Assignment #7 Due Thu March 14, 11:59 PM
Please refer to Assignment #7 on Canvas

Please complete Week 9 - Activities in zyBook (team.zybooks.com). WORK ON the following Participation Activities:

- S.1.1, S.1.2, S.1.4, S.1.5
- S.2.1, S.2.2, S.2.4, S.2.5, S.2.6, S.2.7
- S.3.1, S.3.2, S.3.3, S.3.4, S.3.5, S.3.6
- S.4.1

AND Challenge Activities - S.3.1 and S.4.1.


Please submit these in Canvas. Submit ONE scanned PDF file of your work.

Midterm #2: Hi 100, Lo 5, Avg. 64, MEDIAN 65
Please collect exams: Today 11AM- Noon (KEC408)
4-6PM (KEC4107)

Rework Problem #3 of Test 2 for additional credit (optional) by 11:59pm Friday Canvas submission

Two new components (circuit elements)
- Capacitor
- Inductor

Capacitor
Consists of two conducting plates or separated by an insulator (dielectric)
When a voltage \( v \) is applied the source deposits a positive charge \((+q)\) on one plate and an equal and opposite charge \((-q)\) on the other plate.

The amount of charge deposited (or stored) is directly proportional to the applied voltage.

\[
q \propto v \quad \Rightarrow \quad q = C \cdot v \quad \text{(Linear component)}
\]

\( C \) = capacitance in farad (F) is the proportionality constant

\[
C = \frac{q}{v} \quad \text{1 F = 1 C/1V}
\]

Note: \( C \) is independent of \( q \) and \( v \)

\[
C = \frac{\varepsilon A}{d}
\]

\( \varepsilon \) = permittivity of the material between the plates

\( C \) for free space (air) = \( 8.85 \times 10^{-12} \text{ F/m} \)

\[\text{Symbol}\]

\[
i = \frac{dq}{dt} \quad v^+ \xrightarrow{1 \mu s} v^-
\]

\[
i = \frac{d}{dt}(Cv) = C \frac{dv}{dt}
\]

The current flow is referred to as displacement current.

**Observation 1** Current through a capacitor is due to a time-varying voltage.

If a dc voltage is applied then

\[
i = C \frac{dv}{dt} = 0
\]

I.e. the capacitor acts like an open circuit for dc.

**Observation 2**

The voltage across a capacitor cannot change instantaneously (abruptly).

\[
\frac{dv}{dt} \to \infty \Rightarrow i = \infty
\]

\( \frac{dv}{dt} \) not practically possible
However, the current can change abruptly

\[ i = C \frac{dv}{dt} \]

\[ v(t) = 7t + 3 \quad \text{V} \quad \text{u} = 1 \text{F} \]

\[ i(t) = 7 \text{A} \]

\[ v(t) = \frac{1}{C} \int_{-\infty}^{t} i \, dt \]

\[ = \frac{1}{C} \int_{t_0}^{t} i \, dt + \frac{1}{C} \int_{-\infty}^{t_0} i \, dt \]

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

**Remark**

Since a capacitor stores charge it is an energy storage element. The capacitor stores charge when charging and releases charge when discharging.

\[ v^+ \quad \frac{1}{C} \int_{t_0}^{t} \]

\[ v^- \quad \frac{1}{C} \int_{-\infty}^{t_0} \]

charging

\[ v^+ \quad \frac{1}{C} \int_{t_0}^{t} \]

discharging

An ideal capacitor does not dissipate energy

**Power and energy**

\[ P = vi = v \left( C \frac{dv}{dt} \right) = C \frac{dv}{dt} \frac{dv}{dr} = c \frac{d}{dt} \left( \frac{1}{2} v^2 \right) \]

Energy stored on the capacitor is

\[ W = \int_{-\infty}^{t} P \, dt \]

\[ = \frac{1}{2} C v^2 \]
Example:
\[ i_c = C \frac{dv_c}{dt} \]
\[ p = v_c i_c \]
\[ w = \int_{-\infty}^{t} p \, dt \]

In phase I energy is stored in the capacitor.
In phase II energy is delivered.

**Parallel combination**
\[ \frac{1}{\sum c_i} = \frac{1}{C_e} \]
\[ C_e = C_1 + C_2 + C_3 + \ldots + C_n \]

**Series combination**
\[ \frac{1}{\sum \frac{1}{C_i}} = \frac{1}{C_e} \]
\[ C_e = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \ldots + \frac{1}{C_n}} \]

**Exercise**
\[ \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C_e} \]
\[ C_e = \frac{C_1 C_2}{C_1 + C_2} \]