# 3rd Homework Problem

- In this homework problem, we wish to exercise the application of the algorithms by Pantelides and Tarjan, as well as the tearing method.

- The problem deals with another simple electrical circuit.

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Structural Singularity
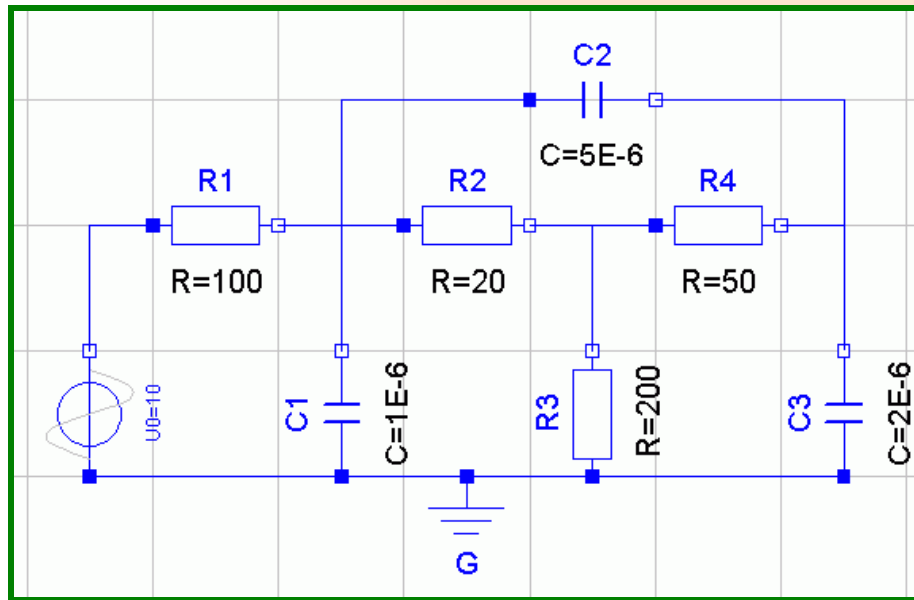
Show that the circuit depicted on the left exhibits a *structural singularity*.

To this end, find a complete set of equations in currents, potentials, and Voltages (ignoring the mesh equations), and draw the digraph of the resulting DAE system.

Subsequently, color the digraph by use of the algorithm by Tarjan, and demonstrate that the system is indeed structurally singular.

Explain the structural singularity by analyzing the mesh that is formed by the three capacitors.

Pantelides Algorithm

- Apply the algorithm by Pantelides to the equation system found before, and determine the resulting DAE system that by now no longer exhibits any structural singularity.

- Find the structure incidence matrix of the resulting implicit DAE system.

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Algorithm by Tarjan

- Draw the digraph of the resulting DAE system, and color it by use of the algorithm by Tarjan.

- The colored digraph symbolizes a partially sorted equation system, which however still contains a large algebraic loop. Write down the partially sorted equation system.

- Find the structure incidence matrix of the partially sorted equation system. This is now in block lower triangular form (BLT-Form).

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Start Presentation

Tearing of the Algebraic Loop

- Find appropriate tearing variables using the following heuristics:

  ▾ In the digraph, determine those equations with the largest number of unknowns.

  ▾ For every one of these equations, find those unknowns that show up most frequently in the not yet used equations.

  ▾ For every one of these variables, determine how many additional equations can be made causal if they are assumed known.

  ▾ Choose the one variable as the next tearing variable, which allows to make the largest number of additional equations causal.

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Structure Diagram

- Draw the structure diagram of the causalized algebraic loop.

- It can be seen that two tearing variables are needed to make all equations of the loop causal.

- The two tearing variables decouple the equation system in such a way that there result two separate equation systems in one tearing variable each (this is not always the case, but it happens in the given example).

- Find the structure incidence matrix of the fully causalized DAE system. This now has two diagonal blocks of smaller sizes.

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Solving the Coupled Equations

- Solve the two equation systems symbolically, and replace the residual equations of the equation system by the so found explicit equations.

- Draw the digraph of the once more modified equation system, and color it by use of the algorithm by Tarjan.

- Determine the resulting structure incidence matrix. This is now in lower triangular form.

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