Problem 3.82 Use the DC Operating Point Analysis in Multisim to find the power dissipated or supplied by each component in the circuit in Fig. P3.82 and show that the sum of all powers is zero.

![Circuit for Problem 3.82](image)

Figure P3.82: Circuit for Problem 3.82.

Solution: This circuit is the same as one found in the Multisim Demos. Remember that for power calculations, we need to know the voltage across and current through each component in the circuit. We’ve learned that in Multisim the easiest way to do that is to put 0-VDC sources in place so that the current through them can easily be measured and used in equations.

So place the appropriate sources where needed. In the end your circuit should resemble that shown below:

![ Manipulated Circuit](image)

The mess of a circuit shown above may look intimidating, but remember you created it, so you can destroy it (although you don’t want to) and (most importantly) you can manipulate it.

All right, so how do we determine power in an element using variables? Let’s begin by bringing up DC Operating Point Analysis by using the arrow portion of the button.
The DC Operating Point

So the power through a component is of course given by the product of the voltage across that component and the current through that component. If the product is positive it is ... dissipating power, and if the product is negative it is ... supplying power.

Click on the Add Expression... button so we can get down to work with determining power and writing expressions.

Power across the resistor R1 should be \( I(v4) \times (V(5) - V(8)) \). This obeys the implied sign notation for power calculations. For everything:

- Power in R1: \( I(v4) \times (V(5) - V(8)) \)
- Power in R2: \( I(v5) \times (V(3) - V(2)) \)
- Power in R3: \( I(v3) \times (V(3) - V(7)) \)
- Power in R4: \( I(v7) \times V(1) \) [\( V(11) \) is 0 V so the equation simplifies]
- Power in R5: \( I(v2) \times (V(5) - V(6)) \)
- Power in R6: \( I(v6) \times V(4) \) [\( V(10) \) is 0 V so the equation simplifies]
- Power in V1: \( I(v5) \times (V(2) \times V(9)) \)
- Power in V2: \( I(v2) \times V(6) \)
Adding the values up in the second column of the output tables gives an answer of approximately 0 (go on and verify it.) A sum of zero implies that power conservation holds. Of course power conservation always holds, so in reality, a sum of zero implies that you typed in all of those equations properly. Congratulations.
Note that you could have also calculated the power dissipated in the resistors by using the equation below:

\[ P = \frac{V^2}{R}. \]

Using this approach, for example:

- Power in R1: \( \frac{((V(5)-V(1))^2)}{25} \)
- Power in R2: \( \frac{((V(3)-V(2))^2)}{25} \)

Etc…

And this will in fact give you the same values…go on and try… The problem with this approach is that these equations no longer rely solely on variables. They now involve values which can’t be referenced in the variable equations, so if you change a resistor value, then you have to go and change your equations too… Sort of a pain.