

# lcapy issue

October 17, 2019

I've observed some strange behaviour which may be a bug but could also be me misunderstanding the role of the ground (0) node.

I was calculating the transient voltage across a capacitor in a RC circuit with a constant voltage source and found that the initial voltage on the capacitor was sometimes ignored, depending on the labelling of nodes. I think I have traced the problem to connecting the voltage source to the zero node.

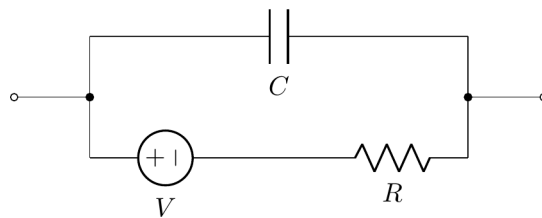
The key evidence is examples 1 and 5 below.

```
In [1]: from lcapy import *
```

## 1 0 - as an expression

Everything works fine.

```
In [2]: expr=C('C', 'V0')|(Vdc('V') + R('R'))
        expr.draw()
```



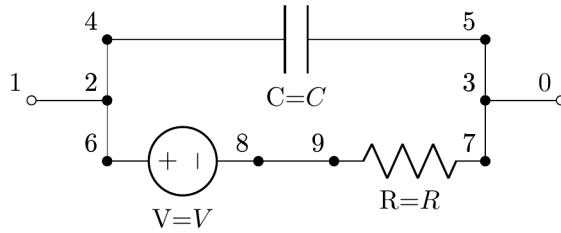
```
In [3]: expr.Voc(t)
```

```
Out[3]:
```

$$\left\{ V + (-V + V_0) e^{-\frac{t}{CR}} \quad \text{for } t \geq 0 \right.$$

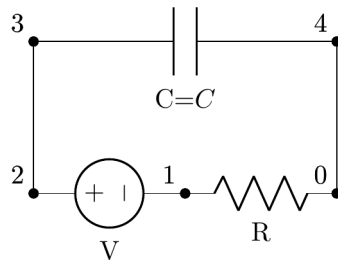
Correct - exponential approach from V\_0 to V as expected.

```
In [20]: expr.cct.draw()
```



## 2 1 - as a circuit

```
In [4]: cct1 = Circuit("""
V 2 1 dc; right
R 1 0; right
W 3 2; down
C 3 4 C V0; right
W 4 0; down
""")
cct1.draw()
```



```
In [5]: cct1.C.V(t)
```

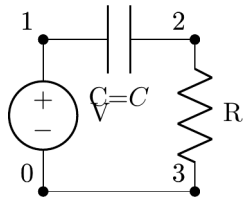
Out[5]:

$$\left\{ V + (-V + V_0) e^{-\frac{t}{CR}} \quad \text{for } t \geq 0 \right.$$

Correct

## 3 2 - equivalent circuit with fewer nodes and different node labelling

```
In [10]: cct2 = Circuit("""
V 1 0 dc; down
C 1 2 C V0; right
R 2 3; down
W 0 3; right
""")
cct2.draw()
```



In [11]: `cct2.C.V(t)`

Out[11]:

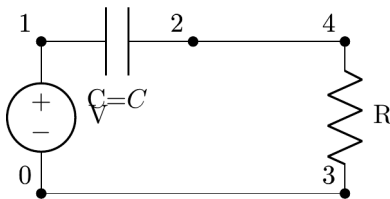
$$\left\{ V \left( 1 - e^{-\frac{t}{CR}} \right) \text{ for } t \geq 0 \right.$$

Incorrect! Somehow V0 is being treated as zero.

#### 4 3 - putting a wire next to the capacitor

Is it to do with wires around the capacitor?

```
In [12]: cct3 = Circuit("""
V 1 0 dc; down
C 1 2 C V0; right
W 2 4; right
R 4 3; down
W 0 3; right
""")
cct3.draw()
```



In [21]: `cct3.C.V(t)`

Out[21]:

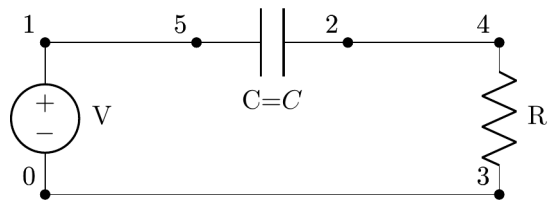
$$\left\{ V \left( 1 - e^{-\frac{t}{CR}} \right) \text{ for } t \geq 0 \right.$$

Incorrect

## 5 4 - another wire

Add more wires around the capacitor...

```
In [14]: cct4 = Circuit("""
V 1 0 dc; down
C 5 2 C V0; right
W 2 4; right
W 1 5; right
R 4 3; down
W 0 3; right
""")
cct4.draw()
```



```
In [15]: cct4.C.V(t)
```

Out[15]:

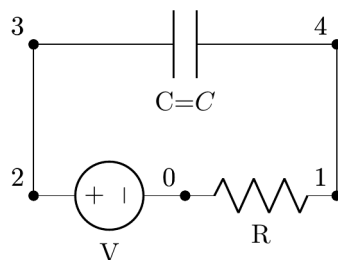
$$\left\{ V \left( 1 - e^{-\frac{t}{CR}} \right) \text{ for } t \geq 0 \right.$$

Still incorrect

## 6 5 - maybe node labelling?

The same as example 1 except the 0 and 1 nodes are swapped.

```
In [18]: cct5 = Circuit("""
V 2 0 dc; right
R 0 1; right
W 3 2; down
C 3 4 C V0; right
W 4 1; down
""")
cct5.draw()
```



In [19]: `cct5.C.V(t)`

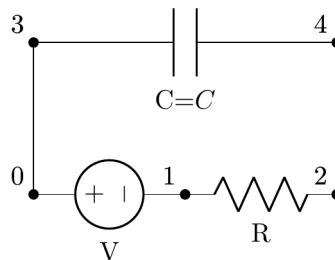
Out[19]:

$$\left\{ V \left( 1 - e^{-\frac{t}{CR}} \right) \text{ for } t \geq 0 \right.$$

Incorrect. Conclude that the problem has something to do with node labelling.

## 7 6 - relabel nodes again

```
In [25]: cct6 = Circuit("""
V 0 1 dc; right
R 1 2; right
W 3 0; down
C 3 4 C V0; right
W 4 2; down
""")
cct6.draw()
```



In [26]: `cct6.C.V(t)`

Out[26]:

$$\left\{ V \left( 1 - e^{-\frac{t}{CR}} \right) \text{ for } t \geq 0 \right.$$

Incorrect. Is the problem have ground connected to voltage source?