Now try to simplify the expression. In terms of $V_{C1}(0)$ and $V_{C2}(0)$:

- Recall that charge is also conserved:

$$q(0) = q(\infty)$$

$$C_1 \cdot V_{C1}(0) + C_2 \cdot V_{C2}(0) = (C_1 + C_2) \cdot V_{C1}(\infty)$$

$$V_{C1}(\infty) = \frac{(C_1 \cdot V_{C1}(0) + C_2 \cdot V_{C2}(0))}{C_1 + C_2}$$

- Substitute into equation (1)

$$E_{diss} = \left[ \frac{1}{2} C_1 \cdot (V_{C1}(0))^2 + \frac{1}{2} C_2 \cdot (V_{C2}(0))^2 \right] - \left[ \frac{1}{2} (C_1 + C_2) \cdot \left( \frac{(C_1 \cdot V_{C1}(0) + C_2 \cdot V_{C2}(0))}{C_1 + C_2} \right)^2 \right]$$

$$E_{diss} = \frac{1}{2} \left[ \frac{(C_1 + C_2) \cdot (C_1 \cdot (V_{C1}(0))^2 + C_2 \cdot (V_{C2}(0))^2)}{C_1 + C_2} \right] - \frac{(C_1 \cdot V_{C1}(0) + C_2 \cdot V_{C2}(0))^2}{C_1 + C_2}$$

$$E_{diss} = \left( \frac{1}{2} \right) \left[ \frac{C_1^2 \cdot V_{C1}(0)^2 + C_1 \cdot C_2 \cdot V_{C1}(0)^2 + C_1 \cdot C_2 \cdot V_{C2}(0)^2 + C_2^2 \cdot (V_{C2}(0))^2}{C_1 + C_2} \right] - \frac{C_1^2 \cdot V_{C1}(0)^2 + 2 \cdot C_1 \cdot C_2 \cdot V_{C1}(0) \cdot V_{C2}(0) + C_2^2 \cdot (V_{C2}(0))^2}{C_1 + C_2}$$

$$E_{diss} = \frac{1}{2} \left( \frac{C_1 \cdot C_2}{C_1 + C_2} \right) \cdot (V_{C1}(0)^2 - 2 \cdot V_{C1}(0) \cdot V_{C2}(0) + V_{C2}(0)^2) = \frac{1}{2} \left( \frac{C_1 \cdot C_2}{C_1 + C_2} \right) \cdot (V_{C1}(0) - V_{C2}(0))^2$$
Differential Equations

RL, RC, LC, RLC

- series
- parallel

100s of Hertz to 100 kHz

- R, L, C in Ω, H, F - per unit

1000, 1000
5, 5

- 38

Voltage Transformer

Current ratio

240V 132kV

mH μF
Steps for transient analysis

1. System equivalent circuit
   - 3 line diagram
   - 2 single phase equivalent for balanced transients

2. Steady state initial conditions
   - by hand
   - power flow solution

3. Represent transient
   - model trigger event
   - differential equations
- If Diff Eq by hand
  - Simplify circuit
    1st ord. RL, RC
    \[ k_1 s + k_0 = - \]
    
    2nd \[ k_0 + k_1 s + k_2 s^2 = \]
    
    LaPlace Domain, or time domain
    \[ L \frac{di}{dt} + c \int io dt - \]
    
    Solve:
    - Particular solution - steady state
    - Homogeneous solution - transient
    - Can be done with phasors for AC circuit
    - Final conditions
    - Constants & boundary conditions for constants
1st order

\[ k e^{-\frac{t}{T}} \left( 1 - k e^{-\frac{t}{T}} \right) c \]

2nd order

\[ f(t) = \left( A, (\cos\omega_n t) + B (\sin\omega_n t) \right) e^{-\frac{t}{T}} \]