EECE 210

Quiz 1, October 13, 2012

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**1.** Determine *I,* assuming *ISRC* = 3 A.

**Solution:** The circuit reduces to that shown. From current division:



**Version 1:** *ISRC* = 3 A, *I* = -1 A

**Version 2:** *ISRC* = 6 A, *I* = -2 A

**Version 3:** *ISRC* = 9 A, *I* = -3 A

**Version 4:** *ISRC* = 12 A, *I* = -4 A

**Version 5:** *ISRC* = 15 A, *I* = -5 A.

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**2.** Determine *V,* assuming *VSRC* = 5 V.

**Solution:** The 12 Ω in parallel with 6 Ω is 4 Ω, which in parallel with 4 Ω gives 2 Ω. The circuit reduces to that shown. From voltage division:



**Version 1:** *VSRC* = 5 V, *V* = 2 V

**Version 2:** *VSRC* = 7.5 V, *V* = 3 V

**Version 3:** *VSRC* = 10 V, *V* = 4 V

**Version 4:** *VSRC* = 12.5 V, *V* = 5 V

**Version 5:** *VSRC* = 15 V, *V* = 6 V.

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**3.** Determine the power delivered or absorbed by the dependent source, assuming *R* = 1 Ω.

**Solution:** From KVL, *Vx* + 5*Vx* = 12 V, which gives *Vx* = 2 V. Hence, *Io* = *Vx*/*R* = 2/*R* A. From

KCL, *Ix* = (2/*R* – 2) A. The power *Px* absorbed by the dependent source is 5*VxIx* = 20(1/*R* – 1) W.

**Version 1:** *R* = 0.25 Ω, *Px* = 60 W

**Version 2:** *R* = 0.5 Ω, *Px* = 20 W

**Version 3:** *R* = 1 Ω, *Px* = 0

**Version 4:** *R* = 2 Ω, *Px* = -10 W

**Version 5:** *R* = 4 Ω, *Px* = -15 W.

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**4.** The voltage shown is applied to a 1 μF capacitor. Determine the maximum value of the current through the capacitor.

**Solution:** The charge on the capacitor is *q* = *Cv*, and the current through the capacitor is . The largest magnitude of *dv*/*dt* is (2 V)/(0.5 s) = 4 V/s. hence, *i* = 4*C* μA, where *C* is in μF.

**Version 1:** *C =* 1 μF*, i =* 4 μA

**Version 2:** *C =* 2 μF*, i =* 8 μA

**Version 3:** *C =* 3 μF*, i =* 12 μA

**Version 4:** *C =* 4 μF*, i =* 16 μA

**Version 5:** *C =* 5 μF*, i =* 20 μA.

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**5.** Determine *Gx* such that *I* = 0, assuming *G* = 0.5 S.

**Solution:** The currents in the two resistors are 3*G* + 3*Gx*. From KCL at the upper node, *I* + 6 =

3*G* + 3*Gx*. If *I* = 0, then *Gx* = 2 – *G*. Alternatively, it can be argued that if the voltage across the circuit shown is 3 V, then when this circuit is connected to the 3 V source, *I* = 0. It follows that , which gives the same equation as before.

**Version 1:** *G* = 0.2 S, *Gx* = 1.8 S

**Version 2:** *G* = 0.4 S, *Gx* = 1.6 S

**Version 3:** *G* = 0.6 S, *Gx* = 1.4 S

**Version 4:** *G* = 0.8 S, *Gx* = 1.2 S

**Version 5:** *G* = 1 S, *Gx* = 1 S.

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**6.** Determine *Ix* if *VSRC* = 1 V.

**Solution:** The dependent current source is transformed to its equivalent voltage source. It follows that , which gives *Ix* = *VSRC*/4 A.

**Version 1:** *VSRC =* 1 V, *Ix =* 0.25 A

**Version 2:** *VSRC =* 2 V, *Ix =* 0.5 A

**Version 3:** *VSRC =* 3 V, *Ix =* 0.75 A

**Version 4:** *VSRC =* 4 V, *Ix =* 1 A

**Version 5:** *VSRC =* 5 V, *Ix =* 1.25 A.

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**7.** Determine the total power delivered by the voltage sources *V*1, *V*2, and *V*3, assuming each voltage source is of 1 V, with *I*1 = 2 A, *I*2 = 1 A, and *I*3 = 1 A.

**Solution:** The total power delivered by the voltage sources is *P* = -1(*I*2 + *I*3) +1(*I*1 – *I*3) -1(*I*1 + *I*2) = 0×*I*1 -2I2 – 2*I*3 = -2(*I*2 + *I*3) W

**Version 1:** *I*2 = 1 A, *I*3 = 1 A, *P* = -4 W

**Version 2:** *I*2 = 1 A, *I*3 = -1 A, *P* = 0

**Version 3:** *I*2 = -1 A, *I*3 = 2 A, *P* = -2 W

**Version 4:** *I*2 = 1 A, *I*3 = -2 A, *P* = 2 W

**Version 5:** *I*2 = 1 A, *I*3 = -3 A, *P* = 4 W.

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**8.** Determine *V*, assuming *R* = 1 Ω.

**Solution:** The voltages will be as shown; the voltage across the 5 Ω resistor is zero and that across *R* is *R* V. Starting with the lower node and moving through the circuit, KVL gives: *V* = -12 + 10 + *R* = *R* – 2 V.

**Version 1:** *R =* 1 Ω*, V =* -1 V

**Version 2:** *R =* 2 Ω*, V =* 0

**Version 3:** *R =* 3 Ω*, V =* 1 V

**Version 4:** *R =* 4 Ω*, V =* 2 V

**Version 5:** *R =* 5 Ω*, V =* 3 V.

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**9.** Determine the total energy stored in the inductor, assuming *L* = 0.5 mH and *vSRC* is the time function shown, where *vSRC* = 0 for *t* < 0, *vSRC* = 1 V from *t* = 0 to *t* = 2 s, and *vSRC* = 0 for *t* > 2s. There is no initial energy stored in the inductor for *t* < 0.

**Solution:** From the *i-v* relation for an inductor, A, with *t* is in s and *L* in H. At *t* = 2 s, *iL* = 2/*L* A, and the energy stored is  J. Alternatively, it can be argued that the flux linkage *λ* at *t* = 2 s is the area under the *vSRC* vs. *t* curve, which is 2 Vs. The energy stored at *t* = 2 s is  J.

**Version 1:** *L* = 0.5×10-3 H, *w* = 4 kJ

**Version 2:** *L* = 10-3 H, *w* = 2 kJ

**Version 3:** *L* = 2×10-3 H, *w* = 1 kJ

**Version 4:** *L* = 4×10-3 H, *w* = 0.5 kJ

**Version 5:** *L* = 8×10-3 H, *w* = 0.25 kJ.

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**10.** Determine each of the resistors of the equivalent delta between terminals “a”, “b”, and “c”, expressed in S. Assume *G* = 1/6 S.

**Solution:** The inner Δ is transformed to three 2/3 Ω resistors connected in Y. To each is added 1/3 Ω in series to give

three 1 Ω resistors connected in Y. These are transformed to three 1/3 S resistors connected in Δ. Each of the resistors of the equivalent Δ will be (1/3 + G) S.

**Version 1:** *G =* 1/6 S*, Gx =* 1/3 + 1/6 = 1/2 S

**Version 2:** *G =* 1/3 S*, Gx =* 1/3 + 1/3 = 2/3 S

**Version 3:** *G =* 2/3 S*, Gx =* 1/3 + 2/3 = 1 S

**Version 4:** *G =* 4/3 S*, Gx =* 1/3 + 4/3 = 5/3 S

**Version 5:** *G =* 5/3 S*, Gx =* 1/3 + 5/3 = 2 S.

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**11.** Determine the energy stored in the capacitor.

**Solution:** The independent current source is transformed to its equivalent voltage source. From KVL, *Vo* = 8 – 6*Ix*. It also follows from KCL and Ohm’s law that *Vo* = 6(*Ix* + 2*Ix* + 0.5*Vo*), or *Vo* = 18*Ix* + 3*Vo*, or *Vo* = -9*Ix*. Substituting, for *Vo*, *Ix* = -8/3 A and *Vo* = 24 V. The energy stored in the capacitor is  J.

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**12.** Determine *Ix* and *Vy*. (12 points for *Ix* and 8 points

for *Vy*).

**Solution:** The 0.5*Ix* current flows in the 20 Ω

resistor. From KCL, the current in the 40 Ω resistor

is 1.5*Ix*. From KVL around the mesh on the

left-hand-side, 30 – 60*Ix* – 30*Ix* = 0, which gives

*Ix* = 1/3 A.

From KVL around the upper mesh,

-*Vy* – 10*Ix* + 60*Ix* = 0, so that *Vy* = 50*Ix* = 50/3 V.

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**13.** Determine the power delivered or absorbed by each of the two independent sources (10 points each).

**Solution:** applying KCL to node “a” on the right-hand side, the current entering the node is 2*Io*, which is also the current leaving “a” on top. The current from ”a” to “c” is (2 – 2*Io*). The current from “c” to “b” is 2*Io* + *Io* + 2 – 2*Io* = 2 + *Io*, which then divides between the two sources.

 *Io* can determined by applying KVL around a loop that does not involve current sources, because the voltages across these sources are unknown. Going “d, b, c, a, d”, KVL gives: 2 + 4 + 2*Io* + 4 – 4*Io* – 3*Io* = 0, so that 10 = 5*Io*, and *Io* = 2 A.

 Since *Io* is in the direction of a voltage drop of 2 V of the voltage source, this source absorbs 2×2 = 4 W.

 Going from “b” to “c” to “a” and to the top terminal of the current source, the voltage rise across the current source is: 4 + 2*Io* + 4 – 4*Io* +4 = 12 – 2*Io* = 8 V. It follows that the current source delivers 8×2 = 16 W.