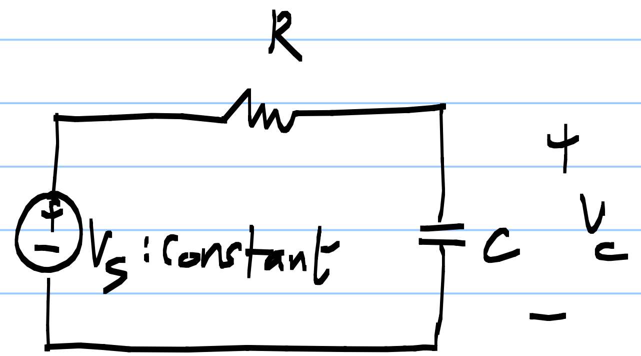
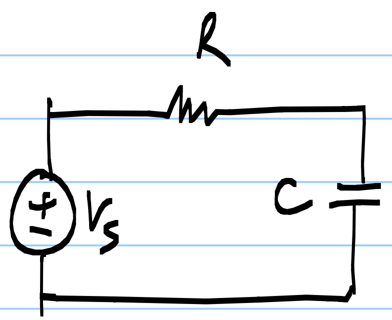
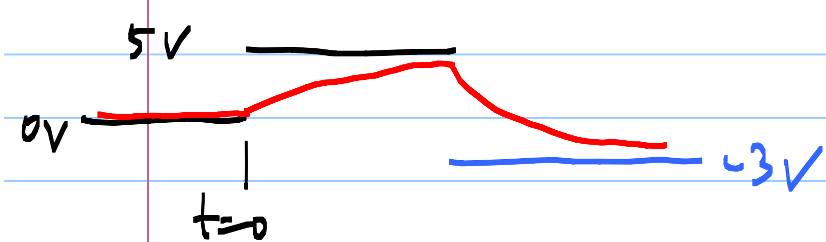
EC 1010: Lecture 24







Total response: (Piecewise Constant inputs)

$$V_c(t) = \underbrace{V_s}_{\text{Steadystate}} + \underbrace{\left(V_c(0) - V_s\right)\exp\left(-\frac{t}{RC}\right)}_{\text{Transient}}$$

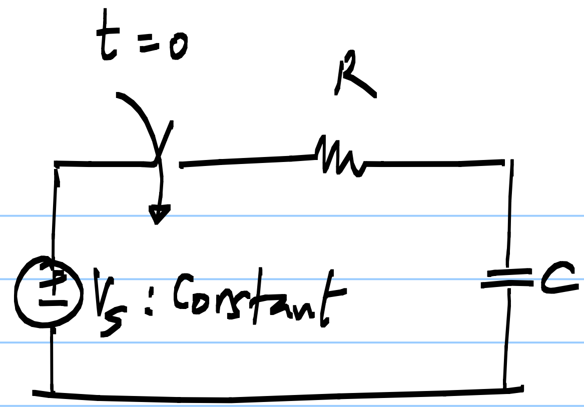
Steadystate — Transient

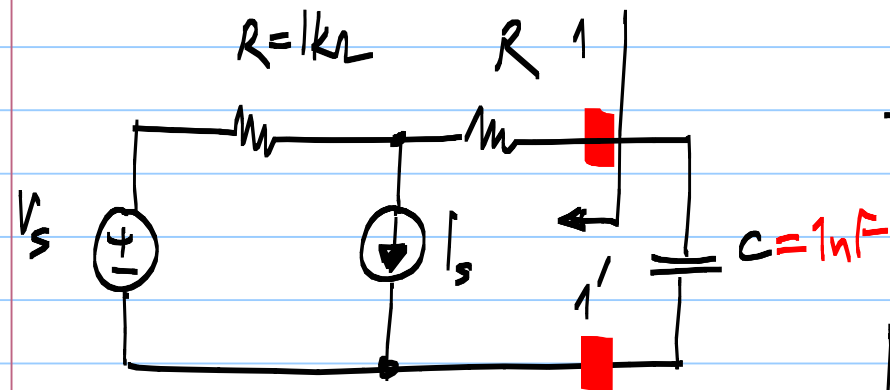
Forced — Natural

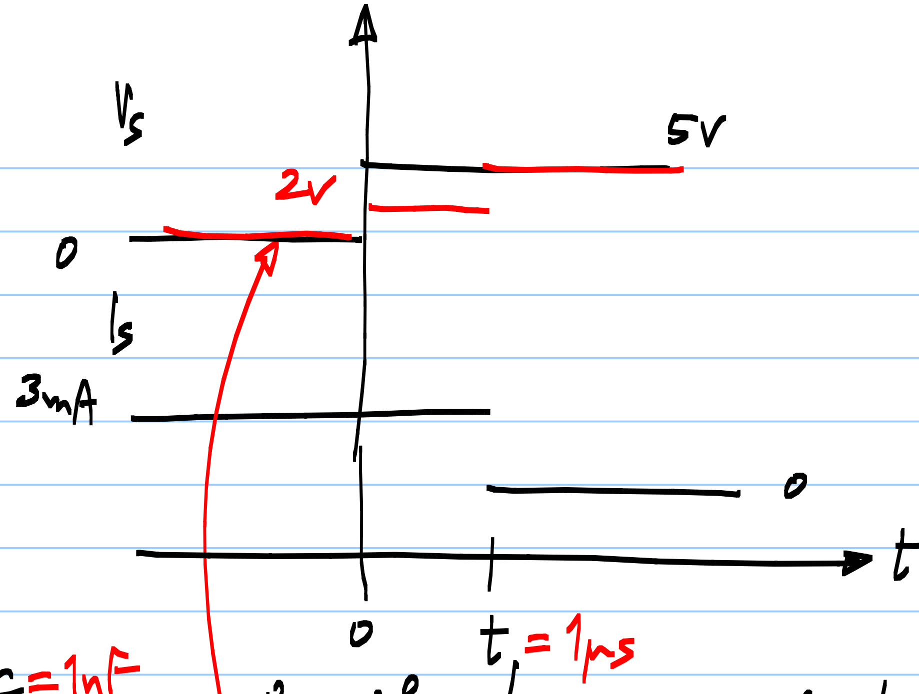
Particular Solution — Homogeneous solution

$$= V_s\left(1 - \exp\left(-\frac{t}{RC}\right)\right) + V_c(0)\exp\left(-\frac{t}{RC}\right)$$

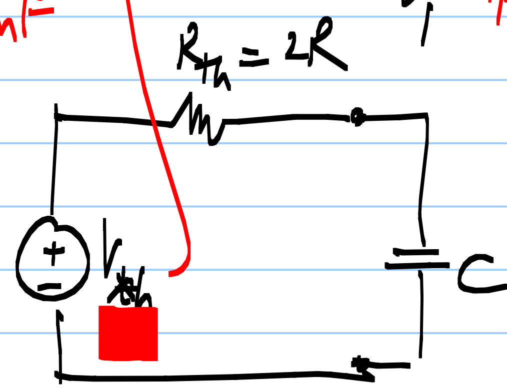
Zero-state response — Zero input response





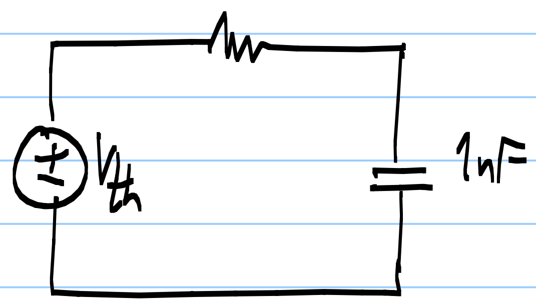


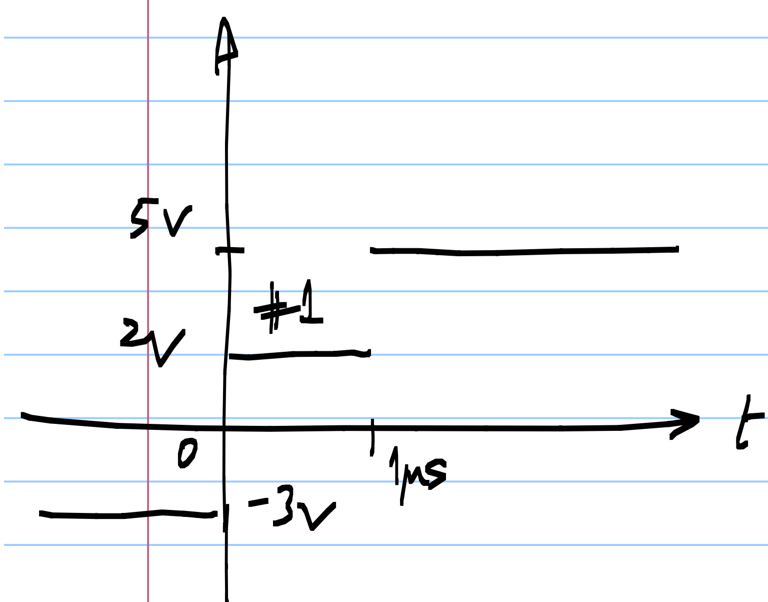
$v_C(0) = 0$



$\cdot \exp\left(-\frac{t}{2R \cdot C}\right)$

$R_{th} = 2k\Omega$





$$\underbrace{V_{th}}_{\text{Final value}} + \underbrace{(V_c(0) - V_{th})}_{\text{Initial} - \text{Final value}} \exp\left(-t/R_{th}C\right)$$

#1: $2V + (-2V)\exp\left(-t/2\mu s\right)$

@ $t = 1\mu s$ $\quad 2V - 2V\exp\left(-1/2\right)$

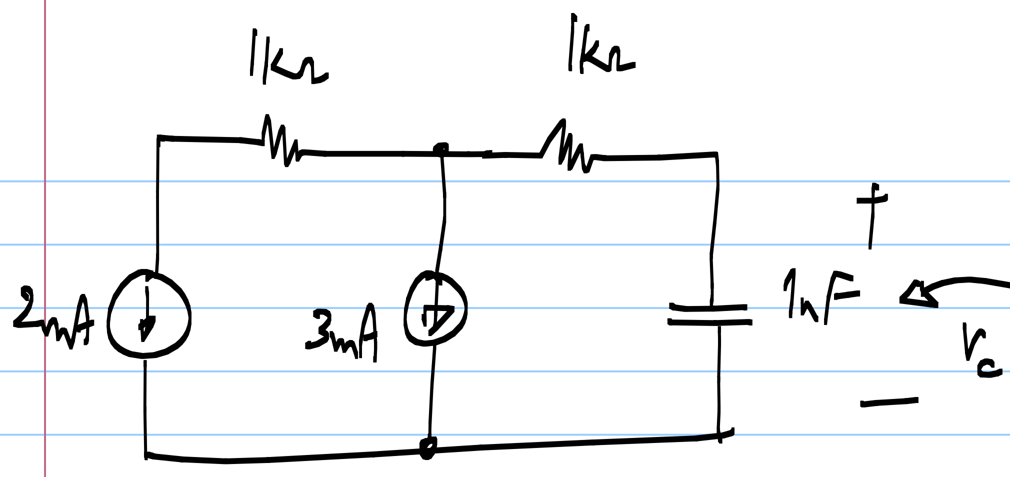
$= 0.7869V$

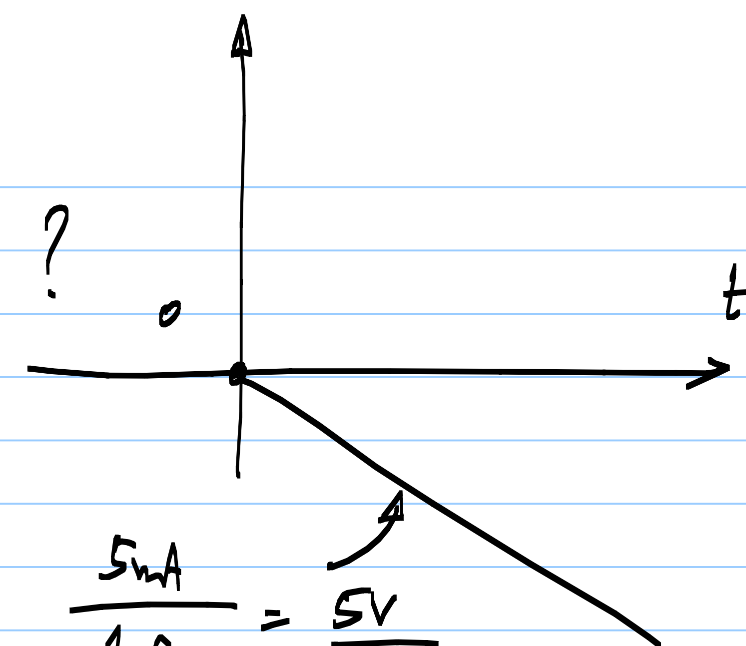
#2: $5V + (-4.22V)\exp\left(-\frac{(t-1\mu s)}{2\mu s}\right)$

$2V + (-5V)\exp\left(-t/2\mu s\right)$

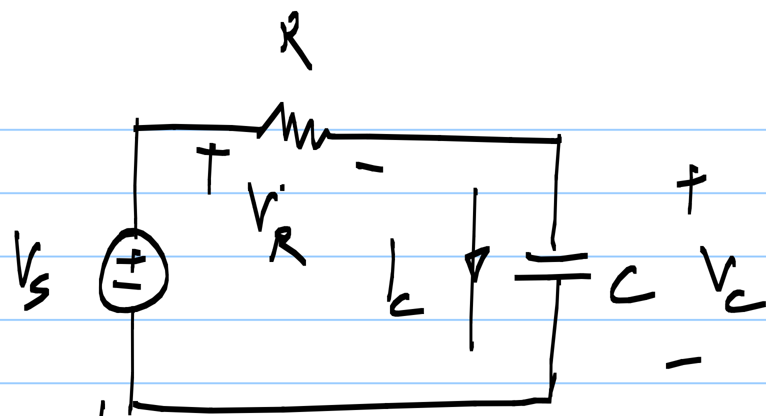
$2V - 5V\exp\left(-1/2\right) = -1.003V$

$5V + (-6V)\exp\left((t - 1\mu s)/2\mu s\right)$





$$\frac{5\,mA}{1\,nF} = \frac{5\,V}{\mu s}$$



$$RC\frac{dV_c}{dt} + V_c = V_s$$

$$RC\frac{dI_c}{dt} + I_c = C\frac{dV_s}{dt} \qquad I_c$$

$$RC\frac{dV_R}{dt} + V_R = RC\frac{dV_s}{dt} \qquad V_R$$

Natural response

$$V_c = (\ )\cdot\exp\left(-\frac{t}{RC}\right)$$

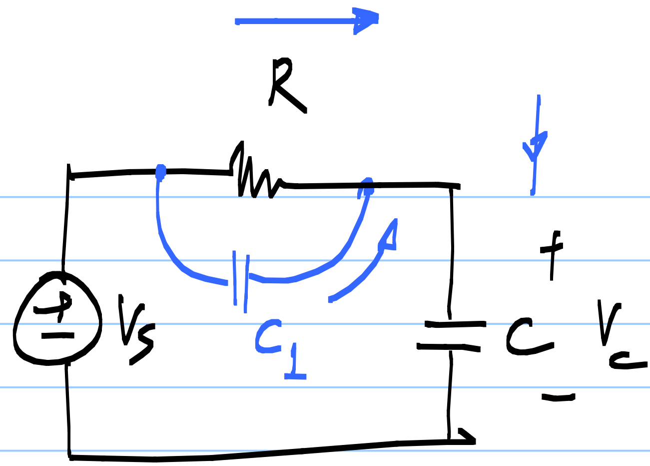
$$I_c = (\ )\cdot\exp\left(-\frac{t}{RC}\right)$$

$$V_R = (\ )\ \exp\left(-\frac{t}{RC}\right)$$

Piecewise constant input:

V_c : $V_s + (V_c(0) - V_s)\exp(-t/RC)$

I_c : $I_c(\infty) + (I_c(0) - I_c(\infty))\exp(-t/RC)$



$$RC\frac{dV_c}{dt} + V_c = V_s$$

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

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