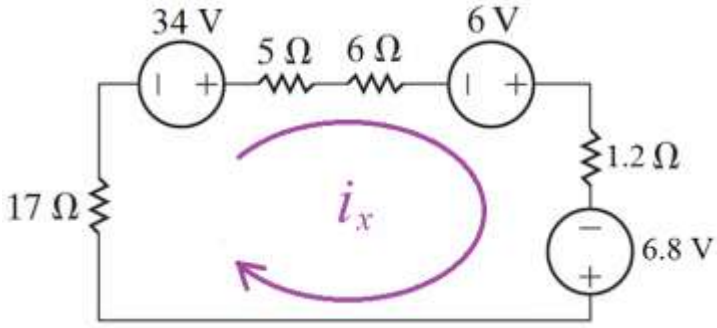
a) Three source transformations (right, left, and middle) to get:



b) Combine two resistors and one source transformation to get:



c) Mesh analysis



ix = (34+6+6.8)/(17+5+6+1.2) = 1.603 A

$P_{5\_Ohms} = 5\ (1.603)^2 = 12.848$ W absorbed.

Question 3:

For the circuit shown in Figure 2, use source transformation to find the following:

a) The voltage v_o.
b) The power dissipated by the 10 Ω resistor.

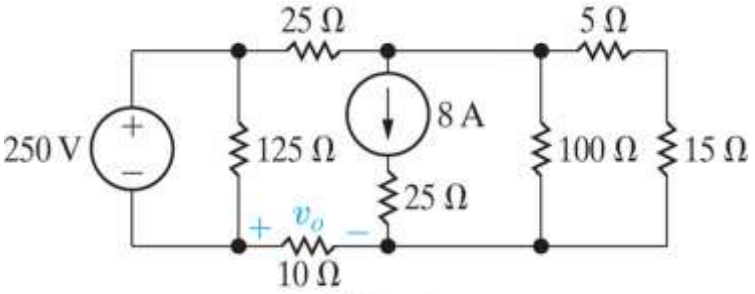
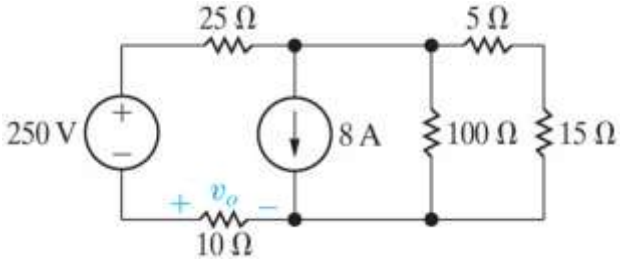


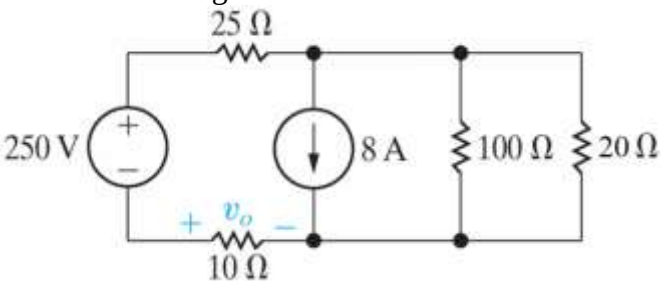
Figure 2

Solution:

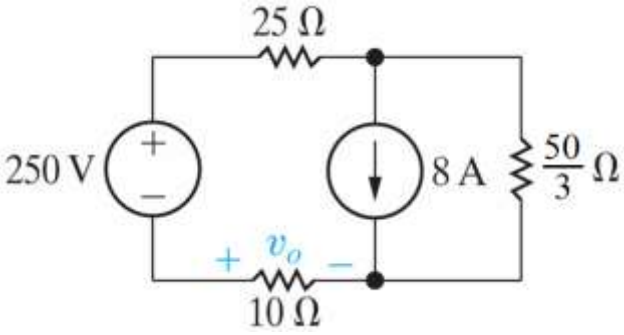
a) Remove 125 Ω and 25 Ω resistors as follows:



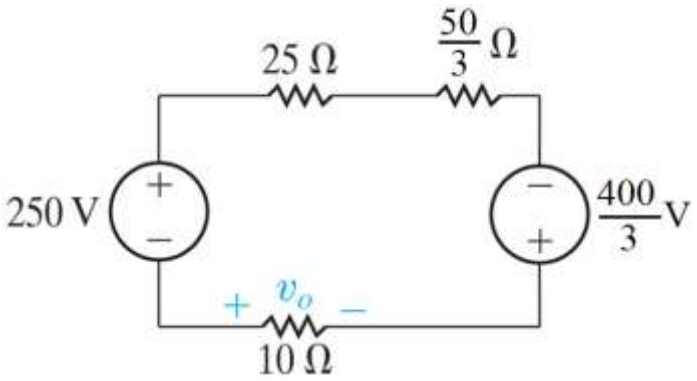
b) Combine two series resistors to get:



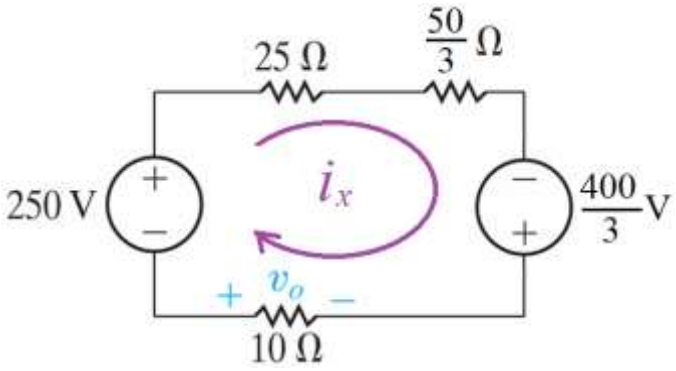
c) Combine two parallel resistors to get:



d) One source transformation from the right to get:



e) Mesh analysis:



ix = (250+400/3)/(25+50/3+10) = 7.42 A

vo = -10 ix = -74.2 V

P_{10_Ohms}= 10 (7.42)^2 = 550.564 W

Question 4:

For the circuit shown in Figure 3, find the Thevenin equivalent circuit with respect to the terminals a,b.

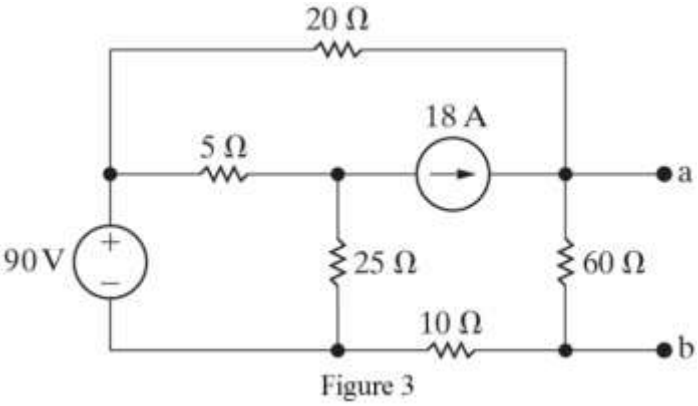
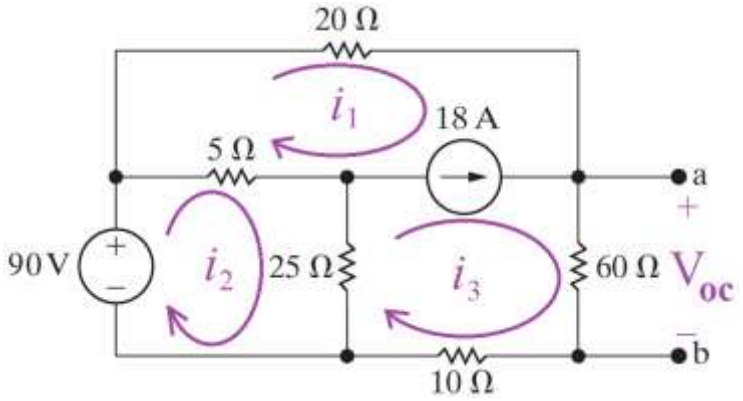


Figure 3

Solution:

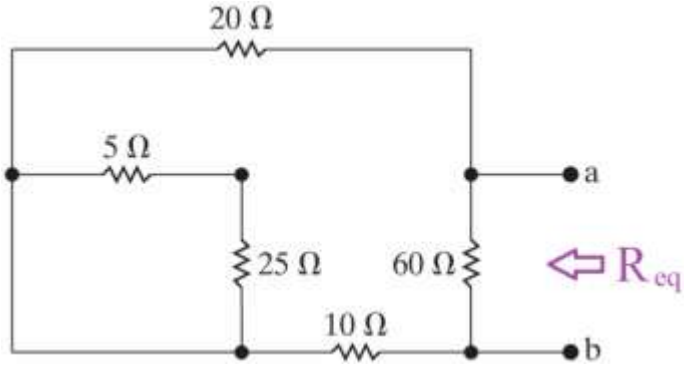
Start with finding V_{oc}:



The mesh current equations are
$-90 + 5(i_2 - i_1) + 25(i_2 - i_3) = 0$
$i3 - i1 = 18$
Supermesh around M1&M3:
$20\ i_1 + 60\ i_3 + 10\ i_3 + 25(i_3 - i2) + 5(i_1 - i_2) = 0$

$V_{oc} = 60\ i3 = 60(5) = 300$ V

Then find R_{Th} as follows



$R_{Th} = R_{eq} = 60\ //\ (20+10) = 20\ \Omega$

Question 5:

For the circuit shown in Figure 4,

a) Find the open circuit voltage V_{oc} with respect to the terminals a, b. Use the mesh-current method.
b) Find the short circuit current I_{sc} with respect to the terminals a, b. Use the mesh-current method.
c) Use an external current source (1.0 A) to find the Thevenin resistor R_{th}. Use the mesh-current method.
d) Find the Thevenin equivalent circuit with respect to the terminals a, b.
e) Find the Norton equivalent circuit with respect to the terminals a, b.

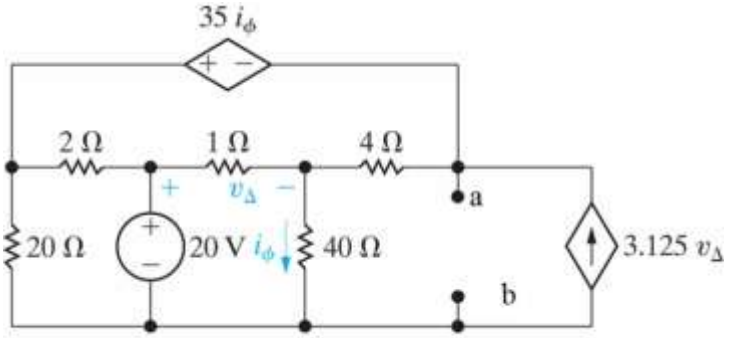
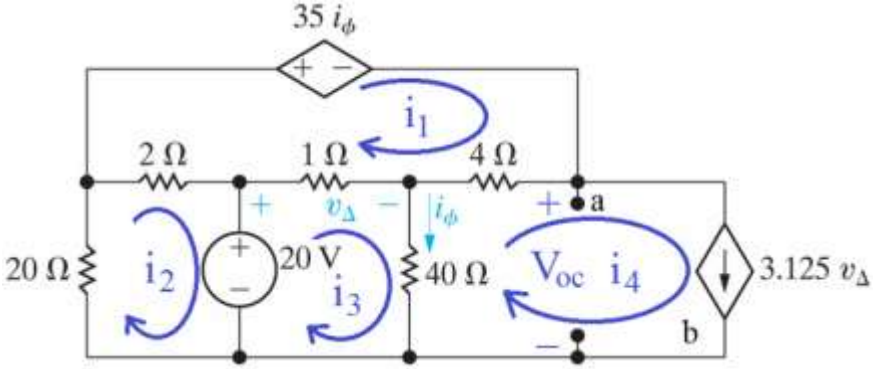


Figure 4

Solution:

a) Start with finding V_{oc} as follows:



The mesh equations are:

$35\ i_{phi} + 4(i_1 - i_4) + (i_1 - i_3) + 2(i_1 - i_2) = 0$

$20\ i_2 + 2\ (i_2 - i_1) + 20 = 0$

$-20 + (i_3 - i_1) + 40(i_3 - i_4) = 0$

$i_4 = 3.125\ v_{delta}$

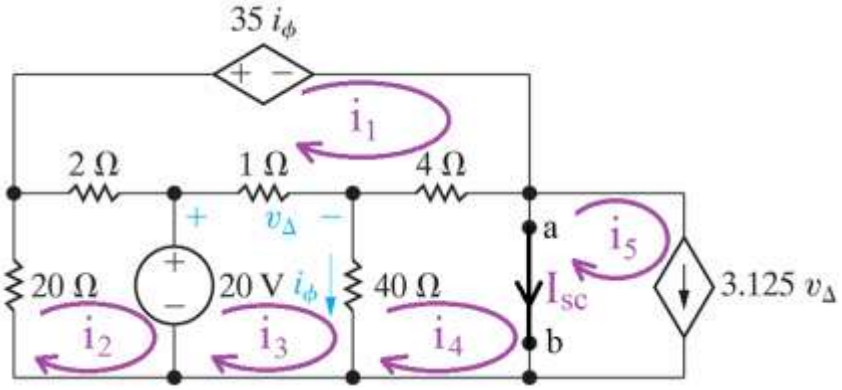
Help equations:

$i_{phi} = i_3 - i_4$

$v_{delta} = i_3 - i_1$

$V_{oc} = 4\ (i_1 - i_4) + 40(i_3 - i_4) = 21.08$ V

b) Finding I_{sc} as follows:

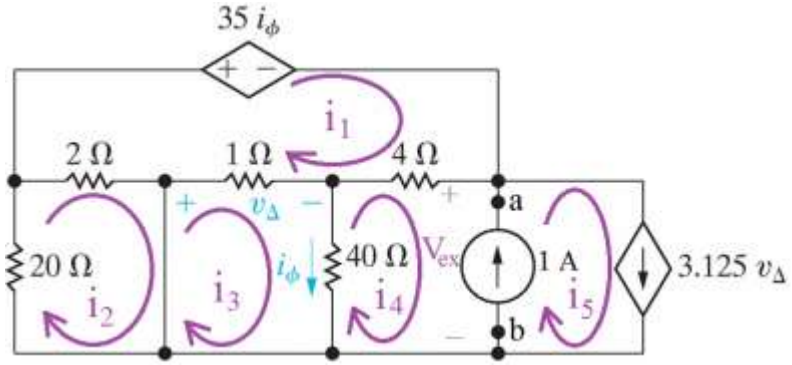


The mesh equations are:
$35\ i_{phi} + 4(i_1 - i_4) + (i_1 - i_3) + 2(i_1 - i_2) = 0$
$20\ i_2 + 2\ (i_2 - i_1) + 20 = 0$
$-20 + (i_3 - i_1) + 40(i_3 - i_4) = 0$
$40(i_4 - i_3) + 4(i_4 - i_1) = 0$
$i_5 = 3.125\ v_{delta}$

Help equations:
$i_{phi} = i_3 - i_4$
$v_{delta} = i_3 - i_1$

$I_{sc} = i_4 - i_5 = 13.8$ A

c) Finding R_{Th} using an external current source



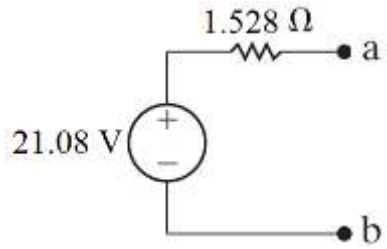
The mesh equations are:
$35\ i_{phi} + 4(i_1 - i_4) + (i_1 - i_3) + 2(i_1 - i_2) = 0$
$20\ i_2 + 2\ (i_2 - i_1) = 0$
$(i_3 - i_1) + 40(i_3 - i_4) = 0$
$i_5 - i_4 = 1$
$i_5 = 3.125\ v_{delta}$

Help equations:
$i_{phi} = i_3 - i_4$
$v_{delta} = i_3 - i_1$

$V_{ex} = 4\ (i_1 - i_4) + 40(i_3 - i_4) = 1.528$ V

$R_{Th} = V_{ex}/1.0 = 1.528\ \Omega$

d) Thevenin Equivalent Circuit



e) Norton Equivalent Circuit