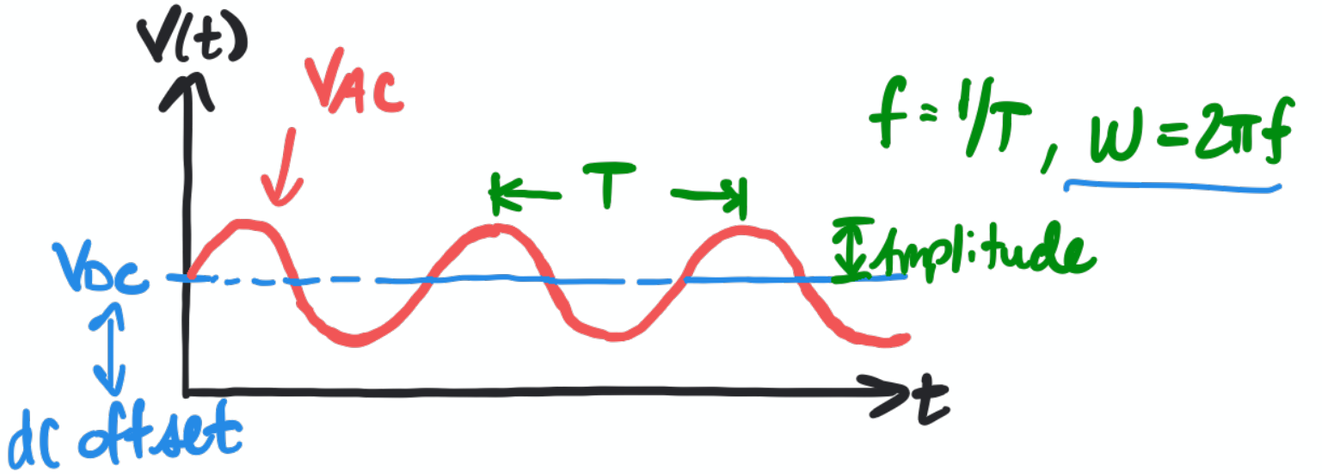
Intro to ECSE Lecture Notes 4/21

Quiz 3 Topics:

- Difference between DC and AC signals
- Signals in the time domain vs. frequency domain
- Representations of sine waves in the time and frequency domains
- Impedance of resistors, capacitors, and inductors
- Transfer functions for 1st and 2nd order filter circuits
  - → magnitude (be able to calculate), phase (be able to describe)
  - → corner frequency (1st order low-pass and high-pass filters)
  - → center frequency (2nd order band-pass & band-stop filters)
  - → Bode plots
  - → decibels
- Application of filters

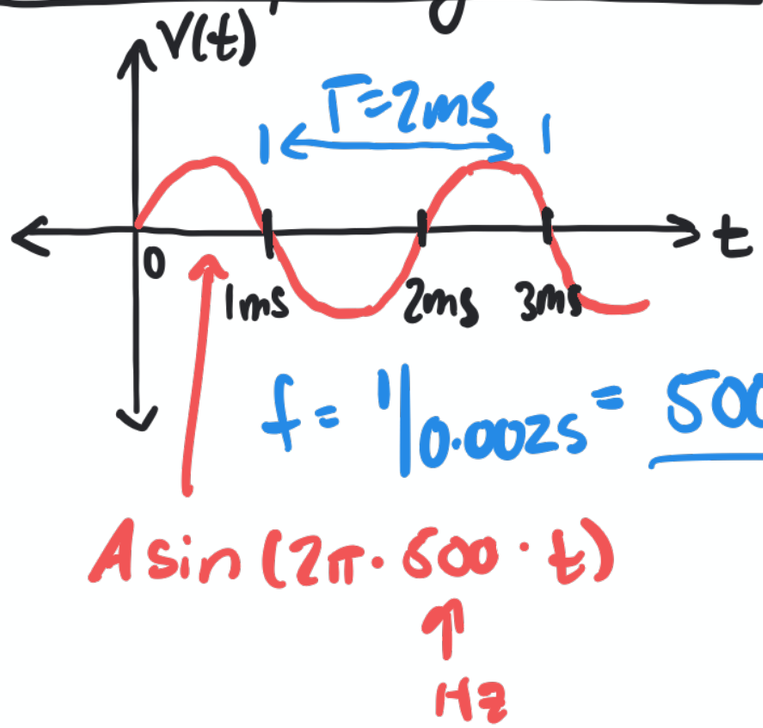
1) DC vs. AC signals :

$$V(t) = V_{DC} + V_{AC}(t)$$



$f = 1/T$, $\omega = 2\pi f$

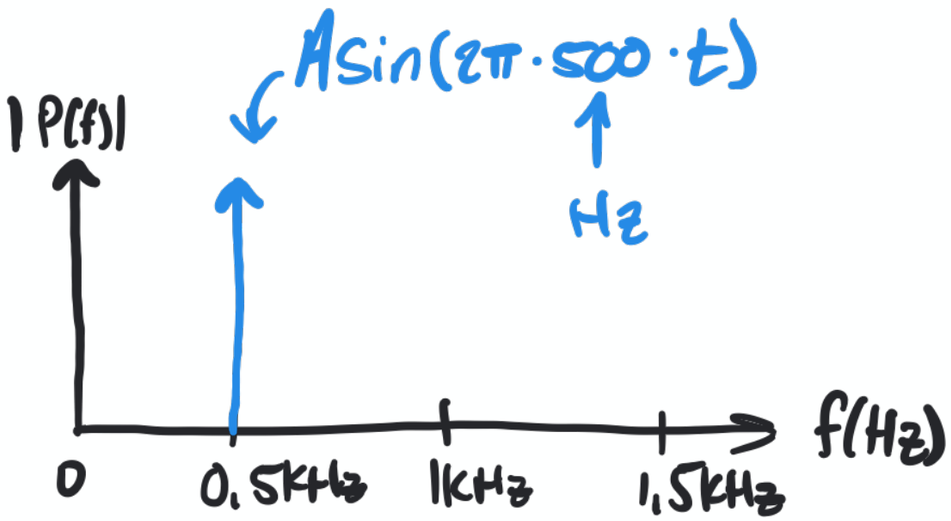
2) Time vs. Frequency Domain



$f = 1/0.002s = 500\,Hz$

$A\sin(2\pi \cdot 500 \cdot t)$

↑ Hz



- In the frequency domain $\sin(2\pi f_0 t)$ is a peak at $f = f_0$

3) Impedance of Resistors, Capacitors and Inductors

$Z_R = R$; $Z_C = 1/jwC$; $Z_L = jwL$ where $w = 2\pi f$

(s: $Z_C = 1/sC$; $Z_L = sL$)

- at low frequency ($w \to 0$): $Z_R = R$, $Z_C \to \infty$ (open circuit), $Z_L \to 0$ (short circuit)
- at high frequency ($w \to \infty$): $Z_R = R$, $Z_C \to 0$ (short circuit), $Z_L \to \infty$ (open circuit)

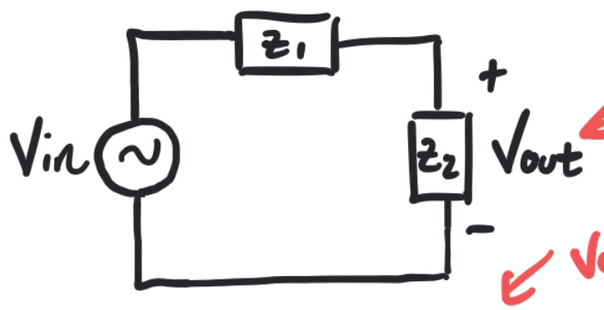
4) Transfer Functions for Filter Circuits

Given a filter circuit: 1) find V_{out} & $H(s)$ (find $|H(s)|$)

2) Evaluate for $s \to 0$; $s \to \infty$

3) Sketch Bode plot

4) find corner or center frequency



voltage

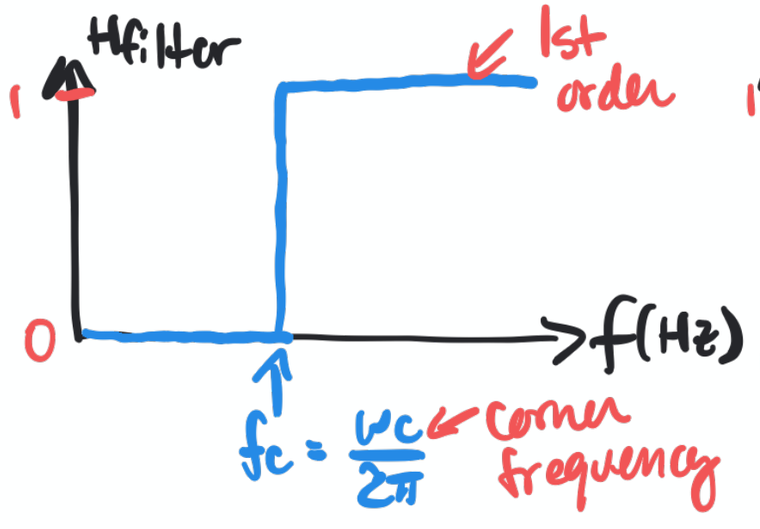
$H_{v,dB} = 20\log_{10}\left(\frac{V_{out}}{V_{in}}\right) = 20\log_{10}|H_v|$

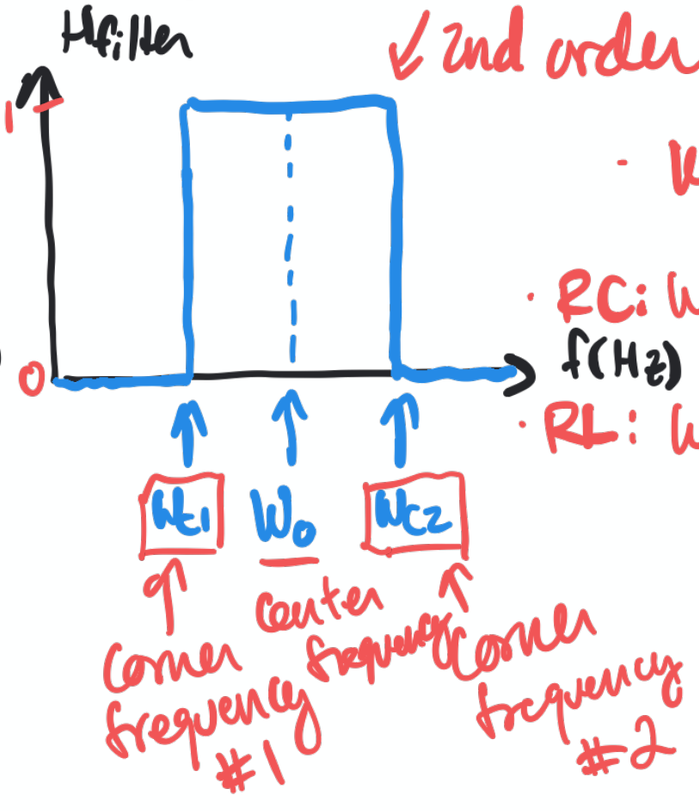
+ also be able to convert H to Decibels

$H_{p,dB} = 10\log_{10}\left(\frac{P_{out}}{P_{in}}\right)$

5) Applications of Filters

- Given a desired range of frequencies (information) and a frequency response plot, be able to identify where the desired information is and where the noise is.
- Know what kind of ideal filter (BPF, BSF, LPF, HPF) we can use to isolate the information / noise
- Be able to specify an appropriate corner frequency (1st order) or center frequency & corner frequencies (2nd order) for an ideal filter.





- $\omega_0 = \frac{1}{\sqrt{LC}}$
- RC: $\omega_c = \frac{1}{RC}$
- RL: $\omega_c = \frac{R}{L}$

$\omega = 2\pi f$

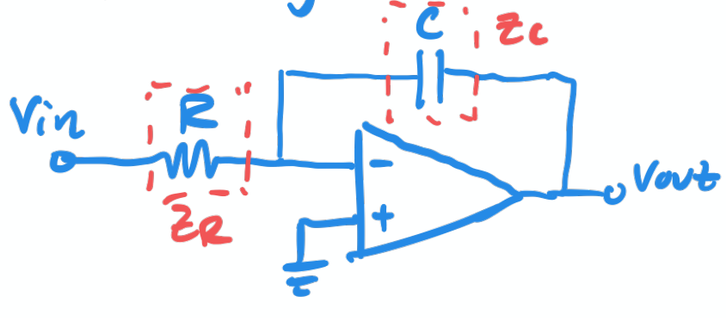
$f = \frac{\omega}{2\pi}$

Notes on the Final Exam: Wednesday 5/3, 3pm - 6pm Academy Auditorium

- Cumulative: will test material covered by lab01 - lab03
- May mix concepts from multiple parts of the course, for example:

Find the transfer function of the following circuit:

inv. amp: $H = -\frac{R_f}{R_i}$



$$H(s) = -\frac{Z_C}{Z_R} = -\frac{1}{j\omega RC}$$

$$V_{out} = -\frac{1}{RC}\int V_{in}(t)\,dt$$

- Open notes: cannot be electronic or include quiz solutions
- Non-communicating calculator allowed
- Requirements for opting out of final:
  - 2/3 omega labs completed
  - 80%+ on those two omega labs
  - ~88/88 on proof of skills

→ I will let you know after Quiz 3 if you are able to opt out (if you completed 2/3 omega labs)

→ If you may opt out, but still want to take the final, it cannot lower your grade, only help!