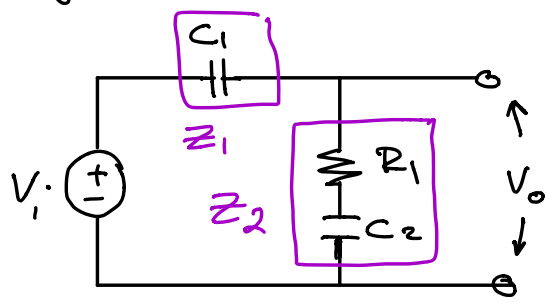
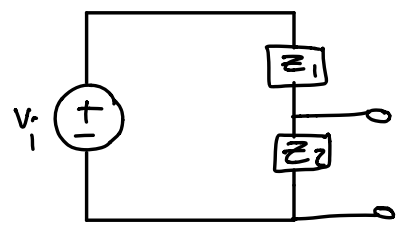
Last Class: - Phasors

- Step RC Circuits

Today: - Electrical Safety





Lab Stuff

$$Z_1 = \frac{1}{j\omega C_1} \qquad Z_2 = R_2 + \frac{1}{j\omega C_2}$$

$$H(\omega) = \frac{V_o}{V_i} = \frac{Z_2}{Z_1 + Z_2} = \frac{\left(R_2 + \frac{1}{j\omega C_2}\right)}{\underbrace{\left(R_2 + \frac{1}{j\omega C_2}\right)}_{Z_2} + \underbrace{\frac{1}{j\omega C_1}}_{Z_1}} \left(\frac{j\omega C_2}{j\omega C_2}\right)$$

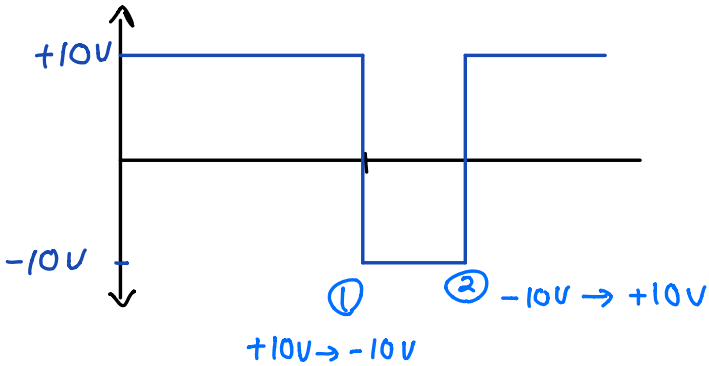
$$H(\omega) = \frac{j\omega C_2 R_2 + 1}{j\omega C_2 R_2 + 1 + \frac{C_2}{C_1}}$$

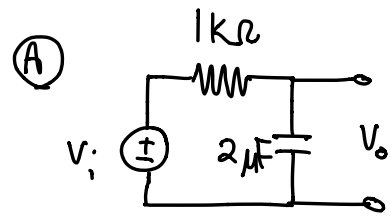
$$\lim_{\omega \to 0} \quad H(0) = \frac{1}{1 + \frac{C_2}{C_1}}$$

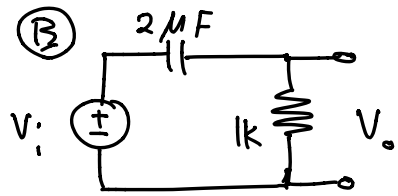
$$H(\omega) = \frac{jC_2R_2 + \cancel{\frac{1}{\omega}}^{\,0}}{jC_2R_2 + \cancel{\frac{1 + C_2/C_1}{\omega}}^{\,0}}$$

$$\lim_{\omega \to \infty} \quad H(\infty) = 1$$

Rise and Fall Times



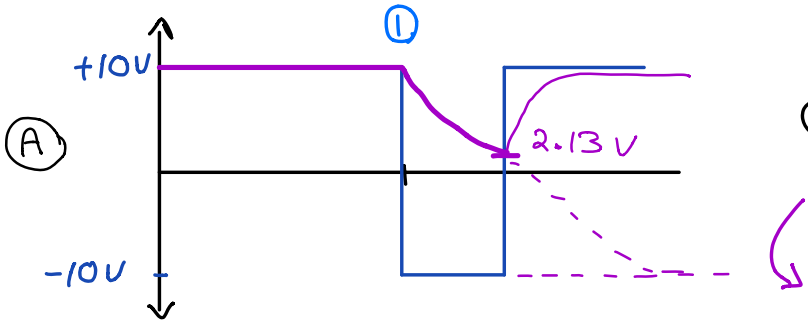


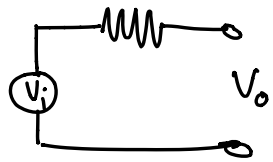


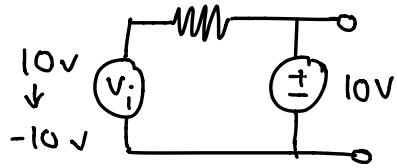
At equilibrium $C \equiv$ open ckt

At transition $C \equiv$ Battery

Transition Exp $\tau = RC = 1k\Omega\,(2\mu F)$ 2ms





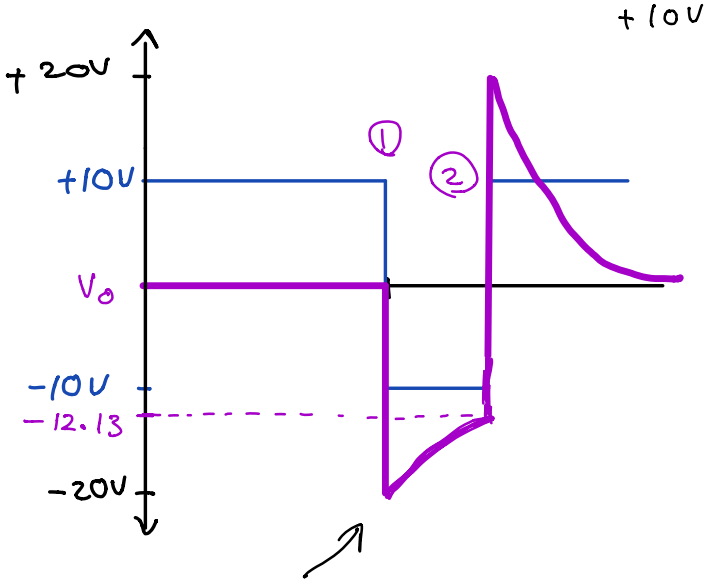


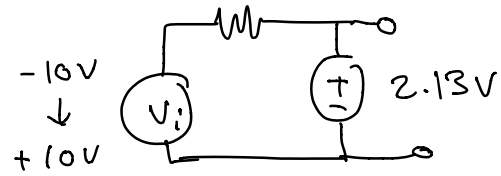
$$V_f - V_\infty = (V_i - V_\infty)\,e^{-t/\tau}$$

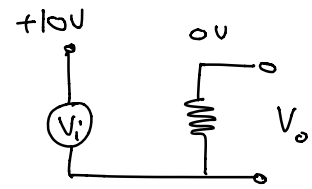
$$V_f = -10V + (10-(-10))\,e^{-1ms/2ms}$$

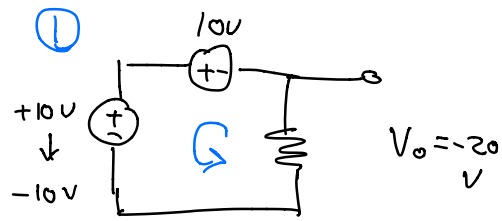
$$= -10V + 20V\,e^{-1/2} = 2.13V$$

Circuit A
- Eventually $V_o = V_i$ (after change)
- Responds slowly to changes.



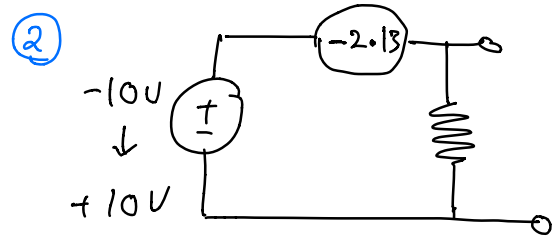






responds to change $= V_{after} - V_{before} = -10-(+10) = -20$ V

$$V_f = 0 + (-20-0)e^{-1/2} = -12.13 \text{ V}$$



Circuit B
- Eventually $V_o = 0$
- responds immediately to change

Electrical Safety

Biopotential

Notes online (just some highlights here)

Activation of a neuron

Body produces electricity via Na^+ & K^+.

Neuron only conducts in one direction & rests for a few ms.

ECG The heart is an electrical body part.

Einthovens limb leads → Not used anymore.

EMG
- Skeletal muscles (voluntary via nerves)
- Smooth muscles (slow response, involuntary)
- Cardiac muscles (fast response, low fatigue)

Anatomy of muscles

Muscle activation → motor neurons

↳ 1 motor neuron → 10s of thousands of muscle fibres.

Know:
- motor unit vs muscle fibres
- Spatial vs temporal recruitment

ECG vs EMG why graphs look diff.

ie. structured vs chaotic

↳ Heart has to work in a coordinated way

↳ All muscle fibres are aligned in the same way and do not need to work in a coordinated way.

Increasing current affects the body (look at slides)

↳ 1mA → start sensing

↳ Let go current → the threshold current where you would not be able to let go of a wire.

Q! Threshold of perception: You notice it

Diff b/w fib & full contr: why? One is taking out the rythm. The other, heart stops

Macroshock & Microshock

Optocoupler isolation → more next lecture.