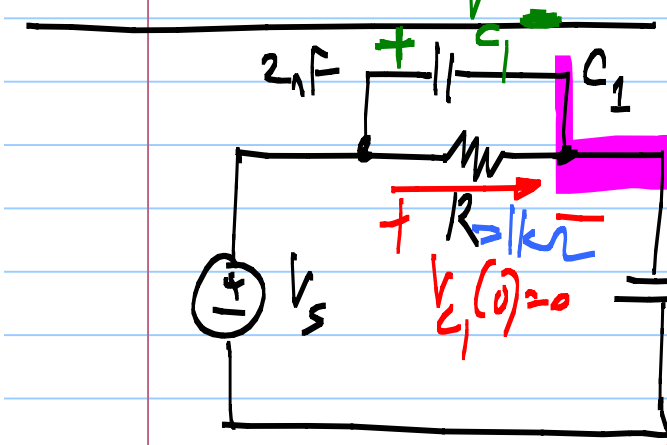
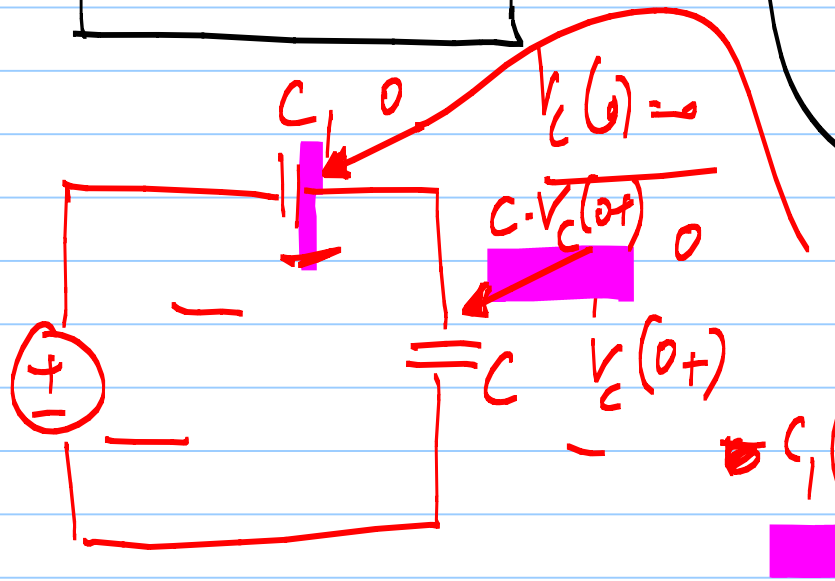
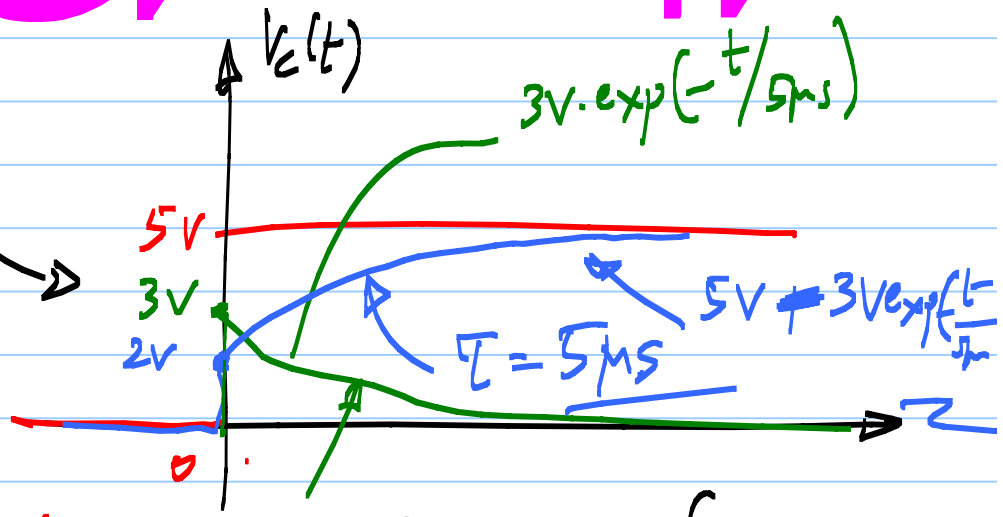
EC1010: Lecture 25



1st order circuit → 1st order diff. eqn.

$$R(C+C_1)\cdot\frac{dV_c}{dt} + V_c = V_s + RC_1\cdot\frac{dV_s}{dt}$$

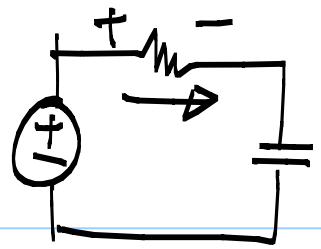




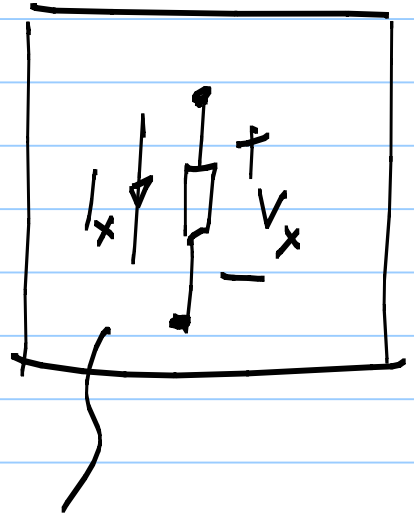
$$V_c(0+) = V_s\cdot\frac{C_1}{C_1+C_2}$$

0: Instant of the step

Step response of a first order circuit



Step input



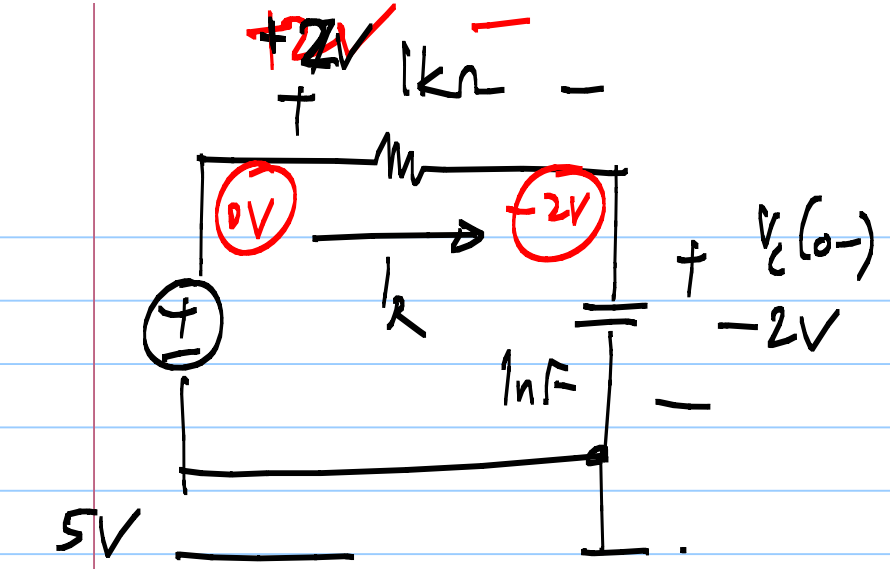
First order circuit

$$V_x = V_{x,final} + \left(V_x(0+) - V_{x,final}\right) \cdot \exp\left(-\frac{t}{\tau}\right)$$

$$V_x(\infty) + \left(V_x(0+) - V_x(\infty)\right) \cdot \exp\left(-\frac{t}{\tau}\right)$$

Initial condition given: $V_c(0-)$

Input source known: $V_s(0-)$



$$I_R(t) = 7mA \cdot \exp\left(-\frac{t}{1\mu s}\right) \quad (t>0)$$

$I_R(0-) = +2mA$

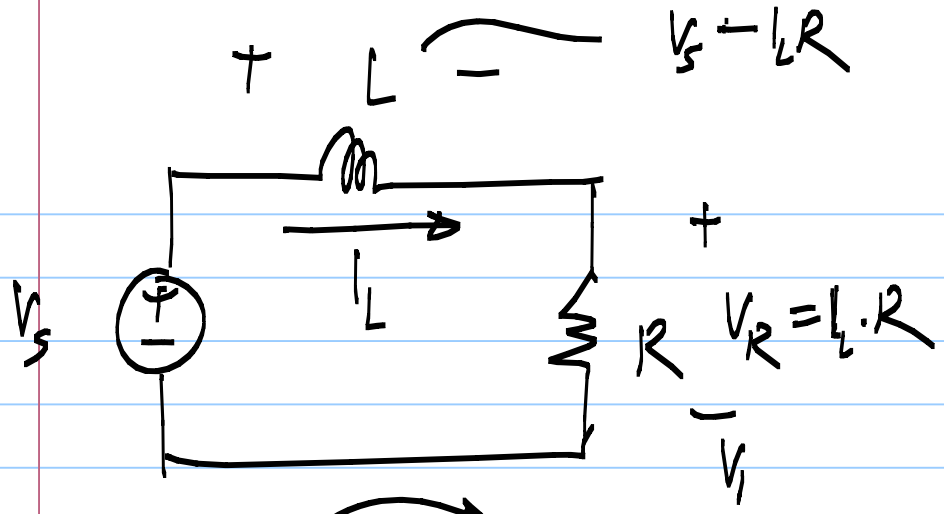
$I_R(0+) = 7mA$

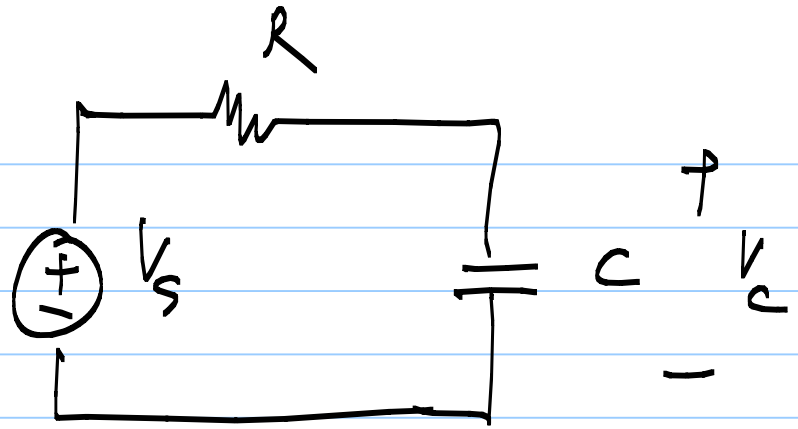
$I_R(\infty) = 0$

$\tau = 1\mu s$

Step response of a first-order circuit

* Determine the time constant
  - set sources = 0
  - $C_{eff} \cdot R_{th} = \tau$
* Determine the values at $t = 0-$
  - From initial conditions & ckt. analysis
* Determine discontinuities in cap. voltages at $t = 0$
  - Voltage source - capacitor loops
  - open circuit all resistors & determine cap. voltages
* Determine values at $t = 0+$
* Determine final values (open circuiting all capacitors)





$$V_s - I_L R = L \cdot \frac{dI_L}{dt}$$

$$\frac{L}{R}\frac{dI_L}{dt} + I_L = \frac{V_s}{R}$$

$$\frac{L}{R}\frac{dV_R}{dt} + V_R = V_s$$

$$RC\frac{dV_C}{dt} + V_C = V_s$$