CAPER

Center for Advanced Power Engineering Research

Power Engineering Curriculum at NC State: A Student Perspective

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

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

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

$$\left|\tilde{I}_a\right| = 2510.2 \quad A$$

(b)

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

What I didn't Know

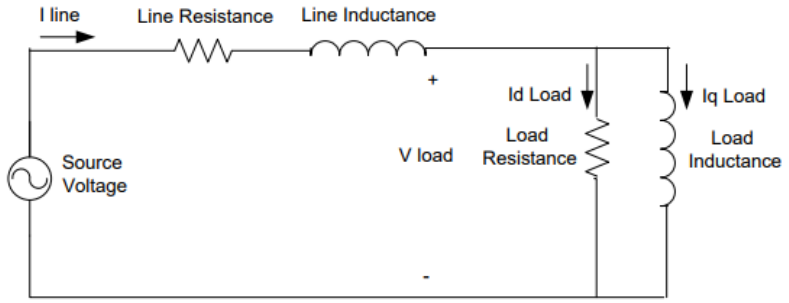
Three-Phase Transformer Options

- Three individual transformers or multi-legged core.

With a Bachelors Degree

What I Knew

Impact of Reactive Power Example



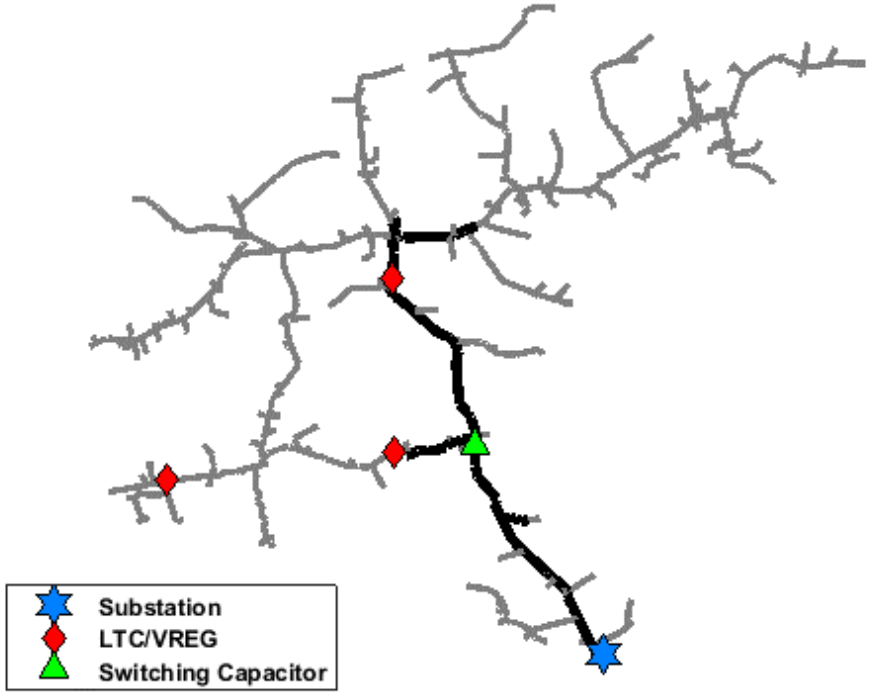
- Metrics
  - Voltage Drop
  - Line Loss
  - Source Apparent Power, S
  - Source Reactive Power, Q

Source Voltage (kV)	12.47
Load (kVA)	3000
Power Factor	0.85
Line Resistance per Mile	0.30
Line Reactance per Mile	0.68
Line Length (Miles)	3

Load Voltage (kV)	12.01
Percent Voltage Drop	3.7%
Line Loss (kW)	56.2
Percent Line Loss	2.2%
Source kVA	3115
Source kVAR	1641

David Lubkeman (North Carolina State University) ECE 551 Smart Electric Power Distribution Systems 18

What I Didn't Know



With a Bachelors Degree

What I knew

- Math
- Circuit Diagrams
- What is happening

What I Didn't Know

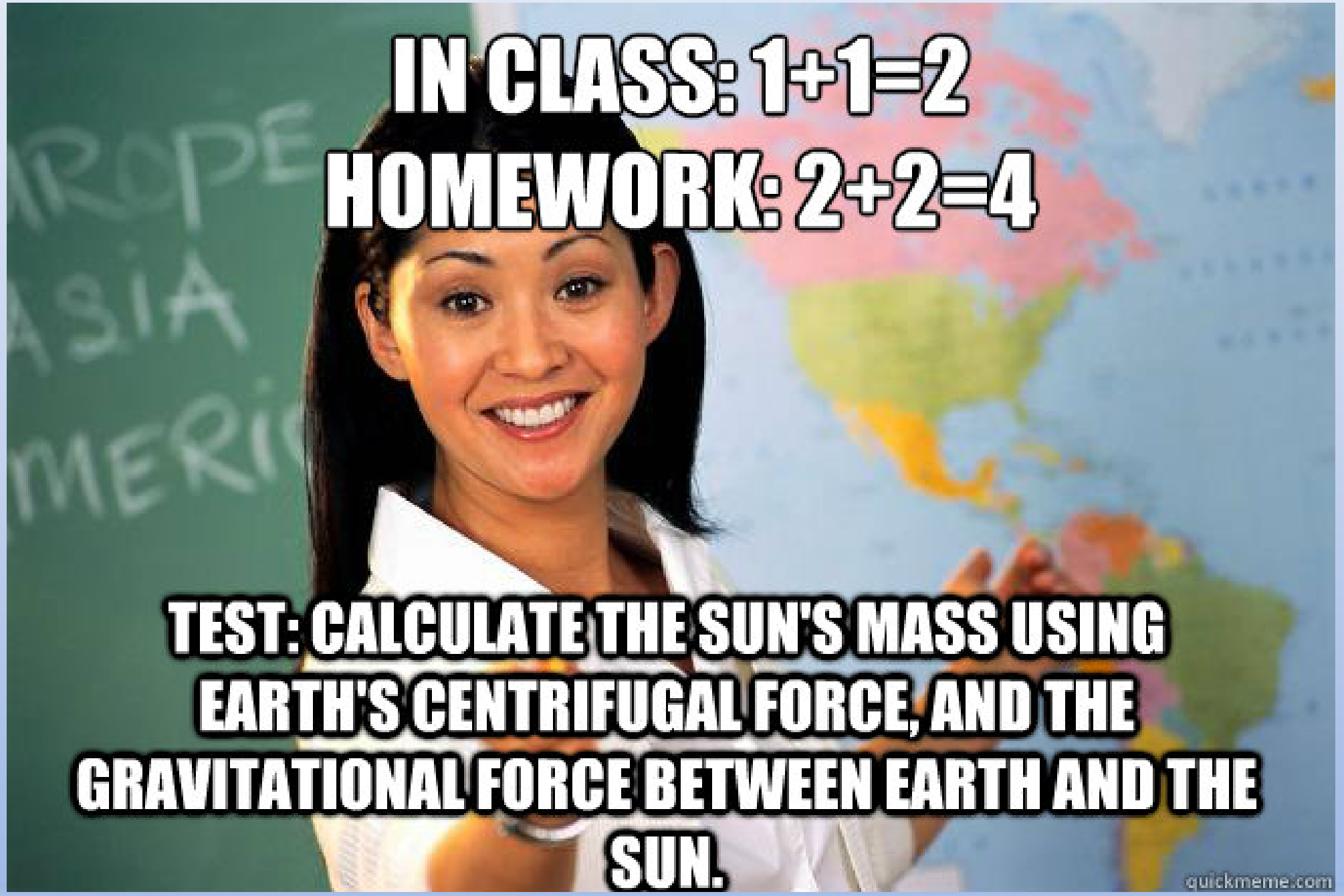
- Design
- Electrical Drawings
- What do we want to happen
- Why?

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?