Electric Circuits I

ELCT 301

Assignment I

You will be asked to solve one of the assigned problems during your tutorial in the week of 24-30 October 2022

Solution

Name:	
I.D. Number	
Tutorial:	
TA Name	

Problem I:

Use KCL and KVL to find i_ϕ and v_Δ in the circuit shown below.

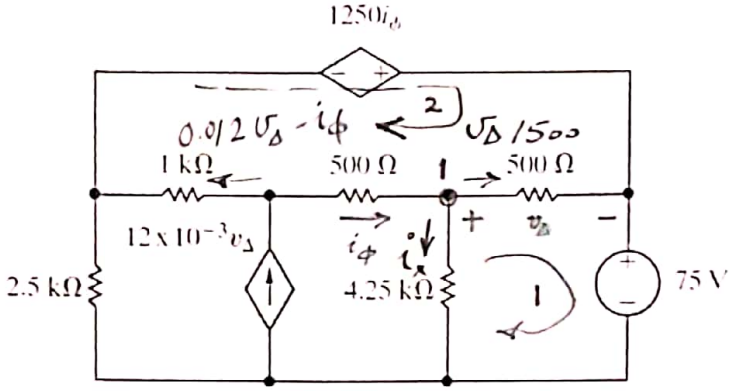


Figure 1

KCL 1

$i_x = i_\phi - v_\Delta/500$

KVL 1

$-4.25k\Omega\,(i_\phi - v_\Delta/500) + 500\Omega\,(v_\Delta/500) + 75 = 0$

$-4250 i_\phi + 9.5 v_\Delta = -75 \rightarrow (1)$

KVL 2

$-1250 i_\phi - v_\Delta + 500\Omega\, i_\phi + 1k\Omega\,(0.012 v_\Delta - i_\phi) = 0$

$-1750 i_\phi + 11 v_\Delta = 0 \rightarrow (2)$

Solving (1) & (2)

$\therefore \quad v_\Delta = 4.36V \ \#$

$i_\phi = 0.027A$

$= 27mA \ \#$

Problem II

Use KCL and KVL to calculate the power supplied or absorbed by the 200 mA source.

$P = V \times I$

$= -v_1 \times 200mA$

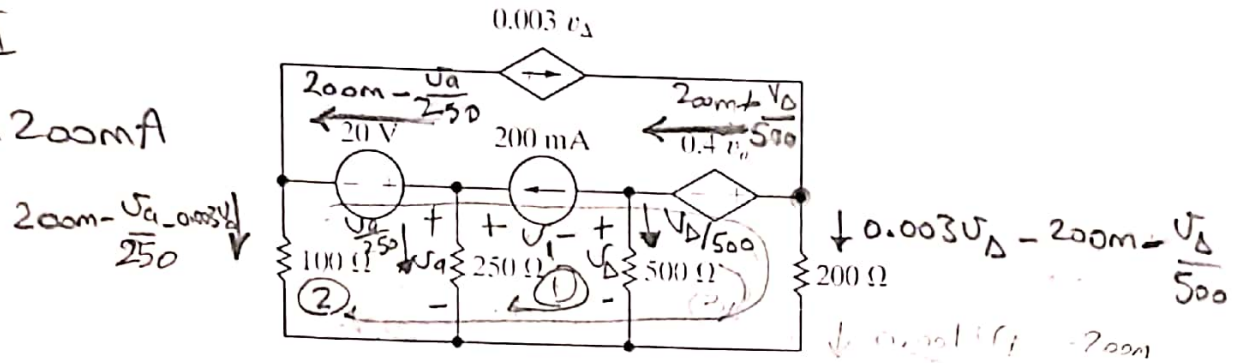


Figure 2

KVL 1: $v_1 + v_\Delta - v_a = 0 \rightarrow (1$

KVL 2: $-20V + v_1 - 0.4v_a + 200\Omega\left(0.003v_\Delta - 200m - \frac{v_\Delta}{500}\right)$

$+ 100\Omega\left(\frac{v_a}{250} + 0.003v_\Delta - 200m\right) = 0 \rightarrow v_1 + 0.5v_\Delta = 80 \rightarrow (2$

KVL 3: $-0.4v_a + \left(0.003v_\Delta - 200m - \frac{v_\Delta}{500}\right)200\Omega - v_\Delta = 0$

$-0.4v_a + 0.6v_\Delta - 40 - 0.4v_\Delta - v_\Delta = 0 \rightarrow (3$

from (3 $\therefore$ $\boxed{v_a = -72V}$

$\therefore$ $\boxed{v_\Delta = 440V}$

in (1 & (2 $\rightarrow$ $\therefore$ $\boxed{v_1 = 116V}$

$\therefore$ $P = -v_1 \times 200mA =$

$\boxed{P = -23.20}$ #

Problem III

For the circuit shown in Fig. 3, calculate (a) i_Δ and (b) v_o show that the power developed equals the power absorbed

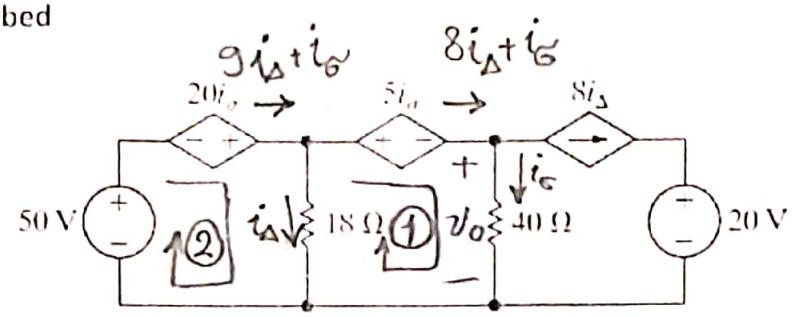


Figure 3

KVL 1

$$-18\Omega\, i_\Delta + 5 i_6 + v_o = 0 \rightarrow (1)$$

KVL 2

$$-50V - 20 i_6 + 18\Omega\, i_\Delta = 0 \rightarrow (2)$$

Ohm's law

$$v_o = 40 i_6 \rightarrow (3)$$

$\therefore$ $\boxed{i_6 = 2\ A}$

$\boxed{v_o = 80V}$

$\boxed{i_\Delta = 5\ A}$

Problem IV

Using KVL & KCL Prove that the total power supplied is equal to the absorbed power in the circuit shown in Fig. 4

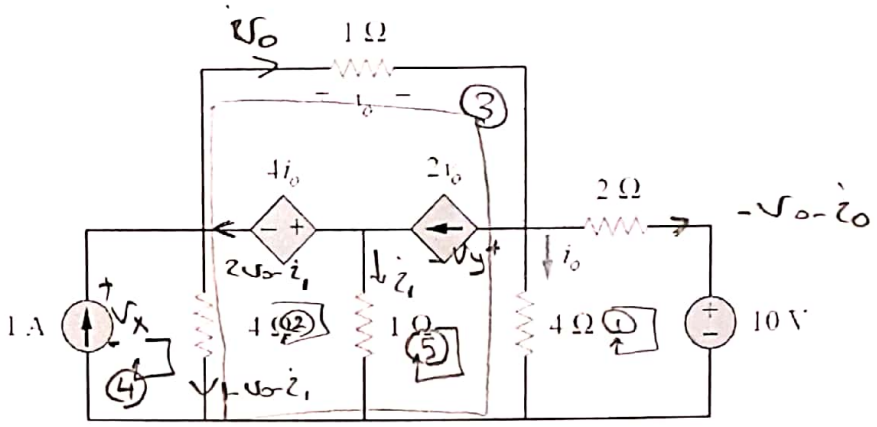


Figure 4

KVL in Loop 1:

$$-4i_o + 2(-v_o - i_o) + 10 = 0$$

$$-2v_o - 6i_o + 10 = 0$$

$$v_o = -3i_o + 5 \longrightarrow (1)$$

KVL in Loop 2:

$$-4(1 - v_o - i_1) - 4i_o + i_1 = 0$$

$$4v_o - 4i_o + 5i_1 = 4$$

Sub with Eqn (1)

$$-16i_o + 5i_1 = -16$$

$$i_1 = \frac{-16 + 16i_o}{5} \longrightarrow (2)$$

KVL in Loop ③

$$-4(1-v_o \cdot i_1) + v_o + 4i_o = 0$$

$$5v_o + 4i_o + 4i_1 = 4$$

Sub with Eqn ① & ②

$$i_o\left(-15 + 4 + \frac{16\times 4}{5}\right) = 4 + \frac{16\times 4}{5} - 25$$

$$i_o = -4.56\ A$$

$$v_o = 18.67\ V$$

$$i_1 = -17.792\ A$$

KVL in Loop ④:

$$-v_x + 4(1 - v_o \cdot i_1) = 0$$

$$v_x = 0.4188\ V$$

KVL in Loop ⑤

$$-i_1 + v_y + 4i_o = 0$$

$$v_y = 0.4148\ V$$

$P_{4\Omega,(1-v_o-i_1)}$	$= 4(1-v_o-i_1)^2$ $= 0.0595$ watt	$P_{4\Omega,i_o}$	$= 4(i_o)^2$ $= 83.1744$ watt
P_{1A,v_x}	$= -v_x(1)$ $= -0.488$ watt	$P_{2\Omega,-v_o-i_o}$	$= 2(-v_o-i_o)^2$ $= 398.1842$ watt
$P_{4i_o,(2v_o-i_1)}$	$= 4i_o(2v_o-i_1)$ $= -1005.607$ watt	$P_{10V,(-v_o-i_o)}$	$= 10(-v_o-i_o)$ $= -141.1$ watt
$P_{1\Omega,i_1}$	$= 1(i_1)^2$ $= 316.556$ watt	$\sum P_{supplied} = 1163.9$ watt	
$P_{1\Omega,v_o}$	$= 1(v_o)^2$ $= 348.56$ watt	$\sum P_{absorbed} = 1146.53$ watt	
P_{2v_o,v_y}	$= -2v_o(v_y)$ $= -16.778$ watt		

Problem V

Find the voltage difference between the nodes a and b in the circuit shown below

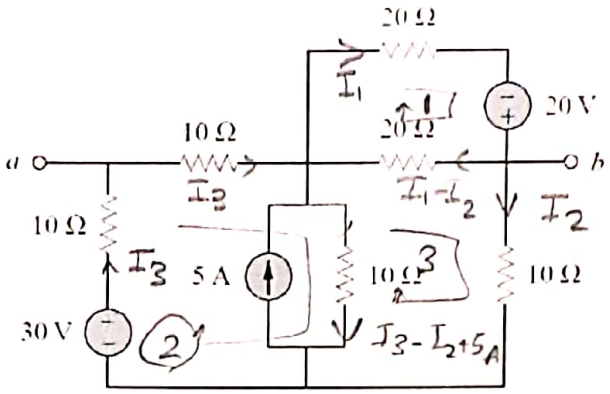


Figure 5

KVL in Loop 1:

$$20(I_1 - I_2) + 20I_1 - 20 = 0$$

$$2I_1 - I_2 = 1$$

$$I_2 = 2I_1 - 1 \rightarrow (1)$$

KVL in Loop 2:

$$-30 + 10I_3 + 10I_3 + 10(I_3 - I_2 + 5) = 0$$

$$-10I_2 + 30I_3 = -20$$

Sub with Eqn (1)

$$-20I_1 + 30I_3 = -20 - 10$$

$$I_3 = \frac{2}{3}I_1 - 1 \rightarrow (2)$$

KVL in Loop 3:

$$-10(I_3 - I_2 + 5) - 20(I_1 - I_2) + 10I_2 = 0$$

$$-20I_1 + 40I_2 - 10I_3 = 50$$

Sub with Eqn (1) & (2)

$$I_1\left(-20 + 80 - \frac{20}{30}\right) = 50 - 10 + 40$$

$$I_1 = 1.5\ A$$

$$I_2 = 2\ A$$

$$I_3 = 0\ A$$

$$V_a = -10\ I_3 + 30 = 30V$$

$$V_b = 10\ I_2 = 20V$$

$$V_{ab} = 30 - 20 = 10V$$

Problem VI

Use KCL and KVL to Find V_Δ in the circuit shown below in Fig. 6

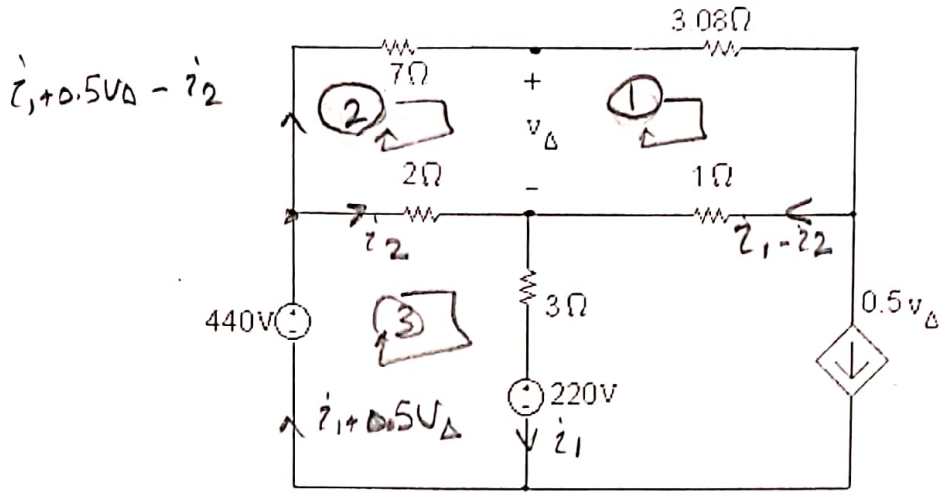


Figure 6

KVL in Loop 1:

$$-V_\Delta + 3.08(i_1 + 0.5V_\Delta - i_2) + (i_1 - i_2) = 0$$

$$V_\Delta(-1 + 3.08 * 0.5) + i_1(3.08 + 1) + i_2(-3.08 - 1) = 0$$

$$0.54V_\Delta + 4.08\,i_1 - 4.08\,i_2 = 0 \rightarrow (1)$$

KVL in Loop 2:

$$7(i_1 + 0.5V_\Delta - i_2) + V_\Delta - 2i_2 = 0$$

$$7i_1 + 9i_2 + 4.5V_\Delta = 0 \rightarrow (2)$$

KVL in Loop 3:

$$-440 + 2i_2 + 3i_1 + 220 = 0$$

$$3i_1 + 2i_2 = 220$$

$$i_2 = -\frac{3}{2}i_1 - 110 \rightarrow (3)$$

Sub in Eqn ①

$$0.54V_\Delta + 4.08\dot{i}_1 - 4.08\left(\frac{-3}{2}\dot{i}_1 - 110\right) = 0$$

$$0.54V_\Delta + 10.2\dot{i}_1 = -448.8$$

$$V_\Delta = \frac{-10.2\dot{i}_1 - 448.8}{0.54}$$

$$V_\Delta = -18.8\dot{i}_1 - 831.1 \rightarrow (4)$$

Sub in Eqn ③ & ④ in Eqn ②

$$7\dot{i}_1 + 9\left(\frac{-3}{2}\dot{i}_1 - 110\right) + 4.5\left(-18.8\dot{i}_1 - 831.1\right) = 0$$

$$\dot{i}_1\left(7 + 9*\frac{-3}{2} + 4.5*-18.8\right) = 9*110 + 831.1*4.5$$

$$\dot{i}_1 = -51.92\ A$$

$$\dot{i}_2 = -32.119\ A$$

$$V_\Delta = 144.996\ V$$

Problem VII

Use KCL and KVL to calculate the power supplied or absorbed by the dependent (Controlled) sources.

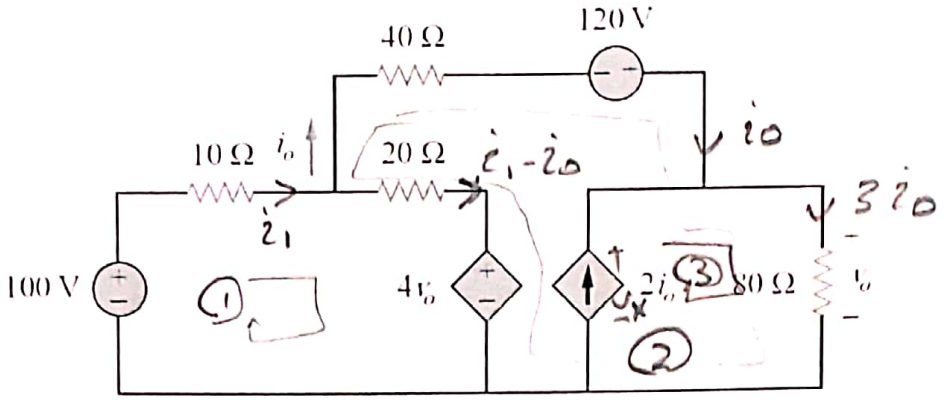


Figure 7

For 80Ω ⇒ $v_o = 80 \times 3i_o$

$$v_o = 240\, i_o \rightarrow (1)$$

KVL in Loop 1:

$$-100 + 10i_1 + 20(i_1 - i_o) + 4v_o = 0$$

sub with eqn (1)

$$-100 + 10i_1 + 20(i_1 - i_o) + 960 i_o = 0$$

$$950 i_o + 30 i_1 = 100$$

$$i_1 = \frac{100 - 950 i_o}{30} \rightarrow (2)$$

KVL in Loop 2:

$$-4v_o - 20(i_1 - i_o) + 40 i_o - 120 + v_o = 0$$

$$-3v_o - 20 i_1 + 60 i_o = 120$$

sub with eqn (1) & (2)

$$-3(240 i_o) - 20\left(\frac{100 - 950 i_o}{3}\right) + 60 i_o = 120$$

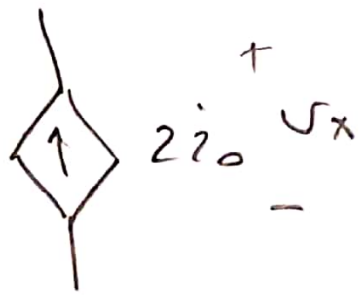
$$-720\,i_o + 633.3\,i_o + 6i_o = 120 + \frac{200}{3}$$

$$i_o = -2.313\ A$$

$$v_o = -555.14\ v$$

$$i_1 = 76.57\ A$$

For

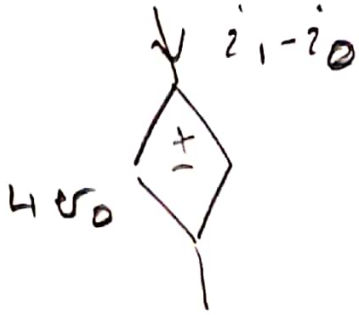


$\Rightarrow v_x = v_o$

$$P_{2i_o} = -(2i_o)(v_o)$$

$$= -2568.077\ watt$$

For



$$P_{4v_o} = (4v_o)(i_1 - i_o)$$

$$= -175.164\ Kwatt$$