



Research Methods in Science in Engineering

## Science & Research

Slide 1

## Lecture Outline

- Science and engineering
- Art of science and engineering

Slide 2

# Science & Engineering

## Science

Logic and reason drive  
the scientific method.

*Systematic* study of the structure and behavior of the  
*natural world* through *observation and experiment*.

Not the supernatural  
world.

Evidence based

## Engineering

Engineering is science!

Branch of *science* primarily concerned with *applying* science.

We build things to improve the world.

## Origin of Scientific Ideas

Ideas can come from anywhere!

We do not have to justify the origin of our ideas.

However, we must be ready to abandon our ideas when evidence proves the ideas are wrong.



## Scientific Hypothesis

A proposed explanation about what might be true.

Usually is used as a starting point for scientific research.

## Engineering Problem Statement

Engineering research very often does not have a hypothesis.

Sometimes we already know what is true.  
Engineers just have to get that true thing to work in a way that is useful  
and convenient.

## Scientific Theory

A well-established explanation of an aspect of the natural world that can be repeatedly verified by experiment.

Galileo Galilei argued that a scientific theory must make predictions that can be tested by experiment. Theories must be disprovable.

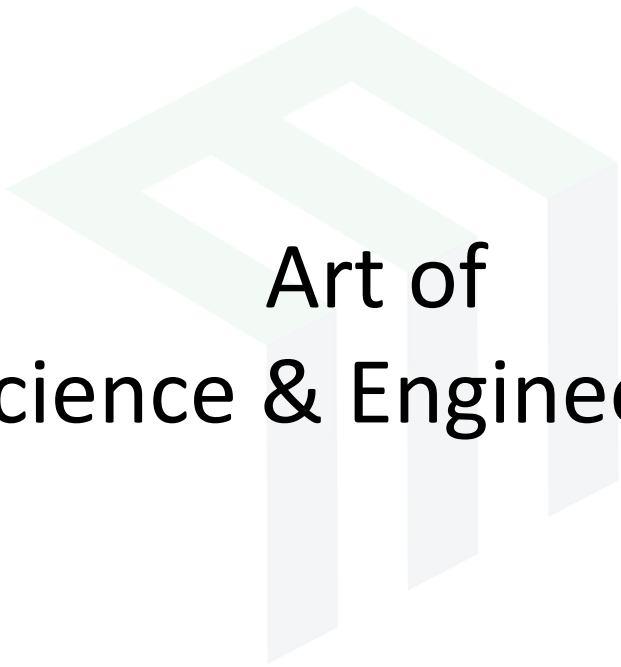
Kurt Gödel stated that a formal logical system cannot prove itself consistent. Theories cannot explain everything.

## Facts

There are no *facts* in science.

There are only things that we assume to be true in order to get other things done.

We must always be willing to abandon what we assume to be true (facts?) when evidence suggests otherwise.



# Art of Science & Engineering

## Creativity

Can creativity be taught or learned?

The most creative people tend to be the most *curious*, most *playful* and the *least bothered by peer pressure*.

Society does an incredible job of beating the creativity out of people.

## Brains or Stamina

Getting your PhD is much more about *stamina* and *dedication* than it is about intelligence.

A PhD is an *independent researcher* who has demonstrated an *insane level of commitment*.

## Failure

*Failure* is your most powerful tool for *success*.

Fail *fast*. Fail *cheap*.

Fail for the *right reasons*.

# How To Do Your Graduate Research

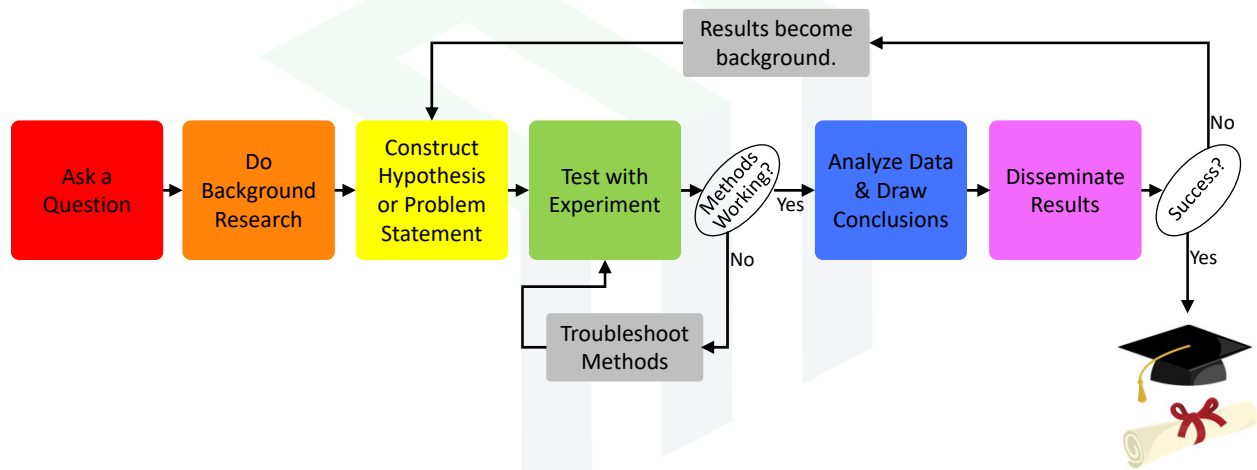
## One-Slide Summary of Grad School

Get a Job  
↓  
Branding  
Materials Search  
Apply  
Interview  
Accept

- Find a good advisor and let them guide you
- Read everything and become a subject matter expert
- Identify a research topic
- **Perform preliminary research to better understand your topic and perhaps prove feasibility**
- Propose your topic to your committee
- **Finish your research**
- Disseminate and defend your research.



## The Scientific Method



## Plan Your Research Wisely



Break large and difficult problems down into a series of smaller and simpler problems.

## Follow the Advice of Your Advisor

Your advisor has seen and been through many common traps that graduate students fall into.

They understand the game and what it takes to be successful.

Choose your advisor wisely and follow their advice.