Experiences on Development and Design of STACK Problems for Circuit Analysis

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Contents

• Introduction

• STACK

• STACK Problems in Circuit Analysis

• Student Feedback

• Conclusions
Introduction

• Circuit Theory at University of Vaasa is divided into two courses: Circuit Analysis A and B.

• Contents of Circuit Analysis A:
  – Basics of DC Analysis and solution methods in a steady state
  – AC Analysis, filters, compensation of reactive power, symmetric 3-phase system.

• Contents of Circuit Analysis B:
  – Transient Analysis
  – Solving circuits with the use of Laplace Transform
  – Transmission lines
  – Z & Y-parameters in a 2-port network.
Introduction

- The sufficient skill level and knowledge of the circuit theory must be acquired during the first circuit analysis course.

- Any misinformation and problems in understanding the fundamentals are carried on to Circuit Analysis B which makes the course more challenging.

- Fundamental knowledge of the circuit theory must be on an acceptable level when attempting the more advanced and applied courses.
STACK
(System for Teaching and Assessment using a Computer algebra Kernel)

• STACK is a Moodle plugin which allows the teachers to develop mostly mathematical problems with automated evaluation and feedback.

• To achieve the desired skills, the Circuit Analysis A consists of lectures, excercises, simulations and as a new addition: STACK problems.
STACK Problem

Briefly, the **STACK problems** consist of three main parts:

- **Question Variables**
  - Variable definitions (integers, strings, equations etc.)

- **Question Text**
  - The main HTML
  - Assignement, information, visualisation, inputs etc.

- **Potential Response Tree (PRT)**
  - Automatic evaluation of the student answer
  - Feedback based on the answer
STACK – Potential Response Tree

- Consists of several evaluation tests called ‘nodes’

- In the nodes, the students’ answer can be compared with the right answer to determine if the answer is correct.

- Each node has two outputs: true or false. These outputs can be connected to other nodes to construct a tree-like structure.

- Each node can also give a very specific feedback for the student related to the test result.

- Grading can also be implemented.
STACK Problems in Circuit Analysis

• Circuit Analysis problems can also be converted into **STACK problems** to enhance the student’s learning possibilities.

• One of the most important things to consider is the visual presentation of the problem, usually the circuit diagram.

• In Circuit Analysis A visualization is achieved by using the **JSXGraph** JavaScript Library which is supported by STACK.
STACK Problems in Circuit Analysis

- **JSXGraph** allows the teacher to draw geometrical figures like circles, lines, rectangles etc.

- These interactive elements can be used to draw electrical components and a whole circuit diagram.

- The variables defined in **Question Variables** can be used as parameters when drawing the components.
STACK Problems in Circuit Analysis

• Variables can be assigned with random values from a given set. This allows the generated circuit (and problem) to be different on each attempt.

• Therefore, different components can be presented each time the student tries to solve the circuit.

• This creates more variation which can help the student to realize the key concepts better.
The components created with JSXGraph can be moved around allowing the creation of interactive and dynamic question types.

Consequently, instead of typing a value or an equation the student has to interact with the components and the circuit to answer the question properly.
Student Feedback

- A feedback related to the **STACK problems** from the students was gathered at the end of Circuit Analysis A in Spring 2020. 14 students out of 25 answered. (N = 14).

- Overall the feedback was very positive. Some answers praised the helpfulness of the **STACK problems** in understanding the key concepts better.

- Few improvement ideas were also introduced.
Student Feedback

Some positive feedback given by the students:

• “With the help of the problems, I learned to solve the exercises as well.”

• “Simple enough, one could learn the new topics from them.”

• “My calculation routine developed.”

• “The questions helped me to understand some of the concepts better like the Nodal analysis or voltage differences over a component.”

• “Problems helped to illustrate some of the concepts.”

Some negative feedback and improvement ideas given by the students:

• “There could have been more problems. Some of the deadlines could have been given immediately. Now they came out too suddenly.”

• “The feedback from the questions could have been better in some parts.”

• “Change the needed percentage for the question to be considered done right from 100% to 98%. It was frustrating doing a problem for 45 minutes just to begin from scratch due to a miss click.”

• “Sometimes it is frustrating to start from scratch if for example a minus sign inside a matrix is missing.”

• “There could have been more problems.”
Conclusions

• Circuit Analysis problems can be implemented to STACK with the help of JSXGraph.

• Different variations of the questions are easily achieved with the use of randomization.

• With the Potential Response Tree and its feedback, fundamental mistakes can be identified and corrected.

• A very powerful tool in addition with other teaching methods and materials. Students liked these STACK problems.
THANK YOU FOR YOUR INTEREST AND ATTENTION!

Any Questions?

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