EELE 250: Circuits, Devices, and Motors
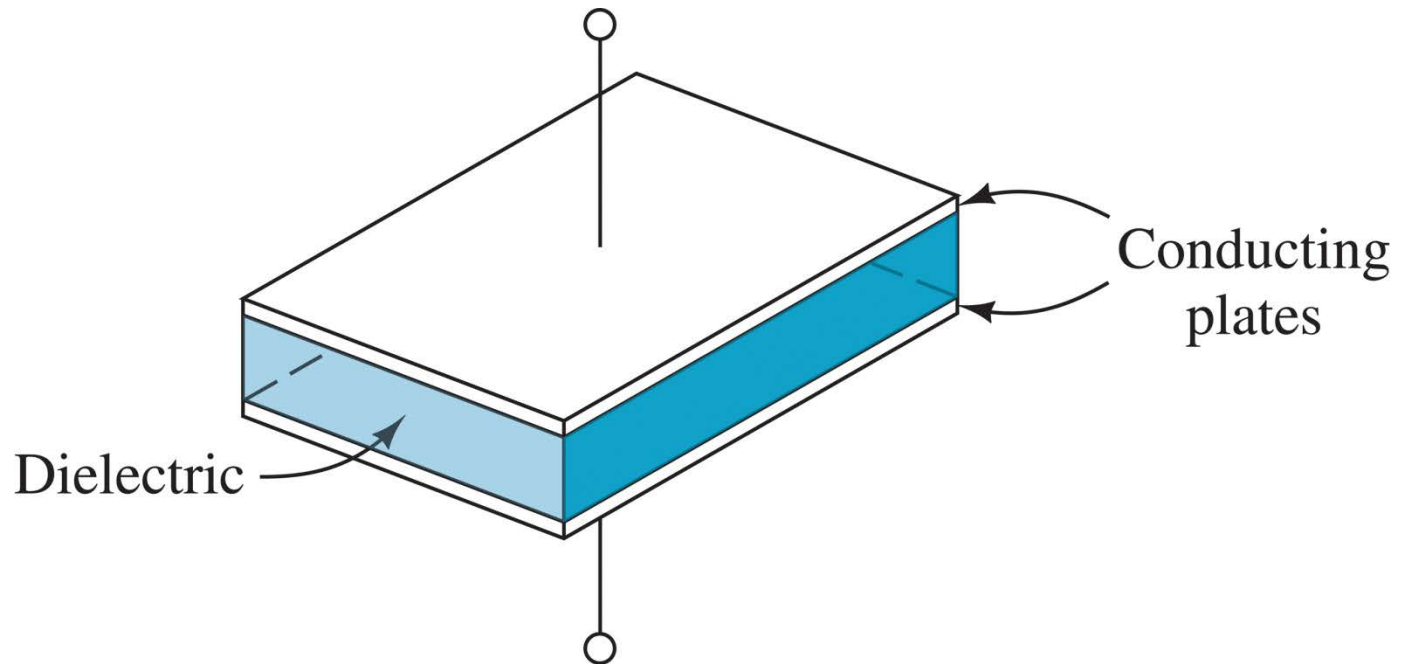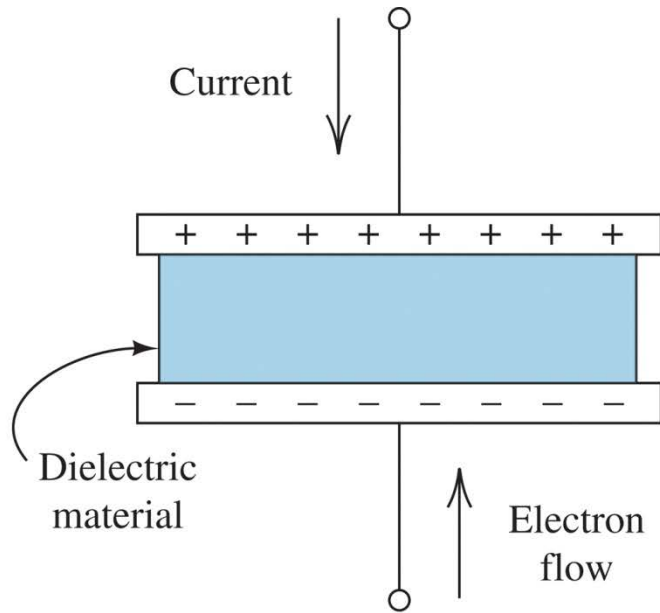
Lecture 8

Assignment Reminder

- Read 3.4 - 3.7, AND 4.1 - 4.3
- Practice problems:
  - P2.57, P2.59, P2.88 <--**note that these involve *controlled* sources**
  - P3.6, P3.7, P3.8, P3.11

- D2L Quiz #4 by 11AM on Monday 26 Sept. (The quiz will be posted soon).

- REMINDER: [Lab #3](#) this week will require a formal lab report due at the start of your lab session during the week of October 3. There will be no lab during the week of September 26, although the lab TA (Nick Havens) can let you in to do any follow-up measurements that are needed for Lab #3.
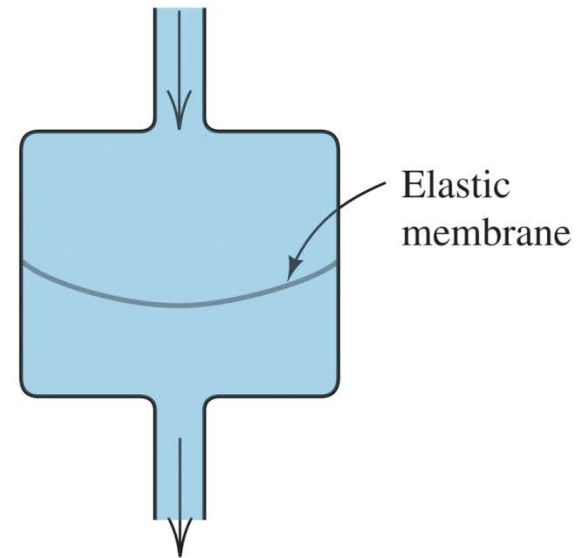
Capacitors

- A capacitor stores electric charge. The capacitor "charges up" as a current delivers charge to it.

Conducting plates

Dielectric

Capacitors (cont.)

Current

$+ \quad + \quad + \quad + \quad + \quad + \quad + \quad +$

$- \quad - \quad - \quad - \quad - \quad - \quad - \quad -$

Dielectric
material

Electron
flow

(a) As current flows through a capacitor, charges
of opposite signs collect on the respective plates

Elastic
membrane

(b) Fluid-flow analogy for capacitance

Capacitors (cont.)

- Circuit symbol
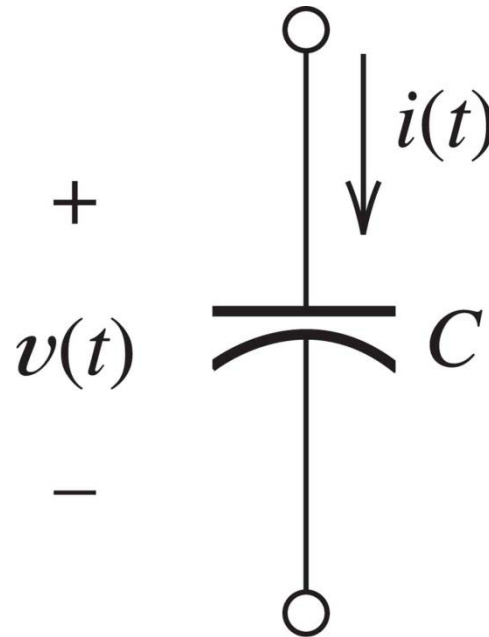 and
  polarity convention

$+$

$v(t)$

$i(t)$

C

$-$
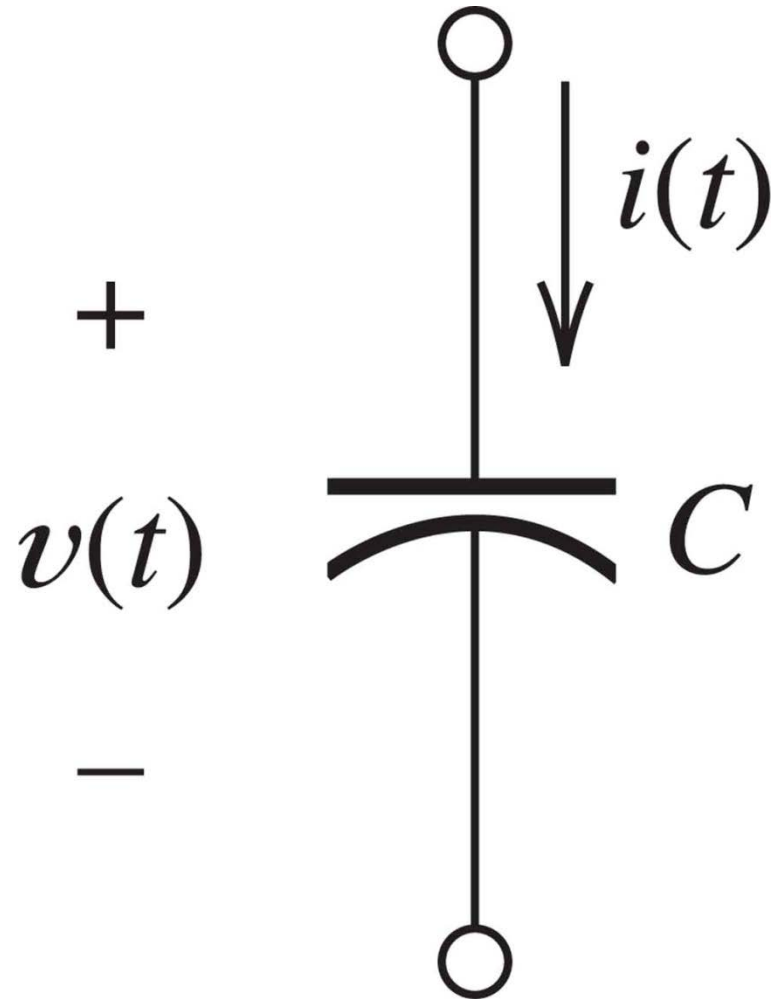
Capacitance

- Capacitance is measured in *Farads*

$$C = \frac{q}{v}$$

$$i = \frac{dq}{dt} = \frac{d}{dt}(Cv)$$

$$i = C\frac{dv}{dt}$$

$i(t)$

$+$

$v(t)$

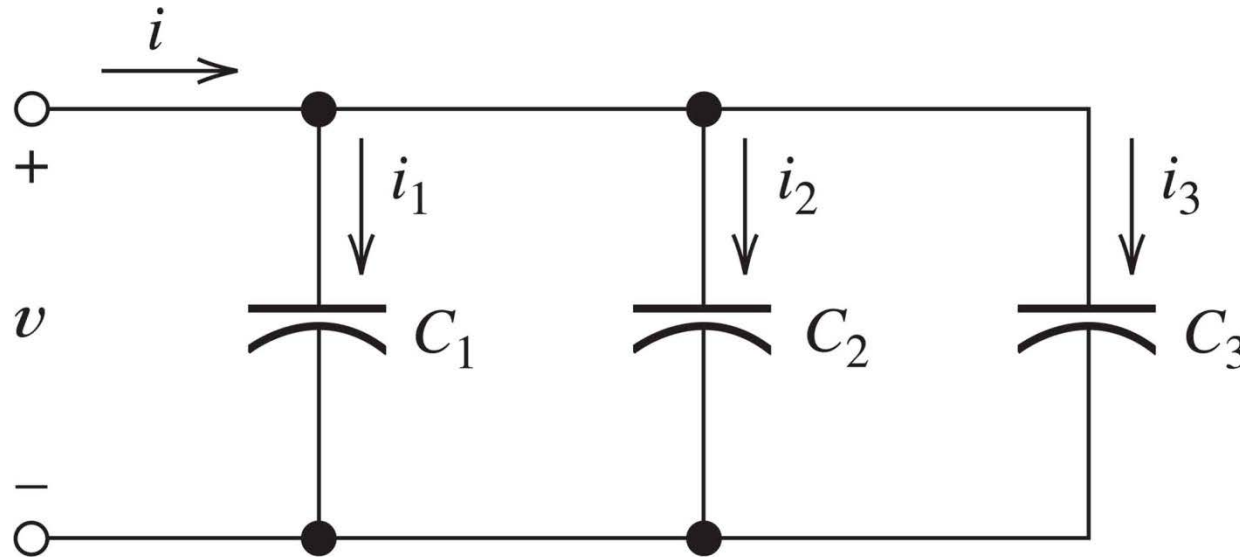C

$-$

Capacitance (cont.)

- In terms of voltage:

$$v(t) = \frac{1}{C} \int_{t_0}^{t} i(t)dt + v(t_0)$$

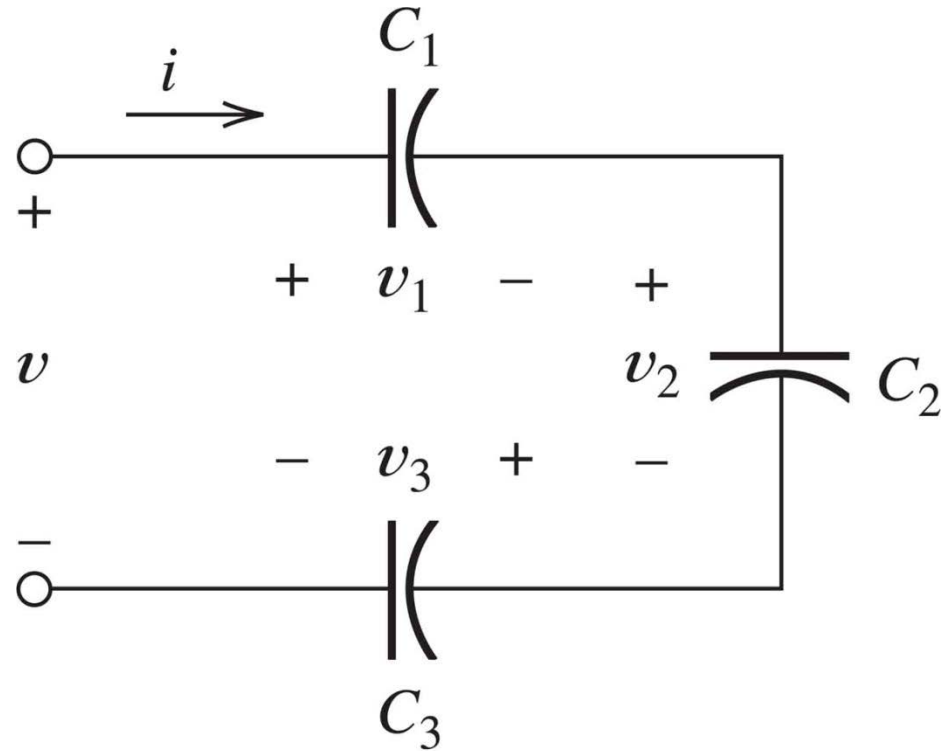$$q(t) = \int_{t_0}^{t} i(t)dt + q(t_0)$$

Parallel and Series

- Capacitors in parallel have the same voltage but different currents, so they act like the sum of the individual capacitances

$$C_{eq} = C_1 + C_2 + C_3$$

Parallel and Series (cont.)

- Capacitors connected in series share the same current, but have different voltages, so they combine as reciprocals

$$C_{eq} = \frac{1}{1/C_1 + 1/C_2 + 1/C_3}$$

Summary and Review

- Capacitors store charge: they *integrate* the current as the voltage charges up
- $C = q/v$
- $i = C \, dv/dt$
- $V = (1/C) \int i \, dt$
- Capacitors in parallel add together, like resistors in series.
- Capacitors in series add *reciprocally*, like resistors in parallel.