



**Center for Advanced Power  
Engineering Research**

# **Power Engineering Curriculum at NC State: A Student Perspective**

**Catie McEntee  
November 9, 2017**

# Wolfpack for Life

- 2015: Bachelors in Electrical Engineering
  - Renewable Electric Energy Systems Concentration
- 2016: Masters Electric Power Systems
- Now: PhD Student

# Required Courses (REES)

## Required ECE Courses

- ECE109
- ECE200
- ECE209
- ECE211
- ECE212
- ECE220
- ECE301
- ECE302
- ECE303
- ECE305
- ECE380
- ECE452
- Senior Design

## Electives (6)

- Foundational Electives (1)
- ECE Electives (2)
- REES Elective (1)
  - ECE 451
- Open Electives (2)

# ECE211: Electric Circuits

- AC and Phasors
- Three phase power
- Real/Reactive Power
- Transformers
- Transient Response

# ECE 305: Intro to Power systems

- Three Phase Power
- Real/Reactive Power
- Transformers
- Motors and Generators

# ECE 451: Power Systems Analysis

- Power Flow
- Fault Calculations
- Economic Dispatch
- Unit Commitment

# ECE 452: Renewable and Efficient Generation

- PV cells
- PV systems
- Wind Turbines
- Conventional Generation (coal, oil, gas)
- Economics

# Other Things Undergrads Learn

- Math
- Programming
- Verbal & Written Communication skills
- Communications (RF, etc.)
- Electromagnetics
- GEPs



# **Did I Need a Masters Degree to be an Effective Power Engineer?**

# With a Bachelors Degree

## What I Knew

### Three-Phase Transformer Example 1 (2)

$$(a) \quad V_{base,pri} = 4160 V, \quad V_{base,sec} = 480 V, \quad S_{base} = 2500 KVA$$

$$I_{base,pri} = \frac{S_{base}}{\sqrt{3} \times V_{base,pri}} = \frac{2500 \times 10^3}{\sqrt{3} \times 4160} = 347.0 A \quad ; \quad I_{base,sec} = \frac{2500 \times 10^3}{\sqrt{3} \times 480} = 3007.0 A$$

$$\tilde{I}_a = \frac{S_{3\phi}}{\sqrt{3} \times V_{line,sec}} \angle -\cos^{-1} PF = \frac{2000 \times 10^3}{\sqrt{3} \times 460} \angle -\cos^{-1} 0.9 = 2510.2 \angle -25.8^\circ \quad ;$$
$$|\tilde{I}_a| = 2510.2 \quad A$$

$$(b) \quad |\tilde{I}_A| = \left( |\tilde{I}_a| \right) / n_{eff} = \frac{480}{4160} (2510.2) = 289.6 A \quad ; \quad n_{eff} = \frac{V_{L,Rated,pri}}{V_{L,Rated,sec}} = \frac{4160}{480}$$

## What I didn't Know

### Three-Phase Transformer Options



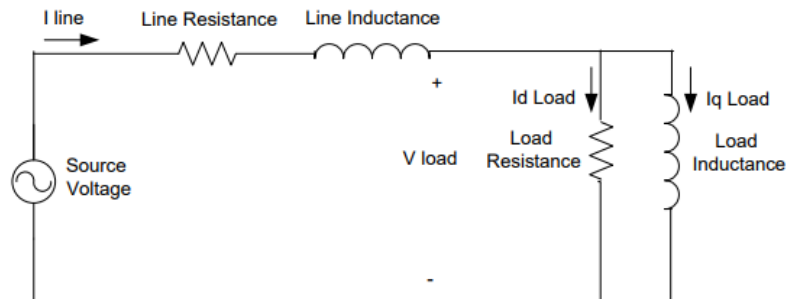
- Three individual transformers or multi-legged core.



# With a Bachelors Degree

## What I Knew

### Impact of Reactive Power Example



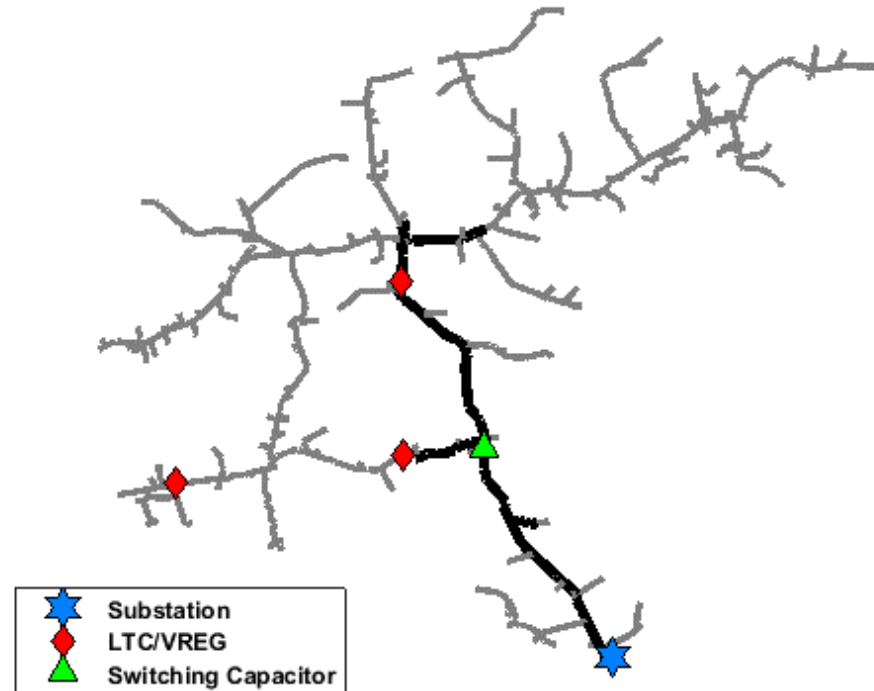
- Metrics
  - Voltage Drop
  - Line Loss
  - Source Apparent Power, S
  - Source Reactive Power, Q

Source Voltage (kV)	12.47	Load Voltage (kV)	12.01
Load (kVA)	3000	Percent Voltage Drop	3.7%
Power Factor	0.85	Line Loss (kW)	56.2
Line Resistance per Mile	0.30	Percent Line Loss	2.2%
Line Reactance per Mile	0.68	Source kVA	3115
Line Length (Miles)	3	Source kVAR	1641

David Lubkeman (North Carolina State University) ECE 551 Smart Electric Power Distribution Systems

18

## What I Didn't Know



- ★ Substation
- ◆ LTC/VREG
- ▲ Switching Capacitor

# With a Bachelors Degree

## What I knew

- Math
- Circuit Diagrams
- What is happening

## What I Didn't Know

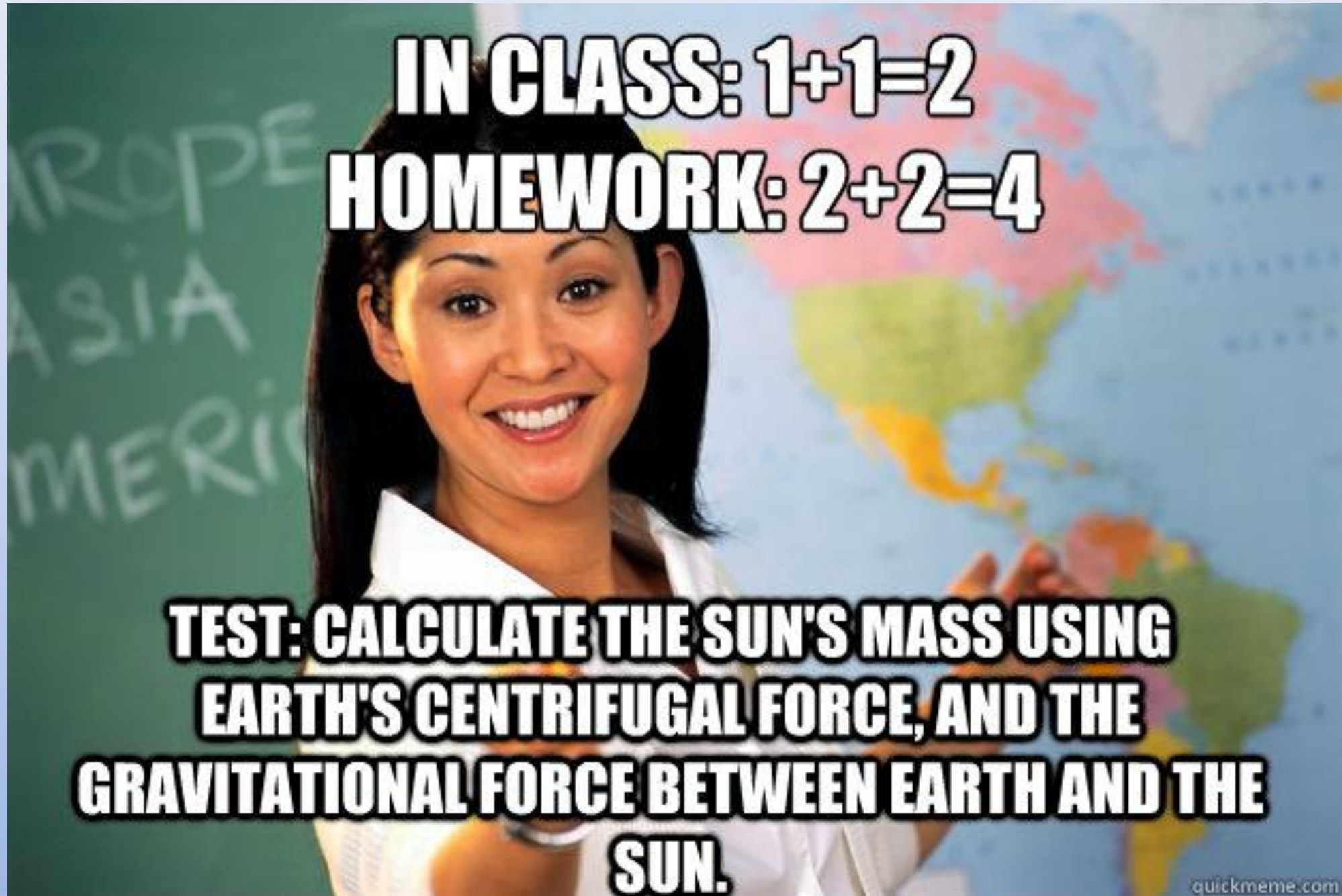
- Design
- Electrical Drawings
- What do we want to happen
- Why?

# Suggestion

## Intro power class

- What is the grid and how does it work?
- What are the problems facing the power industry?
- What skills will I need to help solve them?
- What types of jobs exist in the power industry?
  - Include field trips so students can learn what actual engineers do

# What Makes Classes Hard?



**IN CLASS:  $1+1=2$**   
**HOMEWORK:  $2+2=4$**

**TEST: CALCULATE THE SUN'S MASS USING  
EARTH'S CENTRIFUGAL FORCE, AND THE  
GRAVITATIONAL FORCE BETWEEN EARTH AND THE  
SUN.**

quickmeme.com

# What Makes Classes Hard

- Notes and examples that are confusing or incorrect
- Unclear conventions or assumptions
- Discouragingly hard homework
  - Critical thinking is important but impossible if you never knew the basics to start



# What Makes Classes Bearable?

# The Best Teachers

- Clear, error-free notes with thoroughly worked-out examples
- Homework that is a mix between direct application and inference
- Work examples on the board in real time
- Find ways to make class interesting
  - Is going to class more engaging than reading the textbook?

# What Makes Classes Useful?

# What Makes Classes Useful: Motivation

- What job can I get that will use this?
- What does someone with this job do on a daily basis?
- Is this a job I would like?
- Who should I talk to if I want this job?