EEC390: Teaching Electrical and Computer Engineering
Session II - Helping the Student

Richard Spencer
Vice Chair for Undergraduate Studies

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Outline

- Objectives
- Methods
- Examples

Objectives

- You want to *assist* the student to find the answer, not give it
- They need to learn how to function independently
  - How to find information on their own
  - How to move on when “stuck”
  - How to double check a solution
- Engineers solve problems, so learning the *process* is more important than the answer

Critical Thinking

- A critical thinker:
  - Is proficient at gathering and assessing data, different approaches and concepts
  - Spots incorrect assumptions and fallacious arguments
  - Does not get stuck (i.e., knows how to move on when temporarily stymied)
- To learn critical thinking:
  - Take time - *struggle* with the problem!
  - Ask *precise* questions
  - Don’t look for a quick answer or set procedure
  - Work on a problem more *after* you have “the answer”

When You Don’t Know What to Do

- Don’t just sit there, do *something*!
  - Check your algebra and arithmetic
  - Check your assumptions (it *can’t* be the …)
  - Check your data - are they reliable? reasonable? can you get them another way?
  - Check your models - are they good enough?
  - Rephrase the question
  - Try a different approach
  - Explain the problem to someone else
  - Try a simpler, but similar, example

Learning Strategy

- Develop intuition, for example;
  - Virtual ground for op amps - why?
  - View op amp circuits as V-to-I, followed by current summing, followed by I-to-V
  - Why does current lead voltage in a capacitor?
- Look for connections and restrictions, for example;
  - Why do we use exponential signals? sine waves?
  - Are Kirchoff's laws always true?

Teaching Problem Solving

- Be careful with concepts you find obvious!
- Be sure you understand the question
- Listen carefully for what they *don't* say
- Make them be precise and complete
- Make them have all the information at hand (e.g., schematics, SPICE files)
- Encourage and motivate them
- Ask the right questions
- Ask them to outline a procedure - which steps do they not know how to do?

Teaching Problem Solving II

- Have them make rough estimates
- Have them look for extra sources of information - other books, the web, journals
- Have them check intermediate results for consistency (reality check, units)
- Consider extreme cases (i.e., if some variable assumes an extreme value, the answer may be obvious - then work from there)

Teaching Problem Solving III

- Ask them questions!
  - What do you know about the problem?
  - What should the answer be? Why?
  - Can you break it down into smaller steps?
  - Why did you do that? (get roadmap)
  - How did you do that? (get details)
  - Is there another way to do that?

Common Problems

- Round off errors in intermediate steps
- Mixing units
- Not checking assumptions
- Not doing a reality check
- Not really understanding what they are trying to do
- Not really understanding some basic principle
- Using an insufficient or improper model

Common Problems II

- Jumping to the answer
  - If it was that easy, who would pay you?
- Wanting a universal procedure
  - If one existed, who would pay you?
- Applying a procedure that doesn't apply
- Not knowing the limitations of a method or model

Examples

- Final voltage on two capacitors
- Argument for virtual ground
- Measured bandwidth way too small
- Measured gain off by a factor of two
- Why can we use superposition for the large- and small-signal solutions to a non-linear problem?
- How can you explain the small-signal approximation?