

The left circuit is referred to as a delta interconnection because the circuit looks like the Greek letter delta. The second circuit is often called a wye circuit since it looks like an upper case character Y. We will derive the transformation that relates R_1 , R_2 , and R_3 to R_a , R_b , and R_c . The transformation is often called delta-to-wye equivalent transformation.

If the circuits are to have the same terminal characteristics, terminal current and voltage for each of the circuits has to be the same. This also means that the resistance between the corresponding terminal pairs is the same for each circuit. We will first write equations equating the resistances between the terminals.

For the delta circuit, note that R_2 and R_3 are in parallel with R_1 across terminals a and b. Combine R_2 and R_3 by adding their resistances. Then combine that result with R_1 , dividing their product by their sum. This is the equivalent resistance between terminals a and b, R_{ab} .

For the wye circuit, notice that R_c has nothing to do with the equivalent resistance between a and b. To find the equivalent resistance, note that R_a and R_b are in parallel between the two terminals. Add their resistances. This is R_{ab} .

Now equate the two values for R_{ab} and call this Equation (1). Next, perform the same operation to find R_{ac} and R_{bc} for both the delta and wye circuits. Equate these results, and call the equation for R_{ac} Equation (2); R_{bc} will be Equation (3).

Next we'll combine these equations. Subtract Equation (3) from Equation (1), and simplify. Call this result Equation (4).

Next, add Equations (2) and (4) and simplify. Call this result Equation (5). If you did the algebra correctly, you should have an equation for R_a in terms of R_1 , R_2 , and R_3 . Now repeat this procedure to find equations for R_b and R_c . Those will be Equations (6) and (7), respectively.

Now that we can convert from a delta to wye circuit, let's try to convert the other way.

Subtract Equation (7) from Equation (5), and call this result Equation (8). Then divide that by Equation (7), and you'll get an equation for R_1 in terms of R_a , R_b , and R_c . Perform a similar operation to find equations for R_2 and R_3 .