



Vaasan yliopisto
UNIVERSITY OF VAASA

Experiences on Development and Design of STACK Problems for Circuit Analysis

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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, excersises, simulations and as a new addition: **STACK problems**.

STACK Problem

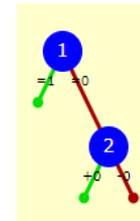
Briefly, the **STACK problems** consist of three main parts:

- **Question Variables**
 - Variable definitions (integers, strings, equations etc.)
- **Question Text**
 - The main HTML
 - Assignment, information, visualisation, inputs etc.
- **Potential Response Tree (PRT)**
 - Automatic evaluation of the student answer
 - Feedback based on the answer

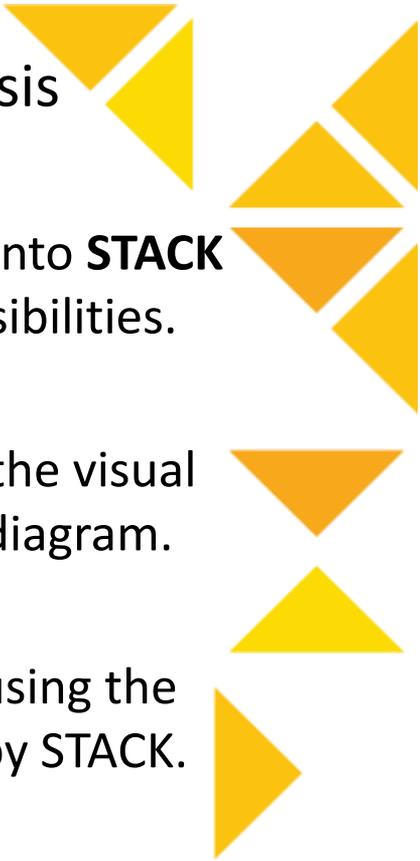
STACK – Potential Response Tree

- 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.

This potential response tree will become active when the student has answered: **ans1**



STACK Problems in Circuit Analysis



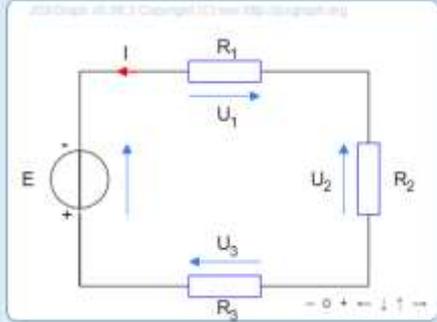
- Circuit Analysis problems can also be converted into **STACK problems** to enhance the student's learning possibilities.
- One of the most important things to consider is the visual presentation of the problem, usually the circuit diagram.
- In Circuit Analysis A visualization is achieved by using 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

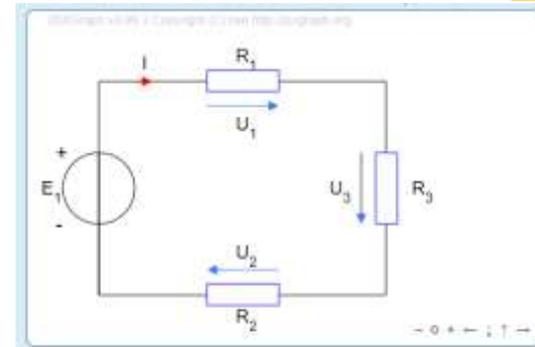
Write the given circuits voltage equation according to Kirchhoff's voltage law. Use the variables E , U_1 , U_2 and U_3 . It does not matter which way you choose to circulate the loop.

Equation : = 0

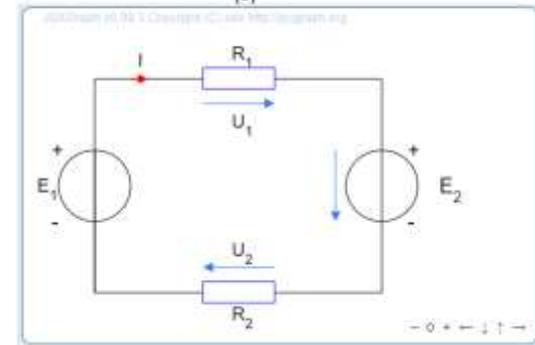


STACK Problems in Circuit Analysis

- 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.

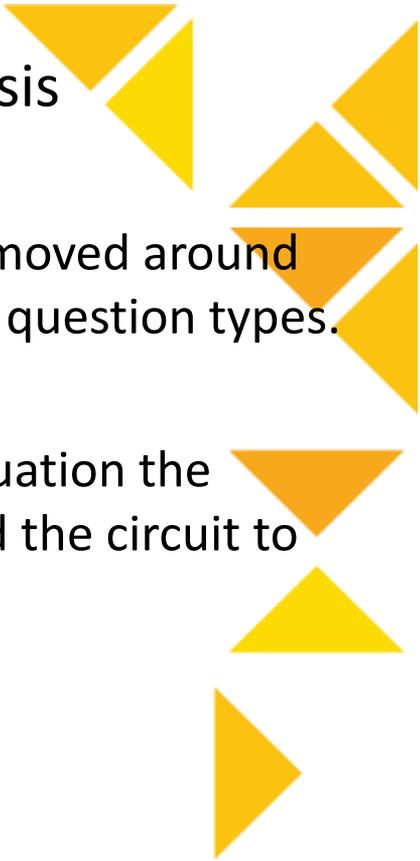


(a)



(b)

STACK Problems in Circuit Analysis



- 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 k 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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