# University of Washington

## BEE331 Lab 1.1


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# Characterising Diodes; I-V Curve

## Design Objective

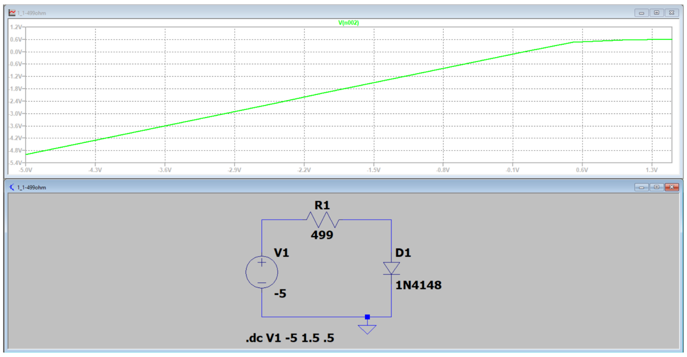
In this lab, we introduce ourselves to the diode, we characterise its function by the I-V curve.

## Circuit Design Outline

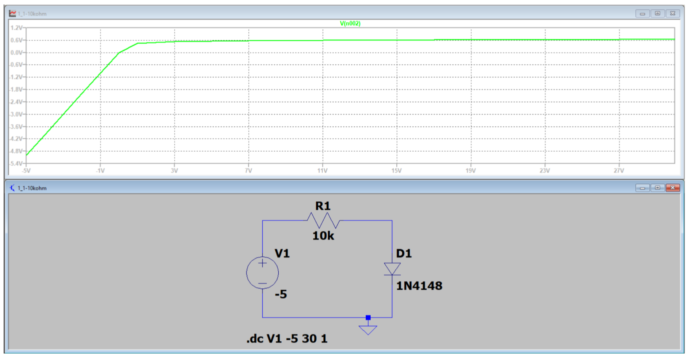
With a resistor of an arbitrary impedance greater than 100Ω ($R \geq 100\Omega$), and the natural impedance of the Function Generator in series ($R_{TOT} = R_{FG} + R \geq 150\Omega$), the (1N4148 silicon) diode is set in series to forward-bias from the function generator. Set the function generator @ f=1kHz and $V_P = 5V$.

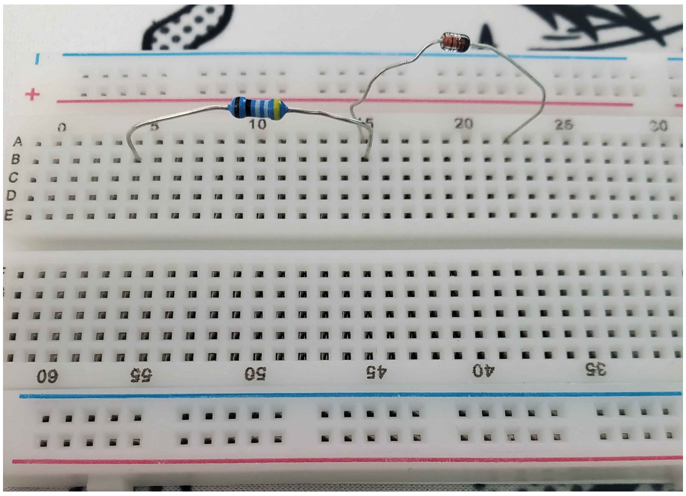
Figure 1: Series R + Diode

(a) LTSpice + Rudimentary Schematic Series RD (499Ω) Circuit

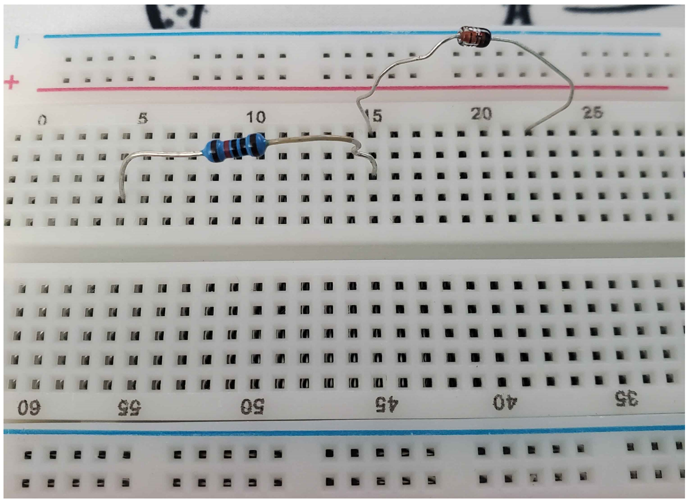



(b) LTSpice + Rudimentary Schematic Series RD (100Ω) Circuit



(c) Series RD Circuit 499Ω



(d) Series RD Circuit 100Ω

### Descriptions of Measurements & Calculations

## Analysis

- **i. Describe how you measured $I_D$ and $V_D$?**

  At the node where R; $(R > 100\Omega)$ and the Diode; $(D)$ meet, we denote this junction as $V_{out}$. We attach our Multimetre's positive lead (Red) to $V_{out}$, and attached our ground lead to the opposing node of the Diode; $(D)$ - which should be grounded.

- **ii. In this experiment how would you determine the value of $I_{D,max}$**

  $I_D = I_S(e^{\frac{V_D}{V_T}} - 1)$; reference Figure 1b.

- **iii. In the circuit, what limits $I_D$?**

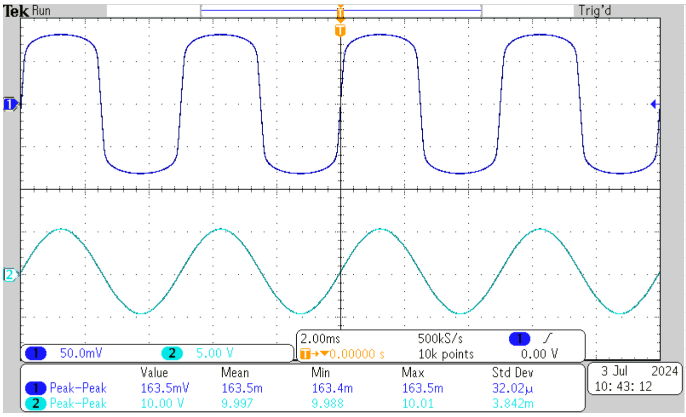
  The characteristics of the I-V curve of a diode has current $I_D$ exponentially rise towards a cut-off at the threshold, towards the C.V.D @ $V_D$.

- **iv. Explain why $V_D$ does not change much while $I_D$ can change a lot.**

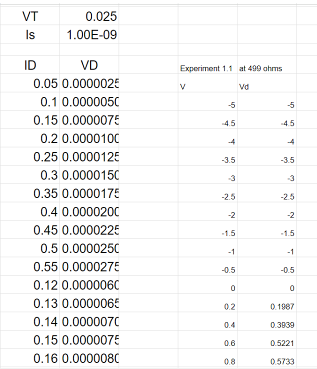
  Given the equation of a Diode's characteristics of $I_D = I_S(e^{\frac{V_D}{V_T}} - 1)$. Putting the equation in reference to $I_D$ is an exponential function, while $V_D$ is a logarithmic function with a very slow rise time.

Figure 1: RD Circuit

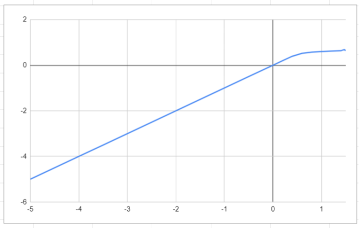
(a) RD Circuit Measurement




(b) Sample Measurement



| | | | Experiment 1.1 | at 499 ohms |
|---|---|---|---|---|
| VT | 0.025 | | | |
| Is | 1.00E-09 | | | |
| ID | VD | | V | Vd |
| 0.05 | 0.0000025 | | -5 | -5 |
| 0.1 | 0.0000050 | | -4.5 | -4.5 |
| 0.15 | 0.0000075 | | -4 | -4 |
| 0.2 | 0.0000100 | | -3.5 | -3.5 |
| 0.25 | 0.0000125 | | -3 | -3 |
| 0.3 | 0.0000150 | | -2.5 | -2.5 |
| 0.35 | 0.0000175 | | -2 | -2 |
| 0.4 | 0.0000200 | | -1.5 | -1.5 |
| 0.45 | 0.0000225 | | -1 | -1 |
| 0.5 | 0.0000250 | | -0.5 | -0.5 |
| 0.55 | 0.0000275 | | 0 | 0 |
| 0.12 | 0.0000060 | | 0.2 | 0.1987 |
| 0.13 | 0.0000065 | | 0.4 | 0.3939 |
| 0.14 | 0.0000070 | | 0.6 | 0.5221 |
| 0.15 | 0.0000075 | | 0.8 | 0.5733 |
| 0.16 | 0.0000080 | | | |



### Summary & Conclusions

Revealed in Figure RD-Circuit 1A & 1B, the generated oscilloscope readings of the two periodic function match the characteristics of the transfer function found in 1b (RD Circuit). So the measurements do infact closely align.

**Addendum Pages**

Figure 2: Jason Truong Addendum

(a) Lab Design Calculations

$$I_D = I_S(e^{qV_D / NkT} - 1)$$

Where,

$I_D$ = Diode current in amps

$I_S$ = Saturation current in amps (typically $1 \times 10^{-12}$ amps)

e = Euler's constant (~ 2.718281828)

q = charge of election ($1.6 \times 10^{-19}$ coulombs)

$V_D$ = Voltage applied across diode in volts

N = "Nonideality" or "Emission" coefficient (typically between 1 and 2)

k = Boltzmann's constant ($1.38 \times 10^{-23}$)

T = Junction Temperature in Kelvins

**Bibliography**

**Cited:**


- Lab 1 Manual
- Sedra, Adel, and Kenneth Smith. Microelectronic Circuits. S.L., Oxford Univ Press Us, 2019.
- "How Do You Calculate, a Silicon Junction Diode with N = 1 Has v = 0.7 v al I = 1 MA. What Is the Voltage Drop at I=0.1 MA and I=10 MA.?" Quora, 2024, appliedmathematics.quora.com/How-to-calculate-A-silicon-junction-diode-with-n-1-has-v-0-7-V-al-I-1-mA-What-is-the-voltage-drop-at-I-0-1-mA-an?top_ans=223007030. Accessed 15 July 2024.



(a) Look at her, she's perfect.