



Research Methods in Science in Engineering

Learning Strategies

Slide 1

Lecture Outline

- In the Classroom
- Study Techniques
- Homework
- Final Exams

Slide 2

In the Classroom

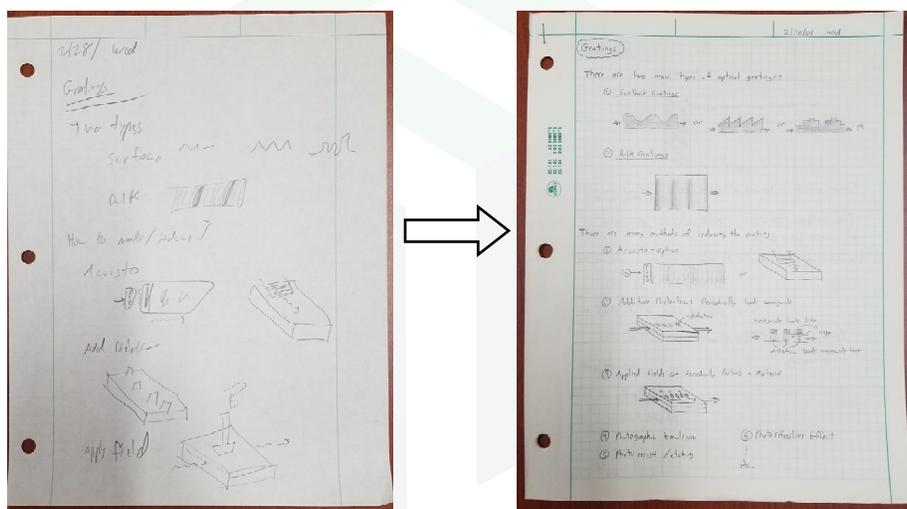
Attending the Lecture

- Attend every lecture.
- Arrive early to get seated and prepare for class.
- Turn off electronic devices and put away other distractions.
- Review your notes or any required reading or videos before class.
- Listen carefully for high-level organization of material.
- Pay attention and do not be a distraction.

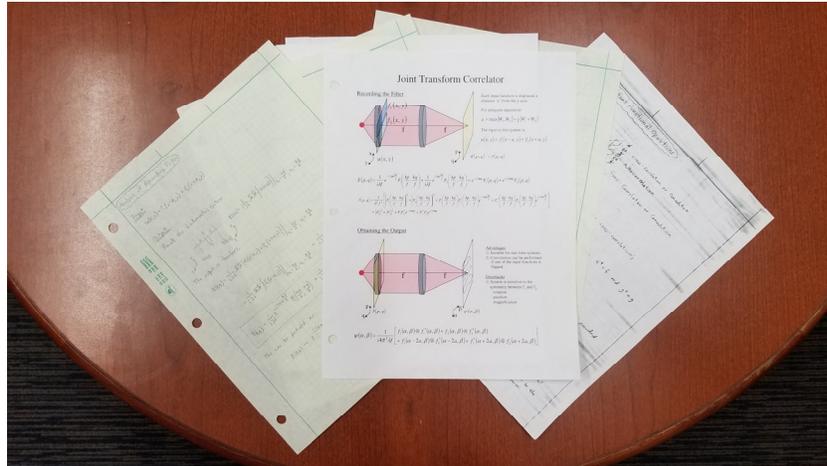
Notes

- Use a separate notebook for each class.
- Start each lecture with a new piece of paper with the date and topic at the top.
- Take good and clean notes.
- Consider rewriting your notes immediately after the lecture. Write neatly, with better organization, and supplementing the notes from the textbook to make your notes a complete resource.
- Consider making a one-page summary of the lecture for that day.

Rewriting of Notes



One-Page Summary of Notes



Study Techniques

When to Study What

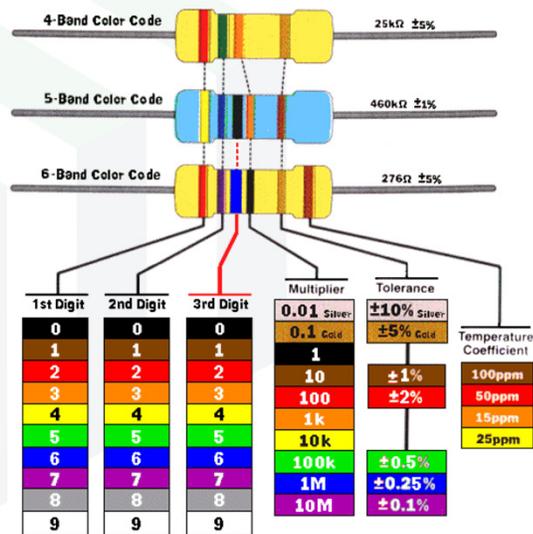
They say...

Study new concepts in the mornings.

Study memorization in the evenings.

Mnemonics

Bright Black
 Boys Brown
 Rave Red
 Over Orange
 Young Yellow
 Girls Green
 But Blue
 Veto Violet
 Getting Gray
 Wed White



Write a Topic Summary

Summarize a topic on single side of a single piece of paper.

The summary should contain all necessary information to review the topic and to solve problems.

A one-page summary allows the brain to visualize and organize all of the key information in a single glance.

Consider including supplementary information, such as derivations and practice problems behind the summary.

Propagating Uncertainty  <https://empossible.net/>

Description of the Problem
Very often the exact values for quantities are not known due to uncertainty in measurements. For example, the height of a person may be written as 1.8 ± 0.02 m. In this case, 0.02 m is the uncertainty in the measurement and is interpreted as the standard deviation σ of a normal distribution with mean value $\mu = 1.8$ m.

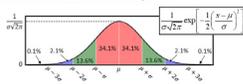


Table of Common Uncertainty Calculations

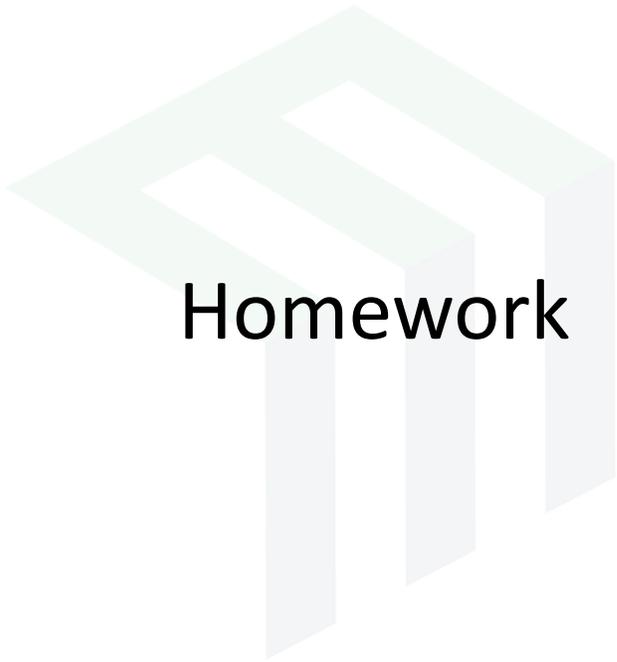
Math Operation	Uncertainty After Operation
$f(x) = ax$	$\sigma_f = a\sigma_x$
$f(x,y) = ax + by$	$\sigma_f^2 = (a\sigma_x)^2 + (b\sigma_y)^2$
$f(x,y) = ax - by$	$\sigma_f^2 = (a\sigma_x)^2 + (b\sigma_y)^2$
$f(x,y) = xy$	$\sigma_f/f = \sqrt{(\sigma_x/x)^2 + (\sigma_y/y)^2}$
$f(x,y) = x/y$	$\sigma_f/f = \sqrt{(\sigma_x/x)^2 + (\sigma_y/y)^2}$
$f(x) = x^n$	$\sigma_f/f = n\sigma_x/x$
$f(x) = \ln(x)$	$\sigma_f = \sigma_x/x$
$f(x) = \exp(x)$	$\sigma_f = \exp(x)\sigma_x$
$f(x) = \sin(x)$	$\sigma_f = \cos(x)\sigma_x$
$f(x) = \cos(x)$	$\sigma_f = \sin(x)\sigma_x$
$f(x) = \tan(x)$	$\sigma_f = \sec^2(x)\sigma_x$
$f(x) = \arcsin(x)$	$\sigma_f = \sigma_x/\sqrt{1-x^2}$
$f(x) = \arcsin^2(x)$	$\sigma_f = 2x\sigma_x/(1-x^2)$
$f(x) = \ln(x^2 + y^2)$	$\sigma_f = 2\sqrt{(\sigma_x/x)^2 + (\sigma_y/y)^2}$
$f(x) = \ln(x/y)$	$\sigma_f = \sqrt{(\sigma_x/x)^2 + (\sigma_y/y)^2}$

Propagating Uncertainty
Suppose a function is calculated from multiple quantities where each has an uncertainty. What is the uncertainty σ_f of $f(\dots)$?

$$\sigma_f^2 = \left(\sigma_x \frac{\partial f}{\partial x}\right)^2 + \left(\sigma_y \frac{\partial f}{\partial y}\right)^2 + \dots + \left(\sigma_n \frac{\partial f}{\partial x_n}\right)^2$$

Rewrite Your Notes

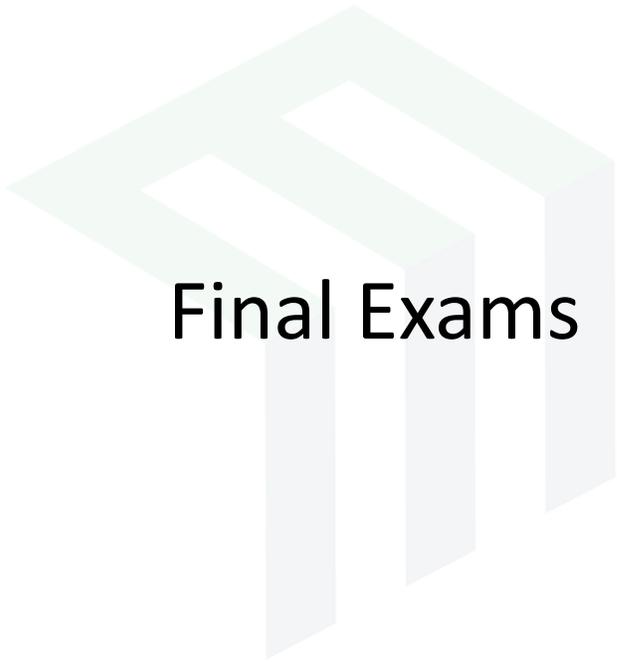
- Rewrite your lecture notes as immediately after class as possible.
- Clean up your writing.
- Better organize the information.
- Supplement the information with information gathered from the textbook, internet or other sources.
- Fill in steps in derivations and example problems.
- Consider creating a one-page summary for each set of notes.



Homework

Homework Advice

- Write your homework to be understood and useful to yourself ten years from now.
- Time permitting, go overboard with graphics, formatting and explanations.
- Get started early and seek help from instructor early if needed.
- Every one hour in the classroom requires at least three hours of study and homework outside of the classroom.
- Take frequent breaks.
- Consider making and revising your summaries and cheat sheets as you do your homework.



Final Exams

Strategize Your Study Time

1. Calculate what grade you will need on each final exam to get an A in the classes.
2. Devote more study time to the classes needed a higher grade on the final exam instead of just the difficulty of the material.

Cheat Sheets?

If you are allowed a cheat sheet, create an excellent cheat sheet.

If you have been making one-page summaries, pull from this material to make your cheat sheets.