**Homework 3**



**P3.1.2** Determine *Req* in Figure P3.1.2.

**Solution:** On the RHS, (0.5 kΩ||2 kΩ) = 1/2.5 = 0.4 kΩ; in series with 0.1 kΩ, this becomes 0.5 kΩ; in parallel with 2 kΩ, this gives again 0.4 kΩ. On the LHS, (0.6 kΩ||1.2 kΩ) = 0.72/1.8 = 0.4 kΩ; in series with 0.2 kΩ, this becomes 0.6 kΩ; in parallel with 0.3 kΩ, this gives 0.18/0.9 = 0.2 kΩ. This resistance appears in series with the0.4 kΩ from the RHS, giving a total of 0.6 kΩ. *Req* = (1.8 kΩ||0.6 kΩ) = 0.45 kΩ.



**P3.1.9** Determine  between terminals ab in Figure P3.1.9.

**Solution:** *G* in series with *G* is =0.6 *G*. The *G* resistor connected to node b may be split into two  *G* resistors, each of which is in series with 0.6 *G*. This gives ;

*G*ab = .

**P3.1.14** Determine each of the resistors of the equivalent delta between terminals ‘a’, ‘b’, and ‘c in Figure P3.1.14, expressed in 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 + 1/6) = 1/2 S.

**P3.2.3** Determine *Ix* and *VO* in Figure P3.2.3 by transforming: (a) the current source to a voltage source; (b) the voltage source to a current source. Note that *Ix* and *VO* can be identified with respect to terminals ‘ab’.



**Solution:** (a) The current source is transformed to a voltage source 0.5*Ix*×2 = *Ix* A in series with 2 Ω (Figure P3.2.3a). It follows that , which gives *Ix* = 1 A.; from KVL, *VO* = 4 – 1×1 = 3 V.



(b) The voltage source is transformed to a current source 4/1 = 4 V in parallel with 1 Ω (Figure P3.2.3b). The two current sources are combined to (4 + 0.5*Ix*) and the two resistances to (1||2) = 2/3 Ω. Hence, , with *VO* = 2×1.5*Ix*. = 3*Ix*. This gives *Ix* = 1 A and *VO* = 3 V, as before.

**P3.2.12** Determine *Vx* and *Iy* in Figure P2.3.12.



**Solution:**   Ω,  Ω,  Ω.



 V.

 A,  A.

**P3.2.15** Determine *IO* in Figure P3.2.15 using source transformations.



**Solution:** The voltage of node ‘a’ with respect to the lower reference node is 3*Ix* V, and the voltage of node ‘b’ is (3*Ix* – 2*IO*) V. The 10 V source in series with 2 Ω is transformed to a 5 A source in parallel with 2 Ω. This resistance is combined with the 3 Ω resistance to give a resistance of 2×3/5 = 1.2 Ω. The current in this resistance is 3*Ix*/1.2 = 2.5 *Ix*. The 3*Ix* dependent source in series with 5 Ω is transformed to a 0.6 A source in parallel with 2 Ω. This resistance is combined with the 5 Ω resistance to give a resistance of 2×5/7 = 10/7 Ω. The current in this resistance is 7(3*Ix* – 2*IO*)/10 = 2.1*Ix* – 1.4*IO*.

KCL at node ‘a’ gives, 2.5*Ix* + *IO* + 5 = 0, or *Ix* = -2 – 0.4*IO*. KCL at node ‘b’ gives: *IO* + 0.6*Ix* = 2.1*Ix* – 1.4*IO*, or 2.4*IO* = 1.5*Ix*, or *Ix* = 1.6*IO*. Substituting the first equation, 1.6*IO* = -2 – 0.4*IO*, gives *IO* = -1 A.

**P3.3.1** Determine *ISRC* in Figure P3.3.1 so that no current flows in 



**Solution:** When no current flows in *RL*, *Vad* is, from voltage division,  V, and *ISRC* flows in the 3 kΩ resistor only. From KVL around the mesh ‘abcd’, *Vad* + *Vba* + *Vbc* + *Vcd* = 0, or 3 + 6 +0 + *Vcd* = 0. This gives *Vcd* = -9 = 3*Isrc*. so that *I*SRC = -3 mA.



**P3.3.7** Determine *Vx* in Figure P3.3.7. Transform the voltage source to a current source and apply KCL and KVL.



**Solution:** The 30 V source in series with 2 Ω transforms to a 15 A source in parallel with 2 Ω; the parallel combination of this resistor and the 4 Ω resistor is a resistor of Ω, which, from KCL, carries a current of 24 A and therefore has a voltage drop across it of  V. From KCL, the current in the 3 Ω resistor is 6 A, so that the voltage across it is 18 V. It follows that *V*x = 32 + 18 = 50 V.