Resistor Ladder

Q7 of the quiz on Equivalent resistance and nodal analysis
Resistor Ladders

- They are used to model long distances of wire. The resistance in series is the resistance of the wire. The resistors in parallel is associated with the current leakage from one wire to another.
Example

• Twisted pair – a hot wire and a ground wire are wrapped around each other as the wire travel from the electrical panel to the component.
  ▫ Commonly used to connect a landline phone base to the telecommunication network.

http://www.networkcablinglosangeles.com/wp-content/themes/networkcablinglosangeles/images/unshielded_cable.jpg
Impedance Ladders

- A more common ladder is one where there are resistors in series and capacitors in parallel.
Electrical transmission lines

- The high voltage power lines that run from a power plant to a step-down transformer station are modeled as a RC ladder as are the metal connections between transistors on an integrated circuit (IC).

http://en.wikipedia.org/wiki/Electric_power_transmission
IC chips

- Connections between components on integrated circuits (ICs) are modeled as a RC ladder, though the values of R and C are much smaller than those used to model a high voltage electrical transmission line.
  - A current area of research in IC design is methods to reduce both the magnitude of the resistor and the capacitor, primarily the capacitor, in the RC network to improve the speed of the IC.

http://moodle.insa-toulouse.fr/pluginfile.php/2632/mod_resource/content/0/content/interconnect_design_rules.html
Resistor Ladder

\[ R_{eq} = \left\{ \left[ \left( R_1 + R_2 \right) \parallel R_3 \right] + R_4 \right\} \parallel R_5 \]
Equivalent Resistance

\[ R_{eq} = \left\{ \left\{ (R_1 + R_2) \| R_3 \right\} + R_4 \right\} \| R_5 \]

If all of the resistors have the same value,

\[ R_{eq} = \left\{ \left\{ \left( 2R \| R \right) + R \right\} \| R \right\} \| R \]

\[ R_{eq} = \left\{ \left\{ \left( \frac{2}{3}R \right) + R \right\} \| R \right\} \| R \]

\[ R_{eq} = \frac{5}{3} R \| R = \frac{5}{8} R \]
Current Division

• To solve for the current flowing through the resistor in the ladder, one technique that can be used is current division along with Ohm’s Law.
  ▫ Other techniques such as voltage division, nodal analysis or source transformation may also be used.
Once you know the current flowing through a resistor, you can apply Ohm’s Law to find the voltage dropped across the resistor.