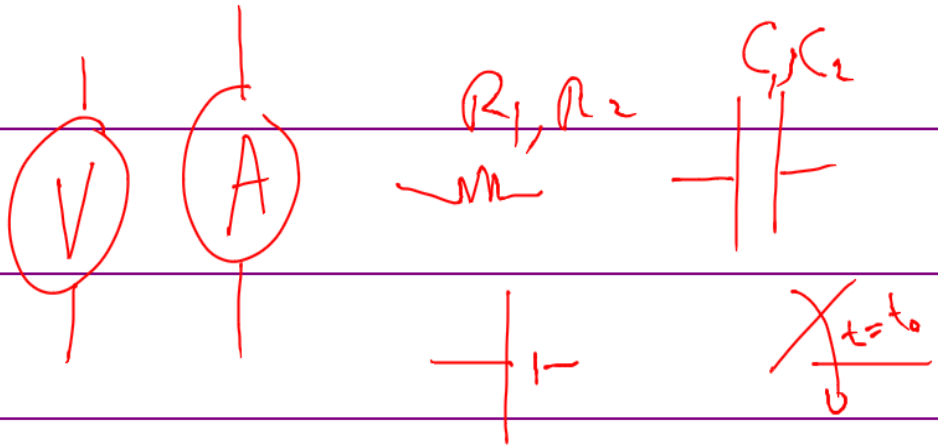


Stopwatch

$\tau \equiv RC$

q, C, V

$C \equiv q/V$

$V \equiv q/C$

$q = CV$

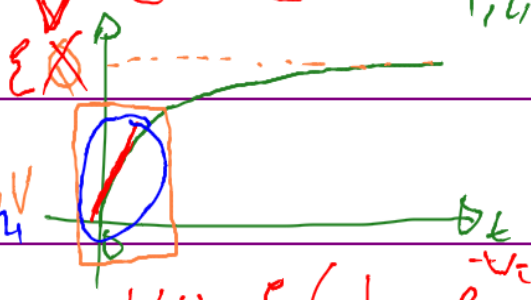
$Q = C\mathcal{E}$

charging of capacitor

$q(t) = Q\left(1 - e^{-t/\tau}\right)$

$\frac{q}{C} = \frac{Q}{C}\left(1 - e^{-t/\tau}\right)$

1, 2, 3, ... 19



$V(t) = \mathcal{E}\left(1 - e^{-t/\tau}\right)$

$V(t) \approx \mathcal{E}\left(1 - \left(1 - t/\tau\right)\right)$

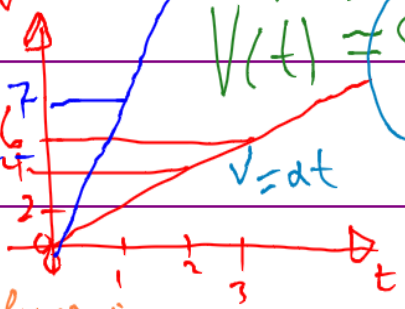
$V(t) \approx \mathcal{E}\, t/\tau$

approximation

$\sum_{n=0}^{\infty} \frac{x^n}{n!} = e^x$

$e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots$

$e^{-t/\tau} \approx 1 + \frac{(-t/\tau)}{1!} + \frac{(-t/\tau)^2}{2!} + \frac{(-t/\tau)^3}{3!} + \cdots$



$t \in [0, 300]\,s$

good for maximum error

$RC = \tau \ggg 300$

t/τ $\quad (t/\tau)^2$ $\quad (t/\tau)^3$

$0.03 = \frac{300}{\tau}$ $\quad 9 * 10^{-4}$ $\quad 27 * 10^{-6}$

10040 >> 0.0005 >>>>

$\mathcal{E} = 10$ Volt $\quad \tau = 10^4 = R * C$

300

$10^4 = R * 10 * 10^{-6}$

$R = 10^9 = 1000\ M\Omega$

$V(t) = \frac{20}{10000} t$

$10^5 * 10^9$

$t = 500 * V(t)$

$R = 5\ M\Omega = 5 * 10^6$

1 mV
7 mV
19 mV
⋮
360 mV
3000 mV

$RC = 10000$

$5 * 10^6 C = 10^4$

$\therefore C = \frac{1}{5} * 10^{-2} = 2 * 10^{-3}$

$C = 2\ mF$

$t =$ ~~3600~~

Digital Electronics mV

4 5

01234--9

Seven segment display

$t = 1000$ V