Netlist Documentation

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1 Introduction

According to the provided project briefing, a netlist describing the circuit will be provided in a file using a reduced SPICE format. It is required by the team to formulate an approach to read the file and store the information in a comprehensible data structure.

This document will research the format of the SPICE netlist and explore the different approaches in storing the information a certain way. This document is primarily used for planning the most effective way to approach the problem as well as allowing fellow teammates to engage productively on a equal knowledge footing.

2 Input (.cir) file

Source file for any version of SPICE has the following format [1].

```
TITLE
ELEMENT
.MODEL STATEMENTS
ANALYSIS COMMANDS
OUTPUT COMMANDS
.END
```

Important points to note:

- First line `TITLE` is used as a title on output files.
- File must end with command `.END` followed by a new line.
- Comment begins with '*' which covers entire line.

3 Netlist Element Format

A circuit description is called a **netlist** which consists of statements defining a each circuit element.

Connections are described by naming nodes [Actually stored as numbers].

Format of an element description is:

$$< \texttt{D} >< \texttt{description} >< \texttt{n1} >< \texttt{n2} > [\texttt{value}][\texttt{parameters}]$$

- $< \texttt{D} >$: A character that is a unique identifier for each type of support circuit component
- $< \texttt{description} >$ A string without space e.g. 5
- [`value`]: The value a circuit component takes e.g. 500 ohms

We have to consider the situation where the input syntax is correct but the circuit represented is wrong. To overcome this, we need a function to check if the circuit described is realistic.

3.1 Passive Elements in `'letter'`

Passive elements are composed of the following:

- Resistors: `R`

  `R` < `description` >< `n1` >< `n2` >< `value` >

- Capacitor: `C` where we can specify the initial value of C for transient analysis.

  `C` < `description` >< `n1` >< `n2` >< `value` > [`ic` =< `value` >]

- Inductor: `L` where we can specify the initial value of L for transient analysis.

  `L` < `description` >< `n1` >< `n2` >< `value` > [`il` =< `value` >]

3.2 Independent Sources

- Voltage Sources

  `V` < `description` >< `n1` >< `n2` >< `value` >

- Current Sources

  `I` < `description` >< `n1` >< `n2` >< `value` >

The character after the letter must be a unique instance name and followed by the nodes associated with + and - respectively.

When users are entering component values, it is important that the software recognises common abbreviations for units.

3.3 Support for powers of ten

In order to support `spice` format, the following abbreviations for powers of ten must be recognised:

- f [femto]: 10^{-15}
- p [pico]: 10^{-12}
- n [nano]: 10^{-9}
- u [micro]: 10^{-6}

- m [milli]: 10^{-3}
- k [kilo]: 10^{+3}
- M [mega]: 10^{+6}
- G [giga]: 10^{+9}
- T [tera]: 10^{+12}

Any unrecognised characters are ignored.

4 Network Diagram/Graphs

Network Graphs show the relationships between a set of entries. Each entry is represented by a *Node* and the connections between nodes are represented through *Edges*.

There are four main types of network graphs:

- Undirected and Unweighted
- Directed and Unweighted
- Undirected and Weighted
- Directed and Weighted

A graph $G = (X, U)$ consists of: [2]

- a finite set $X = x1, x2, ..., xn$ whose elements are called nodes or vertices
- a subset U of the Cartesian product XxX, the elements of which are called arcs.

The network graph defined will consist of two vector structure:

- Vector of nodes in the circuit
- Vector of branches in the circuit

The theoretical output is an ordered vector of branches and an ordered vector of nodes. **Position starts from 1 as node 0 indicates GND.**

5 Implementation

5.1 struct CirElement

```
CirElement
{
    variables:
```

```
        letter: component name
        name: name of node
        node1: node this node is connected to
        node2: node this node is connected to
        value: float
        initial_val: float

    methods:

        parse(string: input)
        {
            Tokenise
            Put in values into respective variables
            Detect values, pass into custom_pow
            Detect if initial_val is entered:
                Pass into variable otherwise default 0
        }
        custom_pow(string: input)
        {
            Check if there are keywords e.g. k, m, M, G

            If not present, two scenario:
                Unknown letter present: extract digits
                Convert to float
                Empty string (End of recursion): return 0

            If present:
                Find position where keyword appears
                Take string before keyword and convert
                Multiply/divide the digit by keyword
                Recursion to cover case: 5M7k
        }
        tokeniser(string: input)
        {
            Call regex to tokenise the string
            Push each token into a vector
            Return vector
        }
        isdigit(string: input)
        {
            Iterate over string
            Take each character and into 'isdigit' test
            Return boolean
        }
}
```

6 Miscellaneous

There are more components to consider such as:

- Voltage controlled dependent sources
- Current controlled dependent sources
- Diodes
- BJT
- MOSFET
- Python implementation
- Efficient way to use recursion and not efficient to use matrix but more accurate.

References

[1] Phyllis R. Nelson. *Introduction to spice source files*. DOI: https://www.cpp.edu/~prnelson/courses/ece220/220-spice-notes.pdf.

[2] Archana Shankar, David Gilbert, and Michael Jampel. "Transient Analysis and Synthesis of Linear Circuits using Constraint Logic Programming". In: (Oct. 1996).