

# Design Studio – Week 3

## Today you will:

- Begin applying teamwork to engineering design
- Understand the role of communication in the design process
- Learn the requirements and constraints for Project 1
- Use phasors and impedance to calculate RC circuit performance
- Design and model your own RC circuit

## Assignments:

- Exercise worksheet for RC circuit design and analysis
- Technical memo on RC circuit findings

# Managing the Design Process



# Why Work in Teams?

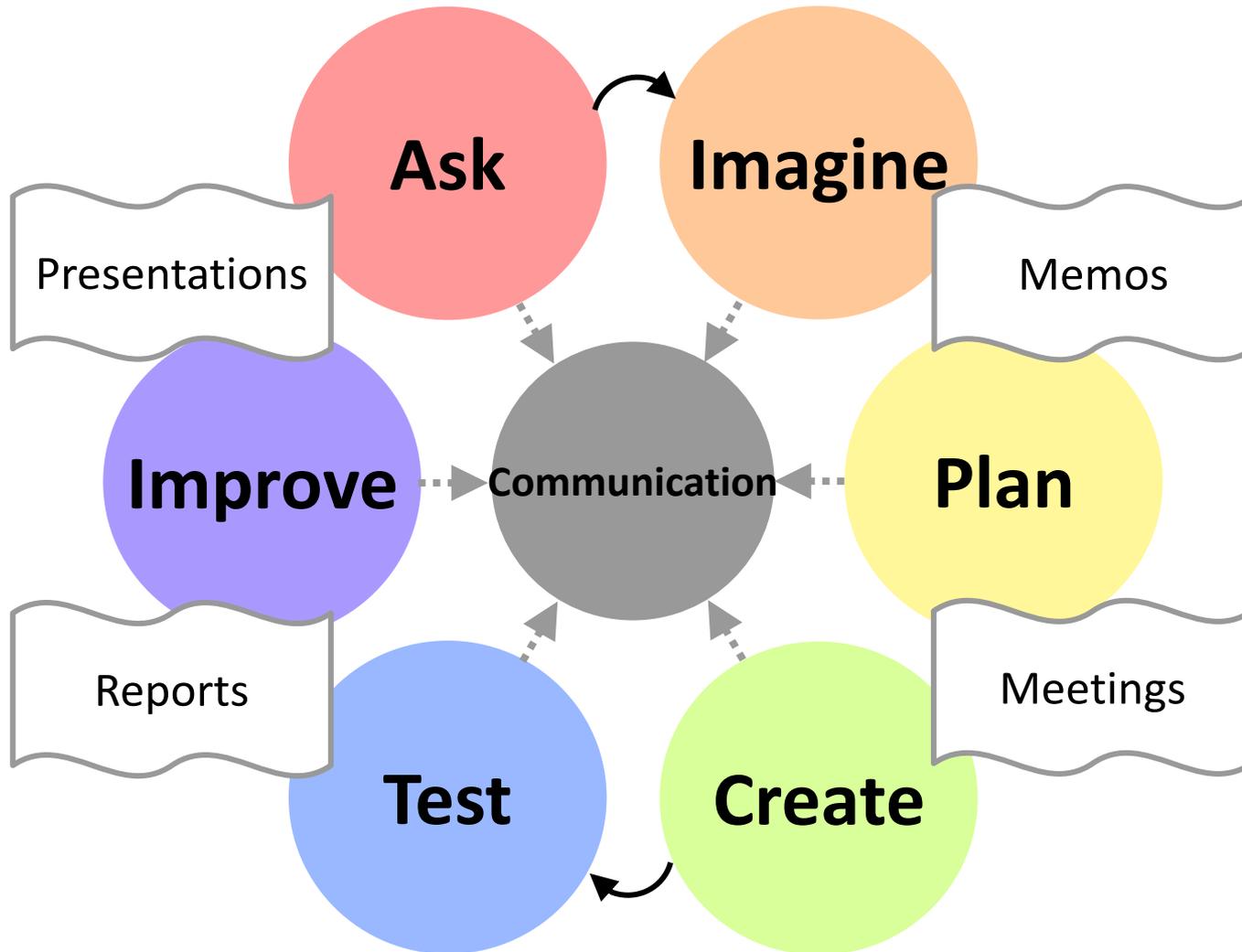
A team is a specific type of group whose members strive to meet common goals, share responsibility, and devise methods and structures to achieve their goals.

- Common goals include the project goals, but also personal goals (such as learning).
- Shared responsibility equates to fair workloads, mutual accountability, and respect for each other as colleagues.
- The methods and structures to achieve your goals will be learned in this course, and include the engineering design process and concepts around effective teams.

Effective teams make the work easier, not harder.

**Now it's time to create teams for Project 1.**

# Discussing and Sharing the Results



# Technical Writing

Most of your project work in Studio will require technical writing. Many weekly exercises include short technical memos and every project concludes with a technical report.

The formatting guidelines for technical writing are provided on the Studio website (and should be similar to those in ENGR 127).

While the guidelines describe the format, we will also emphasize content and purpose in technical writing:

- Technical writing should tell a story (the narrative) with the text.
- Figures, tables, and equations help to tell the story and need to be woven into the narrative.
- The protagonist of the story is the design (not the design team).

# Project 1

Ask

Let's hear from our customer:

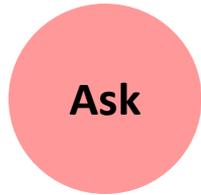


I need a filter circuit.

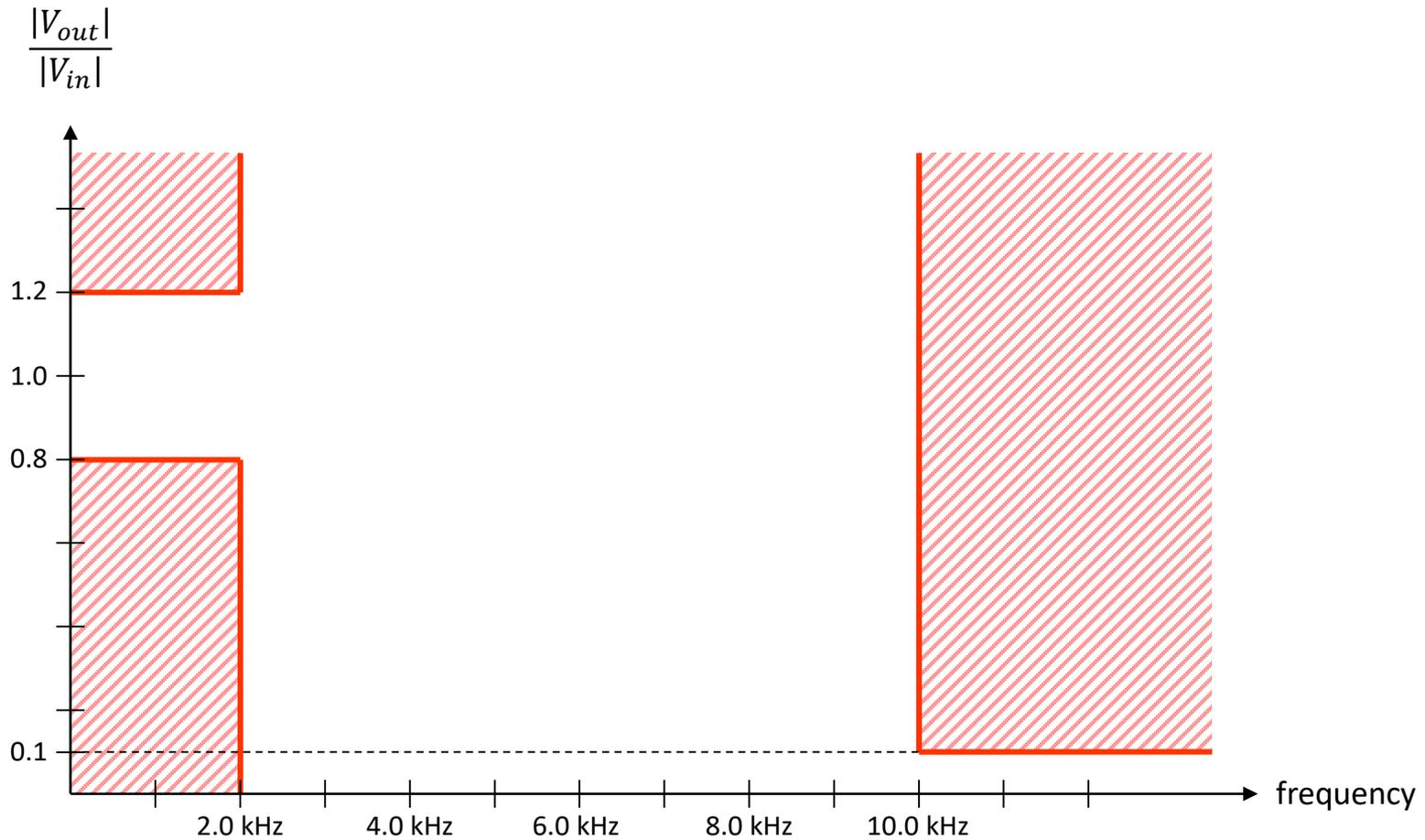
A filter is a circuit that has an output voltage that is based on the frequency of the input. The output should also have the same frequency as the input.

So what is the desired relationship between the output and input?

# Project 1 Requirements



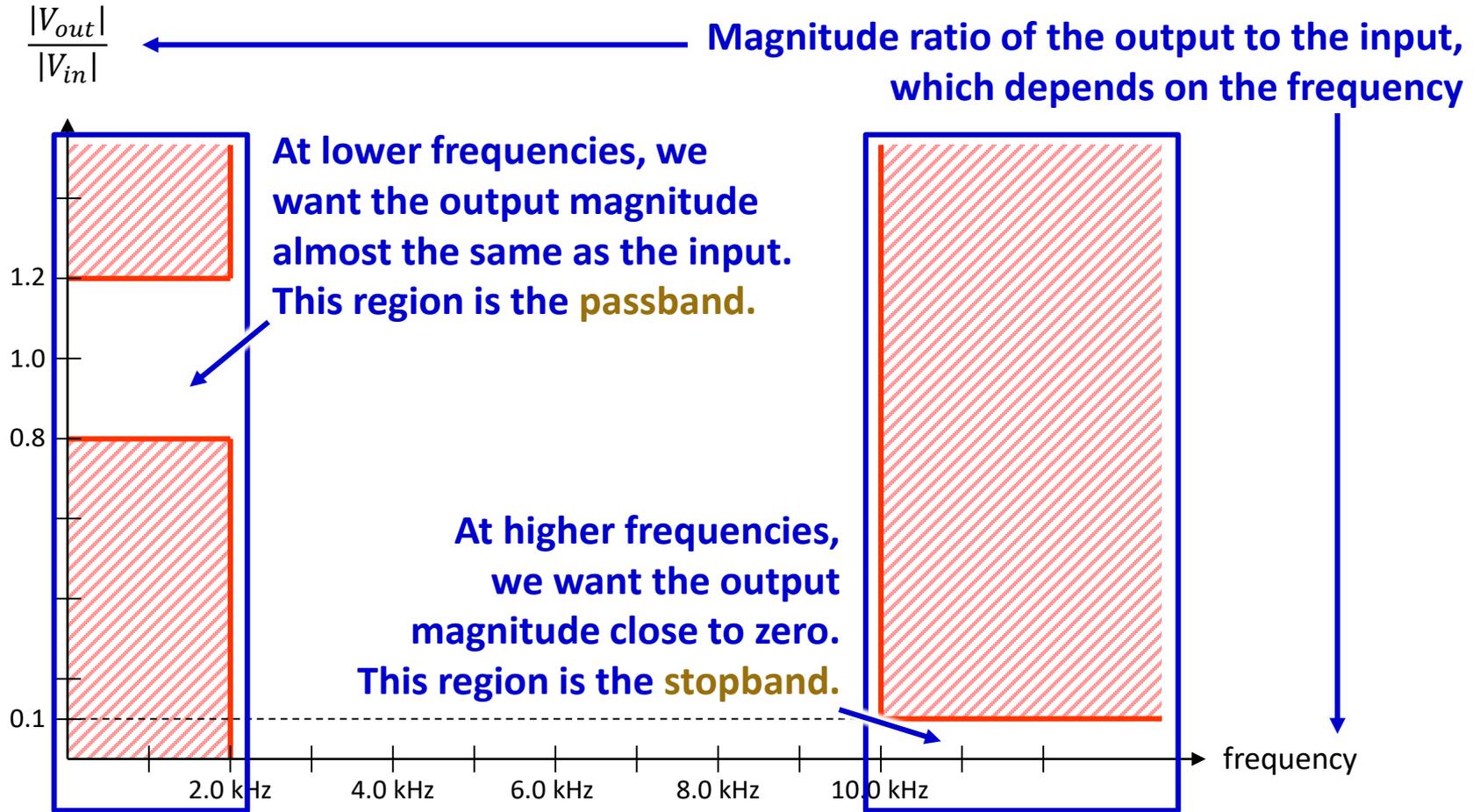
The filter requirements:



# Project 1 Requirements



The filter requirements:



# Project 1 Constraints

Ask

Sometimes we have requirements that don't come from our customer but still impact how we design.

These are commonly called **constraints**.

Common constraints include:

- Budget limits
- Legal and ethical regulations

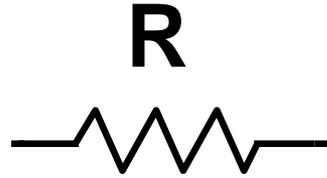
Constraints aren't always negative. There can be value in constraining a design to use a piece of technology or expertise you already have available.

We have one constraint for Project 1:

*Use the resistors, capacitors, and inductors available in ET 311.*

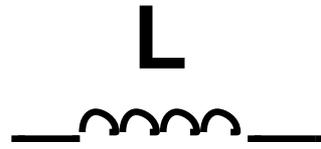
*(A list of parts available is linked on Week 3 of the Studio website)*

# Concept Review – Impedance



$$Z_R = R$$

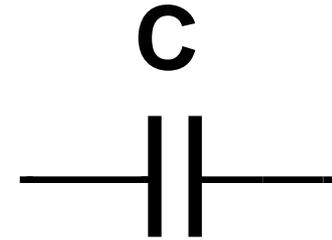
impedance is not  
affected by  
frequency



$$Z_L = j\omega L$$

low impedance at  
low frequencies

high impedance at  
high frequencies



$$Z_C = 1/j\omega C$$

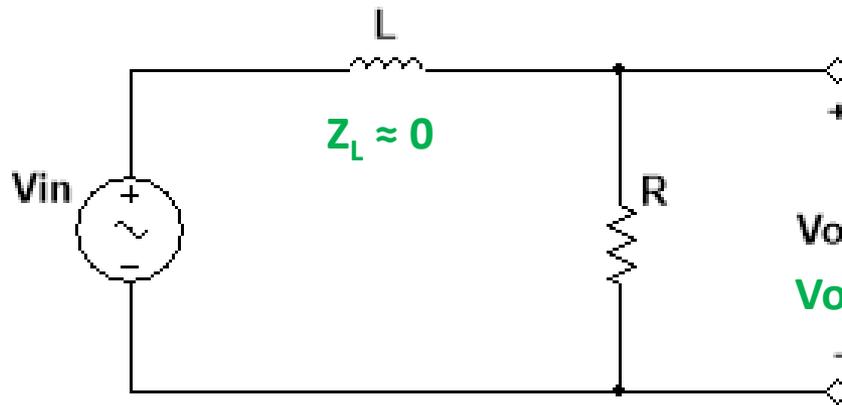
high impedance at  
low frequencies

low impedance at  
high frequencies

**What happens when you start putting resistors, inductors, and capacitors together?**

# Project 1 Design Ideas

Imagine



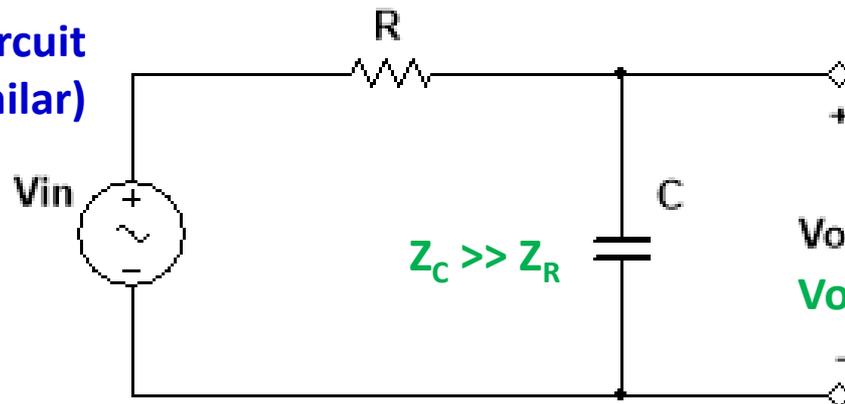
A basic RL circuit  
(covered in lecture)

$$V_{out} = VR$$
$$V_{out} \approx V_{in}$$

At low frequencies...  
(i.e.  $f \approx 0$ )

A basic RC circuit  
(very similar)

At low frequencies...  
(i.e.  $f \approx 0$ )

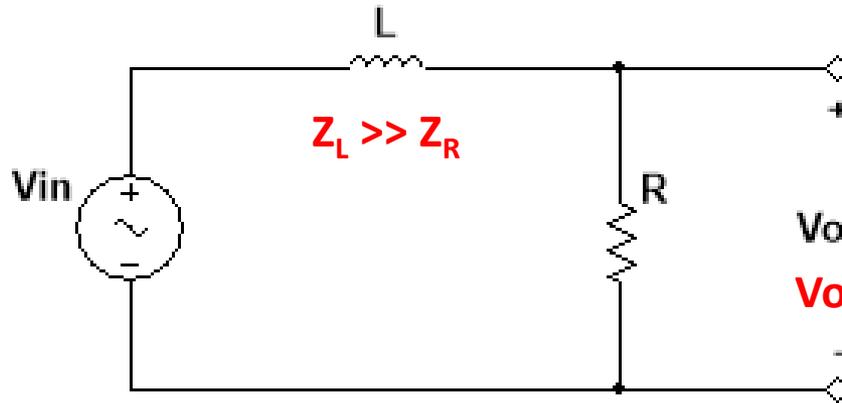


$$Z_C \gg Z_R$$

$$V_{out} = VC$$
$$V_{out} \approx V_{in}$$

# Project 1 Design Ideas

Imagine



$$Z_L \gg Z_R$$

A basic RL circuit  
(covered in lecture)

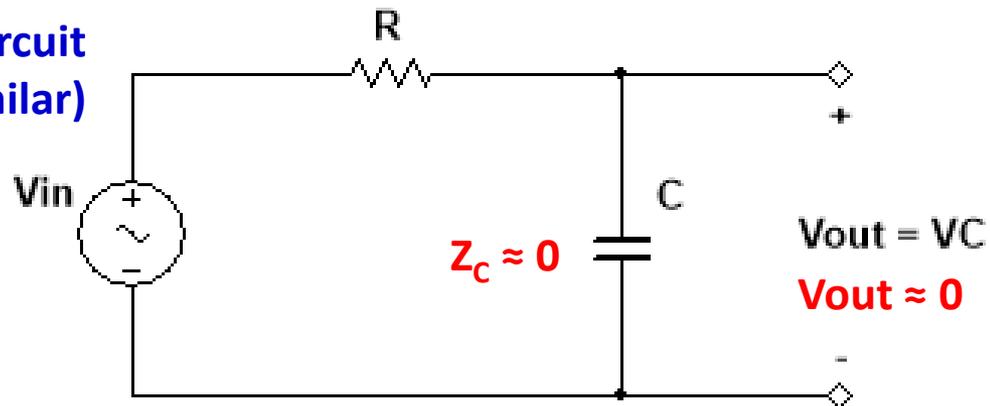
$$V_{out} = VR$$

$$V_{out} \approx 0$$

At high frequencies...  
(i.e.  $f \rightarrow \infty$ )

A basic RC circuit  
(very similar)

At high frequencies...  
(i.e.  $f \rightarrow \infty$ )



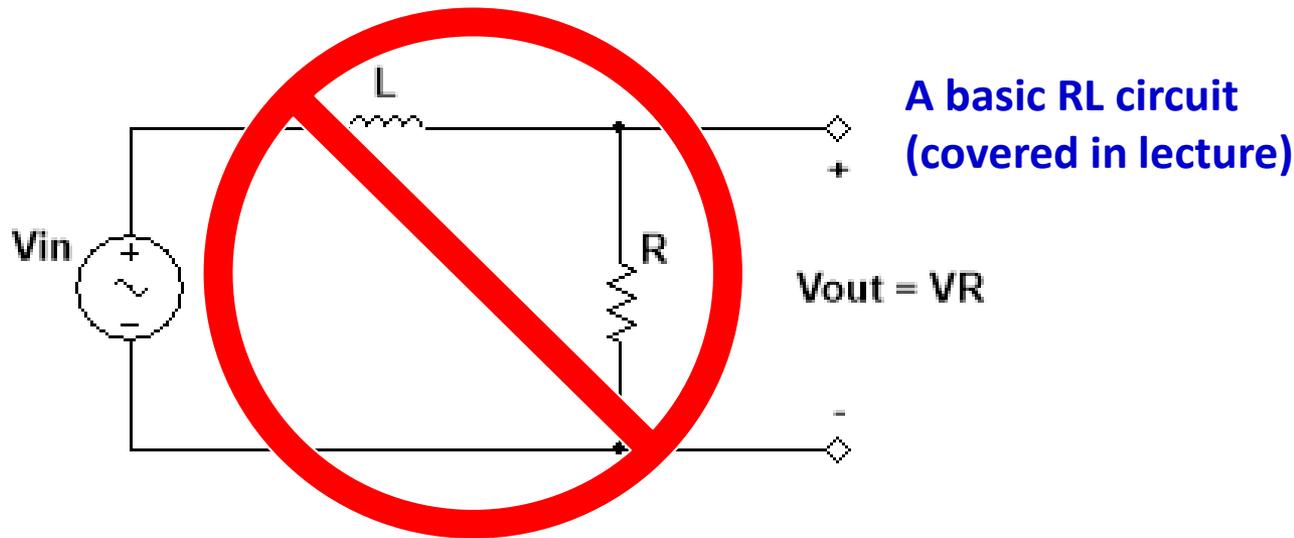
$$Z_C \approx 0$$

$$V_{out} = VC$$

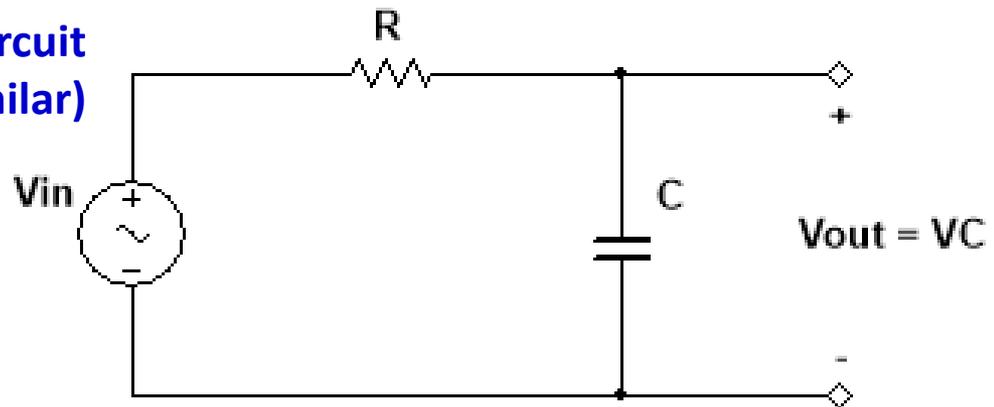
$$V_{out} \approx 0$$

# Project 1 Design Ideas

Plan



A basic RC circuit  
(very similar)



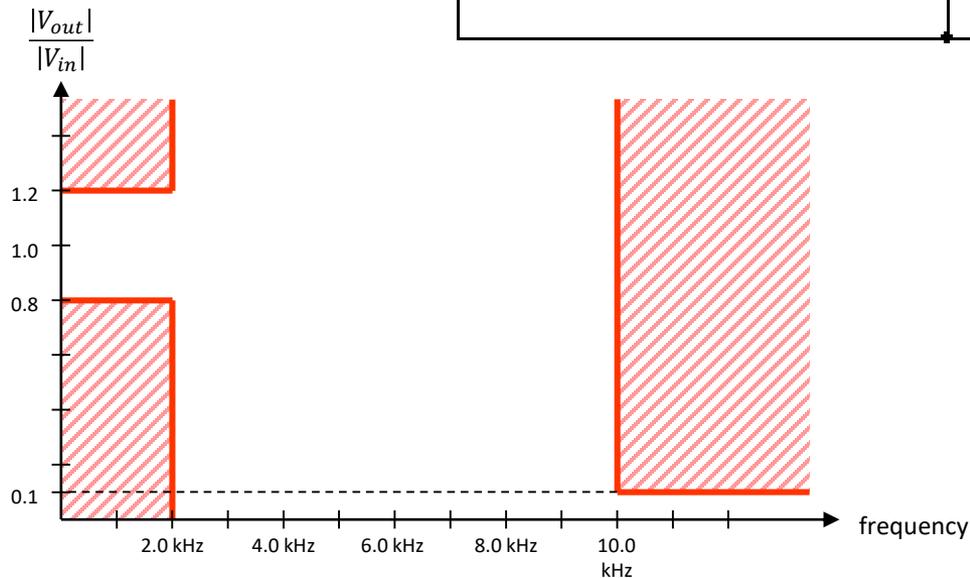
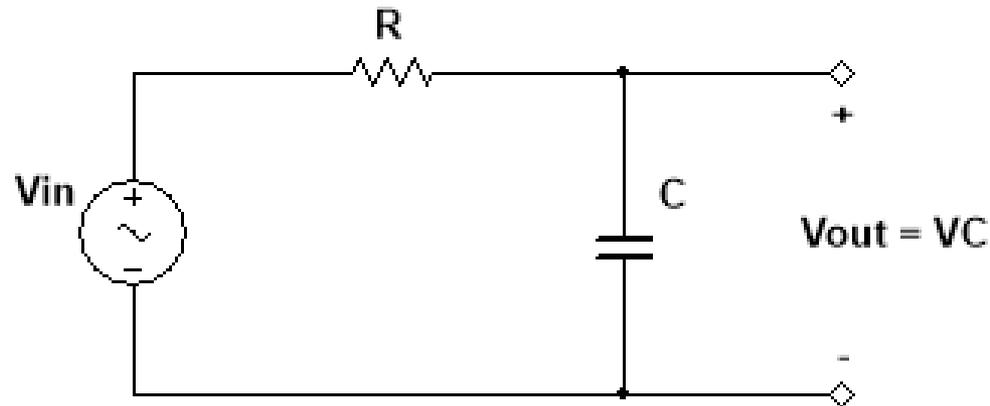
Because inductors are not very common, let's use the RC circuit.

# Project 1 Design Plan

Plan

What values of R and C should you use?

That's up to your team to decide from the given requirements!

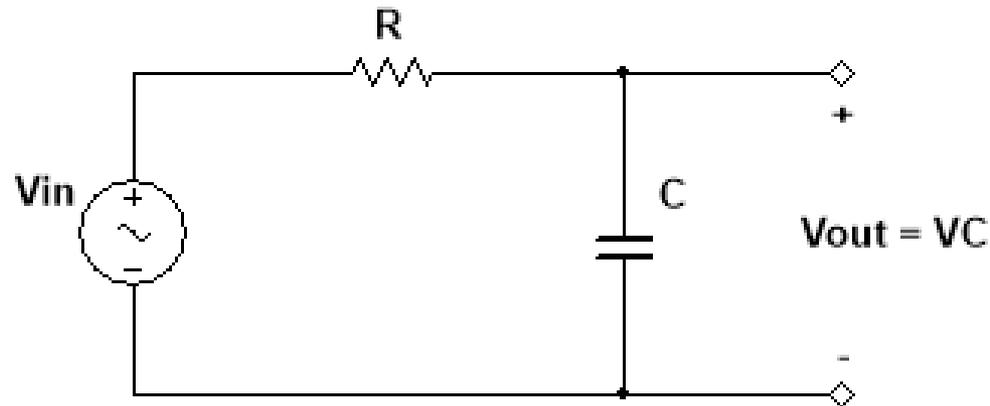


*Use parts from the available parts list*

# Project 1 Modeling and Test

Create

Follow along with the worksheet to build a working version of your circuit design in Multisim with your team.



**Your instructor is here to help answer guiding questions and troubleshoot any problems that your team identifies.**