**EECE 210 Electric Circuits**

**Quiz 1 – Sep 24, 2016**

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1. The current *i*(*t*) through a device in the direction of a voltage drop *v*(*t*) across the device is as shown, where *Im* = 2 A and *Vm* = 1 V. Determine:
2. The charge that passes through the device for *t* ≥ 0 (4 grades).
3. The average current through the device over the interval from 0 to 2 s (4 grades).
4. The energy absorbed or delivered by the device at *t* = 1 s. Specify whether it is absorbed or delivered. (6 grades).
5. The energy absorbed or delivered by the device at *t* = 2 s Specify whether it is absorbed or delivered. (6 grades).

**Solution:** (a) 0 ≤ *t* ≤ 1 s, *i*(*t*) = *Imt*, ; *q*(1) = 0.5*Im* C

1 ≤ *t* ≤ 2 s, *i*(*t*) = *Im*,  C

*t* ≥ 2 s, *q*(*t*) = 1.5*Im* C.

(b) *Iav* = 1.5*Im*/2 = 0.75*Im* A.

(c) For 0 ≤ *t* ≤ 1, *p*(*t*) = *v*(*t*)*i*(*t*) = *VmImt*, *w*(1) =  J, power absorbed.

(d) For 1 ≤ *t* ≤ 2, *p*(*t*) = *v*(*t*)*i*(*t*) = -*VmIm*, *w*(1-2)=

-*VmIm* J, power absorbed, or *VmIm* J power delivered. Hence *w*(2) = -*VmIm* + *VmIm*/2 =

-*VmIm*/2 J, power absorbed, or *VmIm*/2 J power delivered.

**Version 1:** *Im* = 2 A, *Vm* = 1 V, (a) *q* = 3 C, (b) *Iav* = 1.5 A, (c) *w*(1) = 1 J absorbed,

*w*(2) = 1 J delivered.

**Version 2:** *Im* = 4 A, *Vm* = 2 V, (a) *q* = 6 C, (b) *Iav* = 3 A, (c) *w*(1) = 4 J absorbed,

*w*(2) = 4 J delivered.

**Version 3:** *Im* = 6 A, *Vm* = 3 V, (a) *q* = 9 C, (b) *Iav* = 4.5 A, (c) *w*(1) = 9 J absorbed,

*w*(2) = 9 J delivered.

**Version 4:** *Im* = 8 A, *Vm* = 4 V, (a) *q* = 12 C, (b) *Iav* = 6 A, (c) *w*(1) = 16 J absorbed,

*w*(2) = 16 J delivered.

**Version 5:** *Im* = 10 A, *Vm* = 5 V, (a) *q* = 15 C, (b) *Iav* = 7.5 A, (c) *w*(1) = 25 J absorbed,

*w*(2) = 25 J delivered.

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1. Determine the power absorbed or delivered by the 2*IY* dependent source, assuming *VSRC* = 1 V.

**Solution:** **Initialize.** The circuit is marked with given values. The nodes are labeled, as in the Figure.

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

**Deduce.** *IX* = 2 A, so that the CCCS can be replaced by an independent 6 A source. Since *VSRC* = 1 V, the 3*VSRC* source can also be replaced by an independent 3 V source but will be kept as is because different values are going to be used for *VSRC*.

From KCL at node ‘c’, *Icb* = 2 – *IY* A.

From KCL at node ‘b’, *Iba* = 8 – *IY*.

From KVL around the mesh ‘dabcd’, *VSRC* + 2*IY* + 3*VSRC* – 10 = 0. Which gives, *IY* = 5 – 2*VSRC*.

Hence, 8 – *IY* = 3 + 2*VSRC*, and the power absorbed by the 2*IY* source is:

*PA* = 2(5 – 2*VSRC*)(3 + 2*VSRC*) = 2(15 + 4*VSRC* – 4) W.

**Version 1:** *VSRC* = 1 V, *PA* = 2(15 + 4*VSRC* – 4) = 2(15 + 4 – 4) = 30 W absorbed.

**Version 2:** *VSRC* = 2 V, *PA* = 2(15 + 4*VSRC* – 4) = 2(15 + 8 – 16) = 14 W absorbed.

**Version 3:** *VSRC* = 3 V, *PA* = 2(15 + 4*VSRC* – 4) = 2(15 + 12 – 36) = -18 W, or 18 W delivered

**Version 4:** *VSRC* = 4 V, *PA* = 2(15 + 4*VSRC* – 4) = 2(15 + 16 – 64) = -66 W, or 66 W delivered.

**Version 5:** *VSRC* = 5 V, *PA* = 2(15 + 4*VSRC* – 4) = 2(15 + 20 – 100) = -130 W, or 130 W delivered.

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1. Determine the power absorbed or delivered by each circuit element, assuming *ISRC* = 1 A.

**Solution:** The circuit is a two-essential node circuit that can be solved by applying KCL at either essential node.

**Initialize.** The circuit is marked with given values. The nodes are labeled, as in the Figure.

**Simplify.** The two paralleled resistors could be combined into a single resistor, but since the unknown *IX* is in one of the resistors, it is advisable not to combine the resistors.

**Deduce.** *ISRC* flows toward node ‘a’ from the essential branch on the RHS.

From Ohm’s law, *Vab* = 6*IX*.

From Ohm’s law, *Iab* through the 3 Ω resistor is 6*IX*/3 = 2*IX*.

The current flowing away from node ‘a’ through the essential branch on the LHS is .

From KCL at node ‘a’, *ISRC* = 4*IX*.

Voltage across *ISRC* = 6*IX* – 2 = 1.5*ISRC* – 2.

Power absorbed by dependent source *PA*dep= 2 = /8; power absorbed by 4 Ω resistor is *PA*4Ω = 4 = /4; power absorbed by 6 Ω resistor is *PA*6Ω = 6 = 3/8; power absorbed by 3 Ω resistor is *PA*3Ω = 3(4) = 3/4. Total power absorbed *PA* = 

Power delivered by 2 V source *PD*2V = 2*ISRC*; power delivered by *ISRC* = *PDISRC*. Total power delivered = .

**Version 1:** *ISRC* = 2 A, *PA*dep = /8 = 0.5 W; *PA*4Ω = /4 = 1 W; *PA*6Ω = 3/8 = 1.5 W; *PA*3Ω = 3/4 = 3 W; *PD*2V = 2*ISRC* = 4 W; *PDISRC* = 6 W – 4 W = 2 W.

**Version 2:** *ISRC* = 4 A, *PA*dep = /8 = 2 W; *PA*4Ω = /4 = 4 W; *PA*6Ω = 3/8 = 6 W; *PA*3Ω = 3/4 = 12 W; *PD*2V = 2*ISRC* = 8 W; *PDISRC* = 24 W – 8 W = 16 W.

**Version 3:** *ISRC* = 6 A, *PA*dep = /8 = 4.5 W; *PA*4Ω = /4 = 9 W; *PA*6Ω = 3/8 = 13.5 W; *PA*3Ω = 3/4 = 27 W; *PD*2V = 2*ISRC* = 12 W; *PDISRC* = 54 W – 12 W = 42 W.

**Version 4:** *ISRC* = 8 A, *PA*dep = /8 = 8 W; *PA*4Ω = /4 = 16 W; *PA*6Ω = 3/8 = 24 W; *PA*3Ω = 3/4 = 48 W; *PD*2V = 2*ISRC* = 16 W; *PDISRC* = 96 W – 16 W = 80 W.

**Version 5:** *ISRC* = 10 A, *PA*dep = /8 = 12.5 W; *PA*4Ω = /4 = 25 W; *PA*6Ω = 3/8 = 37.5 W; *PA*3Ω = 3/4 = 75 W; *PD*2V = 2*ISRC* = 20 W; *PDISRC* = 150 W – 20 W = 130 W.

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1. Determine *Rab*, the resistance between terminals ‘ab’, assuming all resistances are 3 Ω, except *R* = 1 Ω.

**Solution:** The two Δ’s are transformed to Y’s, the circuit becoming as shown, where all the resistances except *R* become 1 Ω. It is seen that *Rab* = 2 + (*R* + 2)||2 = .

**Version 1:** *R* = 1 Ω; *Rab* = Ω.

**Version 2:** *R* = 2 Ω; *Rab* = Ω.

**Version 3:** *R* = 4 Ω; *Rab* = Ω.

**Version 4:** *R* = 6 Ω; *Rab* = Ω.

**Version 5:** *R* = 8 Ω; *Rab* = Ω.

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1. Determine: (a) the equivalent conductance of the three resistances in series (4 grades); (b) the equivalent conductance of the three resistances in parallel (4 grades); (c) the power dissipated in *RX*, assuming *β* = 0.1 A/V (8 grades); (d) the power delivered or absorbed by the dependent source (4 grades)

**Solution:** (a) *Reqs* = 20 + 10 +20 =

50 Ω; *Geqs* = 1/50 = 0.02 S.

(b) *Geqp* = 1/20 + 1/10 +

1/20 = 0.05 + 0.1 + 0.05 = 0.2 S. Alternatively,

(20 Ω)||(20 Ω) = 10 Ω and (10 Ω)||(10 Ω) = 5 Ω = *Reqp*. Hence, *Geqp* = 0.2 S.

(c) From voltage division, *VX* =  V.

From current division, the current in *RX* is *IX* = A.

Alternatively, voltage across parallel elements is 4*β*/0.2 = 20*β*.

Power dissipated in *RX* is *PX* =  W.

(d) Voltage across parallel resistors is 10×2*β* = 20*β* V

Voltage across dependent source is 20 + 20*β* = 20(1 + *β*)

Power delivered by dependent source is *PS* = 4*β*×20(1 + *β*) = 80*β*(1 + *β*)

Power dissipated in *RX* is (20*β*)2/10 = 40*βI*2 W.

**Version 1:** *β* = 0.1 A/V; *PX* =  W; *PS* = 80×0.1×1.1 = 8.8 W

**Version 2:** *β* = 0.2 A/V; *PX* =  W; *PS* = 80×0.2×1.2 = 19.2 W

**Version 3:** *β* = 0.3 A/V; *PX* =  W; *PS* = 80×0.3×1.3 = 31.2 W

**Version 4:** *β* = 0.4 A/V; *PX* =  W; *PS* = 80×0.4×1.4 = 44.8 W

**Version 5:** *β* = 0.5 A/V; *PX* =  W; *PS* = 80×0.5×0.5 = 60 W.

**Star-Delta Transformation**













