Welcome to ECE 65

Components & Circuits Lab

Winter 2025

Professor:

Saharnaz Baghdadchi

You can call me **Sahar**

I am a Teaching professor in the ECE department.

I graduated from UCSD with a Ph.D. in Photonics in 2017.

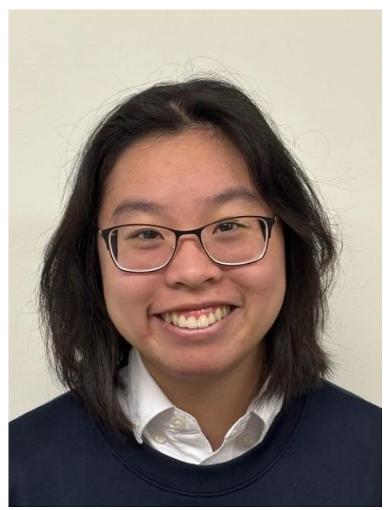
ECE 65 Team

Yong Zhang

David Saltzman

Vera Truong

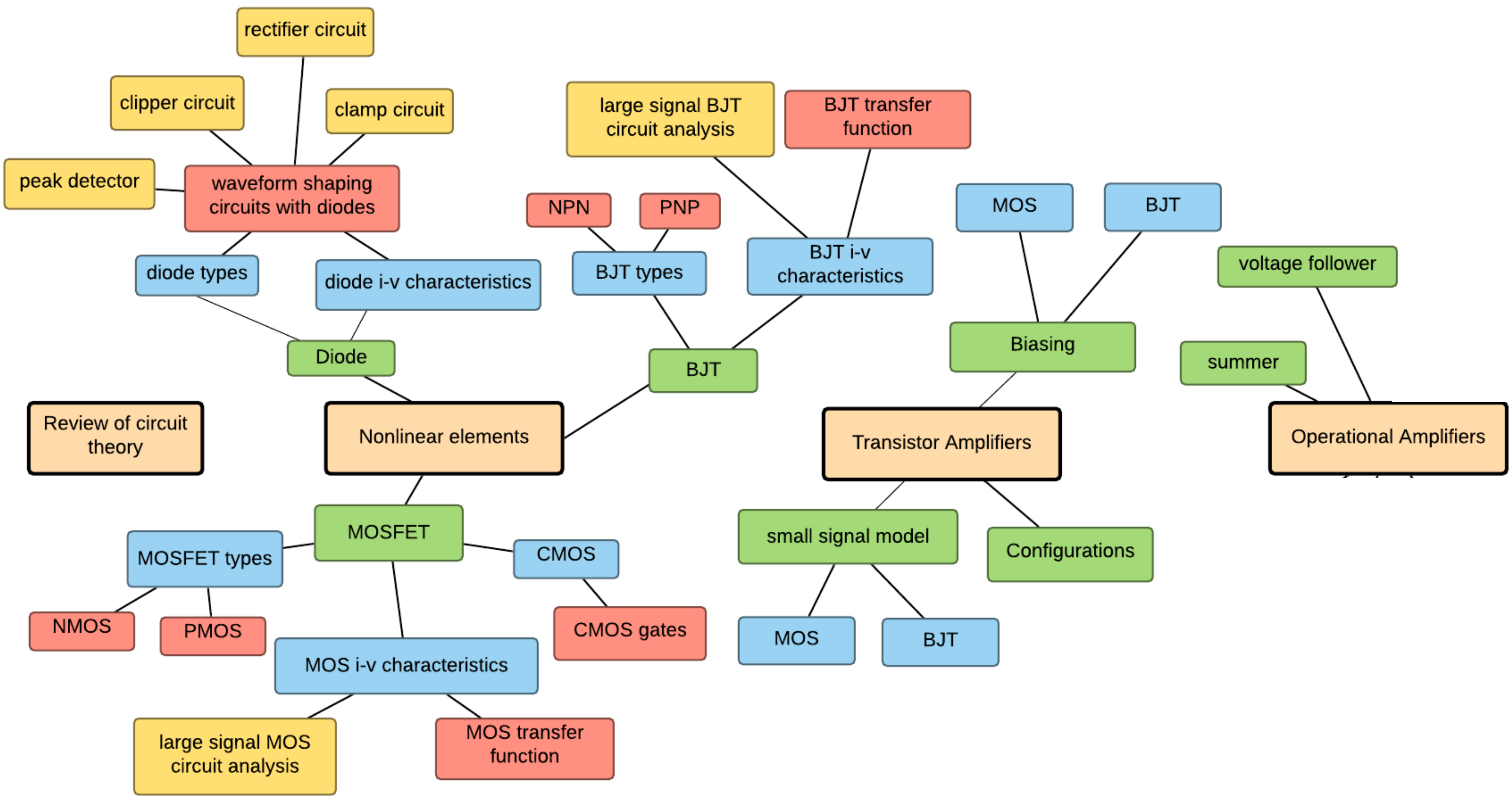
Hanson Liu

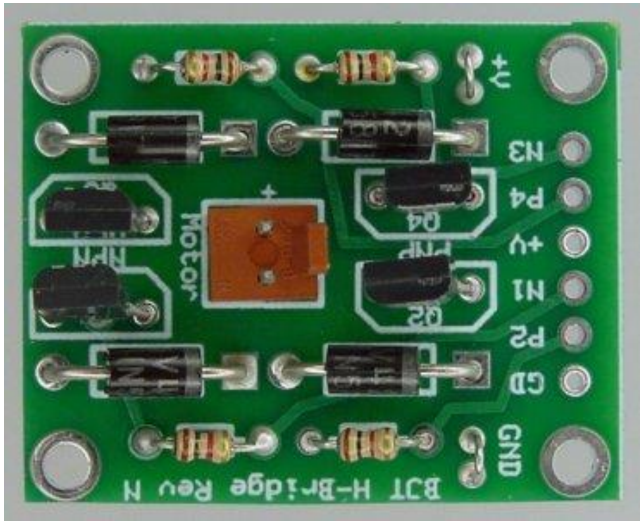


Tiffany Chen

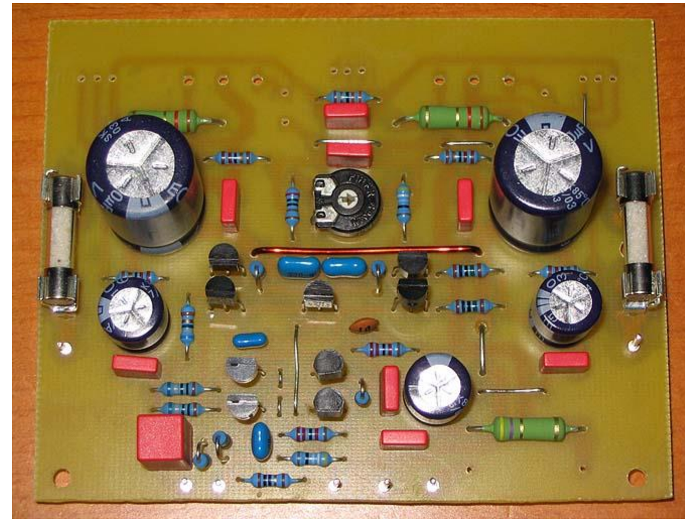
Yu-Han Lou

ECE 65 course map

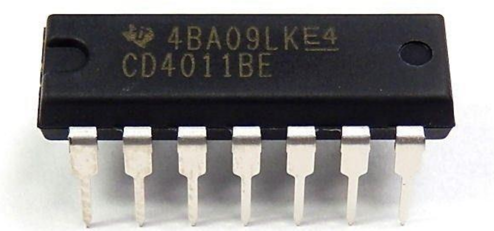




H-bridge motor driver circuit
by robot room



Audio amplifier circuit
By audio kit



CMOS NAND gate
By Texas Instruments

CMOS amplifier
By Texas Instruments

MOS technology 6502 microprocessor

Learning Outcomes

Upon successful completion of this course, you will be able to:

- **Analyze** op-amp circuits
- **Find** the transfer function of diode circuits
- **Design** waveform shaping circuits using diodes
- **Analyze** the area of operation of a MOSFET
- **Analyze** the area of operation of a BJT
- **Identify** the possible biasing circuits for a MOSFET and BJT and **design** bias circuits.
- **Calculate** the small signal voltage gain, input impedance and output impedance of BJT/MOSFET amplifiers
- **Use** Pspice or LTspice to simulate the behavior of the circuits

About this course

Reference notes

Prof. Najmabadi's notes posted on the website.

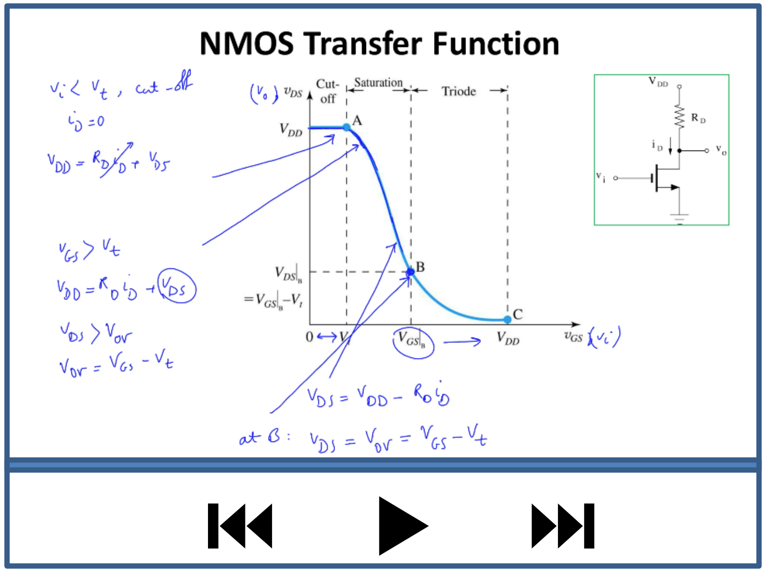
Textbook (optional)

Microelectronic circuits by Sedra and Smith

About this course

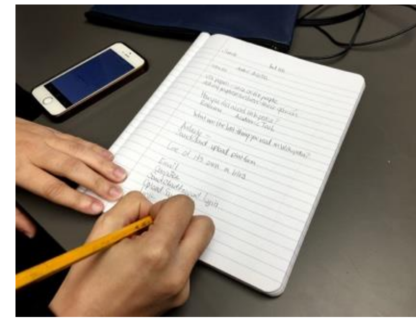
This course is designed based on the flipped-classroom method.

I have recorded a screencast for each lecture, and you are asked to watch them before coming to each class.



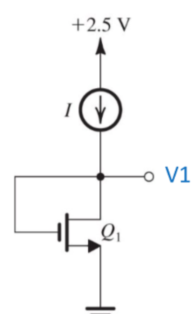
About this course

You will have a guided Reading quiz for each lecture that you need to take after watching the lecture video and before attending the class.



Clicker question 1

In the below MOSFET circuit, find the node voltage V1. How large a resistor can be inserted in series with the drain while maintaining saturation? $V_t = 0.5\ V$, $I = 0.1\ mA$, $V_{GS} = 1\ V$



A. $R_{max} = 5\ k\Omega$

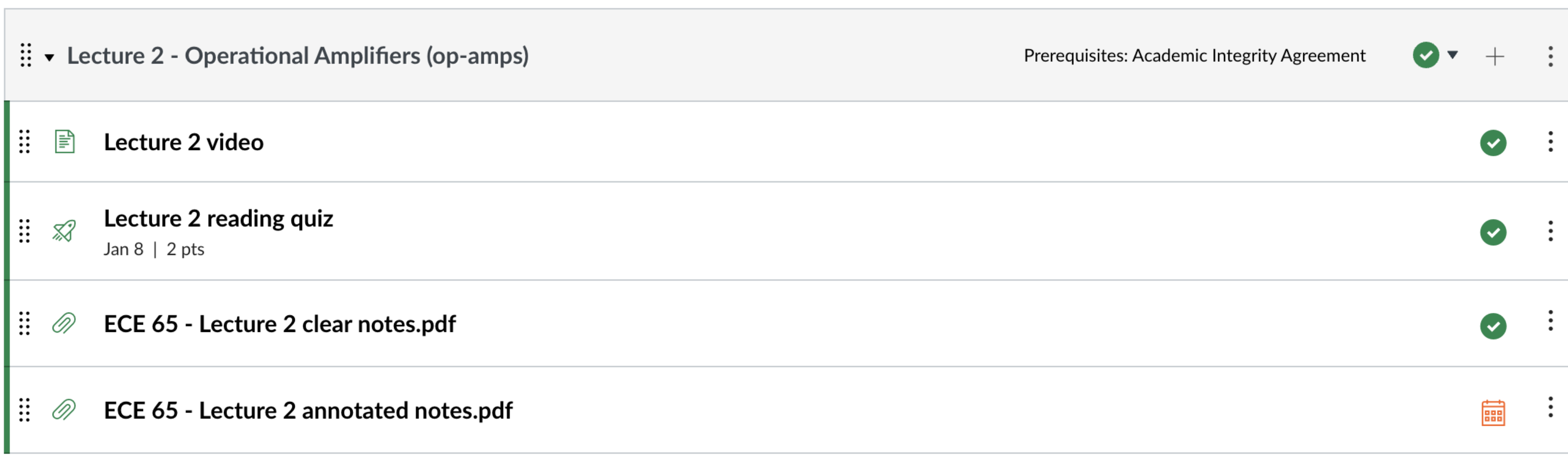
B. $R_{max} = 1\ k\Omega$

C. $R_{max} = 0.6\ k\Omega$

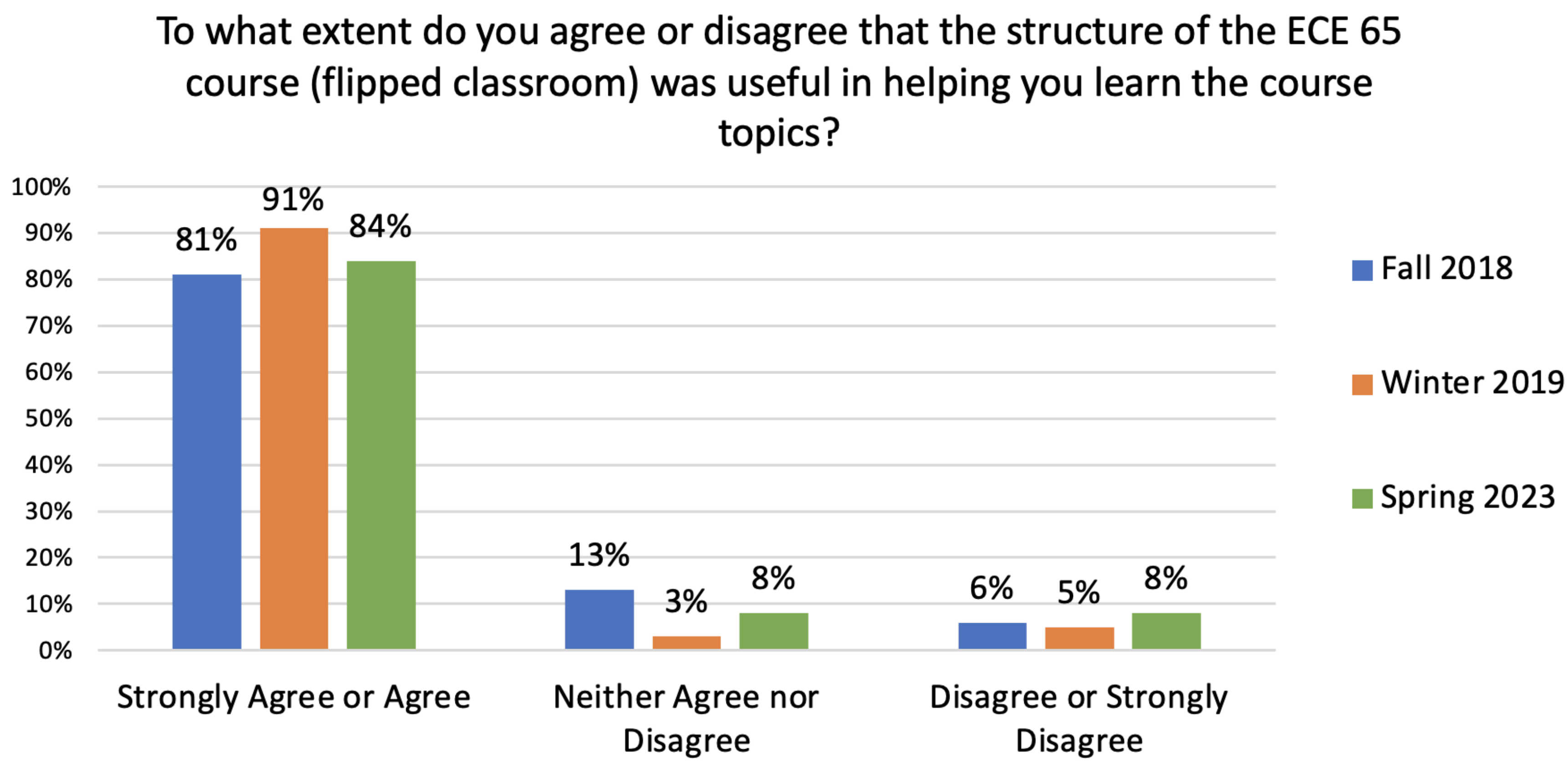
You will have many opportunities for discussions in each class through carefully designed questions.

About this course

Please download the “Clear lecture note” pdf files from the website before attending the lectures. This way, you can spend more time solving the problems in class.

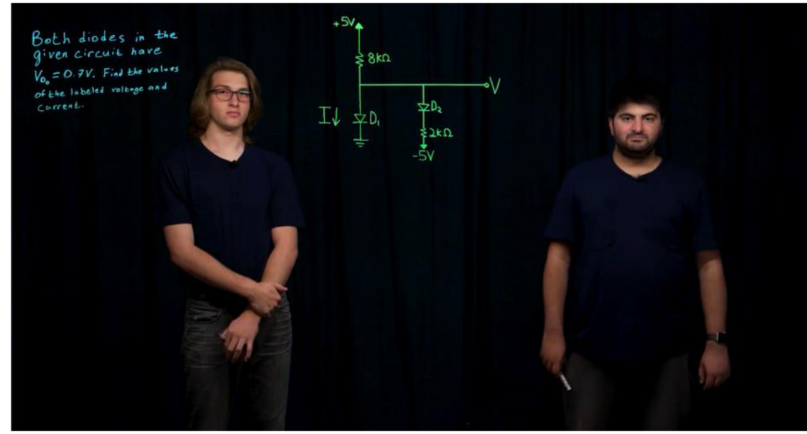


ECE 65 Course Structure Survey Results F18, W19, and SP23



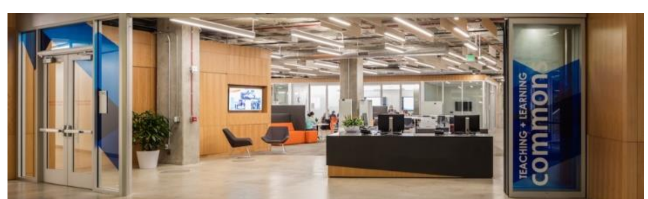
About this course

We have prepared a series of Problem-Solving videos that will be assigned every week.



The videos will replace one of the discussion sessions. The TA, David, will hold a discussion class on Fridays from 9:00 am to 9:50 am in CENTER, Room 214.

The course is supported by the Teaching and Learning Commons at UCSD.



About this course

The course has weekly labs. The labs include circuit analysis, simulation, and hands-on experiments.

You can download PSpice on your Windows-based computers. You can also use LTspice for simulations.

The labs are to be completed in groups of two.

About this course

Before coming to the lab

Prepare a prelab document and submit to **Gradescope**.

The prelab document should include circuit analysis and simulations.

In the lab

Build the circuits and make measurements.

Ask the TAs for help if you have any questions about the results

After the lab

Complete your lab report and submit it to the **Gradescope**.

About this course

ECE65_WI25_A00

ECE 65 - Components & Circuits Lab - Baghdadchi

11 assignments

We will use Gradescope for submitting lab reports and exams.

About this course

The course website is on Canvas.

Please use the Course Finder page (coursefinder.ucsd.edu) to get access to the website.

You can find the links to the necessary files/folders on the Home page.

About this course

We will be using iClickers for voting in class. Please buy, rent, or borrow an iClicker. You can also use iClicker app on your phone. Using the app requires subscription.

About this course

Create an account at iClickers.com using your UCSD email.

Register your remote in the app and add the ECE 65 course in the app.

About this course

Grade Breakdown:

5%, Max [Reading quizzes, Final exam]

5%, Max [Class participation, Final exam]

25%, lab reports

15%, Max [Midterm exam1 , Garde on Op-amp/Diode problem(s) on the final exam]

15%, Max [Midterm exam2 , Garde on BJT/MOSFET problem(s) on the final exam]

35%, Final exam

1%, Extra credit for completing the surveys

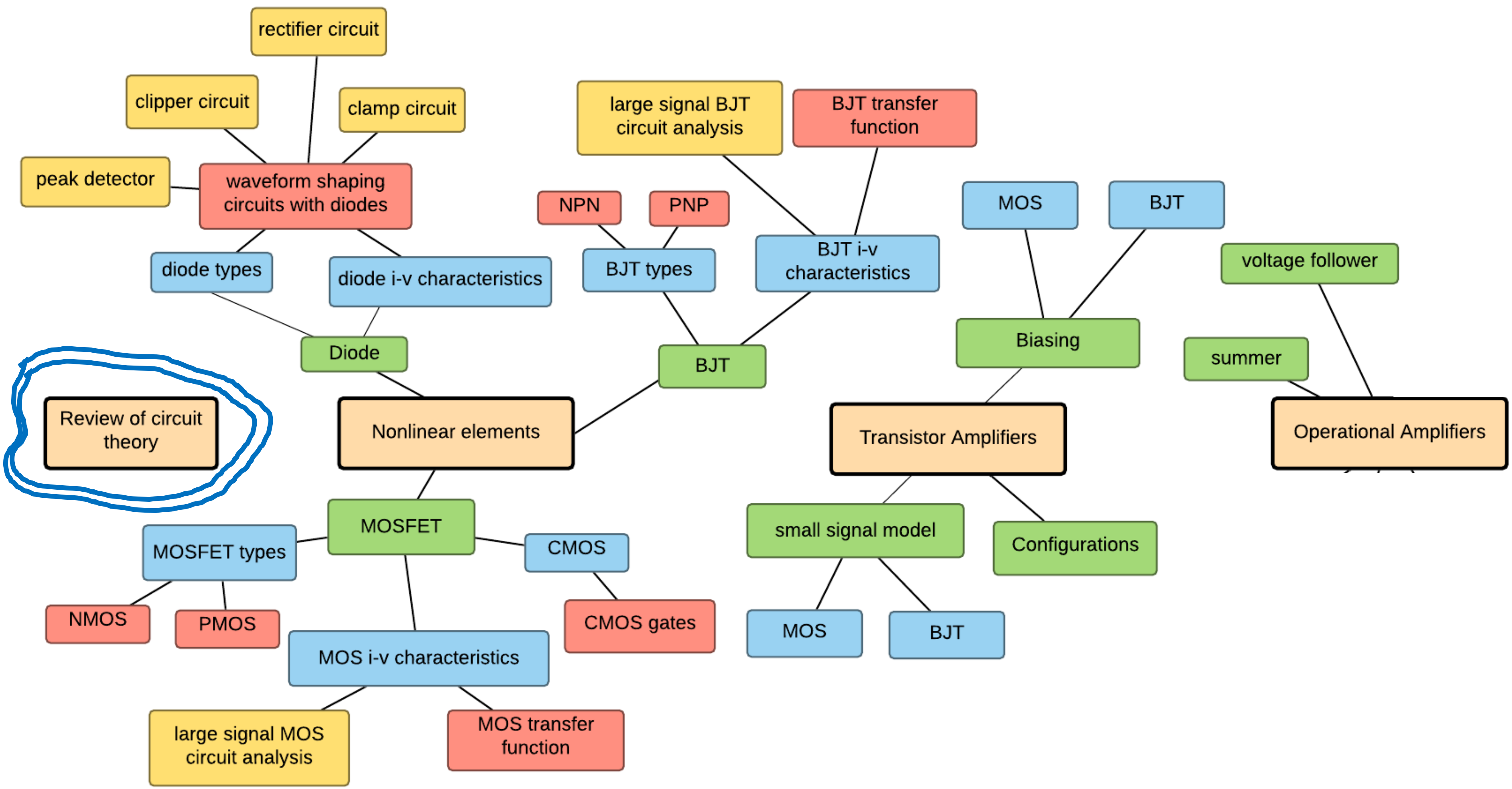
About this course

In collaboration with several other faculty, I am conducting a research study to find out more about how pedagogical choices affect student learning and experience in the classroom.

The purpose of this study is to create knowledge that has the potential to improve the learning and educational experience of students at UC San Diego and beyond.

Course map

1. Review of Circuit theory



1. Review of Circuit theory from ECE 35

Each element can be represented by its i-v characteristics.

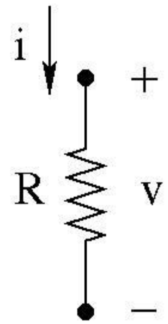
If all elements in a circuit are linear, the circuit would be linear (the i-v characteristic of every element is linear).

Review of Circuit theory

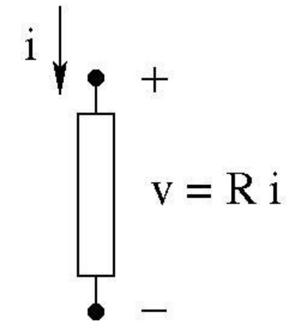
"two-terminal" linear elements	"four-terminal" linear elements
Resistor: $v = Ri$ Capacitor: $i = C\frac{dv}{dt}$ Inductor: $v = L\frac{di}{dt}$ Independent VS: $v = v_s = const.$ Independent CS: $i = i_s = const.$	voltage-controlled voltage source current-controlled voltage source voltage-controlled current source current-controlled current source

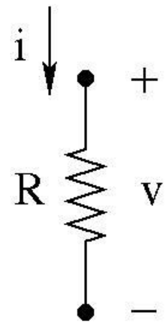
Linear circuits have many desirable properties (e.g., proportionality and superposition) which are essential for many functional circuits.

“Ideal” circuit theory elements are NOT representatives of physical devices!



Is a symbol for

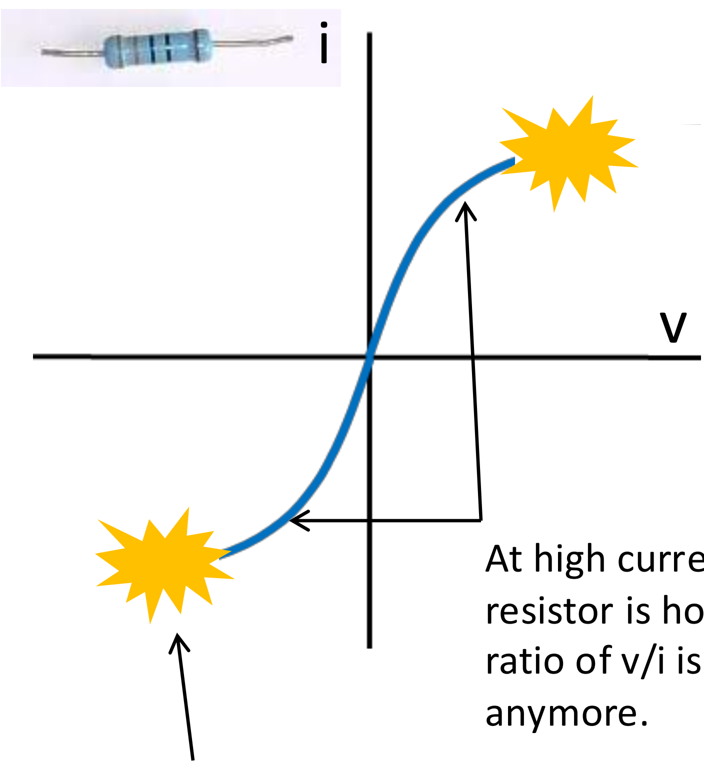




Is **NOT** representative of this

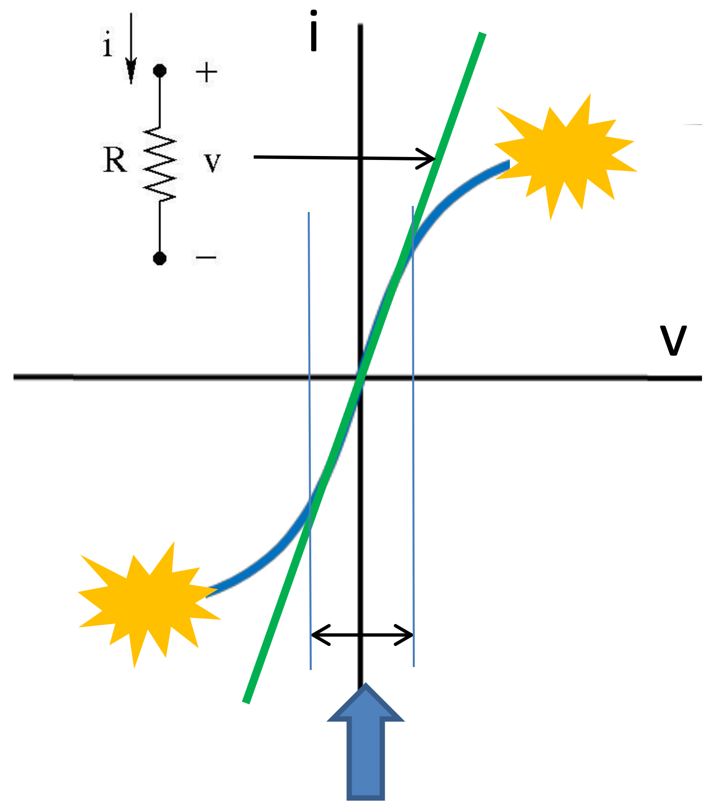
Practical elements are only approximated by "ideal" circuit theory elements

Real resistor



At high currents, when the resistor is hot enough, the ratio of v/i is not constant anymore.

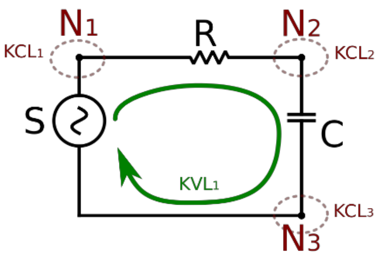
At high enough current, the resistor "burns".



A Lab resistor can be approximated as an ideal circuit theory resistor for a range of current or voltage (identified by its rated maximum power)

Two general rules govern what happens when the circuit elements are connected to each other:

Kirchhoff current law, KCL, which is conservation of electric charge and **Kirchhoff voltage law**, KVL, which is a topology-driven constraint.

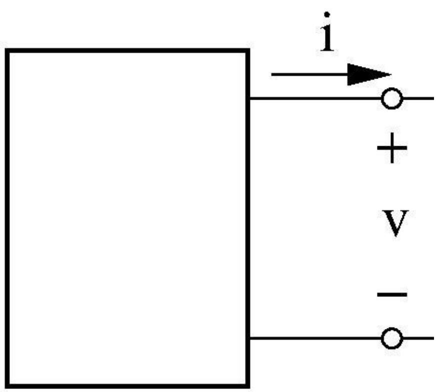


These two rules are independent of internal physics of elements and can be applied to non-linear elements.

“node-voltage” and “mesh-current” methods equally apply to circuits with non-linear elements.

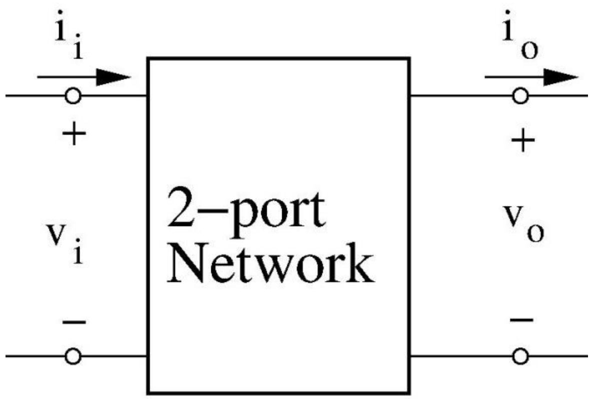
We will analyze many <u>functional circuits</u>

Two-terminal Networks



Function is defined by the iv equation

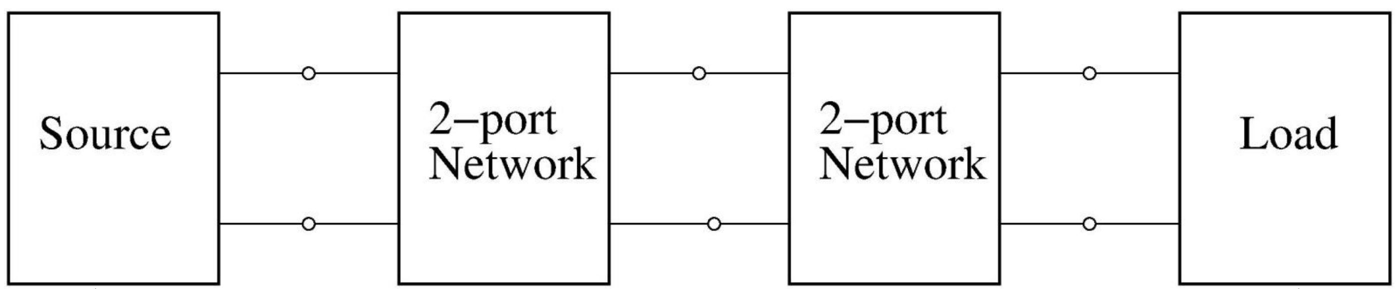
Two-port Networks



Function is defined by the transfer function (e.g., v_o in terms of v_i)

A typical analog circuit contains a load and a source (two-terminal networks) and several two-port networks

We divide the circuit into building blocks to simplify analysis and design



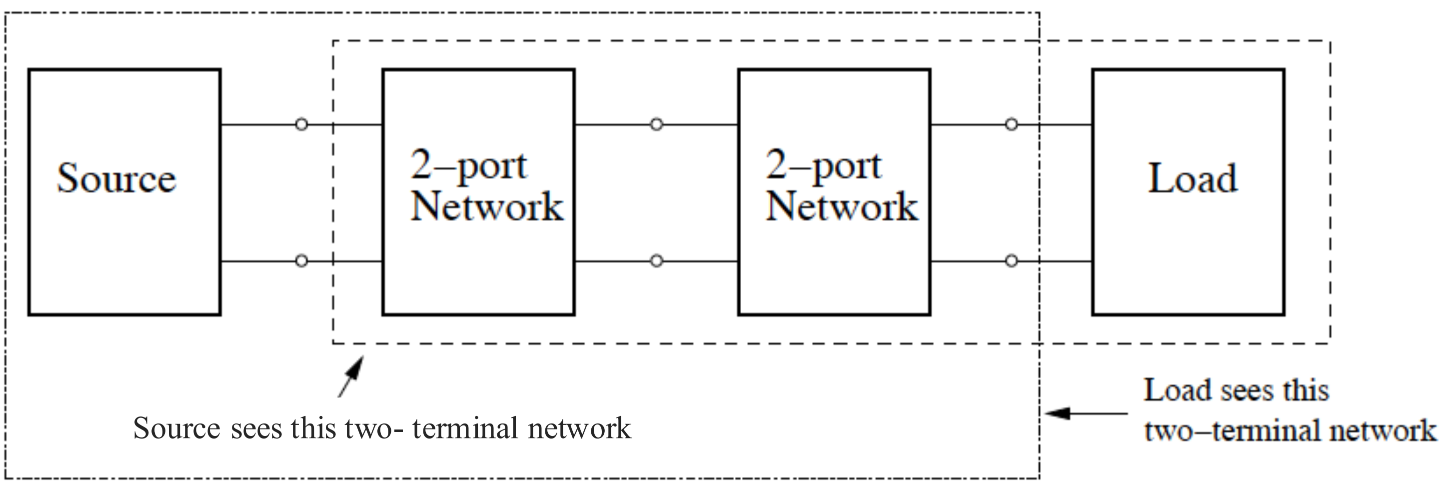
Two-terminal network containing an independent source

Two-terminal network containing NO independent source

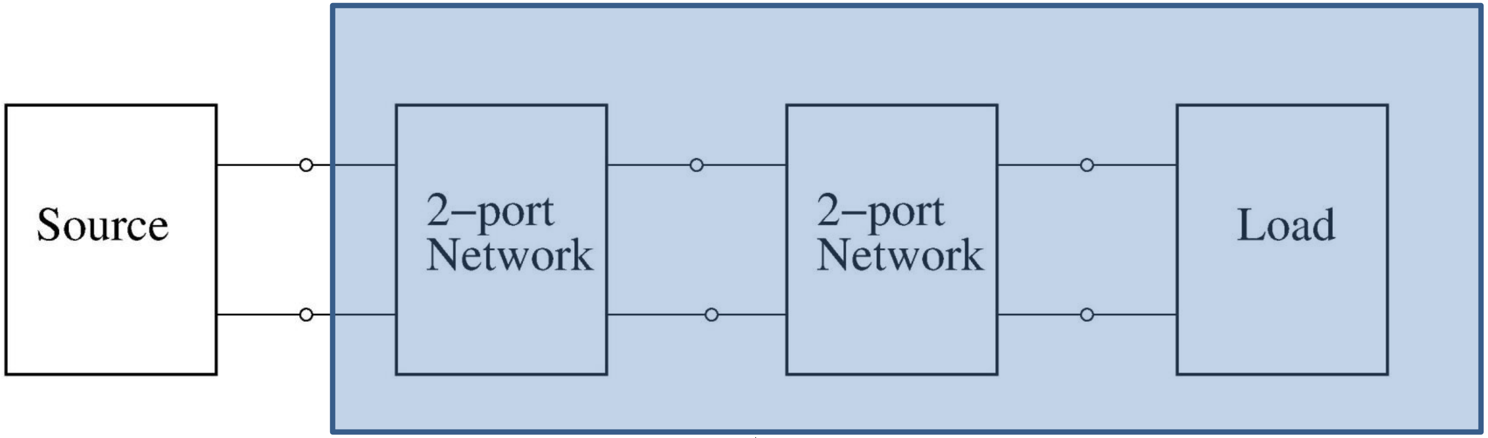
In linear circuits:

Any two-terminal network can be replaced by its Thevenin equivalent circuit.

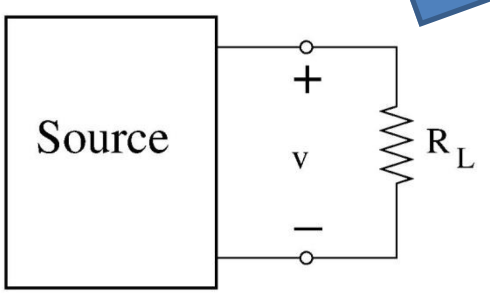
If a two-terminal network does not include an “independent source” it will be reduced to a single “impedance” (even if it includes dependent sources).



Source only sees a load resistor

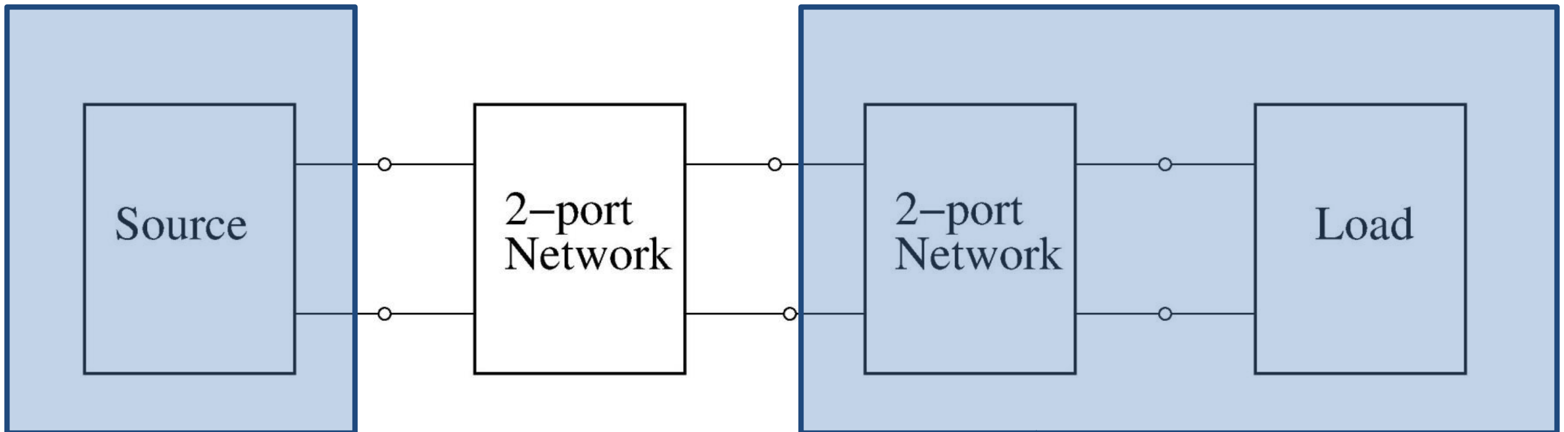


A two-terminal network containing NO independent source



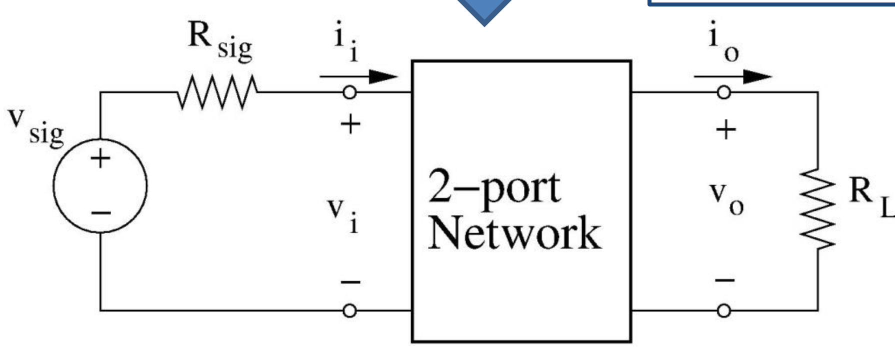
For a linear source, we only find the Thevenin parameters of the source.

Two-port network



A two-terminal network containing an independent source

A two-terminal network containing no independent source



Transfer function of a two-port network can be found by solving the above circuit once.