# The Design-Oriented-Analysis (DOA) Paradigm

- Circuit **analysis** approach taught in most circuits books
  - Circuit topology is given and the value of all circuit's elements are given. Write "enough" independent equations and find the voltage and current for all elements in the circuit: solve a system of N simultaneous equations with N unknown
  - Useful to practice the basic principles that rule the behavior of an electric circuit (KVL, KCL and "Ohm" law → That's all you need to know: if you do not mind to work harder than needed do not even bother learning Thevenin/Norton method)
  - However, once you have practiced enough this is a complete waste of time: usually SPICE can do it faster than you anyway !

- This is a **very distorted perspective** of reality !!!

- In practice the real objective is to **design** circuits (knowing how to to do analysis is finalized to the goal of coming out with a good design)

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# The Design-Oriented-Analysis (DOA) Paradigm

- Design is the reverse of Analysis
  - because:
    the starting point of the design problem (the specification) is the answer to the analysis problem

- Mathematicians tell us:
  - Number of equations must = number of unknowns
- Engineers face this "unpleasant" truth:
  - Number of equations <<<<< number of unknowns
  - But … have to solve the problem anyway (if they want to get a paycheck)

- We need a completely different approach:
  - Instead of solving equations simultaneously, solve them sequentially

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# Conventional problem-solving approach

- My "wild" guess about what you have learned to do so far in school:
  - Make your models as accurate as possible (in other words account for as many details as you can and simplify only at the very end)
  - Postpone approximations as long as possible (approximations are yacky we love perfection)
  - The "answer" is acceptable in whatever form it emerge from the algebra
  - The more work you do, the more valuable the result (" I put a lot of effort on it, I think I deserve an A ☺")
  - Every problem is a brand new problem and requires to be solved from scratch every single time (even if I have seen it already at least 5 times ☺)

**This is a recipe for disaster !!!**

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# We need a different approach

- Divide and Conquer (Divide et Impera)
  - It is easier to solve many simpler problems than one large one
- Make the most out of the equations by expressing them in "Low Entropy Form"
  - A low entropy expression is one in which the terms and element symbols are ordered and grouped so that their physical origin and relative importance are apparent
- Low entropy expressions are essential to navigate the iterations characterizing the design process
- To keep the entropy low at every step
  - Avoid solving equations simultaneously, solve them sequentially
  - Follow the signal path from input to output by Thevenin/Norton reductions and voltage/current dividers
  - Avoid multiplying out series/parallel combinations
- Recognize we do not want an exact answer, it would be too complicated to use, even if we could get it
  - Substitute for missing equations with inequalities, approximations, assumptions and tradeoffs

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# DOA problem-solving approach

- Into your models put only enough to get the answer you need
- Make all the approximation you can, as soon as you can.
  - Approximations are a good thing, not an admission of defeat
- The less work you do, the more valuable the results. You control the algebra not the other way around
- Every problem is not unique (collect and cherish your lego blocks!)

**DOA is the only analysis worth doing**

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