جامعة محمد بوضياف- المسيلة -

Mohamed Boudiaf University at M'sila

كلية التكنولوجيا

Faculty of Technology

قسم الهندسة الكهربائية و قسم الإلكترونيك

Department of Electrical Engineering and Department of Electronics

****

University year: 2024/2025 — السنة الجامعية: 2024 /2025

2nd year Electrical Engineering and Electronics — السنة الثانية هندسة كهربائية و إلكترونيك

Applied Work in Fundamentals of Electronics 1 — أعمال تطبيقية في الالكرونيك الأساسية 1

****

PW n°04: PN junction diode characteristics

Duration: $1^{h}30$.

Date of the experiment: ………. /……../………….. .

Report prepared by:

Last Name	**First Name**	**Group**	**S/Group**	**Final Note**
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Instructions :

- **Internal laboratory regulations must be observed.**
- **You must wear a lab coat.**
- **Attendance is compulsory and will be monitored. Any unjustified absence or failure to hand in a report will result in a mark of 0/20.**
- **Have your assemblies checked before connecting the voltage source.**
- **It is strictly forbidden to move equipment from one station to another. In the event of a breakdown or faulty equipment, contact the teacher.**
- **The report must be written by a maximum of four students.**
- **The report must be handed in at the beginning of the next session.**
- **The report must include the following sections:**
  - **TP cover page.**
  - **The date of the practical session.**
  - **Last Name and first name of the main writer.**
  - **Last Names and first names of the WP participants.**
  - **Preparation and work in manuscript.**

Person in charge of practical work: Dr ROUABHI.R

PW n°04: PN junction diode characteristics

I. Objective of the Experiment

The main objective of this practical work is to study the influence of forward and reverse bias on the current of a PN junction diode and also to plot the current-voltage characteristic of a PN junction diode. current of a PN junction diode and also to plot the current-voltage characteristic of a diode in the forward and reverse directions.

II. Theoretical Background

A diode is an active device with two electrodes, usually called an anode and a cathode. A diode consists of a combination of P-type semiconductors (doped silicon or germanium) on the anode side and N-type semiconductors on the cathode side.

Due to the special properties of the semiconductors, current can only flow through the junction in the direction P → N.

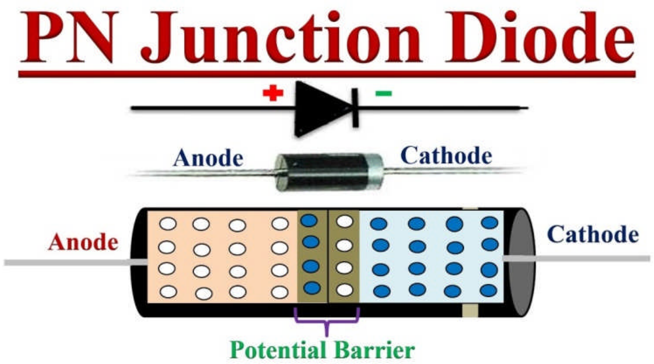

Figure.1: Structure and symbol of a PN junction diode.

1. Diode polarisation

The current flowing through the diode follows the exponential law of the voltage applied:

$$I_d = I_s * \left[exp\left(\frac{qV_d}{nKT}\right) - 1\right] = I_s * \left[exp\left(\frac{V_d}{nV_T}\right) - 1\right] \qquad (1)$$

With:

I_s: is called the reverse saturation current. This is the asymptotic value of the current flowing through the junction in reverse polarisation.

V_T: the thermodynamic voltage $\left(V_T = \frac{KT}{q}\ 26mv\right) at\ 25°\mathrm{C}$

q: the charge of the electron ($1.6*10^{-19}$ C).

K: Boltzmann constant (1.3806488*10-23 J/°C).

T: Absolute temperature in Kelvin.

n: Emission coefficient. Depending on the material, it is around 1 for germanium diodes and between 1 and 2 for silicon diodes.

PW n°04: PN junction diode characteristics

The diode can be polarised in two ways:

1.1. Polarisation in the direct direction (through direction)

Given a circuit containing a variable voltage source and a resistor with a diode in series in series:

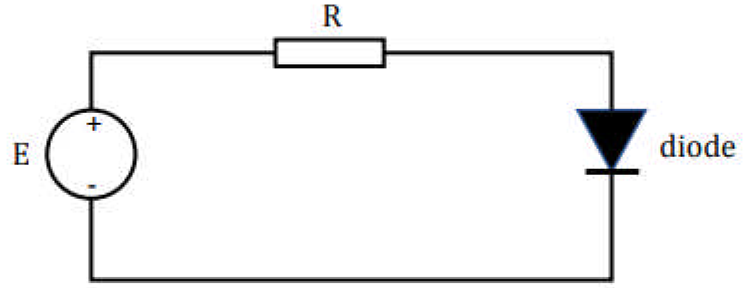

Figure.2: Direct polarisation of the diode.

When the anode is connected to the positive (+) side of the power supply (voltage generator) and the cathode is connected to the negative (-) side, the diode is said to be forward biased (figure 2).

A current flows through the circuit when the voltage across the diode is greater than the threshold voltage V_0 ($V_0 = 0.5$ volts for a silicon diode and $V_0 = 0.3$ volts for a germanium diode).

This current increases very rapidly with V and is practically limited by the resistor in series with the diode. In series with the diode. We can see that the current I flowing through the diode is related to the voltage V applied to it by equation (1).

In the case shown in figure 2, the diode is biased in the on direction, so:

$$I_d = I_s * \left[exp\left(\frac{qV_d}{nKT}\right) - 1\right] \qquad (2)$$

1.2. Reverse polarisation (blocked direction)

Consider the following circuit:

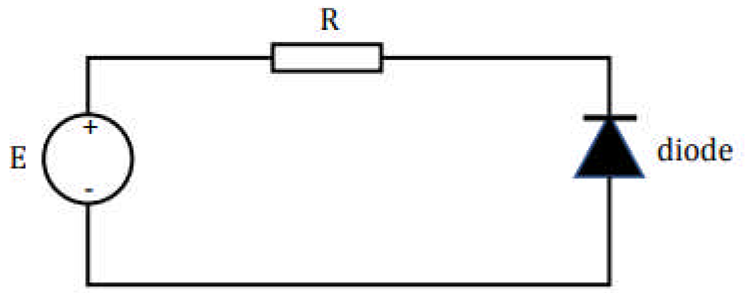

Figure.3: Reverse polarisation (blocked) of the diode.

If the anode is connected to the minus (-) side of the supply and the cathode to the plus (+) side, the diode is said to be reverse biased (Figure 3).

In the case of Figure .3, the diode is reverse biased and $I_d = I_i$; $V_d = V_i$, so equation (1) becomes:

$$I_i = I_s * \left[exp\left(\frac{qV_i}{nKT}\right) - 1\right] \qquad (3)$$

2. The current-voltage characteristic $I_d = f(V_d)$

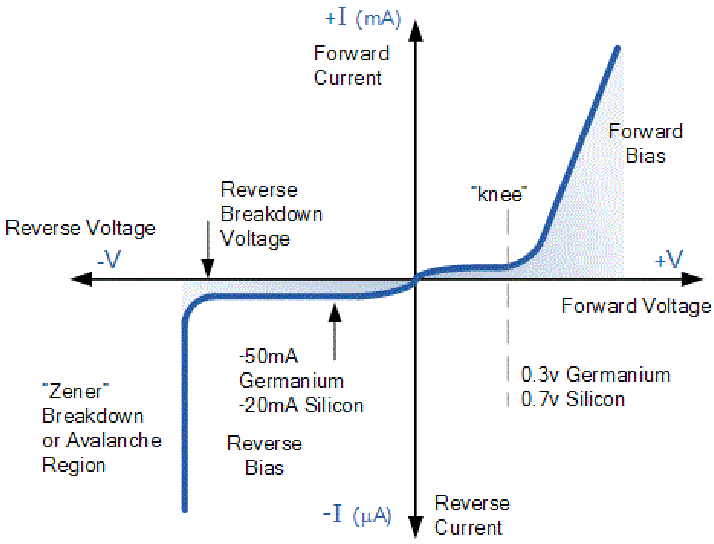

Figure.4: Current-voltage characteristics of the diode.

III. Experiment Procedure

1. Personal work

1.1 Using Proteus, make the following assembl:

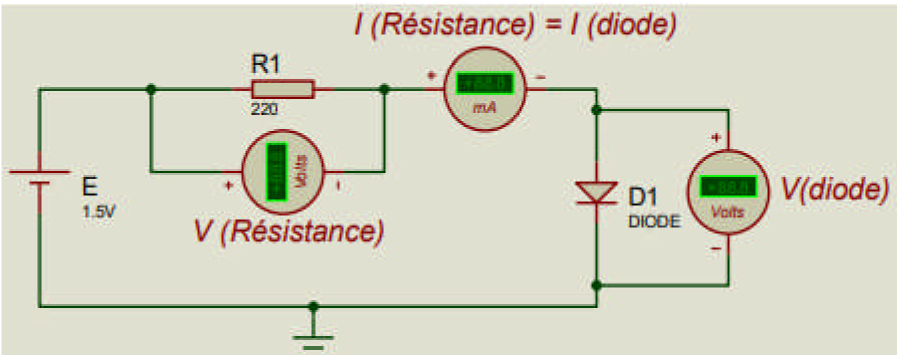

Figure.5

1.2 Simulate the assembly and complete the table below:

Table. 1.

E	**0**	**0.3**	**0.5**	**0.7**	**1**	**3**	**5**	**7**	**9**	**11**	**13**	**15**
V_R												
V_R												
I_R												
V_d												
I_d												

1.3 Invert the diode to obtain the following circuit:

***PW n°04:* PN junction diode characteristics**

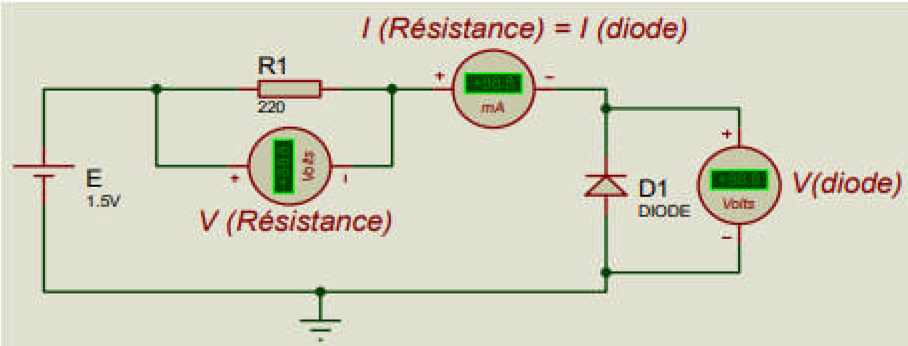

Figure.6

1.4 Simulate the installation and complete the table below:

Table. 2.

E	**0**	**0.3**	**0.5**	**0.7**	**1**	**3**	**5**	**7**	**9**	**11**	**13**	**15**
V_R												
V_R												
I_R												
V_i												
I_i												

1.4 Plot the following functions on the same graph, using appropriate scales: $I_r = f$ (V_R); $I_d = f (V_d)$; $I_i = f (V_i)$.

2. Field work

2.1. Direct polarisation (through beam)

a. Make the following connection:

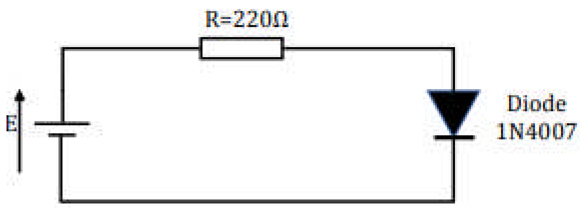

Figure.7

b. By varying the voltage generator *E*, record for each value the voltage drop V_R across the resistor *R* and the current I_R flowing through it and enter these values in the measurement table.

c. By varying the voltage generator *E*, record for each value the voltage drop V_d across the diode and the current I_d flowing through it and enter these values in the measurement table (Table 1).

2.2. Reverse polarisation (blocking direction)

a. Make the following circuit:

***PW n°04:* PN junction diode characteristics**

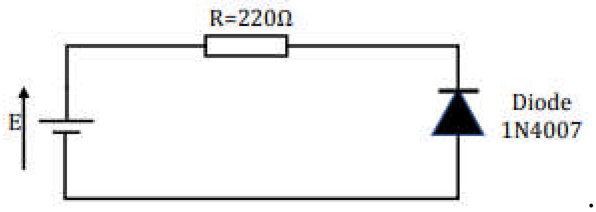

Figure.8

b. By varying the voltage generator *E*, record for each value the voltage drop V_i across the diode and the current I_i flowing through it and enter these values in the measurement table (Table 1).

Table. 3.

E	**0**	**0.3**	**0.5**	**0.7**	**1**	**3**	**5**	**7**	**9**	**11**	**13**	**15**
V_R												
V_R												
I_R												
V_d												
I_d												
V_i												
I_i												

2.3. Work to be carried out

a. Identify the equipment used in the experiment.

b. Plot on the same graph, using appropriate scales, the following functions

$Ir = f\,(V_R);\ Id = f\,(V_d);\ I_i = f\,(V_i)$.

c. Determine the slope of the line $I_R = f\,(V_R)$.

d. Determine the threshold voltage of the diode and its dynamic resistance.

e. Find the saturation current I_s of the diode.

f. Conclusion.