An Active Learning Exercise for the ECE VCP

The goal of the exercise is to help participants think about how to develop learning objectives for their class(es) and how to design learning activities that support those objectives.

1. Working with existing learning objectives
    a. Consider the set of Circuits'learning objectives provided. Choose a learning objective of interest to you, and brainstorm about an activity you could design to help students meet that objective. (The describe/discuss/explain/calculate objectives may allow more creativity in designing learning activities than the define/state objectives.)
    b. Join with 1-2 other participants (breakout sessions) to share your ideas. Choose one idea to develop further as a team.

2. Designing your own learning objectives
    a. Consider a mid-level (sophomore/junior) ECE course you will be teaching in Spring 2014. Identify a topic covered in the course, and draft a learning objective related to this topic. What learning activities have you used in the past to support this objective? What new type of activity might you like to try in the spring?
    b. Join with 1-2 other participants (breakout sessions) to discuss your learning objective and the new type of activity you'd like to try. With feedback from your group, design a preliminary version of the activity.

Circuits Learning Objectives

From Susan M. Lord University of San Diego

1. Describe the concepts of current, voltage, power, & resistance including appropriate units.

- Define and use the units of meter, kilogram, second, ohm, volt, and ampere, and the prefixes of nano, micro, milli, kilo, and mega.
- Define and discuss charge and electric current and write the equation relating these terms.
- Define and discuss voltage and power.
- Define resistance and conductance.

2. **Describe basic circuit elements and compute the power supplied or absorbed by an element.**
   - Define and identify an open circuit, a short circuit, a node, and a closed loop.
   - Describe the current through or voltage across a resistor using Ohm's Law.
   - Define and analyze the two types of independent sources.
   - Define and analyze the four types of dependent sources.
   - State the difference between active and passive circuit elements.
   - Explain the passive sign convention and correctly apply it to power calculations for resistors, voltage sources, and current sources.
   - Calculate the power absorbed or delivered by all circuit elements in an electrical network.

3. **Recognize relationships that are useful for analyzing simple resistive circuits**
   - Define and identify elements that are connected in series or in parallel.
   - Discuss the voltage and current relationships that exist between elements that are connected in series and those connected in parallel.
   - Determine the equivalent resistance for combinations of resistors.

4. **Explain Kirchhoff's Laws in your own words and apply them to analyze a given circuit.**
   - State KVL and KCL.
   - Analyze simple DC circuits using KVL and KCL.
   - Design a circuit that satisfies specified constraints (e.g. power, current or voltage).

5. **Be able to derive, recite, and apply the voltage-divider and current-divider relationships for circuits containing two or more resistors.**
   - Write the voltage divider and current divider equations.
   - State when it is appropriate to use the voltage divider equation.
   - State when it is appropriate to use the current divider equation.

6. **Describe various DC circuit analysis techniques including *Node-Voltage, Mesh-Current*, Superposition, Source Transformation, and Delta to Y transformations. Determine which method is appropriate for a particular circuit and successfully apply the technique to solve for voltages, currents, or powers.**

   a) Node Voltage

   - Distinguish between a node and a supernode. Determine the number of each in a circuit.
   - Explain and correctly apply node voltage analysis to circuits with independent and dependent current and voltage sources. This includes drawing an appropriate diagram, labeling the nodes, selecting a reference node, defining the nodal voltages of the circuit and identifying whether or not a supernode is needed.
   - Write all necessary node voltage equations and constraint equations to completely analyze a given circuit.
   - Calculate all voltages, currents, and powers in a circuit using nodal voltages.

b) Mesh Current

- Distinguish between a mesh, a loop, and a supermesh.
- State the difference between a branch current and a mesh current.
- Explain how to obtain branch currents from mesh currents.
- Explain and correctly apply mesh current analysis to circuits with voltage sources, independent current sources, and dependent current sources. This includes drawing an appropriate diagram, labeling all mesh currents with their directions, and identifying whether a supermesh is needed.
- Write all of the necessary mesh-current equations and constraint equations to completely analyze a given circuit.
- Calculate all voltages, currents, and powers in a circuit using mesh currents.

c) Superposition

- Explain the principle of superposition and when it is valid.
- Apply the principle of superposition to determine the response (V or I) of a circuit to multiple independent sources.
- Explain why deactivating a voltage source means replacing it with a short circuit while deactivating a current source means replacing it with an open circuit.
- Explain why you can not deactivate a dependent voltage or current source when performing superposition.

d) Source Transformation

- Define source transformation and explain why it can be useful in circuit analysis.
- Perform source transformations to simplify circuit analysis.
- Calculate specific voltages, currents, or powers using source transformation.

7. Replace a given circuit with its Thévenin and/or Norton Equivalent circuit.

- Derive the Thévenin or Norton equivalent circuit at a pair of terminals when the circuit contains resistors and independent or dependent sources using the following techniques:
  - Determine both the open-circuit voltage (Voc) and the short-circuit current (Isc) using standard analysis techniques. Calculate Rth =Voc/Isc.
  - Derive the Thévenin equivalent resistance, Rth, by either
    - (i) deactivating all independent sources & determining effective resistance
    - (ii) applying a test current (i_{test}) or test voltage (v_{test}) & calculating Rth = v_{test}/i_{test}.
  - Perform a series of source transformations.
- Convert between a Norton and Thévenin equivalent circuit using source transformation.