Capacitors – chapter 24

Paired conducting “plates” store charge

applications: energy storage, filters, frequency-tuning

**Definition:**  \( Q = C \Delta V \), where:

\[
C: \text{ capacitance} \\
\text{Unit: } \text{Farad (F)} \, = \, 1 \, \text{C/V} \\
\text{note: } \varepsilon_o = 8.8 \times 10^{-12} \, \text{C/V m} = 8.8 \times 10^{-12} \, \text{F/m}
\]

\( Q \): equal/opposite plate charges.
\( \Delta V \): voltage difference between plates

example: “wide” parallel plates: \( C = K \frac{\varepsilon_o A}{d} \)  
(for vacuum-filled use \( K = 1 \))

**Energy:**  
\[
U = \frac{Q^2}{2C} = \frac{Q\Delta V}{2} = \frac{C\Delta V^2}{2} \quad \text{(total stored energy)}
\]

\[
u = \frac{1}{2} \varepsilon_o E^2 \quad \text{energy density (Joule/m}^3)\]

**Dielectrics:** \( C = K C_0 \), with dielectric constant \( K \geq 1 \)

surface charge: \( \sigma \left( \frac{K-1}{K} \right) \)

dielectric strength = breakdown field (“\( E_{max} \)”)

**Combinations:**

series, \( \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + ... \); parallel, \( C = C_1 + C_2 + ... \)