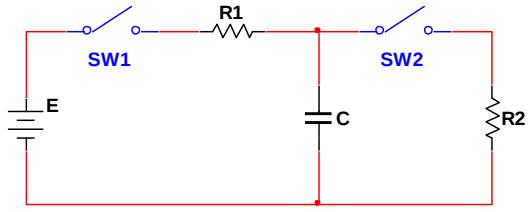
Capacitor Discharging (55:52)

Discuss the electrical properties of a capacitor charging circuit beyond 5 time constants.

Write the formula used to determine the energy stored in a capacitor.

Determine the energy stored in 15uF capacitor with 12V across it.

Capacitor Discharging Circuit 1 (4:44 to 23:31)



Given:

E = 12V
R_1 = 200Ω
R_2 = 400Ω
C = 15µF
C starts the discharging process at 12V

Assume the following polarities:

positive I_1 travels in to out left to right
positive V_1 appears positive to negative left to right
positive I_C travels in to out top to bottom
positive V_C appears positive to negative top to bottom
positive I_2 travels in to out top to bottom
positive V_2 appears positive to negative top to bottom

Describe the discharge process in general terms when SW1 opens and SW2 closes. Discuss the significance of discharge current direction with regard to instrumentation.

Draw the general purpose plot of current through a capacitor as a function of time for a simple capacitor discharging process and identify an equation that describes this phenomenon. Discuss the significance of negation.

Draw the general purpose plot of voltage across a capacitor as a function of time for a simple capacitor discharging process and identify an equation that describes this phenomenon.

Identify the 3 data points necessary to perform the transient analysis of the capacitor discharging process.

Identify the start and end voltage for a complete capacitor discharge process. Determine these values for capacitor discharge circuit 1.

Identify the magnitude of the initial discharge current surge for capacitor discharge circuit 1. Identify the end current for a complete discharge.

Determine the time constant for capacitor discharge circuit 1. Determine the length of a complete discharge.

Derive the time variant expressions for $i_c(t)$ and $v_c(t)$ and plot these properties for a full discharge.

Determine the instantaneous value of I_C and V_C 3.5ms into the discharge process.

Determine the time I_C has dropped to -10mA.

Determine the time V_C has dropped to 6V.

Derive the time variant expressions for $i_{R2}(t)$ and $v_{R2}(t)$ and plot these properties for a full discharge.

Determine the instantaneous values for I_{R2} and V_{R2} at t=3.5ms.

Determine the instantaneous value of I_{R2} at t=4.2ms.

Determine the instantaneous value of V_{R2} at t=6.6ms.

Using data obtained for capacitor charging circuit 1 in the "Capacitor Charging" lecture, plot a back to back charge and discharge sequence for all elements in the system given the following conditions:

t=0 to 15ms, SW1 closed, SW2 open
t=15 to 45ms, SW1 open, SW2 closed

Describe the general behavior of electrical properties for a back to back charge and discharge process.

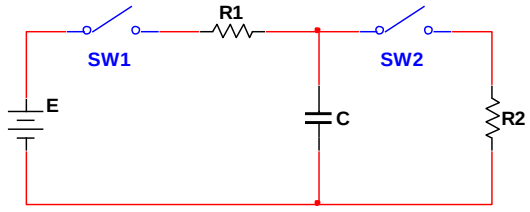
Comment on the asymmetric nature of the charge and discharge process.

Comment how the time values obtained during an analysis of an isolated discharge process must be referenced for a back to back charge and discharge process.

Determine the time discharge current has dropped to 16.7mA for a back to back charge and discharge process.

Draw a plot of voltage across the capacitor for repeated full charges and full discharges. Comment on the shape of this plot.

Capacitor Discharging Circuit 2 (23:31 to 37:20)



Given:

E = 24V
R_1 = 500Ω
R_2 = 200Ω
C = 47µF
C starts the discharging process at 24V

Assume the following polarities:

positive I_1 travels in to out left to right
positive V_1 appears positive to negative left to right
positive I_C travels in to out top to bottom
positive V_C appears positive to negative top to bottom
positive I_2 travels in to out top to bottom
positive V_2 appears positive to negative top to bottom

Following a complete charge where SW1 remains closed for 117.5ms determine the electrical properties for this system if SW1 remains closed until t=150ms.

Given SW1 opens and SW2 closes at t=150ms, determine the discharge time constant, determine initial conditions for the discharge, determine final conditions for a complete discharge, and derive time variant expressions for $v_{R1}(t)$, $i_{R1}(t)$, $v_C(t)$, $i_C(t)$, $v_{R2}(t)$, and $i_{R2}(t)$ during the discharge process. Draw plots for a 150ms charge followed by a full discharge. Assume the discharge phase begins at another supplementary t=0.

Determine the energy stored in the 47uF capacitor with 24V across it after a full charge.

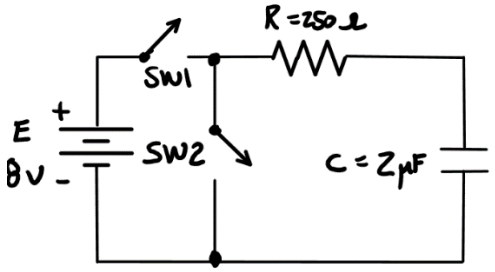
Determine the instantaneous values of I_C, V_C, I_{R2}, and V_{R2} 20ms into the discharge process.

Determine the time voltage across the capacitor has dropped to 5V. At this same time determine the instantaneous values of I_C, I_{R2}, and V_{R2}.

Describe the general behavior of electrical properties for a back to back charge and discharge process.

Comment on the asymmetric nature of the charge and discharge process.

Capacitor Discharging Circuit 3 (37:20 to END)



Assume the following polarities:

positive I_1 travels in to out left to right
positive V_1 appears positive to negative left to right
positive I_C travels in to out top to bottom
positive V_C appears positive to negative top to bottom

Given SW1 and SW2 toggle states every 2.5ms, determine the discharge time constant, determine initial conditions for the discharge, determine final conditions for a complete discharge, and derive time variant expressions for $v_{R1}(t)$, $i_{R1}(t)$, $v_C(t)$, and $i_C(t)$ during the discharge process. Draw plots for a 150ms charge followed by a full discharge. Assume the discharge phase begins at another supplementary t=0.

Describe the general behavior of electrical properties for a back to back charge and discharge process.

Comment on the symmetric nature of the charge and discharge process.

Determine the peak instantaneous power delivered to the resistor at the beginning of the charge and discharge phase. Comment on the sign of power dissipated by the resistor.

Determine power delivery to the capacitor at the beginning and end of the charge phase. Comment on power delivery over the complete charge process.

Comment on power delivered by the source during the charge and discharge phase. Draw a plot of power as a function of time for the charge and discharge phase.

Determine the energy stored in the 2uF capacitor with 8V across it after a full charge. Comment on the mathematical relationship of energy and power. Determine the energy supplied by the source for a complete charge.

Comment on power transfer during the charge and discharge process.