

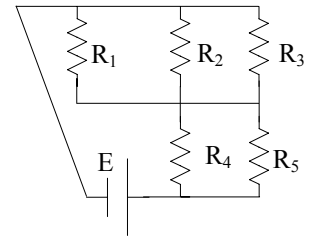
Week #7

Multiloop circuits.

Problem #1: Resistor Networks.

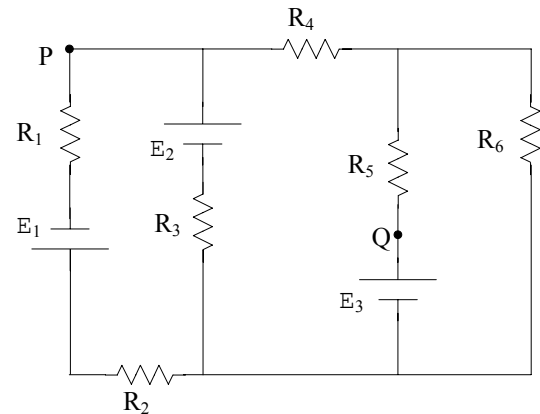
In the circuit, $E = 100 \text{ V}$, $R_1 = 100 \Omega$, $R_2 = 200 \Omega$, $R_3 = 300 \Omega$, $R_4 = 400 \Omega$, $R_5 = 500 \Omega$.

- Find the current through and the voltage across each resistor.
- What is the total power dissipated by the resistor network?
- What is the total power supplied by the battery?



Problem #2.

- (a) Find a set of equations that, if solved, would allow you to determine all the currents in the circuit. Ideally, you should not have more equations than the minimum necessary. (Before you start, can any resistors be replaced with equivalent resistances? Doing this can simplify your work sometimes.)
- (b) Write an equation that, given the currents, would allow you to find the potential difference between locations P and Q: $V_P - V_Q$. Continue to use the directions of the currents you assumed for part (a).



Problem #3. This circuit looks awful. If you approach it the same way you handled problem #2, you will have to work with a 6-loop circuit. If you can *combine* the techniques you used for problems #1 and #2, this problem is no harder than the ones above.

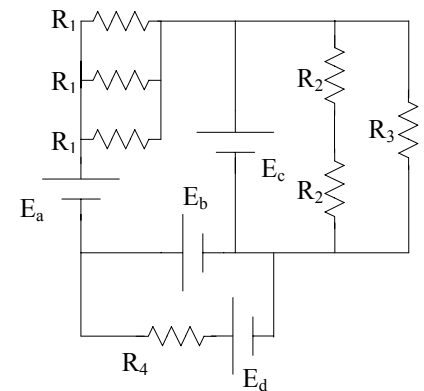
The component values are:

$$E_a = 10\text{V}, E_b = 30\text{V}, E_c = 20\text{V}, E_d = 5\text{V}.$$

$$R_1 = 600 \Omega, R_2 = 100 \Omega, R_3 = 200 \Omega, R_4 = 200 \Omega.$$

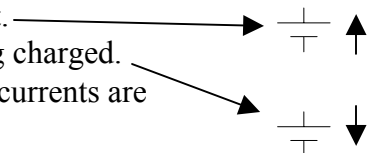
Find:

- P_a, P_b, P_c, P_d = power supplied or used by each battery
- The current through each of the R_1 resistors.
- The current through each of the R_2 resistors.
- If, instead of asking for all of the above, we had only asked for the current through the R_2 resistors, could you solve this problem in your head?



Hints and reminders:

- When you label a current, you will also need to make a guess for its direction. If the value of the current turns out to be negative, the direction is the opposite of what you guessed.
- Calculate battery powers using $P = iV$. The usual convention is to always make this a positive number. If the current from battery is like this, the battery is supplying energy to the circuit. On the other hand, if the current is like this, the battery is getting energy and being charged.
- The node rule helps you find an unknown current in terms of other currents. If no currents are known, you'll need to start with some other approach, like a loop rule.
- If a battery is directly connected to a resistor or resistor network, it may be a waste of time to use loop and node rules. In this case, you know the voltage across the resistor network, calculate the currents using the methods of problem #1.

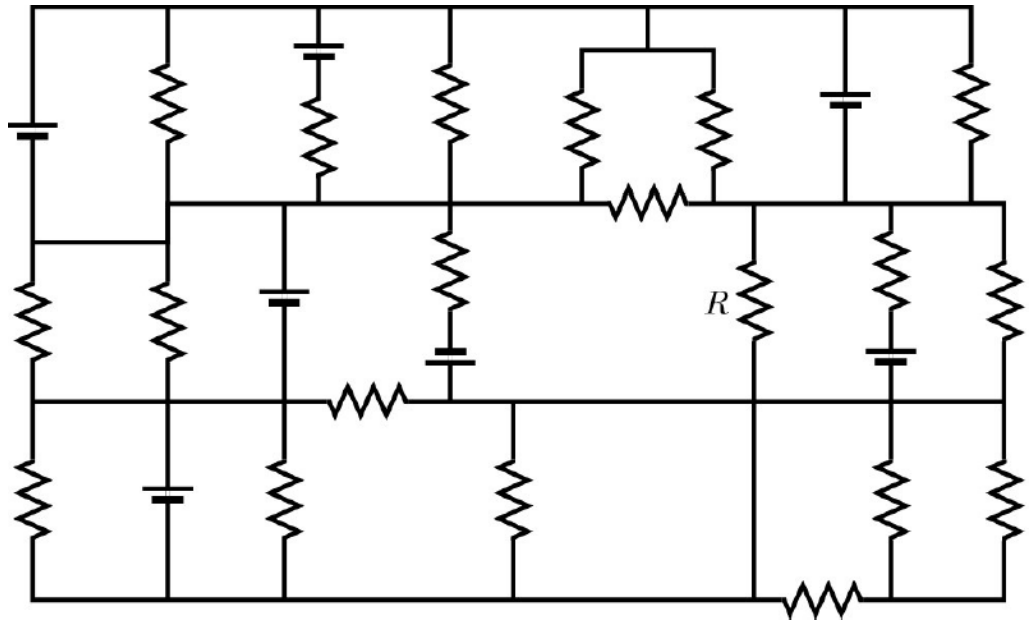


Week #7

Multiloop circuits #2.

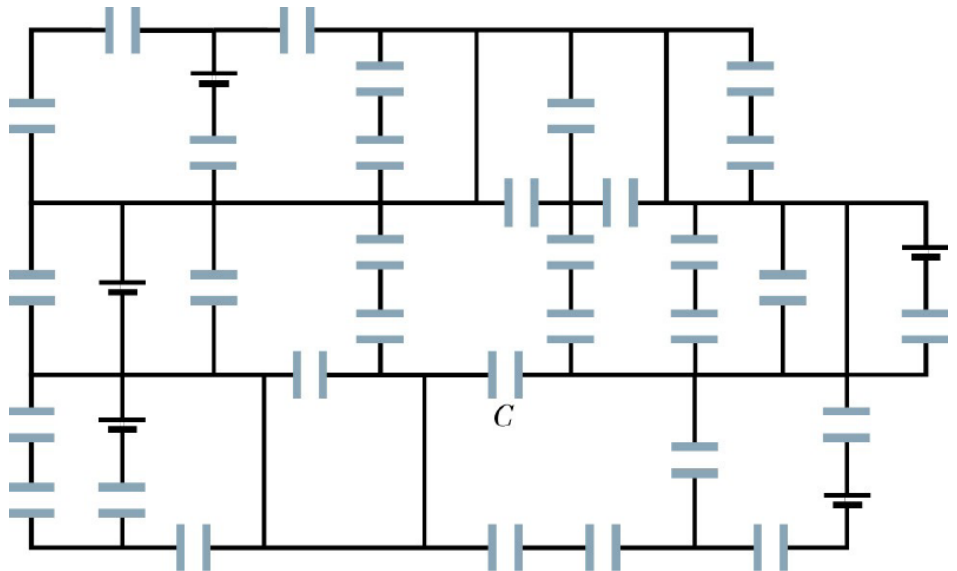
Problem #4. Each resistor is $4\ \Omega$ and each battery is $4\ \text{V}$. Find the current through resistor R .

There's a trick to this. You need to find the potential difference across R . You can do this using the method of "walking" from one end of the resistor to the other and keeping track of the potential differences along the way. The potential difference of a battery is easy. The potential difference of a resistor is harder because you need to know the current through it, so best to avoid resistors during your walk.



Problem #5 Each capacitor is $10\ \mu\text{F}$ and each battery is $5\ \text{V}$. Find the charge on capacitor C .

The text calls problems #4 and #5 circuit "mazes". See why?



Problem #6

$E_1 = 10\ \text{V}$ and battery E_1 is supplying a power of $10\ \text{W}$.

$R = 100\ \Omega$.

The square on the bottom right-hand-side of the circuit labeled E_2 is a battery.

- What is E_2 ? Is battery E_2 supplying power or charging?
- What is the voltage across the $3R$ resistor?
- How much power is dissipated by the resistors in the circuit?

