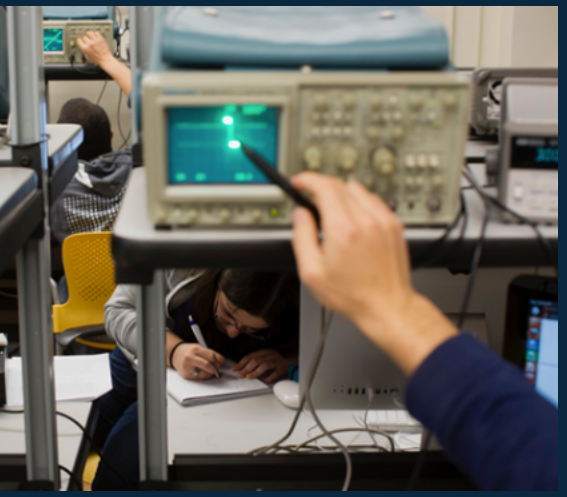
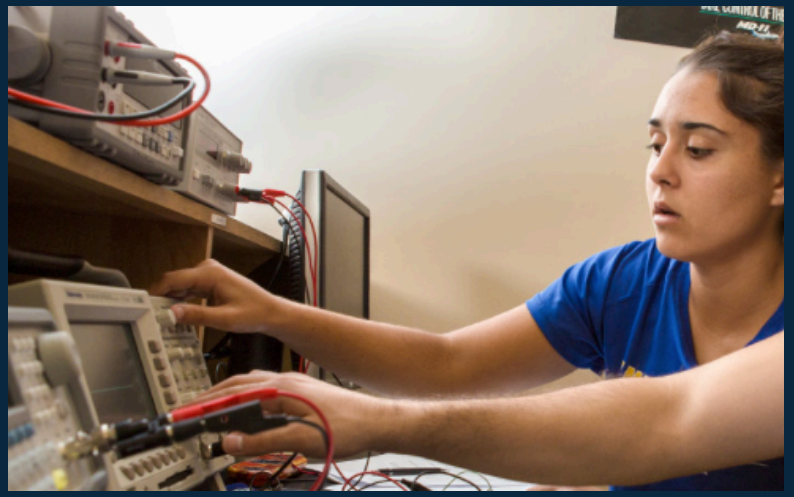
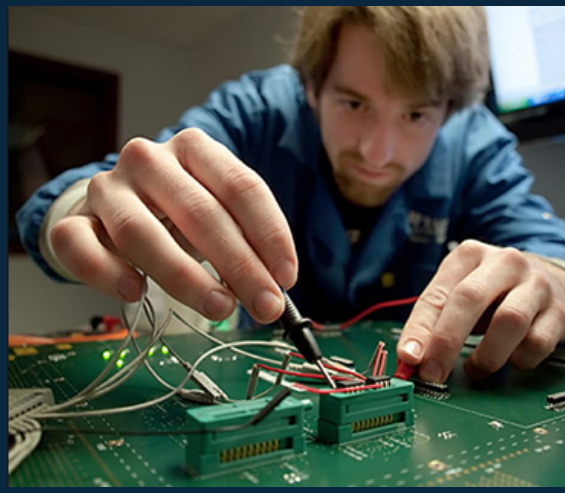
Writing Lab Reports

RCEL Communication Program
Gayle Moran, Ph.D.

Job Descriptions

- Ability to communicate effectively, both orally and in **writing**
- Excellent communication skills, both **written** and verbal
- Demonstrated good **written** and oral communication skills
- Effective verbal and **written** English communication skills
- Correct English **usage** and **grammar**
- **Engineering report writing** and presentation skills

Ostinato Rigore

(Constant Rigor)

Leonardo da Vinci's Motto

This is your brain on writing

Writing –

- Develops critical thinking skills
- Improves how you learn
- Brings you closer to a subject

Agenda

- Think before you communicate
- Improve your writing with these tips
- Format a professional document

Think before you communicate

- Know your audience
- Clarify your purpose

Lab report assessment rubric

ELEC 240 Lab Report Grading Rubric					
Results from the Lab					
Are all relevant measurements, questions in bold, and waveforms included?	Complete				Incomplete
	5	4	3	2	1
Are the measurements/answers to questions accurate?	All				None
	5	4	3	2	1
Objective, Summary, Analysis, and Conclusions					
How is the objective of the lab?	Clear				Vague
	5	4	3	2	1
How is the summary of the lab?	Clear				Vague
	5	4	3	2	1
Are measurements and observations correlated with underlying principles and expectations?	Well				Poorly
	5	4	3	2	1
Are errors or stumbling blocks addressed?	Well				Poorly
	5	4	3	2	1
Presentation and Writing					
How is the presentation of data (i.e., correct units, axes labeled, tables titled, legibility)	Good				Poor
	5	4	3	2	1
How is the formatting and layout?	Good				Poor
	5	4	3	2	1
How is the grammar and spelling?	Correct				Many errors
	5	4	3	2	1
How is the word choice?	Good				Poor
	5	4	3	2	1
Total		out of 50			

Use active voice and personal pronouns

The function generator was reset to a 100 Hz sine wave and the amplitude was decreased.

We reset the function generator to a 100 Hz sine wave and decreased the amplitude.

Use past tense for procedures

Increase the input amplitude until there appears to be output clipping.

We increased the input amplitude until we saw output clipping.

Use specific wording

The maximum distance we could get was equal to the entire length of the BNC cord.

How long was the BNC cord?

We then increased the resistance in intervals until it worked.

What size intervals? How many intervals?

What does "worked" mean?

This is very close to the values measured in 4.1.

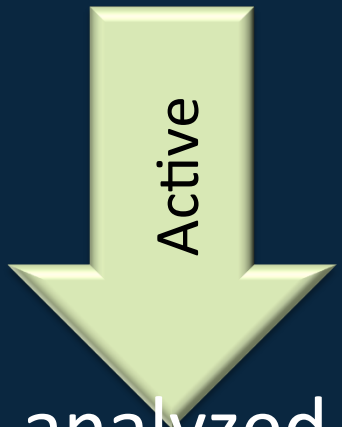
How close is "very close"?

4.1? What's that?

What were those values?

Use active verbs

We performed an analysis on the data.



We analyzed the data.

Reduce wordiness

Another very important consequence of Einstein's theory of special relativity that does not follow from classical mechanics is the prediction that even when a body having mass is at rest, and hence has no kinetic energy, there still remains a fixed and constant quantity of energy within this body.

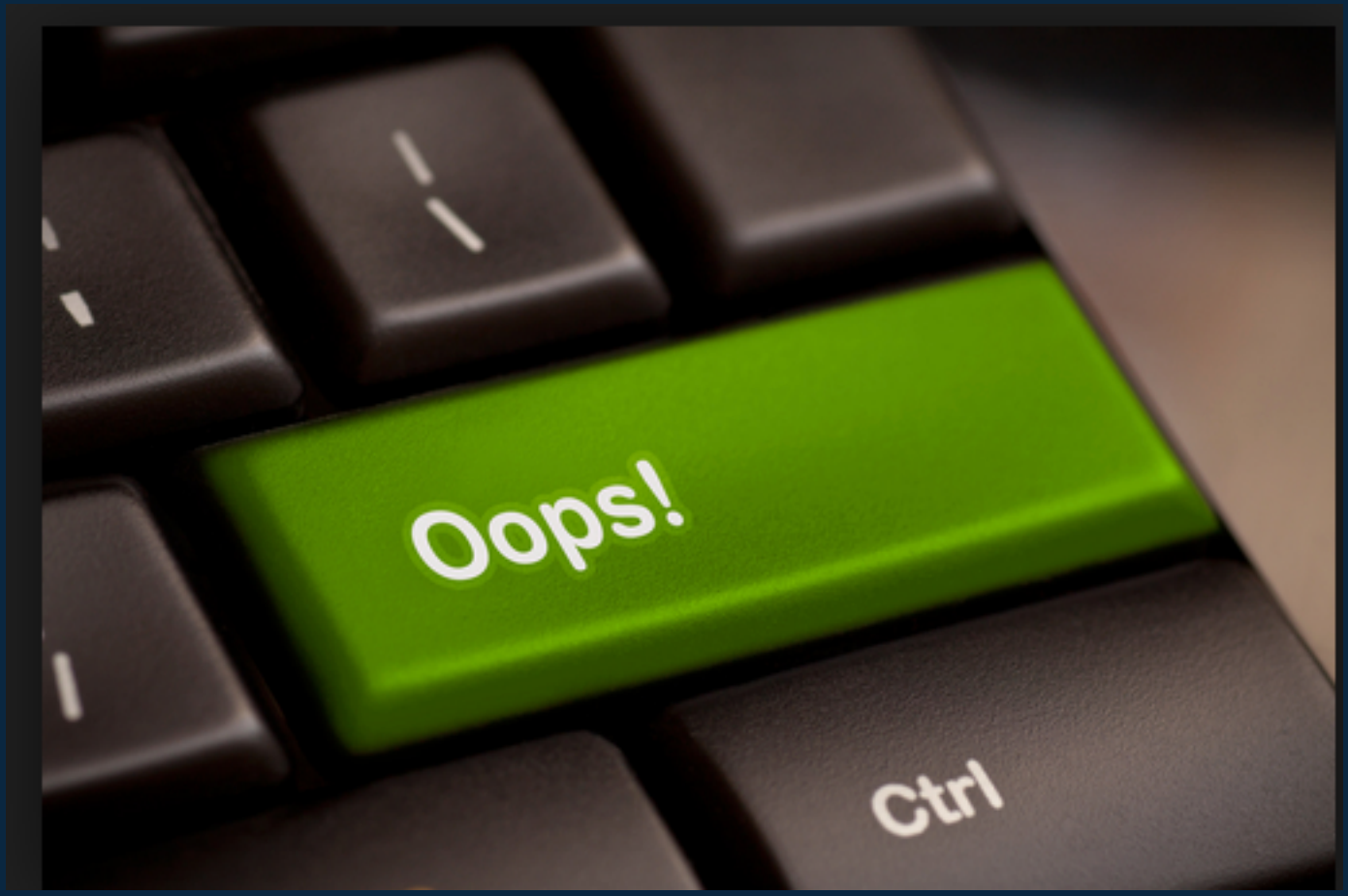
According to the theory of special relativity, even a body at rest contains energy.

The microscope revealed a group of organisms that were round in shape and peculiar in nature.

The microscope revealed a group of peculiar, round organisms.

Gary Blake and Robert W. Bly. *The Elements of Technical Writing*.

Use correct grammar and spelling

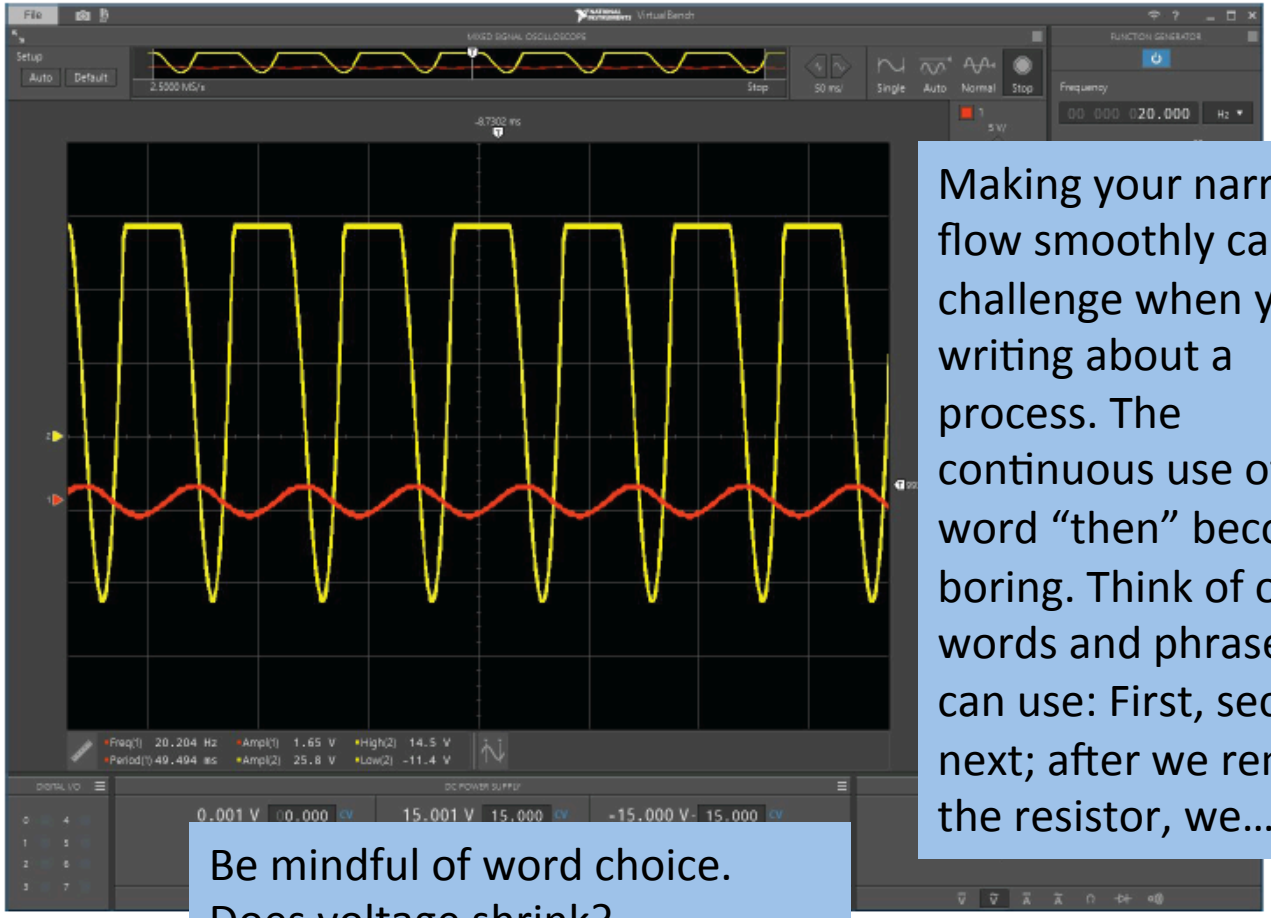


Procedure

- Make your description personal
- Use past tense
- Make it sound like a narrative. Weave in
  - Expectations
  - Observations
- Include some “why” and “how” information
- Explain and analyze your comments
- Include any trouble-shooting steps you took

In Experiment 4.1, we completed two basic steps: We powered up the op-amp and tested the open-loop response. We expected that the circuit we wired would produce…

The team began the first step by color-coordinating the wires on the breadboard as we wired the bus strips to provide positive power, negative power, and ground buses. Then we plugged in the op-amp. Exact placement was important, and we made sure the op-amp straddled the top and bottom socket strip.



Making your narrative flow smoothly can be a challenge when you're writing about a process. The continuous use of the word "then" becomes boring. Think of other words and phrases you can use: First, second; next; after we removed the resistor, we…;

Be mindful of word choice. Does voltage shrink?

Figure 3: Clipped Waveform (5 V/ 50ms)

4) Then, we connected a 100 Ω resistor from v_{out} to ground. The output voltage shrunk considerably (Figure 4). We then removed the resistor and set the function generator output to be a square wave and noted the shape of the v_{out} waveform (Figure 5). Then we made sure the DC offset on the function generator was set to 0.

3) Then, we set up the function generator so that it produced an 8 V p-p, 100 Hz triangle wave. We disconnected the BNC patch cord from FGEN and connected the BNC clip leads. Then we connected the red LED to the clip leads and held it directly above the photodiode (Figure 19). v_{out} was less distorted than it was in Lab 2. Then, we switched the function generator to sine wave. **One noticeable change was that the LED got noticeably brighter when we switched it from a triangle wave to a sine wave (Figures 20 and 21.**

Show your instructor, your labbies, and, in the future, your manager, that you are *thinking* rather than just going through the motions of the experiment. When you say it "was less distorted than it was in Lab 2, explain why you think that happened. Was it what you expected to see?

Figure 26: Our circuit, still separate from the other one

2) We plugged the handset into J1-7 and spoke into it to make sure it worked. We measured the peak-to-peak amplitude to be 46.5 mV (Figure 27).

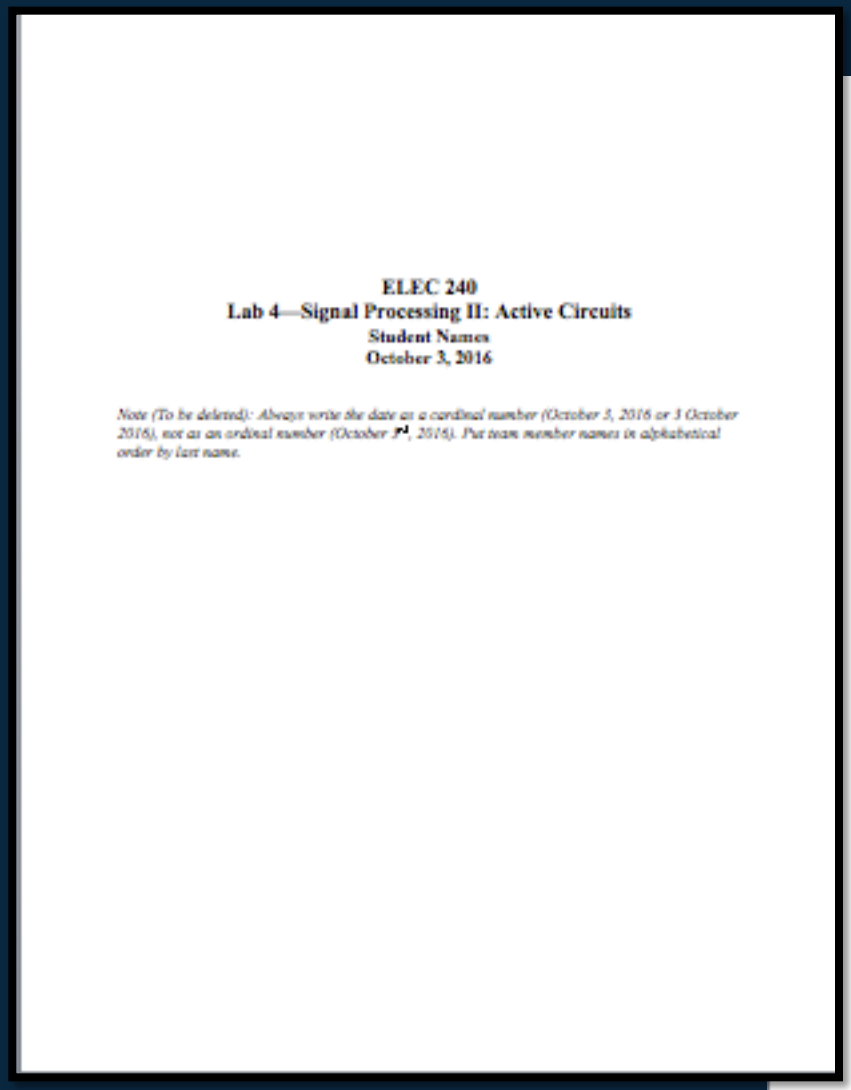
Make figure captions descriptive and specific. Using the phrase “the other one” doesn’t provide readers with enough information to understand what you are talking about.

Summary:

In this lab, we learned to build more complex circuits on our breadboard and how the theoretical work we've been doing in class concerning op-amps and amplifiers works in real life. We will now be able to move forward with a deeper, realistic understanding of how amplifiers and gain affect circuit construction and how they affect the different waveforms.

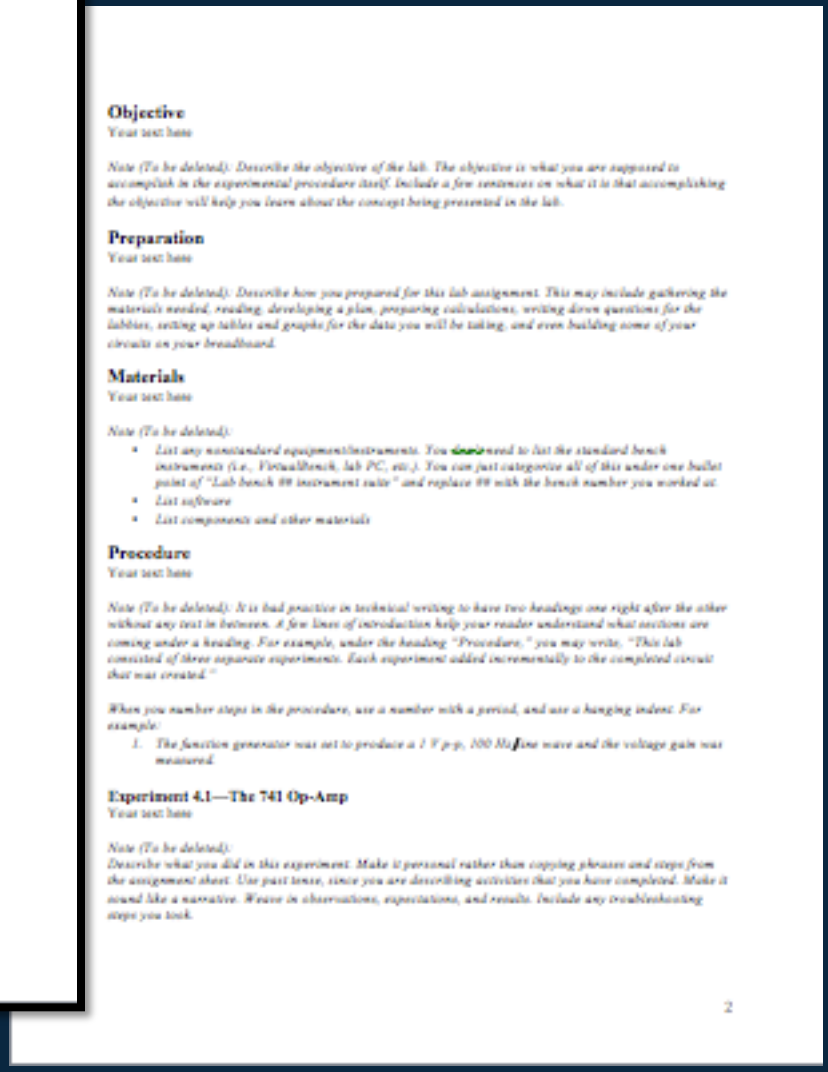
Summary: Overall, this lab focused on exposing us to the use of the op-amp in multiple settings, such as the benefits of using it as an inverting amplifier and using that to create a photodiode and microphone amplifier. Towards the end of the lab, we were able to create a circuit that allowed an op-amp to amplify the microphone input signal so that it can be audible through the handset speaker. Although we can't understand what "magic" is happening within the op-amp, we have gained a general idea on how the op amp takes in power from a battery source and uses that to increase the gain. Beyond that, the lab itself is slowly exposing us to the use of sub systems and how circuits can become a lot more complex when created manually rather than just theoretically drawing them.

Format a professional document



ELEC 240
Lab 4—Signal Processing II: Active Circuits
Student Names
October 3, 2016

Note (To be deleted): Always write the date as a cardinal number (October 3, 2016 or 3 October 2016), not as an ordinal number (October 3rd, 2016). Put team member names in alphabetical order by last name.



Objective
Your text here

Note (To be deleted): Describe the objective of the lab. The objective is what you are supposed to accomplish in the experimental procedure itself. Include a few sentences on what it is that accomplishing the objective will help you learn about the concept being presented in the lab.

Preparation
Your text here

Note (To be deleted): Describe how you prepared for this lab assignment. This may include gathering the materials needed, reading, developing a plan, preparing calculations, writing down questions for the lablers, setting up tables and graphs for the data you will be taking, and even building some of your circuits on your breadboard.

Materials
Your text here

Note (To be deleted):
- *List any nonstandard equipment/instruments. You don't need to list the standard bench instruments (i.e., Virtualbench, lab PC, etc.). You can just categorize all of this under one bullet point of "Lab bench 08 instrument suite" and replace 08 with the bench number you worked at.*
- *List software*
- *List components and other materials*

Procedure
Your text here

Note (To be deleted): It is bad practice in technical writing to have two headings one right after the other without any text in between. A few lines of introduction help your reader understand what sections are coming under a heading. For example, under the heading "Procedure," you may write, "This lab consisted of three separate experiments. Each experiment added incrementally to the completed circuit that was created."

When you number steps in the procedure, use a number with a period, and use a hanging indent. For example:

1. *The function generator was set to produce a 1 V p-p, 100 Hz sine wave and the voltage gain was measured.*

Experiment 4.1—The 741 Op-Amp
Your text here

Note (To be deleted):
Describe what you did in this experiment. Make it personal rather than copying phrases and steps from the assignment sheet. Use past tense, since you are describing activities that you have completed. Make it sound like a narrative. Weave in observations, expectations, and results. Include any troubleshooting steps you took.

2

Professional engineers say:

"You can't be a good engineer if you can't communicate what you did and what it means. Your engineering is only as good as your communication of it."

Portland State University, Civil Engineering Writing Project, 2015.

Using Tables and Figures in Written Documents

Beata Krupa, Ph.D.
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Selected slides courtesy of: Beth O'Sullivan and Gayle Moran

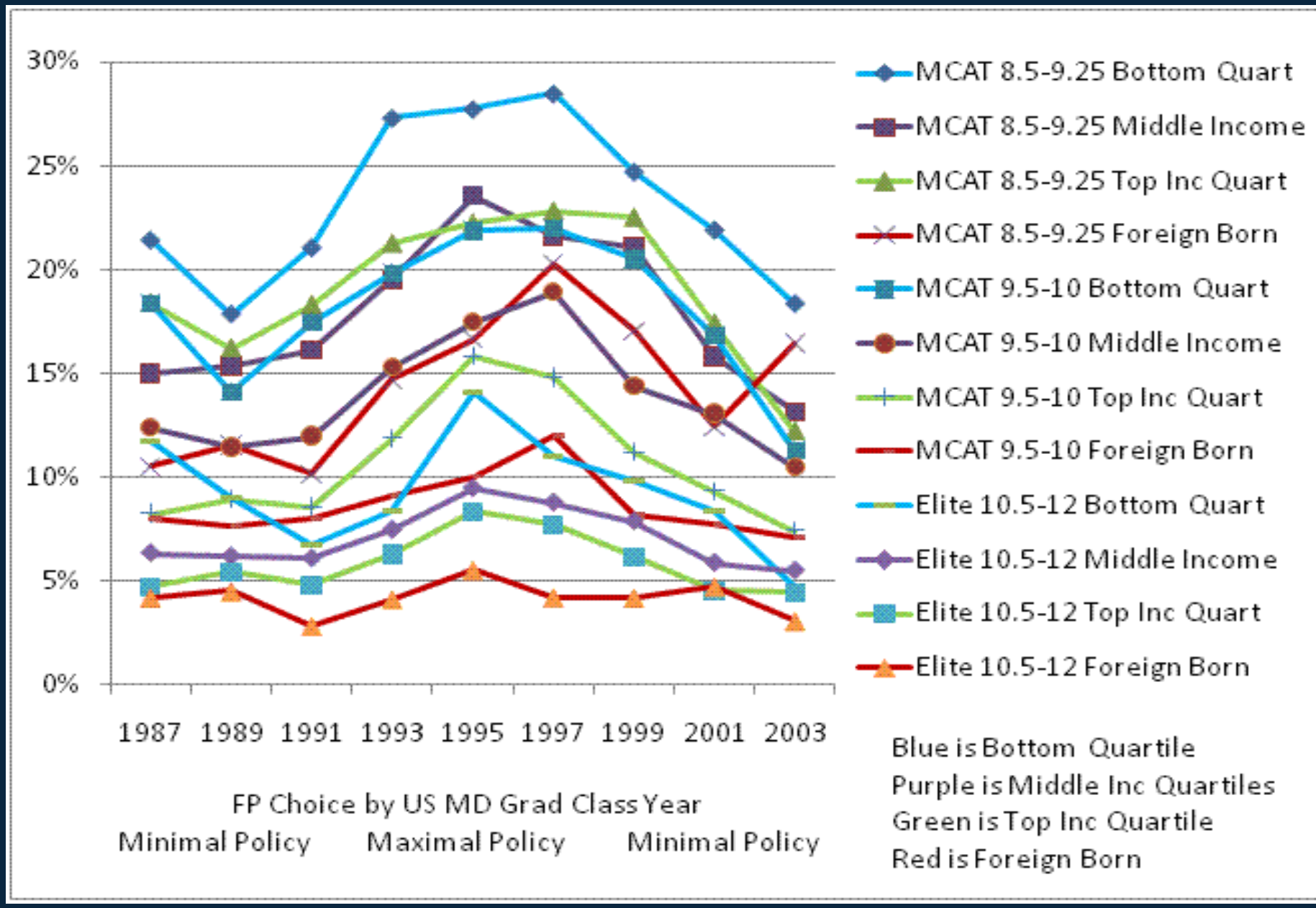
Basic Rules

- Use tables and figures purposefully
  - Add information – most of the time
  - Illustrate something
- Use only necessary tables and figures

Tables vs. Figures

- Use **Tables** to
  - Present and compare large quantities of data or information
  - Sort data or information – alpha, size, time of occurrence
  - Compare data
- Use **Figures** – charts, graphs, diagrams, drawings, screenshots, illustrations/images to talk about
  - Trends
  - Patterns
  - Relationships
  - Processes

Make it simple


30%
25%
20%
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10%
5%
0%
1987
1989
1991
1993
1995
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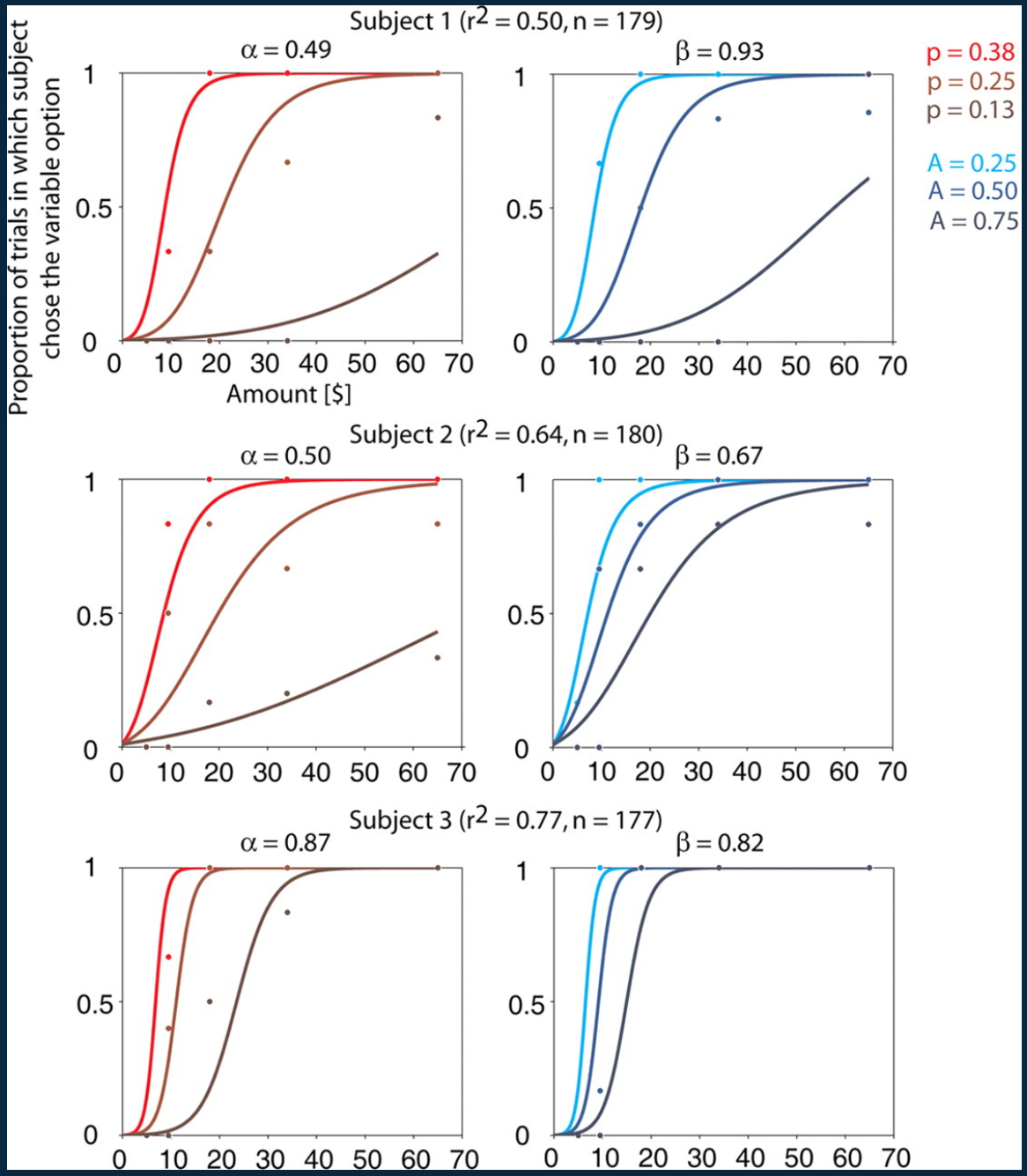
2001
2003
MCAT 8.5-9.25 Bottom Quart
MCAT 8.5-9.25 Middle Income
MCAT 8.5-9.25 Top Inc Quart
MCAT 8.5-9.25 Foreign Born
MCAT 9.5-10 Bottom Quart
MCAT 9.5-10 Middle Income
MCAT 9.5-10 Top Inc Quart
MCAT 9.5-10 Foreign Born
Elite 10.5-12 Bottom Quart
Elite 10.5-12 Middle Income
Elite 10.5-12 Top Inc Quart
Elite 10.5-12 Foreign Born
FP Choice by US MD Grad Class Year
Minimal Policy
Maximal Policy
Minimal Policy
Blue is Bottom Quartile
Purple is Middle Inc Quartiles
Green is Top Inc Quartile
Red is Foreign Born


Subject 1 (r^2 = 0.50, n = 179)
α = 0.49
β = 0.93
p = 0.38
p = 0.25
p = 0.13
A = 0.25
A = 0.50
A = 0.75
Proportion of trials in which subject chose the variable option
Amount [$]
Subject 2 (r^2 = 0.64, n = 180)
α = 0.50
β = 0.67
Subject 3 (r^2 = 0.77, n = 177)
α = 0.87
β = 0.82

You Must!

- Reference (talk about) your tables and figures in the text before they appear on a page:

  … Table 1 summarizes results …

  ... Figure 1 illustrates...

- In the text, verbally explain how to interpret your tables or figures

Visual information needs context

Obvious but important

- Always number figures and tables
- Figures and tables are numbered INDEPENDENTLY, in order in which you refer to them in the text.
  - Figure 1. … Figure 2. … Figure 3.
  - Table 1. … Table 2. … Table 3.
- Bold "**Table 1.**" and "**Figure 1:**"

Table titles and captions are **always** placed ABOVE a table

Table 2. Values for parameters a and b, and the respective standard error, for adjusted total weight (g) and length (cm) for *Stellifer rastrifer*, *S. brasiliensis* and *S. stellifer*, sampled in Caraguatatuba Bay, from August 2003 to October 2004.

Species	Parameter			
	N	*a*	*b*	r^2
S. rastrifer	2852	0.0053 ± 0.0001	3.3503 ± 0.0094	0.9914
S. brasiliensis	357	0.0066 ± 0.0004	3.1960 ± 0.0315	0.9830
S. stellifer	116	0.0085 ± 0.0009	3.0999 ± 0.0452	0.9878

Use informative titles and captions

Table 2. Comparison of solar-energy storage technologies

Table 2. provides a comparison of the predicted cost, performance, and lifetime of solar-energy storage technologies for hypothetical 200 MW plants [5,6].

	Installed cost of energy storage for a 200 MW plant ($/kWhr$_e$)	Lifetime of storage system (years)	Round-trip storage efficiency (%)	Maximum operating temperature (C/°F)
Molten-Salt Power Tower	30	30	99	567/1,053
Synthetic-Oil Parabolic Trough	200	30	95	390/734
Battery Storage Grid Connected	500 to 800	5 to 10	76	N/A

The best titles are conclusions

General:

Table 1. Three-year prognosis after treatment

Specific:

Table 1. Survival rate doubles 3 years after treatment

Figure titles and captions are always placed BELOW the figure

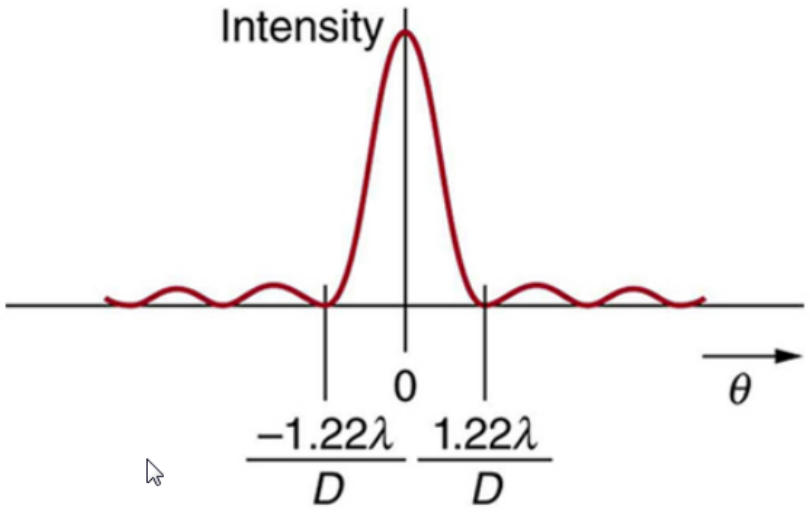


Figure 1.2 *Graph of intensity of the diffraction pattern for a circular aperture. Note that, similar to a single slit, the central maximum is wider and brighter than those to the sides.*

Informative captions

Various levels of captioning

Captions can range from a sentence to several paragraphs:

Figure 2. Comparison of the costs of the three major types of coal gasification plants.

Figure 2. A high-sulfur coal gasification plant is more expensive than either a low-sulfur or anthracite plant, but more than half of its cost is cleanup equipment. If these expenses could be eliminated, high-sulfur bituminous plant would be the least expensive of the three types of plants.

Very important!

Make sure that

- All information is accurate
- Axes are labeled
- Units are correct and clearly displayed
- Font sizes, line thickness, spacing of elements, and proportions help readability, clarity, and interpretation
- All figures have consistent look

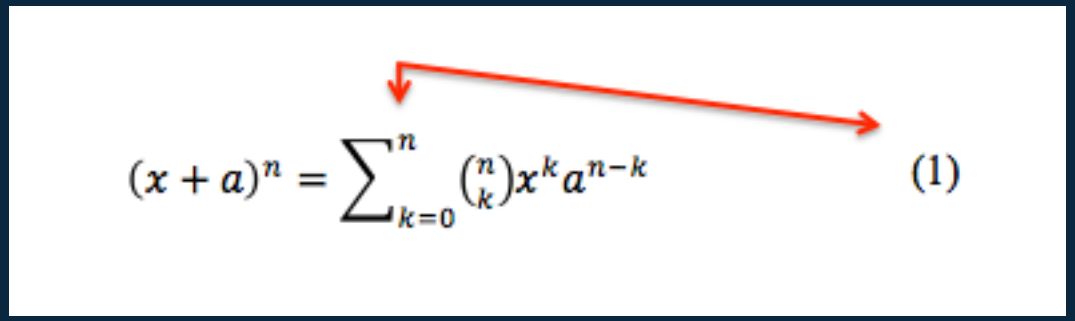
Figures design

Figures should be (most of the time)

- Centered on the page
- Reasonably sized (no more than ½ page)
- Set apart from the text by at least one blank line; text should not flow around figures
- Displaying well in color or gray scale.

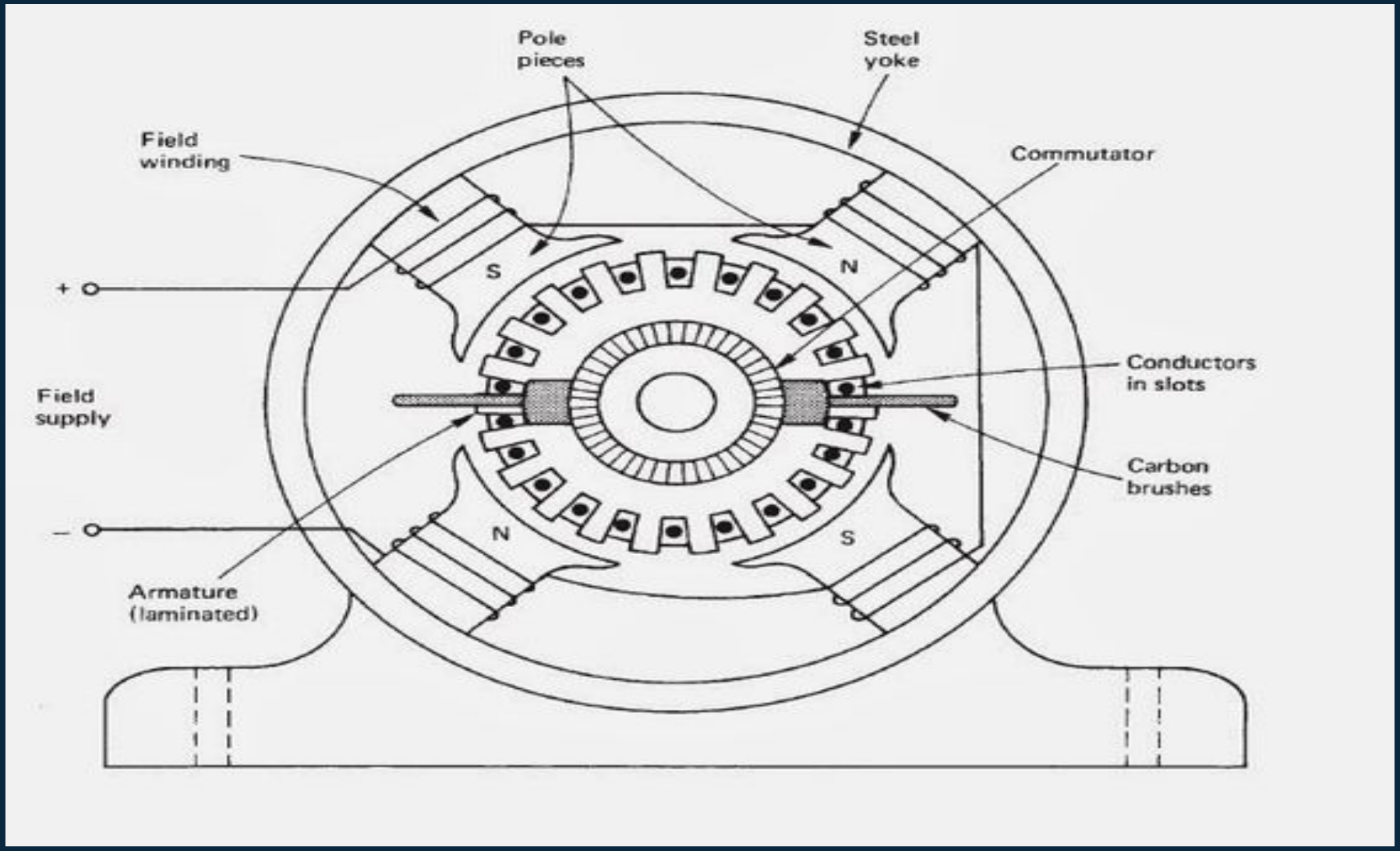
Equations

Center equations. Number equations on the far right of the page.



$$(x+a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k} \qquad (1)$$

Label all elements of illustrations and drawings



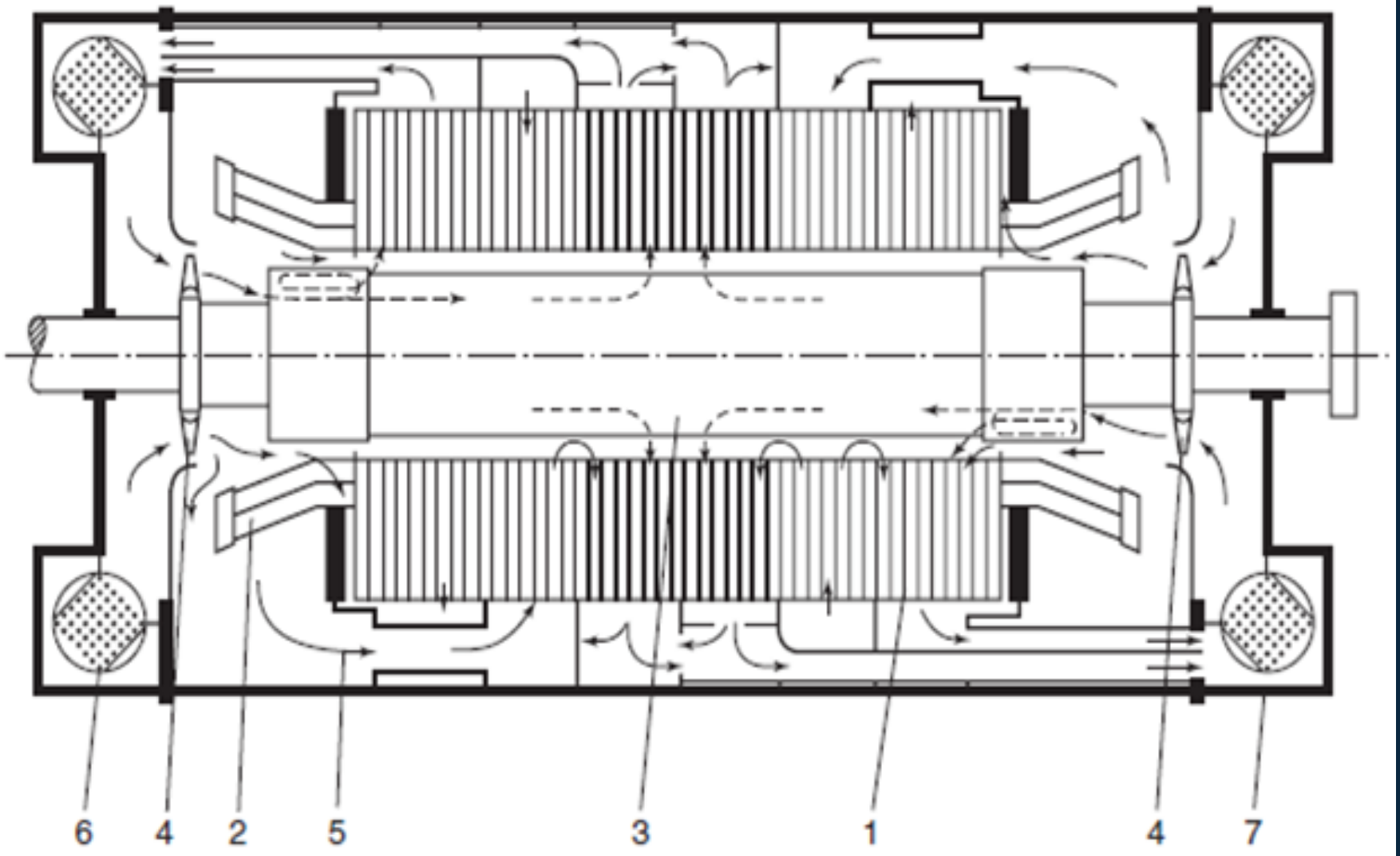
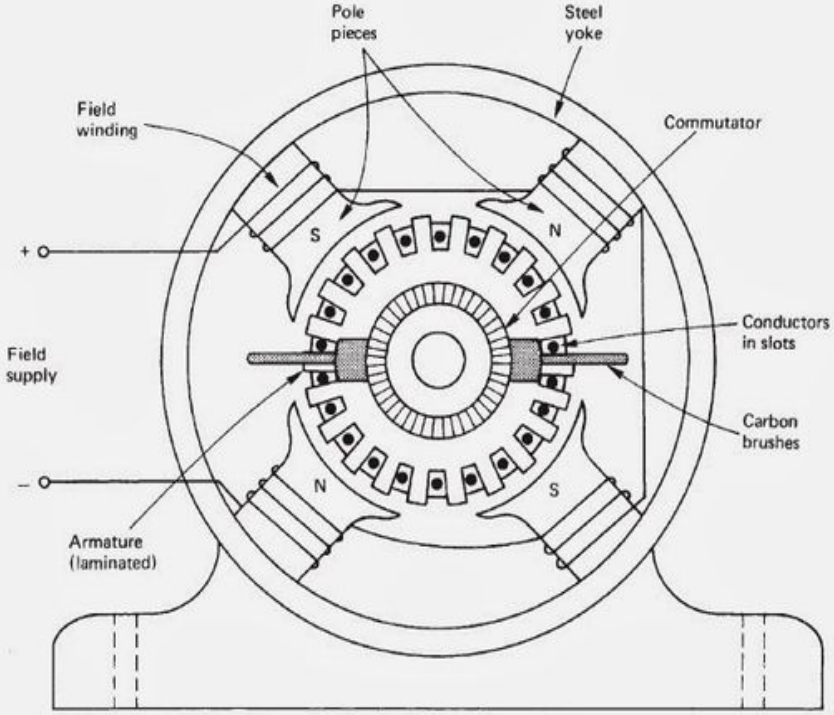


FIGURE 7-22 Cooling system, gas only. (1) stator core; (2) indirect-cooled stator winding; (3) rotor body; (4) axial-flow fans; (5) gas flow; (6) hydrogen cooler; (7) stator housing. (*ABB.*)



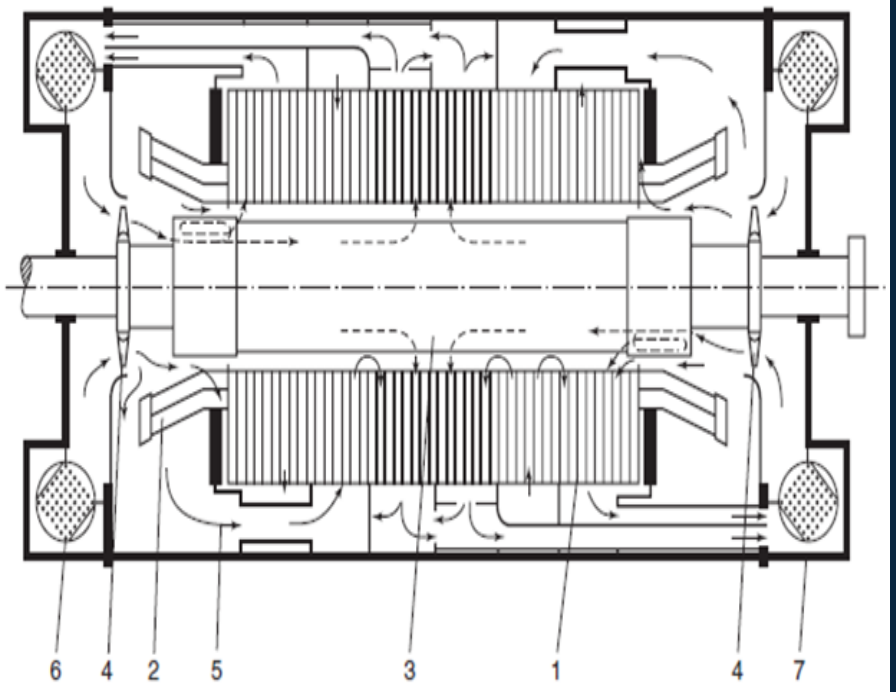


FIGURE 7-22 Cooling system, gas only. (1) stator core; (2) indirect-cooled stator winding; (3) rotor body; (4) axial-flow fans; (5) gas flow; (6) hydrogen cooler; (7) stator housing. (*ABB.*)

Place legends as close to your data as possible

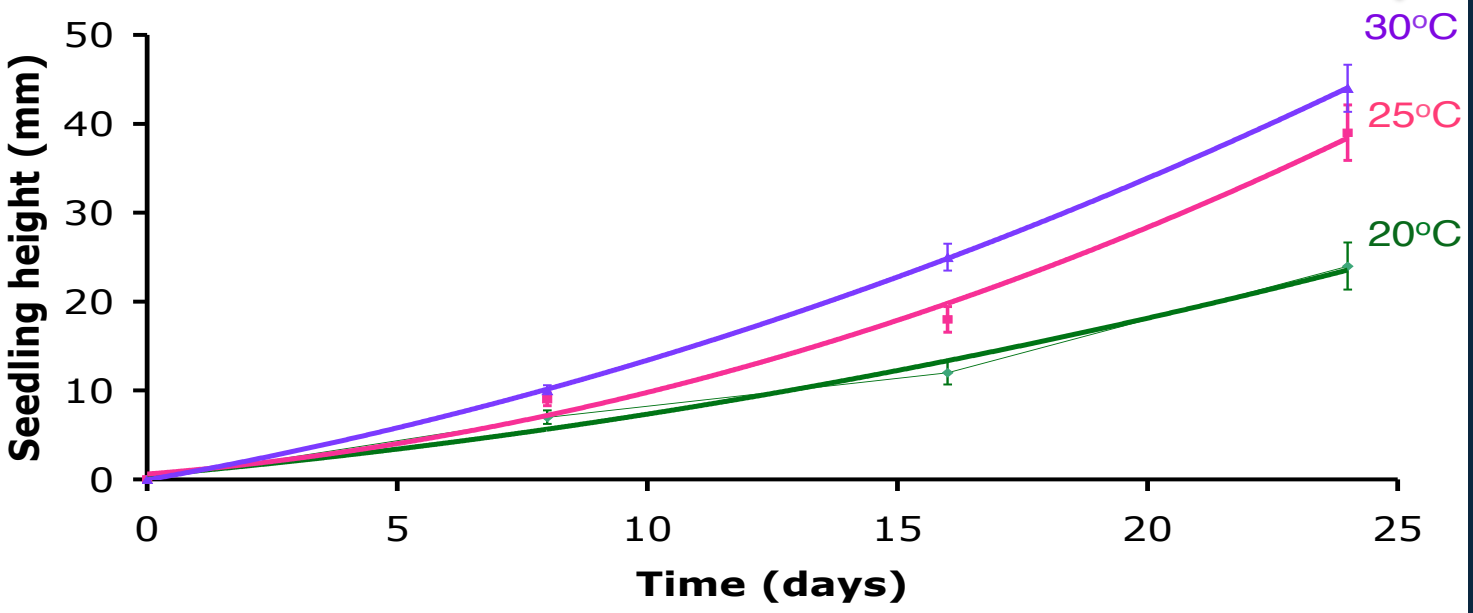
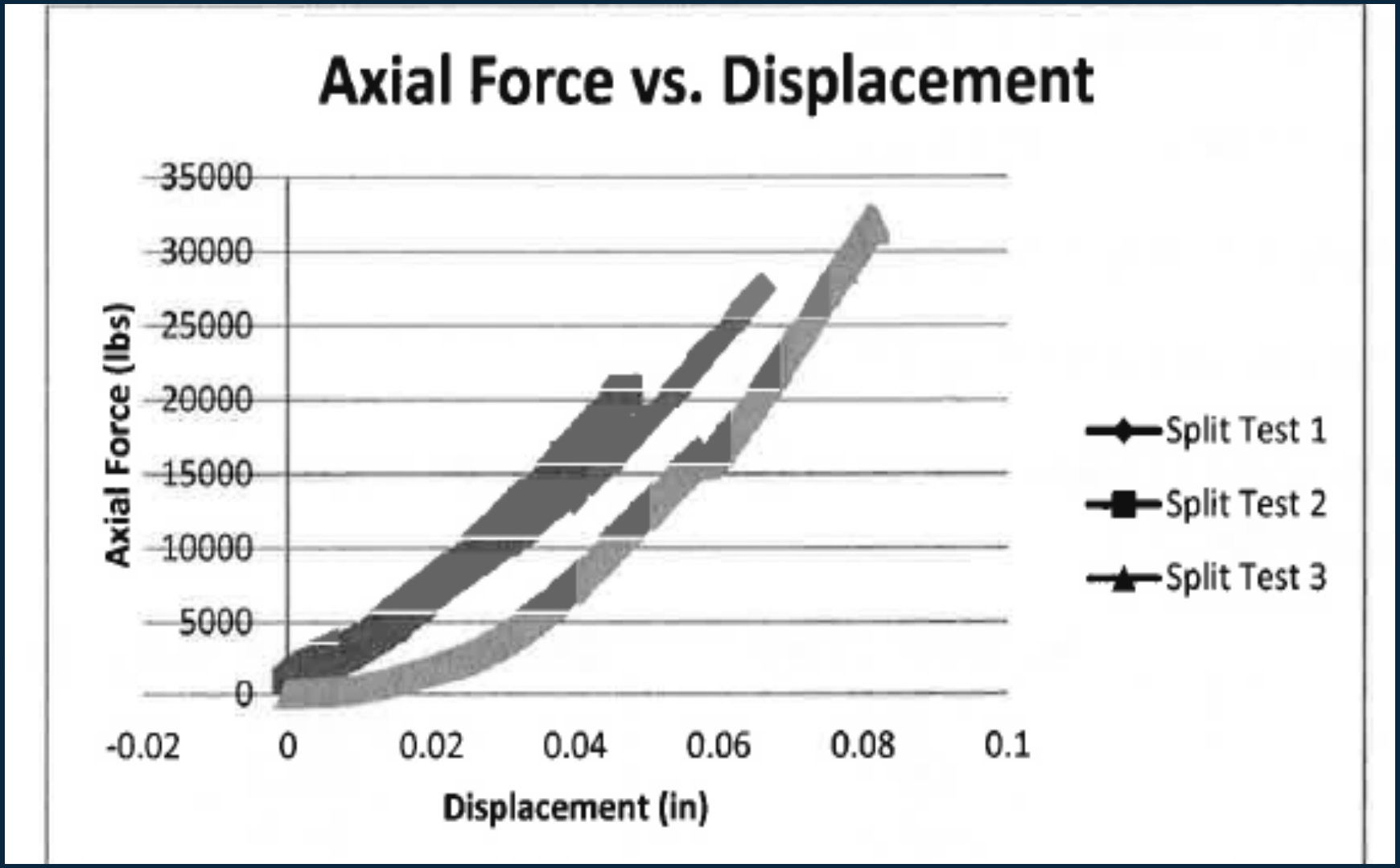


Figure 1: Seedlings grew most rapidly at 30°C

From Cain Project


Axial Force vs. Displacement
35000
30000
25000
20000
15000
10000
5000
0
Axial Force (lbs)
-0.02
0
0.02
0.04
0.06
0.08
0.1
Displacement (in)
Split Test 1
Split Test 2
Split Test 3

Cite all your sources!

Even if you recreated or adapted a figure or table from another author, include the words "Adapted from" or "After" followed by the author's name and a citation at the end of the caption.

Principles of good data visualization

- Design for your audience
  - Use the best type of graphic for your message
  - Reference visuals in text - verbally explain key points
  - Use informative titles, captions, and use labels
- Follow numbering conventions
- Show data without distortion

Handout

Asking for Help in a Lab

Don’t just say

“It does not work!!!”

Preparing to ask questions is an exercise in analyzing problems.

When you ask for Labbies help

- Provide details of the problem. What dose not work? What is happening or not happening?
- Explain what you have done, and why did you do it. Chronological explanations work well.
- Come up with a list of possible explanations of what you think happened.

Template for asking quesions

1. What is happening or not happening - details
2. What have you done and why
3. Possible answers

Show your thinking. Learn how to explain your thinking in an organized way.

We asked Labbies

Not to provide answers too readily

Give a clue

or

Help students to come up with their own answer

From a web site where hackers answer questions

We've found by experience that people who are careless and sloppy in how they ask questions are usually also careless and sloppy at thinking and coding.

Answering questions for careless and sloppy thinkers is not rewarding; we'd rather spend our time elsewhere.