Electric Circuits

- An electric circuit is a graph of sources of emf (E) measured in volts and resistance (R) measured in ohms
- A junction point is a point at which edges of the graph meet
- First rule of Kirchhoff: current at a junction point is conserved
- Second rule of Kirchhoff: net potential around a loop is zero

1. Break the circuit into independent parallel loops
2. Assign arbitrarily a direction for current to flow in each loop
3. Use the first rule of Kirchhoff at each junction point to find an equation
4. Use the second rule of Kirchhoff in each loop (in either direction) to find another equation
   - $\Delta V = +E(-E)$ if the direction is from low to high (high to low) potential
   - $\Delta V = -iR(+iR)$ if the direction is with (against)the current
5. Solve the equations
   - If current is negative, the actual current flows opposite to the chosen direction

Capacitance

- $C = \dfrac{Q}{V}$
- In series, $\dfrac{1}{C_{eq}} = \sum \dfrac{1}{C_i}$
- In parallel, $C_{eq} = \sum C_i$
- Potential energy stored in electric field of a capacitor is $U = \dfrac{Q^2}{2C} = \dfrac{1}{2}QV = \dfrac{1}{2}CV^2$
- Parallel Plate Capacitors with Area A and separation d and dielectric constant κ
  - $C = \dfrac{\kappa\epsilon_0 A}{d}$ where ϵ_0 is the permittivity constant $8.85418 \times 10^{-12} coul^2/nt - m^2$
  - $U = \frac{1}{2}\kappa\epsilon_0 A d E^2$
  - Electric field in a parallel plate capacitor is $E = \dfrac{V}{d} = \dfrac{Q}{\epsilon_0 A}$

