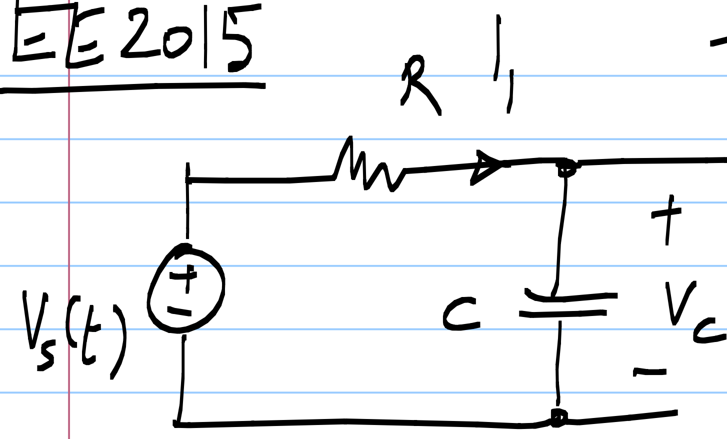
EE2015

$s = 0$: dc/constant input

25/9/2017



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

$$V_s(t) = V_p \exp(st)$$

$$s \neq \cancel{\frac{-1}{CR}}$$

Forced response

$$V_c(t) = \frac{1}{sCR+1} V_p \exp(st)$$

$s \neq \frac{-1}{RC}$ Transfer function $+ \left(V_c(0) - \frac{V_p}{sCR+1} \right) \cdot \exp\left(-t/_{RC}\right)$

Natural response

RC $\quad$ 1

$$a_N \cdot \frac{d^N v_c}{dt^N} + a_{N-1} \frac{d^{N-1} v_c}{dt^{N-1}} + \dots + a_1 \frac{dv_c}{dt} + a_0 \cdot v_c$$

$M \leq N$

$$= b_M \frac{d^M v_s}{dt^M} + \dots + b_1 \frac{dv_s}{dt} + b_0 v_s$$

$$v_s = v_p \exp(st)$$

$$v_c = H \cdot v_p \exp(st)$$

(forced resp.)

$$H = \frac{b_M s^M + \dots\ b_1 s + b_0}{a_N s^N + a_{N-1} s^{N-1} + \dots + a_1 s + a_0}$$

Total solution:

$$V_c(t) = \frac{1}{1+sCR} V_p \exp(st)$$

$$+ \left(V_c(0) - \frac{V_p}{1+sCR} \right) e \text{ [illegible]}$$

$$sCR + 1 = \epsilon$$

$$s = \frac{\epsilon - 1}{CR}$$

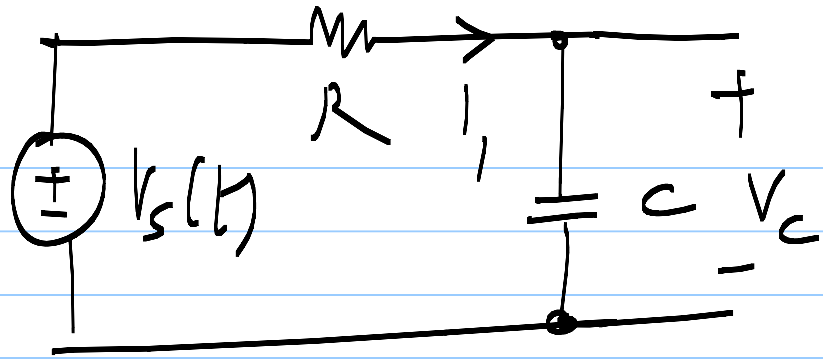
$$\lim_{\epsilon \to 0} V_c(t)$$

$\exp(x) - 1$

$\cancel{\approx}\ x - 1$

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

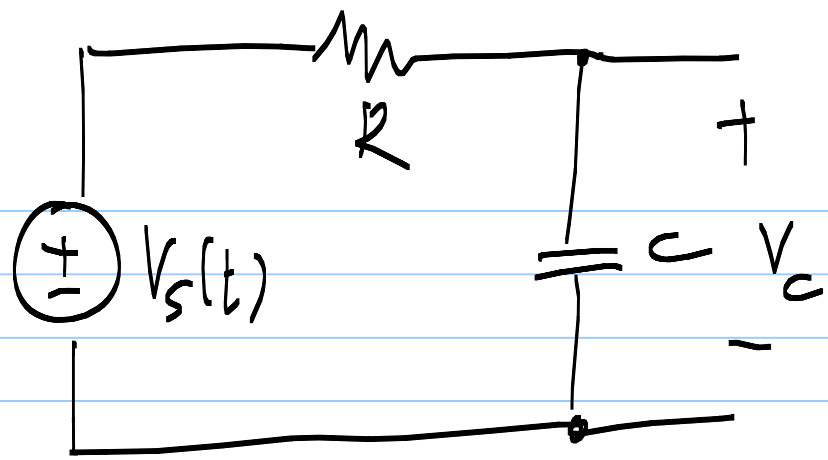
$$= \text{[illegible]} + V_c(0) \exp\left(-t/RC\right)$$



$$i_1 = C\frac{dV_c}{dt} = \frac{V_s - V_c}{R}$$

$$V_c(t) = V_p \exp(st)\cdot\frac{1}{1+sCR} + \left(V_c(0) - \frac{V_p}{1+sCR}\right)\exp\left(\frac{t}{RC}\right)$$

$$i_1(t) = \frac{1}{R}\left[V_p \exp(st)\cdot\frac{sCR}{1+sCR} - \left(V_c(0) - \frac{V_p}{1+sCR}\right)\exp\left(\frac{-t}{RC}\right)\right]$$



$$RC \cdot \frac{dV_c}{dt} + V_c = V_p \underbrace{\cos(\omega t + \varphi)}_{\frac{\exp(j(\omega t+\varphi)) + \exp(-j(\omega t+\varphi))}{2}}$$

$V_p \cos(\omega t + \varphi)$

Find the solution to $V_p \exp(j(\omega t + \varphi))$

$$= V_p \exp(j\varphi) \cdot \exp(j\omega t) \sim V_p \exp(st)$$

Repeat for $\exp(-j\ldots)$

$$V_c(t) = \alpha \cos(\omega t + \phi) + \beta \sin(\omega t + \phi)$$