**Homework 4**



**P4.1.2** (a) Determine *VSRC* in Figure P4.1.2 by deriving TEC between terminals ‘bc’. (b) Determine *ISRC*, *Vx*, and *Vy*.



**Solution:** (a) *VTh* = *Vcd* – *Vbd*, where node ‘c’ is taken as positive with respect to node ‘b’ since current flows from node ‘c’ to node ‘b’. From voltage division, *Vcd* = *VSRC*(24/30), and *Vbd* = *VSRC*(8/20). Hence, = 0.4*VSRC*. With *VSRC* replaced by a short circuit, the resistance seen between terminals ‘bc’ is 8||12 + 6||24 = 4.8 + 4.8 = 9.6 Ω. TEC becomes as shown, where *Ix* is the short circuit current given by: . It follows that *VSRC* = 120 V.



(b) The resistance between nodes ‘a’ and ‘b’ and ‘c’ connected together in the given circuit is 12||6 = 4 Ω, and the resistance between nodes ‘b’ and ‘c’ connected together and node ‘d’ is 8||24 = 6 Ω. The circuit can be redrawn as a voltage divider, as shown. It follows that *ISRC* = 120/(4 + 6) = 12 A; *Vx* = 120(4/10) = 48 V, and *Vy* = 120(6/10) = 72 V. As a check, the current in the 6 Ω resistor is 48/6 = 8 A, and the current in the 24 Ω resistor is 72/24 = 3 A, the difference being 5 A.



**P4.1.5** Derive TEC and NEC looking into terminals ‘ab’ in Figure P4.1.5.



**Solution:** Since there are no independent sources in the circuit, *VTh* and *IN* are zero. To determine *RN*, a test current source *IT* is applied, as shown. The CCCS becomes 2*IT* of reversed polarity. *Vy* = -50×2*IT* =

-100*IT*. The CCVS becomes

0.5×(-100*IT*) = -50*IT*. It follows that *VT* = 75*IT* – 50*IT*, so that *RTh* = *RN* = *VT* /*IT* = 75 – 50 = 25 Ω.



**P4.1.17** Determine *VO* in Figure P4.1.17 using TEC.

**Solution:** From KVL around the mesh that includes the 10 V source, 10 = (20 + 10)*Ix*, so *Ix* = 1/3 A. From KVL around the loop on the LHS, *VTh* = 20 + 10 – 20*Ix* = 30 – 20/3 = 70/3 V. With both sources set to zero, the 80 Ω resistor is short circuited, so that *RTh* = 10||20 = 20/3 Ω. It follows that *VO* = V.



**P4.2.1** Determine, according to the substitution theorem, (a) the independent voltage source, (b) the independent current source, and (c) the resistance that can replace the dependent current source without affecting the rest of the circuit.



**Solution:** From KCL, 3 = 3*Ix*, so *Ix* = 1 A. From KVL, *Vx* = 2 + 2×1 = 4 V. It follows that the 2Ix source can be replaced by: (a) an independent voltage source of 4 V, (b) an independent current source of 2 A, or (c) a resistance of 4/2 = 2 Ω.

**P4.2.5** Determine *IO* in Figure P4.2.5 by using the substitution theorem and by deriving TEC between nodes ‘ab’, where *NA* is an unspecified circuit having a voltage of 15.5 V.



**Solution:** From Ohm’s law, the current in the 2 S resistor flowing away from node ‘a’ is 15.5×2 = 31 A. From KCL, *IN* = 33 A. when the independent sources are set to zero, the input conductance *GN* seen looking into terminals ‘ab’ is 2 S. NEC connected to the 4 S conductance is as shown. It follows that  A.

