Universidade do Vale do Itajaí
Computer Engineering
Basic Electronics

Third Assignment for Basic Electronics

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Teacher Advisor: Walter Antonio Gontijo

August
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Third Assignment for Basic Electronics presented for the class of Twentieth of August, 2021.

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1 Objective

The analysis of multiple electrical circuits containing ideal and non-ideal diodes.

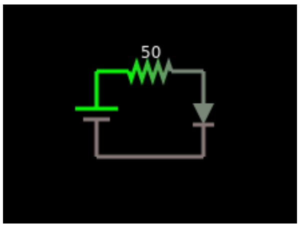
2 Introduction

This paper has the purpose of describing and explaining circuits with ideal, simplified, linear and real diodes

3 Development

3.1 First Circuit

Find the quiescent point of the diode when $V_s = 2V$ and $R_s = 50\Omega$. Then the dynamic resistance when $I_d = 15mA$ and $I_d = 30mA$.



Circuit being analyzed.

From the equation $V_s = V_d + I_d \times R_s$ you can find,

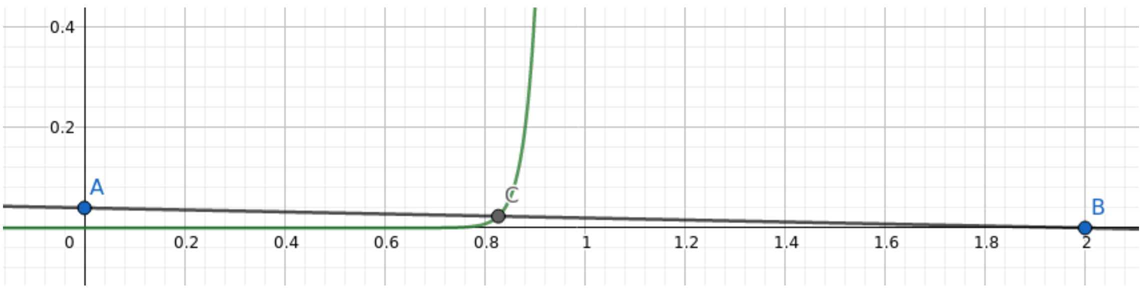
$$I_d = \frac{V_s}{R_s} = \frac{2}{50} = 0.04A$$
$$V_s = V_d = 2V$$

when $V_d = 0V$ and $I_d = 0A$ respectively.

With it the points can be addressed and compared to the standard diode law.

$$A[0V, 0.04A]|$$
$$B[2V, 0A]$$

Which graphs,



The point C stands at $[0.85169V, 0.0229662A]$

with the point C being the quiescent point, and implies a working current of $23mA$ at $0.85V$.

The dynamic resistance at the provided currents are easier to find,

$$R_d = \frac{(0.88) * 1000 - (0.82) * 1000}{30 - 15} = 4\Omega$$

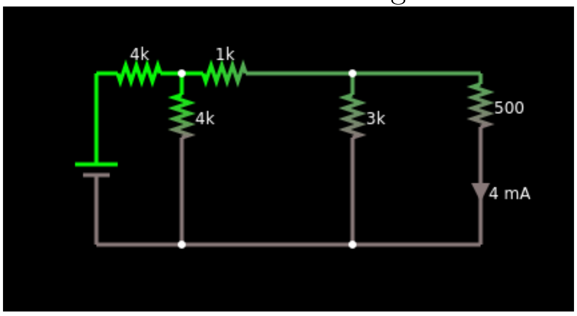
The simulation with a standard silicon diode $1N4004$ wields a current of $25.38mA$ at $0.73V$.

	Calculated	Simulated
V	0.85169	0.73
A	0.0229662	0.02538

3.2 Second Circuit

3.2.1 Ideal Diode Model

Calculate the current through the diode



Circuit being analyzed with an ideal diode.

Though the circuit looks complicated by it's many loops, simply applying the *Thevenin* theorem.

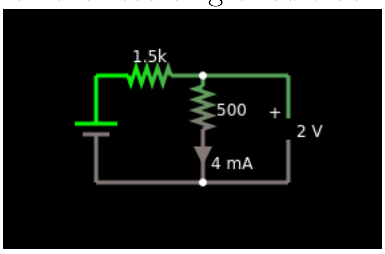
When removing the resistor diode components and simplifying the circuit the equivalent resistance calculated is,

$$R_t = 1.5k\Omega$$

By de-simplifying the circuit where the interested nodes remain untouched we get a circuit divider, with which the Voltage can be calculated,

$$V_t = 8V$$

With the resulting circuit being,



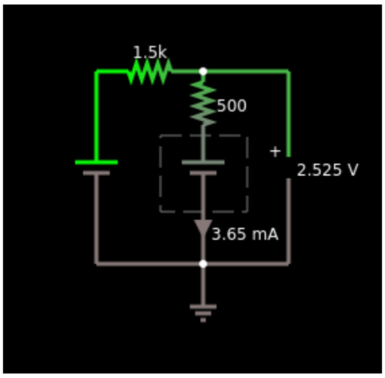
Since the circuit has an ideal diode, the current and voltage of the 500Ω resistor will be the diode's.

	Ideal	1N4004
V	2	2.473
mA	4	3.685

3.2.2 Simplified Diode Model

The same circuit is being analysed, but with a simple diode, wherein the diode is replaced by a counter power supply of $0.7V$ if current passes through it.

The equivalent *Thevenin* circuit with the simplified model applied is as,



In this case the main power supply of $8V$ can be subtracted by $0.7V$ and the same process to find its current and voltage difference can be used.

	Ideal	Simplified	1N4004
V	2	2.525	2.473
mA	4	3.65	3.685

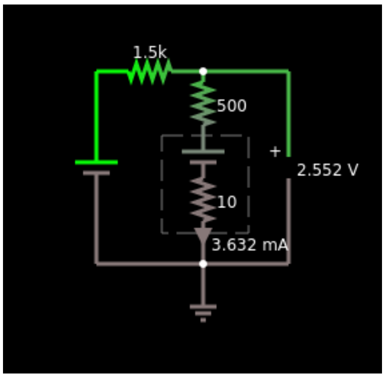
Tabela 1: Notice the values are getting closer to the real diode.

3.2.3 Linear Diode Model

Just as before the *Thevenin* circuit can be re-used, this time with a linear diode, wherein a counter power source and a resistor are used to more accurately represent a diode.

$$R_{avg} = 10\Omega$$

The circuit presents as,

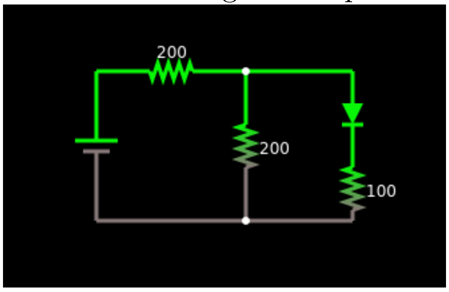


The circuit is simple enough for the method of calculations to be left to the reader, simply add the above resistances to create a voltage divider with a voltage source in the middle, then calculate their separate currents by subtracting and adding the $0.7V$ accordingly.

	Ideal	Simplified	Linear	1N4004
V	2	2.525	2.552	2.473
mA	4	3.65	3.632	3.685

3.3 Third Circuit

Consider the circuit and the following diode specifications, $VCC = 200V$,



Diode	IF(A)	VRM(V)
A	0.2	100
B	0.5	80
C	1.0	50

Which diodes would break under these conditions? And if the power supply polarity was reversed?

Since no R_{avg} was given, the simplified model will be used.

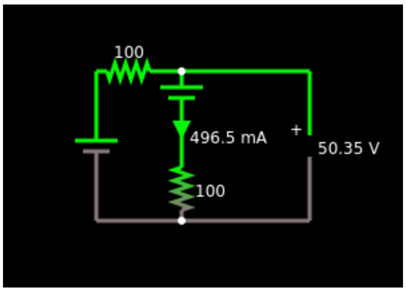
The *Thevenin* theorem was applied, the two parallel resistors induce a resistance of,

$$R_t = 100\Omega$$

And the voltage in the interested nodes is,

$$V_t = 100V$$

Resulting in the following simplified circuit,



The circuit with an ideal diode will not be shown but it's values are calculated in the table below.

	Ideal	Simplified
V	50	50.35
mA	500	496.5

As can be compared between the tables, the first diode will be damaged as it is about $300mA$ over-current.

The second diode will remain intact if the simplified model is taken into account, as it sits on the threshold.

The third one will remain intact as well as it can handle double the current it currently endures.

If the polarity flips however, the same voltage of around $50.35V$ will be applied in reverse, damaging the third but not passing the reverse voltage threshold of the first and second who will pass only nA worth of current.

3.4 Challenge

4 Conclusion

In this paper it was shown four ways of calculating the effects of a diode in a circuit, three by replacing them with simpler components and one which uses an existing law to find its operating conditions.