**EECE 210 – Quiz 1**

**September 28, 2015**

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1. Determine *I* and *VS*, assuming *VSRC* = 2 V and

*ISRC* = 1 A.

**Solution:** From KCL at the upper node of *ISRC*, *I* + *ISRC* = 0, or *I* = -*ISRC*; from KVL around the mesh, starting from

the bottom node and going clockwise, 12 – *VSRC* + *VS* = 0, or *VS* = -12 + *VSRC*

**Version 1:** *VSRC* = 2 V, *ISRC* = 1 A; *I* = -1 A, *VS* = -10 V

**Version 2:** *VSRC* = 3 V, *ISRC* = 2 A; *I* = -2 A, *VS* = -9 V

**Version 3:** *VSRC* = 4 V, *ISRC* = 3 A; *I* = -3 A, *VS* = -8 V

**Version 4:** *VSRC* = 5 V, *ISRC* = 4 A; *I* = -4 A, *VS* = -7 V

**Version 5:** *VSRC* = 6 V, *ISRC* = 5 A; *I* = -5 A, *VS* = -6 V

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**B.** Determine the power actually delivered or absorbed by each source in the preceding problem.

**Solution:** Power absorbed by *ISRC* = *VSISRC*; power delivered by 12 V source is 12*I*; power absorbed by *VSRC* is *VSRCI*.

**Version 1:** *VSRC* = 2 V, *ISRC* = 1 A, *I* = -1 A, *VS* = -10 V; power absorbed by *ISRC* = *VSISRC* = -10 W, source actually delivers 10 W, power delivered by 12 V source is 12*I* = -12 W, source actually absorbs 12 W; power absorbed by *VSRC* is *VSRCI* = -2W, source actually delivers 2 W.

**Version 2:** *VSRC* = 3 V, *ISRC* = 2 A, *I* = -2 A, *VS* = -9 V; power absorbed by *ISRC* = *VSISRC* = -18 W, source actually delivers 18 W, power delivered by 12 V source is 12*I* = -24 W, source actually absorbs 12 W; power absorbed by *VSRC* is *VSRCI* = -6 W, source actually delivers 6 W.

**Version** **3:** *VSRC* = 4 V, *ISRC* = 3 A, *I* = -3 A, *VS* = -8 V; power absorbed by *ISRC* = *VSISRC* = -24 W, source actually delivers 24 W, power delivered by 12 V source is 12*I* = -36 W, source actually absorbs 36 W; power absorbed by *VSRC* is *VSRCI* = -12 W, source actually delivers 12 W.

**Version 4:** *VSRC* = 5 V, *ISRC* = 4 A, *I* = -4 A, *VS* = -7 V; power absorbed by *ISRC* = *VSISRC* = -28 W, source actually delivers 28, power delivered by 12 V source is 12*I* = -48 W, source actually absorbs 48 W; power absorbed by *VSRC* is *VSRCI* = -20 W, source actually delivers 20 W.

**Version 5:** *VSRC* = 6 V, *ISRC* = 5 A, *I* = -5 A, *VS* = -6 V; power absorbed by *ISRC* = *VSISRC* = -30 W, source actually delivers 30, power delivered by 12 V source is 12*I* = -60 W, source actually absorbs 60 W; power absorbed by *VSRC* is *VSRCI* = -30 W, source actually delivers 30 W.

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**C.** Determine the current *IS* and the power dissipated in the 20 Ω resistor, assuming *VSRC* = 20 V.

**Solution:** 20||80 = 20×80/(20 + 80) = 16 Ω;

40||60 = 40×60/(40 + 60) = 24 Ω; 16 + 24 = 40 Ω;

*IS* = *VSRC*/40 A ; *IS* divides between the 20 Ω and 80 Ω resistors in the ratio of 4:1. Hence, the current in the 20 Ω resistor is 4*IS*/5 = A, and the power dissipated is 20(4*IS*/5)2 = 12.8 W.

**Version 1:** *VSRC* = 20 V; *IS* = 20/40 = 0.5 A, *P*20Ω = 12.8 = 3.2 W

**Version 2:** *VSRC* = 30 V; *IS* = 30/40 = 0.75 A, *P*20Ω = 12.8 = 7.2 W

**Version 3:** *VSRC* = 40 V; *IS* = 40/40 = 1 A, *P*20Ω = 12.8 = 12.8 W

**Version 4:** *VSRC* = 50 V; *IS* = 50/40 = 1.25 A, *P*20Ω = 12.8 = 20 W

**Version 5:** *VSRC* = 60 V; *IS* = 60/40 = 1.5 A, *P*20Ω = 12.8 = 28.8 W.

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**D.** Determine the current *I* **by transforming both linear-output current sources to their equivalent linear-output voltage sources**, assuming *R* = 5 Ω.

**Solution:** The transformed sources are

as shown. It follows that *I* = 50/(*R* + 5) A.

**Version 1:** *R* = 5 Ω; *I* = 50/(*R* + 5) = 5 A

**Version 2:** *R* = 10 Ω; *I* = 50/(*R* + 5) = 10/3 A

**Version 3:** *R* = 15 Ω; *I* = 50/(*R* + 5) = 2.5 A

**Version 4:** *R* = 20 Ω; *I* = 50/(*R* + 5) = 2 A

**Version 5:** *R* = 25 Ω; *I* = 50/(*R* + 5) = 5/3 A.

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1. The voltage *v* across a device and the current *i* through

the device are as shown. Determine the largest value

of the magnitude of the energy absorbed or delivered

by the device during the interval 0 < *t* < 3 s, assuming

*V*0 = 1 V.

**Solution:** The largest magnitude of the energy absorbed occurs at *t* = 2 s, and is *w*(2) = (1/2)(*V*0×2)(-1) = -*V*0 J.

**Version 1:** *V*0 = 1 V; *w(*2*) = -V*0 ≡ 1 J delivered

**Version 2:** *V*0 = 2 V; *w(*2*) = -V*0 ≡ 2 J delivered

**Version 3:** *V*0 = 3 V; *w(*2*) = -V*0 ≡ 3 J delivered

**Version 4:** *V*0 = 4 V; *w(*2*) = -V*0 ≡ 4 J delivered

**Version 5:** *V*0 = 5 V; *w(*2*) = -V*0 ≡ 5 J delivered.

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1. Element ‘A’ absorbs 4 W when *ISRC* = 3 A. Determine the power delivered or absorbed by the 2 A source.

**Solution:** The current through ‘A’ is (*ISRC* – 2) A; *VA* =

4/(*ISRC* – 2) V; the power absorbed by the 2 A source

Is *P*2*A* = 8/(*ISRC* – 2) W.

**Version 1:** *ISRC* = 3 A; *P*2*A* = 8/(*ISRC* – 2) = 8 W absorbed

**Version 2:** *ISRC* = 4 A; *P*2*A* = 8/(*ISRC* – 2) = 4 W absorbed

**Version 3:** *ISRC* = 5 A; *P*2*A* = 8/(*ISRC* – 2) = 2.67 W absorbed

**Version 4:** *ISRC* = 6 A; *P*2*A* = 8/(*ISRC* – 2) = 2 W absorbed

**Version 5:** *ISRC* = 7 A; *P*2*A* = 8/(*ISRC* – 2) = 1.6 W absorbed.



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1. Determine *ISRC* given that *VX* = 5 V.

**Solution:** 6||12 = 72/18 = 4 kΩ; from current

division, *IX* = 3*ISRC*/(3 + 9) = *ISRC*/4 mA; *VX* = -5*IX* =

-5*ISRC*/4 V; hence, *ISRC* = -4*VX*/5.

**Version 1:** *VX* = 5 V; *ISRC = -*4 mA

**Version 2:** *VX* = 10 V; *ISRC = -*8 mA

**Version 3:** *VX* = 15 V; *ISRC = -*12 mA

**Version 4:** *VX* = 20 V; *ISRC = -*16 mA

**Version 5:** *VX* = 25 V; *ISRC = -*20 mA.

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1. Determine the power delivered or absorbed by the

independent source, assuming *ISRC* = 1 A.

**Solution:** From KVL on the RHS mesh, *Ia*×1 + *VX* – 2*Ia* = 0, or *VX* = *Ia* V; from KCL at the upper node, with *Ia* replaced by *VX*, 3*VX* = *VX* + *ISRC*, which gives *VX* = *ISRC*/2 V; independent source delivers a power *P* = (*ISRC*)2/2 W.

**Version 1:** *ISRC* = 1 A; *P =* 1/2 = 0.5 W delivered

**Version 2:** *ISRC* = 2 A; *P =* 4/2 = 2 W delivered

**Version 3:** *ISRC* = 3 A; *P =* 9/2 = 4.5 W delivered

**Version 4:** *ISRC* = 4 A; *P =* 16/2 = 8 W delivered

**Version 5:** *ISRC* = 5 A; *P =* 25/2 = 12.5 W delivered.

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1. Determine *IS*, assuming *VSRC* = 6 V.

**Solution:** The 10 Ω resistor is short-circuited, and the

4 Ω and 5 Ω resistors are in series, the series combination being in parallel with the 3 Ω resistor. This gives an equivalent resistance of 9×3/12 = 9/4 = 2.25 Ω. In series with 1.75 Ω, this gives 4 Ω. In parallel with 4 Ω and in series with 1 Ω, the resistance seen by the source becomes 3 Ω. It follows that *IS* = *VSRC*/3 A.

**Version 1:** *VSRC* = 6 V; *IS =* 2 A

**Version 2:** *VSRC* = 9 V; *IS =* 3 A

**Version 3:** *VSRC* = 12 V; *IS =* 4 A

**Version 4:** *VSRC* = 15 V; *IS =* 5 A

**Version 5:** *VSRC* = 18 V; *IS =* 6 A.

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1. Determine *IS*, assuming *VSRC* = 5 V.

**Solution:** The three 1 Ω resistors in Y are transformed to three 3 Ω resistors in Δ. The voltage across the 1 Ω

resistor is 2*IX* V. It follows from KVL around the outer

loop that *VSRC* = 4*IX*, so that the voltage of the rightmost node with respect to the bottom node is *VSRC*/2. From

KCL at the bottom node, *IS* = 

*VSRC* A.

**Version 1:** *VSRC* = 5 V; *IS =* 5 A

**Version 2:** *VSRC* = 10 V; *IS =* 10 A

**Version 3:** *VSRC* = 15 V; *IS =* 15 A

**Version 4:** *VSRC* = 20 V; *IS =* 20 A

**Version 5:** *VSRC* = 25 V; *IS =* 25 A.

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1. Determine the power delivered or absorbed by the dependent source, assuming *VSRC* = 1 V.

**Solution: Initialize:** All given parameters and variables are entered. The nodes are labelled.

**Simplify:** The circuit is already in a simple enough form.

**Deduce:** From Ohm’s law, the current *Iac* is *VX*/1 = *VX* A; from KVL around the mesh on the LHS, the voltage drop across the 2 Ω resistor is (*VSRC* – *VX*), and the current flowing from *VSRC* to node ‘a’ is (*VSRC* – *VX*)/2. From KCL at node ‘a’,

*Iab* = (*VSRC* – *VX*)/2 – *VX* = (*VSRC* – 3*VX*)/2. From KCL at node ‘b’, the current through the 2 Ω resistor on the RHS is *Ibc* = (*VSRC* – 3*VX*)/2 + 2*VX* = (*VSRC* + *VX*)/2. From KVL around the outer loop *VX* – 1×(*VSRC* – 3*VX*)/2 – 2×(*VSRC* + *VX*)/2 = 0, or 2*VX* – *VSRC* + 3*VX* – 2*VSRC* – 2*VX* = 0, which gives *VX* = *VSRC*. Hence, *Vbc* = 2×(*VSRC* + *VX*)/2 = 2*VSRC*. The power delivered by the dependent source is *P* = 2*VSRCIa* = 4(*VSRC*)2 W.

**Version 1:** *VSRC* = 1 V; *P* = 4 W

**Version 2:** *VSRC* = 2 V; *P* = 16 W

**Version 3:** *VSRC* = 3 V; *P* = 36 W

**Version 4:** *VSRC* = 4 V; *P* = 64 W

**Version 5:** *VSRC* = 5 V; *P* = 100 W.

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1. Determine *VO*, given that the six, unmarked Y-connected resistors are 2 Ω each, and assuming *ISRC* = 3 A.

**Solution:** The 2 Ω, Y-connected resistors are transformed to 6 Ω, Δ-connected resistors. 6 Ω are paralleled with each of the outer 3 Ω resistors to give 2 Ω. The resistance in the middle is

 6||6||3 = 1.5 Ω. The resistive circuit in the middle becomes as shown. The upper delta is transformed to a Y-connection as shown. 3/5.5 Ω in series with 2 Ω is 14/5.5 Ω. The two 14/5.5 Ω in parallel are 7/5.5 Ω. In series with 4/5.5 Ω, this gives 2 Ω. The resistors reduce to 2 Ω in parallel with 4 Ω and 4/3 Ω; 2 Ω in parallel with 4 Ω is 4/3 Ω; in parallel with 4/3 Ω this gives 2/3 Ω. It follows that *VO* = 2*ISRC* /3 V.

**Version 1:** *ISRC* = 3 A; *VO* = 2 V

**Version 2:** *ISRC* = 6 A; *VO* = 4 V

**Version 3:** *ISRC* = 9 A; *VO* = 6 V

**Version 4:** *ISRC* = 12 A; *VO* = 8 V

**Version 5:** *ISRC* = 15 A; *VO* = 10 V.

20%

1. Determine *VS*, assuming *R* = 10 Ω.

**Solution:** Successive source transformations are applied to reduce the circuit to a simple enough form. The 25 V source in series with

20 Ω is transformed to a 1.25 A current

source in parallel with 20 Ω. In parallel

with 80 Ω the resistance is 16 Ω. The

1.25 A current source in parallel with

16 Ω is transformed to a 20 V source

in series with 16 Ω. In series with 24 Ω

the resistance is 40 Ω. The 20 V source in series with 40 Ω is transformed to a 0.5 A source in parallel with 40 Ω. In the same manner,

the 20 V source in series with 40 Ω on the RHS is transformed to a 0.5 A source in parallel with 40 Ω, as shown. The two 40 Ω resistors in parallel give a resistance of 20 Ω and the two 0.5 A source add to a 1 A source, as shown. From KCL, the current in the 20 Ω resistor is 1.5 A, and the voltage across the paralleled elements is 30 V. It

follows that *VS* = 30 + 0.5*R* V.

**Version 1:** *R* = 10 Ω; *VS* = 35 V

**Version 2:** *R* = 20 Ω; *VS* = 40 V

**Version 3:** *R* = 30 Ω; *VS* = 45 V

**Version 4:** *R* = 40 Ω; *VS* = 50 V

**Version 5:** *R* = 50 Ω; *VS* = 55 V.