**Homework 5**

**P5.1.5** Determine *IO* in Figure P5.1.5.

**Solution:** From KCL, the current through the connection between the 100 Ω and 300 Ω resistors is zero. The 2 A current flows through the 100 Ω resistor and establishes a voltage of 200 V across the 100 Ω and 300 Ω resistors. It follows that *IO* = 200 V/300 Ω = 2/3 A.

**P5.1.8** Determine the power dissipated in the 5 Ω resistor due to each source in Figure P5.1.8, and the total power dissipated in this resistor. Note that it should be obvious from superposition that the dependent source does not contribute to current in this resistor.

**Solution:** If the dependent source is replaced by an independent source and applied alone, with the two current sources set to zero, no current flows through the 5 Ω resistor. If the 2 A source is applied alone, with the 4 A source set to zero, the current through the 5 Ω resistor is 2 A, and the power dissipated is 4×5 = 20 W. If the 4 A source is applied alone, with the 2 A source set to zero, the current through the 5 Ω resistor is 4 A, and the power dissipated is 16×5 = 80 W. If the two sources are applied together, the current through the 5 Ω resistor is 6 A, and the power dissipated is 36×5 = 180 W.

**P5.1.11** Determine the power delivered or absorbed by the current source in Figure P5.1.11.

**Solution** When the upper delta is transformed to a star and the 120 V source is applied alone, V.

 When the 6 A source is applied alone, the source current divides into = 2 A on the RHS and 4 A on the LHS. Hence, V. It follows that Vab = 30 V and the current source absorbs, 30×6 = 180 W.

**P5.1.20** Determine *VO* in Figure P5.1.20.

**Solution:** When the 10 V source is applied alone,  =, A and  A.

 When the 10 A source is applied alone, with the other sources set to zero, the 8 Ω resistor is in series with the parallel combination of 2 Ω and 4 Ω. The total resistance is 8 + 8/6 = 28/3 Ω. The current in 8 Ω resistor is  A and  A.

 When the dependent source is replaced by an independent source *ISRC* applied alone, the 2 Ω resistor is in series with the parallel combination of 2 Ω and 4 Ω. The total resistance is 2 + 8/6 = 10/3 Ω. The current in 2 Ω resistor is  A and  A.

Substituting *ISCR* = 4*Ix*, it follows from superposition that *Ix* = 25/17 – 20/17 – (32/17)*Ix*, which gives *Ix* = 5/49 A.

 In the original circuit, *Va* = 2*Ix* = 10/49 A. The current in the 4 Ω resistor is (10 – 10/49)/4 = 120/49 A. From KCL, the current in the 2 Ω resistor is 10 + 5/49 – 120/49 = 375/49 A as shown. It follows that VO = 10/49 + 2×375/49 = 760/49 = 15.51 V.

**P5.1.22** Determine *IO* in Figure P5.1.22.

**Solution:** When the 10 A source is applied alone,  A and  V. When the dependent source is replaced by an independent source *VSRC* and applied alone, . By superposition, *Vx* = 5/4 + *VSRC*/2. Substituting *VSRC* = 5*Vx*, gives *Vx* = -5/6 V. It follows that *IO* = -4×5/6 = -10/3 A.

**P5.2.3** Determine *VSRC* in Figure P5.2.3 assuming all resistances are 1 Ω. Note that this is a special ladder known as the *R*-2*R* ladder, in which the resistance between each of the upper essential nodes and the lower common node in 2*R*, and the resistance looking to the right of each of the upper essential nodes is also 2*R*. Consequently, the voltages at the upper nodes are successive multiplied by 2 in going from right to left.

**P5.2.3** It is seen that *Va* = 2 V, *Iad* = 1 A, *Iba* = 2 A, *Vb* = 4 V. *Ibd* = 2 A, *Icb* = 4 A, *Vcd* = *VSRC* = 8 V.

**P5.2.5** Determine *IO* in

Figure P5.2.5.

**Solution:** With *Ix* = -3 A, the dependent source becomes an independent source of 12 V and reversed polarity. The 10 Ω resistor in parallel with the 30 V source and the 20 Ω resistor in series with the 0.75 A source are redundant for the purpose of calculating *IO* and could be removed, the circuit becoming as shown.

 The 30 V source in series 50 Ω is transformed to a 0.6 A current source in parallel with 50 Ω. This, in parallel with 50 Ω becomes 25 Ω. The 0.6 A current source in parallel with 25 Ω is transformed to a voltage source of 15 V in series with 25 Ω. This, in series with 35 Ω becomes 60 Ω. The 15 V source in series with 60 Ω is transformed to a current source of 0.25 A in parallel with 60 Ω. This, in parallel with 30 Ω becomes 20 Ω and the 0.25 A source is added to the 0.75 A source to give a 1 A source in parallel with 20 Ω. This is transformed to a 20 V source in series with 20 Ω, the circuit becoming as shown. It follows that *IO* = (12 + 20)/(20 + 15 + 13) = 32/48 = 2/3 A.

**P5.2.12** Determine *ISRC* assuming all resistances are 1 Ω.

**Solution:** The circuit is symmetrical with respect to the diagonal and could be split into two half circuits, as shown in the figure for one half circuit.

 Combining the resistors, the circuit becomes as shown. It follows that the current due to one half circuit is 7 A, so that the current due to the complete circuit is 14 A.

