Reviewing Circuit Basics Through the Use of a Card Game

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Abstract

Three problems regularly occur when covering electronic circuit basics in lecture: (1) the brightest students already know the material and mostly finish early, are bored, and talk to each other, (2) The struggling students continue to struggle, becoming frustrated and bored and unlikely to get the attention they need to understand the material, and (3) series and parallel circuits are essentially very simple, so a professor creating circuits for lecture must remember which values are on the exam and try to avoid them. A card game has been designed in order to address these problems and enhance learning. Over the course of this card game, students must form groups of four of five and solve circuits together. The students get bonus points for each circuit they solve, but only if all members of a group provide the correct information. This paper and presentation will show how the Circuit Card Game is played and run.

Introduction

In introductory electronics courses, students are familiarized with series, parallel, and series-parallel circuits in lecture, through homework, and, often though not always, through laboratory experiments. Research has shown that the majority of engineering students are active learners rather than reflective learners, meaning that they benefit more from discussing and explaining their work rather than from silent, solitary analysis [1-3]. Laboratory experiments are one method of providing a more active education, but some students might be taking measurements without actually understanding the results that they are getting. To supplement their traditional reflective lecture experience and their active but possibly unclear laboratory experiments, students in "Electric Circuit Analysis I" play an interactive card game to help them review circuits. The remainder of this paper describes this card game.

Game Equipment

The equipment for the Circuit Card Game is as follows:

- Nine E cards, each of which depicts a battery with a voltage value that has many factors (e.g. 360V)
- Nine R_1 cards, each of which depicts a resistor ranging in value from 2Ω to 10Ω
- Nine R_2 cards, each of which depicts a resistor ranging in value from 2Ω to 10Ω
- Nine R_3 cards, each of which depicts a resistor ranging in value from 2Ω to 10Ω
- Five R_4 cards, each of which depicts a resistor ranging in value from 11Ω to 15Ω
- A Visual Basic computer program that students use to enter their values and answers

When Students Enter the Classroom

The top 25% of students, determined by homework, exam grades, class participation, and the professor's judgment, each pick an E card. This is done so that at least one person in each group is likely to have a clear understanding of how to solve series, parallel, and series-parallel circuits. The other 75% of students pick R_1, R_2, or R_3 cards so that the same numbers of E, R1, R2, and R3 cards have been handed out. Since each group will have one of each type of card, students who tend to work together should be given the same type of card so they will be forced to work with students outside of their usual groups. If the number of students in the room is not a multiple of four, all remaining students who do not have cards are given an R_4 card.

After the Cards Have Been Dealt

The professor draws a series circuit on the board. Students are then told to form groups that contain one E, one R_1, one R_2, and one R_3. Students with R_4 can join any group that does not already have an R_4. All players are then told that for the circuit shown, they are to find the voltages, currents, and powers of their components. If the group has an R_4, they are told to put it in series with the other resistors.

Once every member of a group thinks they have all of the correct answers, they come to the front of the room and each in turn enters his or her name, the card value, and the voltage, current, and power, for his or her component. The team clicks on the "Enter" button. If there is a mistake somewhere in their solution, the screen turns red, but there is no specific indication of what mistake was made. The group must then go back to their desks and work together to figure out what went wrong. If everything is correct, the screen turns green, the program enters the students' names into a text file, and students are encouraged to help other groups that are struggling to find their own solutions.

After All of the Groups Have Finished

All students with an R_4 card or no card (because they came to class late) is reassigned to give as few R_4 cards as possible. Other students might be promoted to E at this time to balance everyone out. Students are told to find new groups with no students working together who worked together in the first circuit, though exceptions can be made if this is too difficult for a large group. The series circuit is erased from the board and a parallel circuit is drawn. Students then proceed as they had for the series circuit. Groups with an R_4 are told to put that resistor in parallel with all other elements in the circuit.

For the final round, students then solve a series-parallel circuit. The one coded into the Visual Basic program has the total resistance (R_T) as seen by the voltage source equal to $R_1 + (R_2 \parallel R_3)$. For groups with R_4, $R_T = R_1 + R_4 + (R_2 \parallel R_3)$.

At the End of the Class (Game) Session

Students return their cards and receive five points added to a homework grade for every successfully solved circuit.

Adaptations for Different Classes

Depending on the duration of the lecture session and the skill level of the students, power calculations can be included or omitted, the number of times each different type of circuit is solved can be increased or decreased, and the reshuffling of students can be enforced or relaxed.

Summary

By the end of this class, or game session, students have had an active and lively experience explaining circuits to each other and learning from their classmates, including ones they may not have had the opportunity to speak to before this game. While surveys have not yet been given nor data been analyzed, students seem to enjoy playing this game and at least one expresses the wish every semester that all electronics lectures be taught as interactive card games.

References

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