Ex:

After being closed for a long time, the switch opens at \( t = 0 \).

Write an expression for \( v_C(t > 0) \) using not more than \( R_1, R_2, v_s, i_s, \) and \( C \).

Sol'N:

Step 1: (Redraw circuit at \( t=0 \) and solve for \( v_C \). Capacitor acts as an open since it has been a long time)

Taking a voltage loop

\[ +V_C - V_s = 0 \]

\[ V_C = V_s \]
Step 2: **Initial Value** (Redraw circuit at $t=0^+$ and solve for unknown variable. Capacitor acts as a voltage source since the voltage across capacitor has to remain the same.)

\[ V_c(t=0^+) = V_s \]

Step 3: **Final Value** (Redraw circuit at $t=\infty$ and solve for unknown variable. Capacitor acts as an open since it has sat for a long time in this position.)

The desired voltage is seen to be the voltage across $R_2$ which is

\[ V_c = R_2i_s \]

The sign is positive because the polarity of both are the same.

Find $\tau$ for this circuit: (Note that $R_1$ is floating and does not contribute)

- $Req = R_2$
- $\tau = R_2C$

Step 4: Plug values into general equation:

\[ V_c(t > 0) = i_R \tau \frac{d}{dt} + [V_s - i_R \tau]e^{-t/\tau} V \]