**Quiz 2 – Sections 1, 3 and 4**

**Closed Book – One Hour**

10%



1. Determine *VO* assuming *ISRC* = 0.25 A.

1. 4 V
2. 1 V
3. 5 V
4. 2 V
5. 3 V

**Solution:** The two 5 Ω resistances can be combined in parallel to give a 2.5 Ω resistance, and the two 10 Ω resistances can be combined in parallel to give a 5 Ω resistance carrying a current of 2*Ix*, as shown. It follows that *ISRC* – 2*Ix* = 0.5*Ix*, or  and , so that .



Version 1: *ISRC* = 0.25 A, *VO* = 1 V

Version 2: *ISRC* = 0.5 A, *VO* = 2 V

Version 3: *ISRC* = 0.75 A, *VO* = 3 V

Version 4: *ISRC* = 1 A, *VO* = 4 V

Version 5: *ISRC* = 1.25 A, *VO* = 5 V

10%



2. Determine *ISRC* assuming *VSRC* = 2 V and all resistances are 2 Ω.

1. 1.5 A
2. 3 A
3. 2.5 A
4. 2 A
5. 1 A

**Solution:** From symmetry the two currents *Ix* are equal and sum to zero. Hence, *Ix* = 0 and the two resistors can be removed. The equivalent resistance seen by the source is (2 + 2)||(2 + 2) = 2 Ω. It follows that *ISRC* = *VSRC*/2.



Version 1: *VSRC* = 2 V, *ISRC* = 1 A

Version 2: *VSRC* = 3 V, *ISRC* = 1.5 A

Version 3: *VSRC* = 4 V, *ISRC* = 2 A

Version 4: *VSRC* = 5 V, *ISRC* = 2.5 A

Version 5: *VSRC* = 6 V, *ISRC* = 3 A

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3. Determine *VO* assuming *ISRC* = 1 A.

1. 7.5 V
2. 12.5 V
3. 5 V
4. 15 V
5. 10 V

**Solution:** The two current sources are equivalent to a current source *ISRC* connected as shown, since KCL is the same at the two nodes. The resistance seen by the source is 10||(5 + 5) = 5 Ω. Hence, *VO* = 5*ISRC*.



Version 1: *ISRC* = 1 A, *VO* = 5 V

Version 2: *ISRC* = 1.5 A, *VO* = 7.5 V

Version 3: *ISRC* = 2 A, *VO* = 10 V

Version 4: *ISRC* = 2.5 A, *VO* = 12.5 V

Version 5: *ISRC* = 3 A, *VO* = 15 V

10%

4. Determine Thevenin’s resistance looking into terminals ab, assuming *α* = 10.

1. 50 Ω



1. 25 Ω
2. 100 Ω
3. 200 Ω
4. 20 Ω

**Solution:** When a test source *VT* is applied at terminals ab, with the independent voltage source set to zero, it follows from the circuit that: mA. *IT* = -*αIx* = *αVT* mA. Hence, Ω.



Version 1: *α* = 10, *RTh* = 100 Ω

Version 2: *α* = 5, *RTh* = 200 Ω

Version 3: *α* = 20, *RTh* = 50 Ω

Version 4: *α* = 40, *RTh* = 25 Ω

Version 5: *α* = 50, *RTh* = 20 Ω

10%



5. Determine *V*2 so that *Vx* = 0, assuming

*V*1 = 4 V.

A. 8 V

B. 6 V

C. 6.5 V

D. 7.5 V

E. 7 V

**Solution**: The 6 Ω and 3 Ω resistors do not carry any current. They can removed from the circuit, with nodes a and b being at the same voltage. *V*1 can be transformed to a current source *V*1/4 A in parallel with a 4 Ω resistor. The total current is (0.25*V*1 + 2) A in parallel with 2 Ω. *V*2 is the voltage of node a, which gives: *V*2 = 2(0.25*V*1 + 2) = (0.5*V*1 + 4) V.



Version 1: *V*1 = 4, *V*2 = 6 V

Version 2: *V*1 = 5, *V*2 = 6.5 V

Version 3: *V*1 = 6, *V*2 = 7 V

Version 4: *V*1 = 7, *V*2 = 7.5 V

Version 5: *V*1 = 8, *V*2 = 8 V

25%



1. Derive the mesh current equations in terms of *I*1, *I*2, and *I*3. DO NOT SOLVE THE EQUATIONS (9 % for each of the mesh-current equations of meshes 1 and 2, and 7 % for the third equation).

**Solution:** Considering the voltage drop *Vab* as a unit, the equation for mesh 1 is:

(10 + 5)*I*1 – 5*I*3 = 12 – *Vab*

The mesh-current equation for mesh 2 is:

(20 + 5)*I*2 – 5*I*3 = *Vab*

Adding these two equations:



15*I*1 + 25*I*2 – 10*I*3 = 12

The remaining equations are:

*I*3 = 6, and

*I*2 – *I*1 = 2*I*x = 2(*I*2 – *I*3), or

*I*1 + *I*2 – 2*I*3 = 0

Note that if the 15 Ω resistor is denoted by *R* and the conventional mesh-current procedure is applied, the term in *R* cancels out. Thus, for mesh 1:

(10 + 5 + *R*)*I*1 – *RI*2 – 5*I*3 = 12 – *Vx*, where *Vx* is the voltage drop across dependent current source in the direction of *I*1. For mesh 2, -*RI*1 + (20 + 5 + *R*)*I*2 – 5*I*3 = *Vx*. Adding these two equations gives the same equation as before.

Solving the equations gives: *I*1 = 22.8 A, *I*2 = -10.8 A, *Ix* = -16.8 A, *Vx* = -804 V.

25%



1. Determine Thevenin’s equivalent circuit seen between terminals a and b (12 % for *VTh* and 13% for *RTh*).

**Solution:**

*Method 1:* Leave the circuit as it is. Considering the mesh on the RHS, 1 = 3*Ix* + 4*Ix* + *Vcb*, where *Vcb* = 10 + 2*Ix*. Substituting for *Vcb* gives *Ix* = -1 A, so that *VTh* = 4 V.



Applying a test source with the independent sources set to zero, the branch containing the 6 A source is open circuited. The 6 Ω and 4 Ω resistors are in parallel with one terminal at node b and the other terminal connected to an open circuit. They do not carry any current and can be removed. The circuit reduces to that shown. *VT* = 4*Ix* + 2*Ix* = 6*Ix*, and *IT* = *Ix* + *VT*/3. Substituting for *Ix* gives *VT*/*IT* = *RTh* = 2 Ω.



If terminals ab are short circuited, KVL around the outermost loop gives: 10 + 2Ix + 4Ix = 0, so that Ix = -5/3 A; Isc = -Ix + 1/3 = 2 A. It follows that RTh = 4/2 = 2 Ω.



*Method 2:* If the branch consisting of the 1 V source in series with 3 Ω is removed, *Ix* = 0, the dependent source becomes a short circuit, and the open-circuit voltage between terminals a and b is the same as that of the 10 V source. Hence *VTh*1 = 10 V.

If a test current source *IT* is applied between terminals a and b, with the independent sources set to zero, as before, and the 2 Ω resistor removed because it is in parallel with the 2*Ix* ideal voltage source and is redundant as far as *Vab* is concerned, the circuit reduces to that shown. The 2*IT* CCVS is equivalent to a 2 Ω resistor, which in series with the 4 Ω resistor gives *RTh*1 = 6 Ω.

When the branch between terminals a and b is reintroduced, the circuit becomes as shown. With terminals a and b open circuited, the current in the circuit is 1 A in the direction shown and *Vab* = 4 V. If the voltage sources are set to zero, the resistance seen between terminals ab is (6||3) = 2 Ω. Hence, *VTh* = 4 V and *RTh* = 2 Ω.

