Assignment 1
DC Bias Point Analysis

ECEL 301 ECE Laboratory I

Dr. Edwin Gerber

Electrical and Computer Engineering

Drexel University
College of Engineering

Original Presentation by Dr. Kevin Scoles

Course Goals (1 of 2)

- Introduce you to PSpice, industry standard CAD software for electronics (analog and digital) and systems engineers. Use of this software will continue in ECE Labs II-IV as well as other ECE courses
- Provide examples of how to solve dc bias, dc sweep, ac sweep, and transient problems in PSpice

Course Goals (2 of 2)

- Perform measurements on devices and circuits using power supplies, function generators, multimeters and oscilloscopes
- Improve your capabilities in MATLAB
- Improve your capabilities in technical writing

Learning Objectives

- You have achieved the course outcomes when you can successfully:
  - Predict circuit behavior based on circuit fundamentals
  - Simulate circuit behavior in PSpice, extract performance characteristics under ideal conditions
  - Build the circuit and extract performance characteristics under non-ideal conditions
  - Compare results from all methods and communicate these results to others in a formal lab report

Schedule

- Nine Weekly Assignments
- An end-of-term individual lab practical exam to test how well you have met the course objectives

Expectations

- Mandatory attendance in lab lecture and lab
- Work in a group of 2
- Most Lab reports are to be done in a group with your lab partner. There will be no sharing of work between lab groups.
- Follow safety instructions

A Writing Intensive Course

- Three WI courses required to graduate
  - Two in your subject area
- A WI course requires at least two major writing assignments with the opportunity for a draft-feedback-revise cycle
- Two lab reports will use this structure
  - These lab reports MUST be completed INDIVIDUALLY
  - The specific lab reports to be submitted to the WIT will be told during your lab sections

Blackboard Learn

- Course leverages Bb Learn heavily
  - Tutorials
  - Lecture notes
  - Assignment instructions
  - Distribute grades
  - Web links and support documents

Software

- Using Cadence OrCAD/PSpice software for schematic capture and circuit simulation
- If you want to work on schematics or run simulations on your own computer, you can download free versions of OrCAD/PSpice from Cadence or LTspice from chip manufacturer Linear Technology
  - See the Web Links on the Bb Learn home page
  - Mac users can run PSpice under Parallels

Expected Document Formatting

- Spelling: PSpice, LabVIEW and MATLAB
- Reports have page numbers
- Numbers have units
- No numbers with leading decimal points (use 0.25, not .25)
- Numbers have no more than 4 significant figures (unless justified)
- Space kept between number and unit (2.2 kΩ, not 2.2kΩ)
- Table captions placed above the table, figure captions below the figure
- Columns/Rows of numbers in table have units
- Use an equation editor
- Define all terms in an equation
- Equations have equation numbers in parentheses ((3), not eq. 3)
- Graph axis labels have units
- Figures and tables have captions
- All text in figures are easy to read
- Graphics you did not generate are given credit with a full IEEE format citation
- Refer to all essential material that is in an appendix

ECEL 301 Safety

- No open-toed shoes or sandals
- No roughhousing, pranks or excessive noise
- Remove metal jewelry, watches, rings, etc., before working on electrical circuits
- Remove signal and power before making changes to a circuit
- No food or drink in the lab
- No cell phone use in the lab
- Keep benchtop clear of bags and other clutter
- Report faulty or unsafe equipment to lab staff or a TA. They may be unaware of the problem.

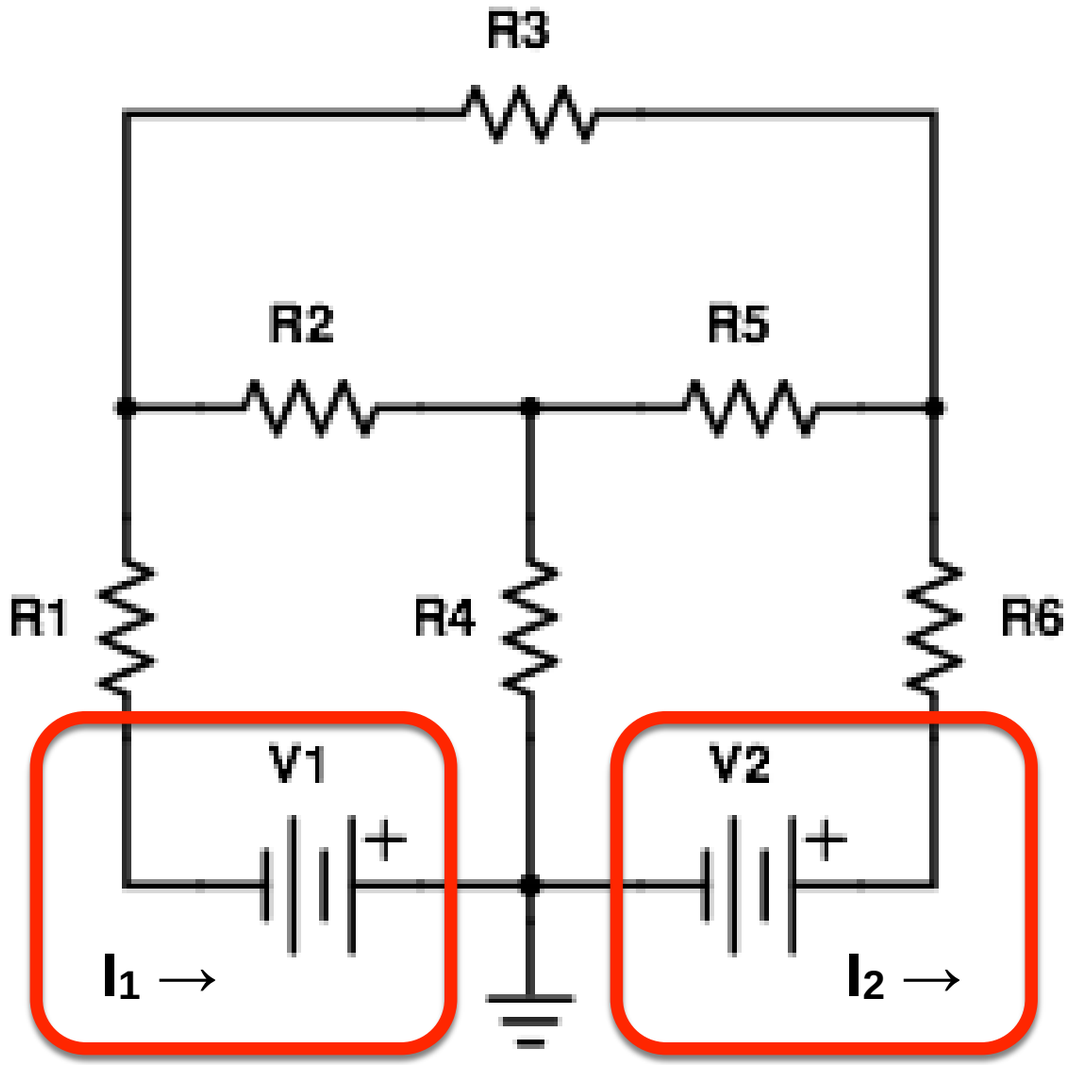
Pre-Lab Activities

- Read course syllabus
- Agree to lab safety rules
- Find a lab notebook
- Do the Week 1 reading
- Do Tutorial 1
  - Work along in PSpice if possible
- Skim the Assignment 1 instructions and Attempt to Solve Circuit

Assignment 1

- Analyze the dc bias point of a resistor network with two voltage sources
- What's a dc bias point?
  - With fixed dc supplies, a bias point analysis gives the static currents and voltages at all nodes and branches in the circuit
  - When ac signals are involved (amplifier analysis), the dc bias point is the point about which the time variation occurs

The Assignment 1 Circuit



- Tasks
  - Find I_1 and I_2
  - Find the power contributed by V1 and V2

Assignment 1

You have four tasks

1. Calculate I_1 and I_2
2. Simulate to find I_1 and I_2
3. Build circuit and measure I_1 and I_2
4. Compare results

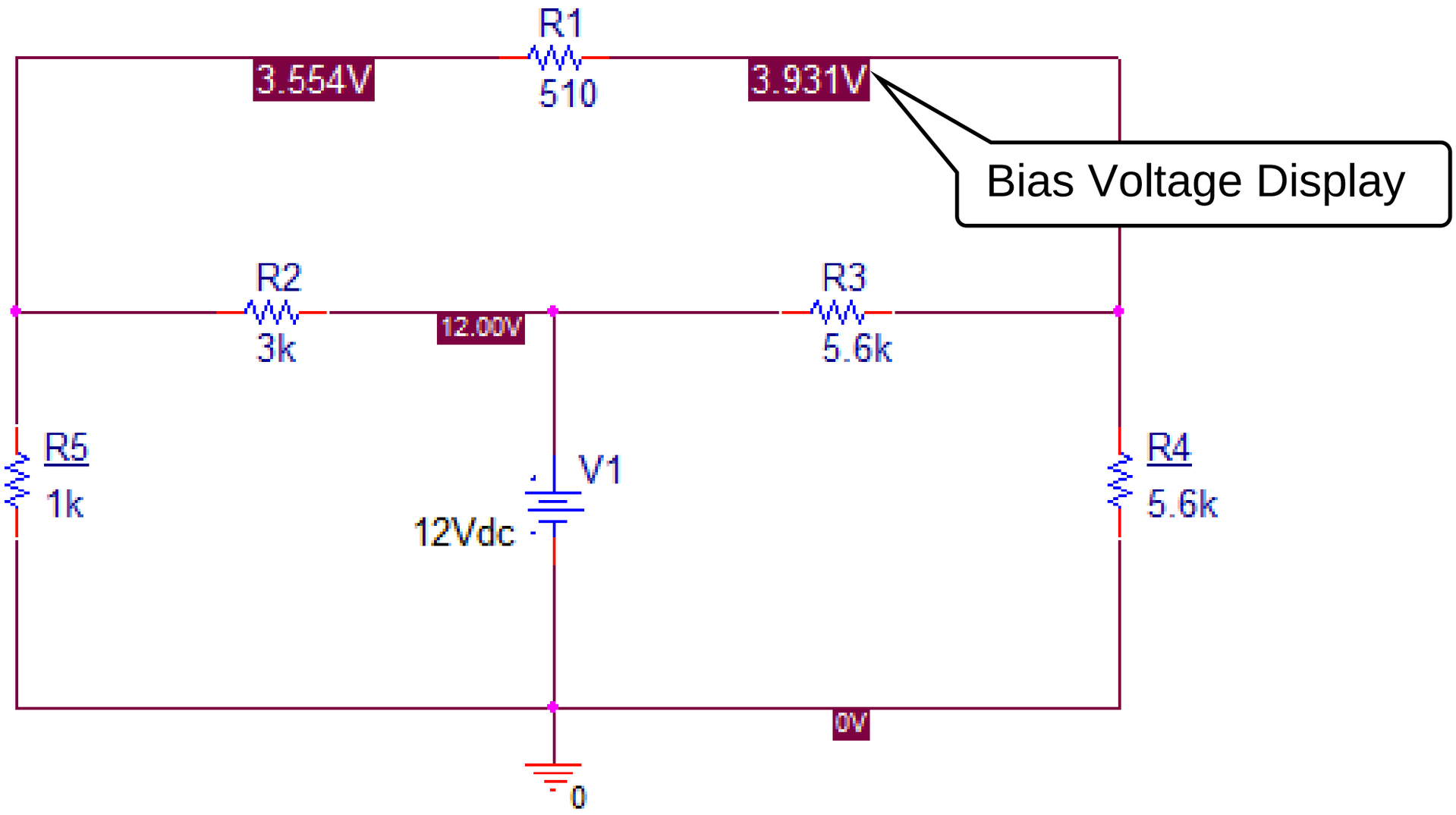
Calculate

- Your choice of technique
  - Mesh analysis
  - Nodal analysis
  - Delta-wye transformation
- You can either solve your equations by hand or use a tool such as MATLAB to solve them

Simulate

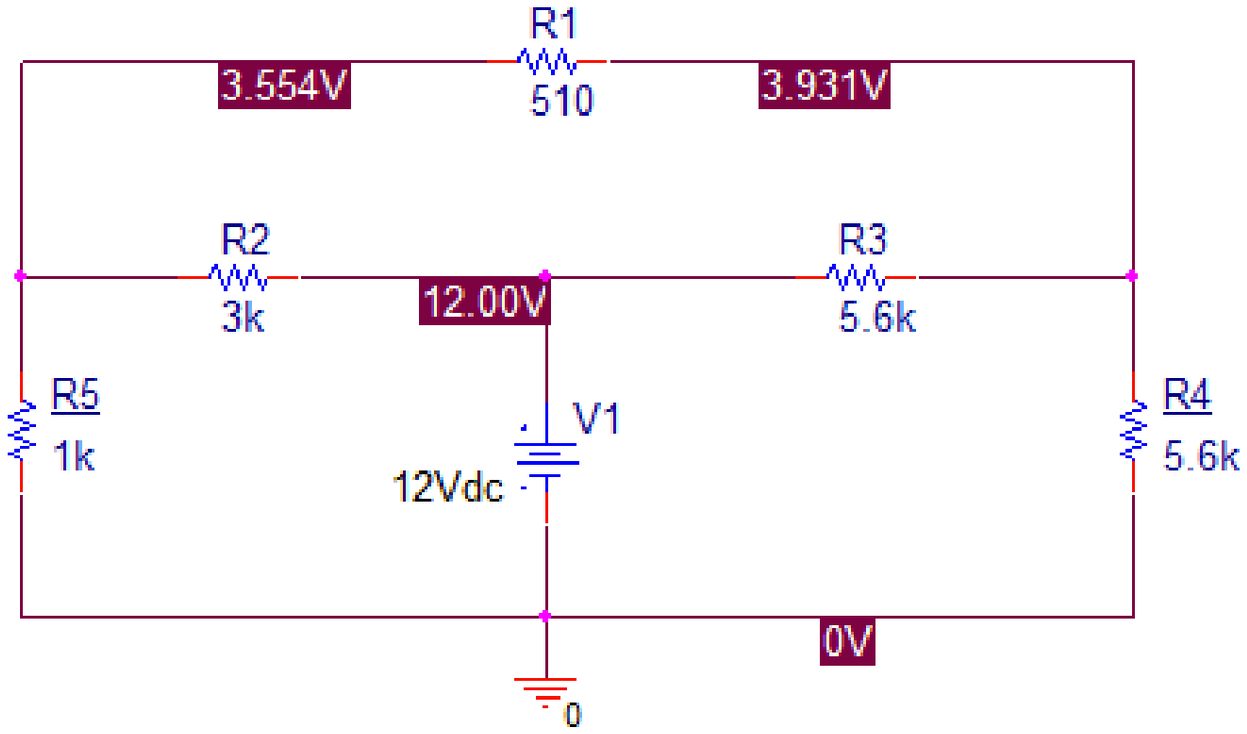
- Capture and simulate your schematic
  - Enable the bias current and power displays to show the status of each node and device
  - Find the currents I_1 and I_2, and the power through V1 and V2
  - All text in ≥10 point font
  - Complete the schematic title box (student names)

Simulate - Example



Simulate - Example

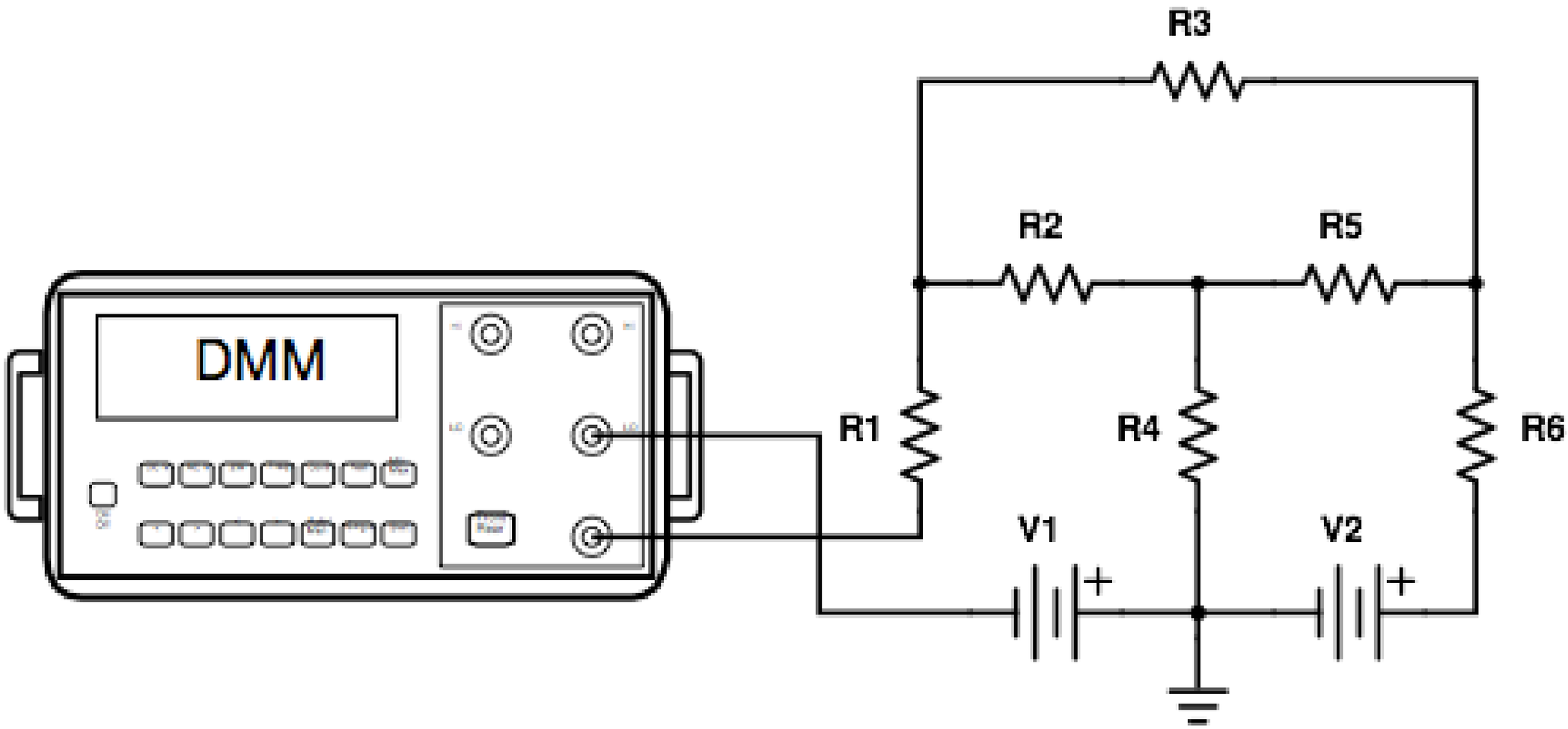
- Clip and paste into worksheet



Measure

- Build circuit on a breadboard
- Measure current I_1 and I_2
  - Sketch the hardware, connections in notebook
  - Record makes and models of equipment used
  - Provide power with dc supplies
  - Break circuit to measure current with digital multimeter - careful with polarity (+ red, - black)
  - Record your results in notebook

Measure



Compare

- Design a table that shows the results for current and power from each technique
- Include the % differences between theory and simulation and between theory and measurement
- The table must follow the format in the Writing Lab Reports document

Before your lab day

- Solve the circuit on your own
  - sketches, equations in your lab notebook, solutions produced either by hand or by MATLAB
- Find the currents and powers
- Compare your solution to your lab partner's when you get to lab

Do Our Results Agree?

- Resistors used are “real”, they have tolerances
  - Tolerances can be worked into equations and simulations
- Meters have resolution and accuracy limitations
- Calculations based on probability will produce a range of expected results

Do Our Results Agree?

- Ideal
  - A + B = C
- Real
  - (A ± ΔA) + (B ± ΔB) = (C ± ΔC)
  - C = A + B, but what is ΔC?
  - Determined by probability and statistics

Deliverables & Deadlines

- Full Lab Report consisting of the following:
  - Cover Page
  - Abstract
  - Introduction
  - Circuit Diagram
  - Procedure
  - Results
  - Discussion of Results
  - Conclusion
  - Appendix (If Applicable)
- One Report per group is to be submitted as a hard copy to the 2nd floor parts window (Bossone 216) by 4 PM the Friday a week after the lab.

Late Policy

- 25% off the grade EACH week it's late
  - From Friday 4 PM to Friday 4 PM the following week
- If you turn it in by the following Monday by 8 AM after it's due, only a 10% late penalty will be given