**Homework 6**



**P6.1.12** Determine *VO* in Figure P6.1.12,

**Solution:** Assigning the node voltages as shown, the node-voltage equations are:

Node ‘a’:

(0.1 + 0.05 + 0.025)*Va* – 0.1*Vb* – 0.05*Vc* = 0.

Node ‘b’: *Vb* = 20

Node ‘c’: *Vc* = 30

Substituting,   20 V.



**P6.1.13** Determine *VO* in Figure P6.1.13.

**Solution:** Considering that a current source  is connected to node ‘a’, the node voltage equation for this node may be written as: = . This may be rearranged as:



1.25*Va* – 0.5*Vb* = -7.5

For node ‘b’:

-0.5*Va* + 0.625*Vb* = 10 – 4*Ix* , where 4*IX* = 4×0.5*Va* = 2*Va*. This may be rearranged as:

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Solving, *Vb* = *VO* = 15.51 V.

**P6.1.15** Determine *IO* in Figure P6.1.15.



**Solution:** Assigning an unknown current *IY* through the dependent source, the node-voltage equations are written as:

Node ‘a’:

4*Va* – 2*Vb* – 2*Vc* = 10 (1)

Node ‘b’:

-2*Va* + 6*Vb* = -*IY*

Node ‘c’:

-2*Va* + 6*Vc* = *IY*



Adding these two equations:

-4*Va* + 6*Vb* + 6*Vc* = 0 (2)

For the dependent source:

*Vb* – *Vc* = 5*VX* = 5*Vb*, or:

4*Vb* + *Vc* = 0 (3)

Solving these equations, *Vb* =

-0.8333 V, and *IO* = 4*Vb* = -3.33 A.

**P6.1.23** Determine *VO* in Figure P6.1.23, assuming that all resistances are 2 Ω.



**Solution:** The resistance in series with the 5 A source is redundant as far as *VO* is concerned, and the CCVS is equivalent to a 0.5 Ω resistance. Making these changes, the circuit becomes as shown. The node voltage equations are:

Node ‘a’: 0.4*Va* – 0.4*Vd* = 5 – *IX*

Node ‘c’: -0.5*Vb* + 1.5*Vc* – 0.5*Vd* – 0.5*Ve* =



*IX*. Adding these two equations:

0.4*Va* – 0.5*Vb* + 1.5*Vc* – 0.9*Vd* – 0.5*Ve* = 5 (1)

For the voltage source: *Va* – *Vc* = 10 (2)

Node ‘b’: *Vb* – 0.5*Vc* = -5 (3)

Node ‘d’: -0.4*Va* – 0.5*Vc* + 0.9*Vd* = 0.5*IX*, where *IX* = 5 – 0.4(*Va* – *Vd*), which gives:

-0.2*Va* – 0.5*Vc* + 0.7*Vd* = 2.5 (4)

Node ‘e’: -0.5*Vc* + 1.5*Ve* = 0 (5)

Solving these equations gives: *Vc* = 2.338 V and *Ve* = 0.779 V, so that *VO* = 2.338 – 0.779 = 1.56 V.



**P6.2.6** Determine *IO* in Figure P6.2.6

**Solution:** assigning mesh currents as shown, the mesh-current equations are:

Mesh 1: 40*I*1 – 10*I*2 – 20*I*3 = 11 (1)

Mesh 2: -10*I*1 + 60*I*2 – 30*I*3 = 33 (2)

Mesh 3: -20*I*1 – 30*I*2 + 60*I*3 = 66 (3)

Solving these equations, *I*2 = 2.60 A, *I*3 = 3.25 A, so that *IO* = *I*3 – *I*2 = 0.65 A



**P6.2.14** Determine *IO* in Figure P6.2.14.



**Solution:** Changing the conductances to resistances, and assigning an unknown voltage *VX* to the dependent current source, the circuit becomes as shown. The mesh-current equations are:

Mesh 1: *I*1 – 0.5*I*2 – 0.5*I*3 = 10 (1)

Mesh 2: *I*2 = -2A (2)

Mesh 3: -0.5*I*1 + 0.75*I*3 = -*Vx*

Mesh 4: -0.5*I*2 + 0.75*I*4 = +*Vx*



Adding these equations: -0.5*I*1 – 0.5*I*2 + 0.75*I*3 + 0.75*I*4 = 0 (3)

For the dependent current source, 2*Ix* = *I*4 – *I*3, where *Ix* = *I*2 – *I*1, which gives:

2*I*1 – 2*I*2 – *I*3 + *I*4 = 0 (4)

Solving these equations gives *I*4 = *IO* = -22 A.

**P6.2.17** Determine the power delivered or absorbed by each independent source in Figure P6.2.17.



**Solution:** Assigning the mesh currents as shown, the mesh-current equations are:

Mesh 1: *I*1 = 10 A (1)

Mesh 2: -2*I*1 + 6*I*2 – 2*I*4 =

-2*Vx*, where *Vx* = -2*I*2, or



*-I*1 + *I*2 – *I*4 = 0 (2)

Mesh 3: -4*I*1 + 8*I*3 – 4*I*4 = 2*Vx*; or

-*I1*+ *I*2 + 2*I*3 – *I*4 = 10 (3)

Mesh 4: -2*I*2 – 4*I*3 + 6*I*4 = -20, or

-*I*2 – 2*I*3 + 3*I*4 = -10 (4)

Solving, *I*2 = 10 A, *I*3 = 0, and *I*4 =

0. The voltage across the 10 A source is 4*I*1 + 2(*!*1 – *I*2) + 4(*I*1 – *I*3) = 80 V. The 10 A source therefore

delivers 800 W. The current through the 20 V source is zero, so this source neither absorbs nor delivers power.

**P6.2.20** Determine *VX* in Figure P6.2.20.



**Solution:** Assigning the mesh currents as shown, and assigning an unknown voltage VY the mesh-current equations are:

Mesh 1: 60*I*1 – 40*I*2 = *VY*

Mesh 3: 10*I*3 = -*VY* – 5*Iφ*, where *Iφ*, = *I*2. Adding these two equations and substituting for *Iφ*:

60*I*1 + 35*I*2 + 10*I*3 = 0 (1)



For the 5 A source,

*I*1 – *I*3 = 5 (2)

Mesh 2: -40*I*1 + 50*I*2 = *VX*

Mesh 4: 20*I*4 = 5*Iφ* – *VX*. Adding these two equations and substituting for *Iφ*:

-40*I*1 + 45*I*2 + 20*I*4 = 0 (3)

For the dependent current source, 2*IX* = *I*4 – *I*2, where *IX* = *I*1, or:

2*I*1 + *I*2 – *I*4 = 0 (4)

Solving, *I*1 = -4.29, *I*2 = 0.714 A, *I*3 = 0, and *I*4 = 0.857 A; *VX* = 5*Iφ* – 20*I*4 = 5*I*2 – 20*I*4 = -13.57 V.