PN JUNCTION DIODE

SEMICONDUCTOR DIODE

prepared by:

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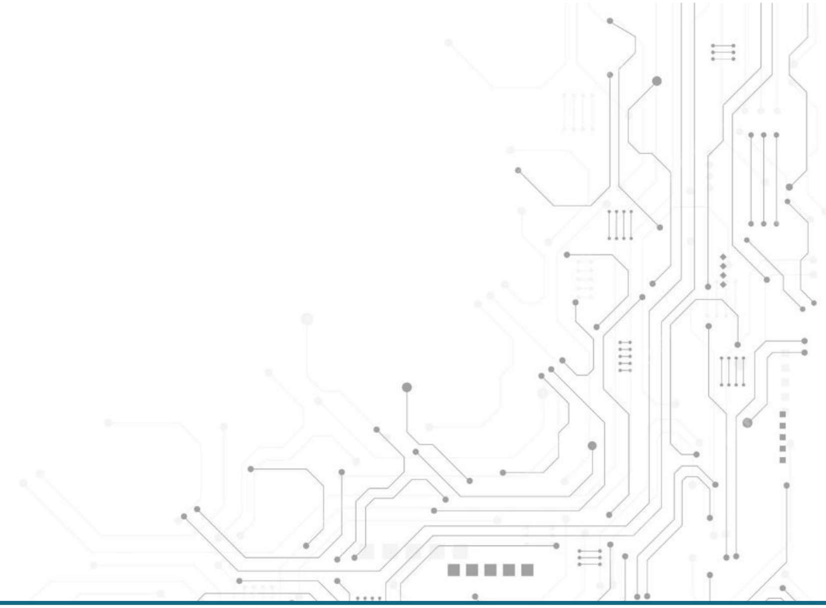

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TOPIC OUTLINE

The Unbiased Diode

The Biased Diode

- Forward Bias
- Reversed Bias

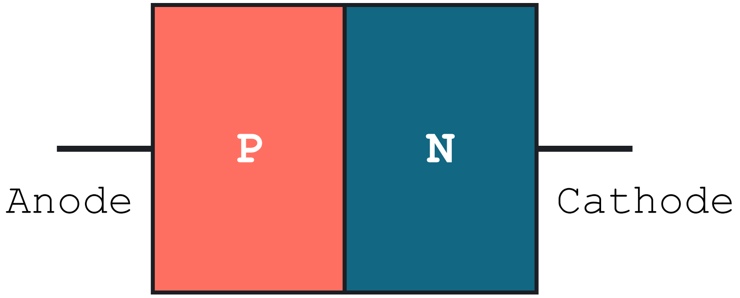
THE UNBIASED DIODE

JUNCTION DIODE

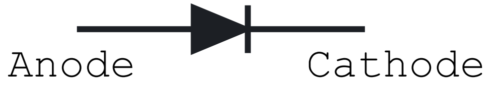
A **junction diode** is a two-terminal semiconductor device formed by the junction of two electrodes or regions: the **P-type** and **N-type** materials.

The term ”di” in diode signifies its two-electrode construction.

Basic Construction



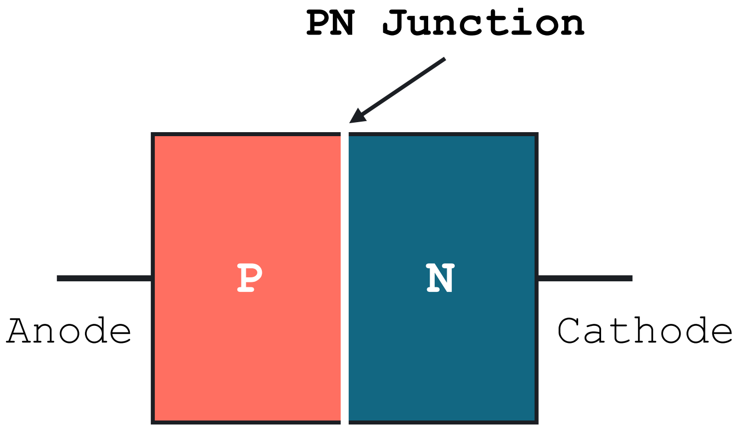
Schematic Symbol



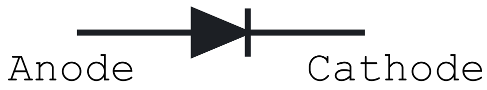
PN JUNCTION

A PN junction is the **boundary** between the P-type and N-type material.

Basic Construction

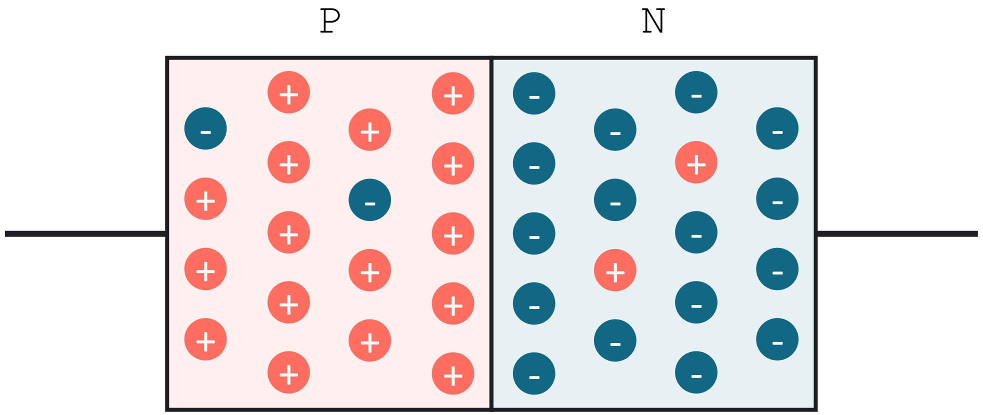


Schematic Symbol



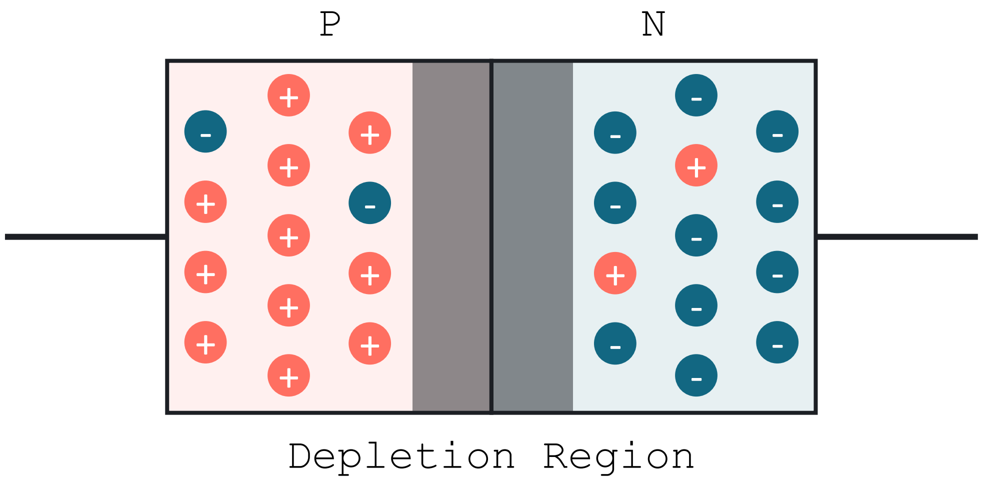
RECOMBINATION

Recombination is the process where a **free electron fills a hole**, causing both to disappear as charge carriers.



DEPLETION REGION

The **depletion region** is a narrow, **charge-free** zone that forms around the PN junction.



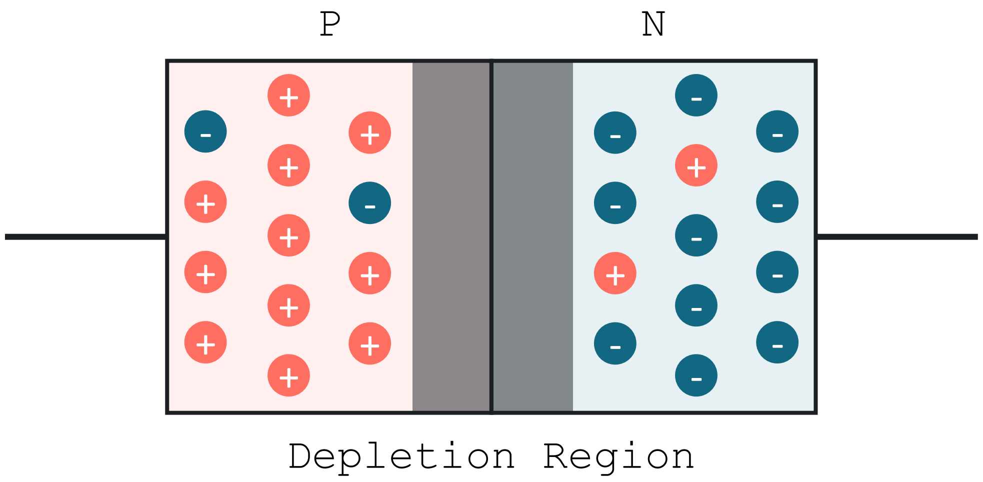
BARRIER POTENTIAL

Barrier potential is the electric potential that forms across a PN junction due to the diffusion and recombination of charge carriers, creating an electric field that **opposes** further movement of electrons and holes.

typical values

0.7 V for Silicon (Si)

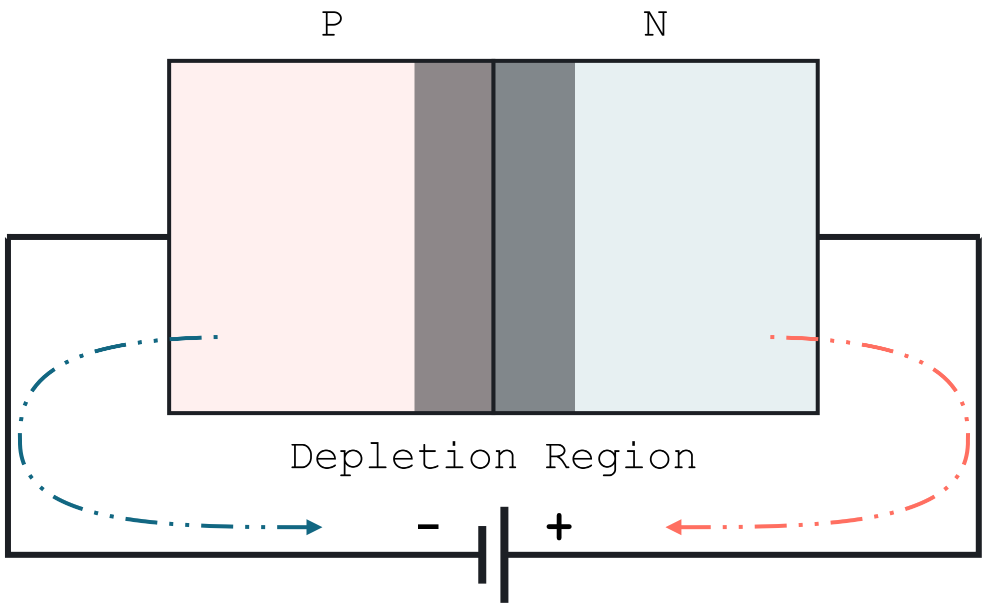
0.3 V for Germanium (Ge)



THE BIASED DIODE

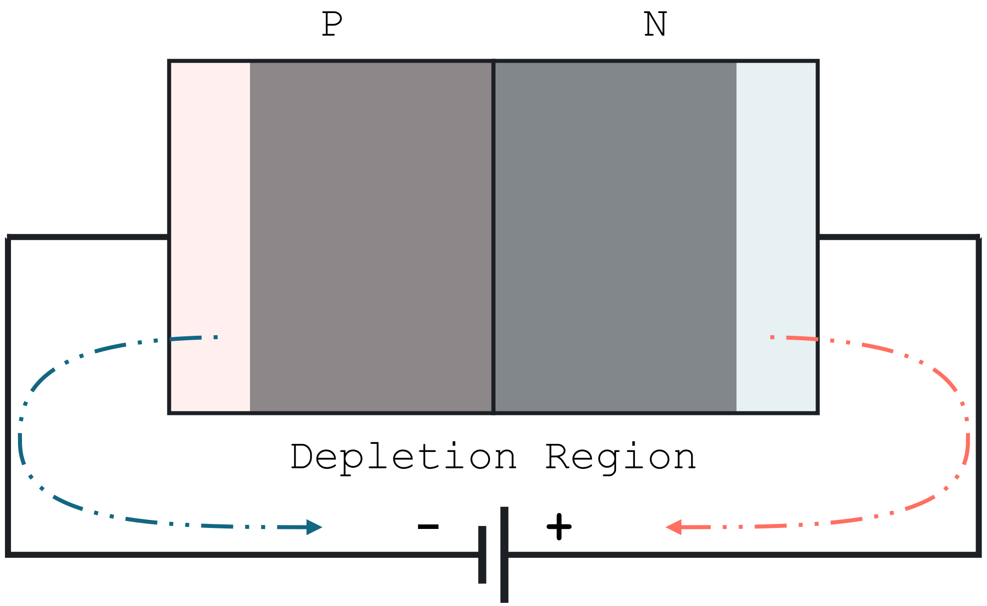
BIASED DIODE

Biasing a diode means **applying a voltage** to it to control whether it conducts current or not.



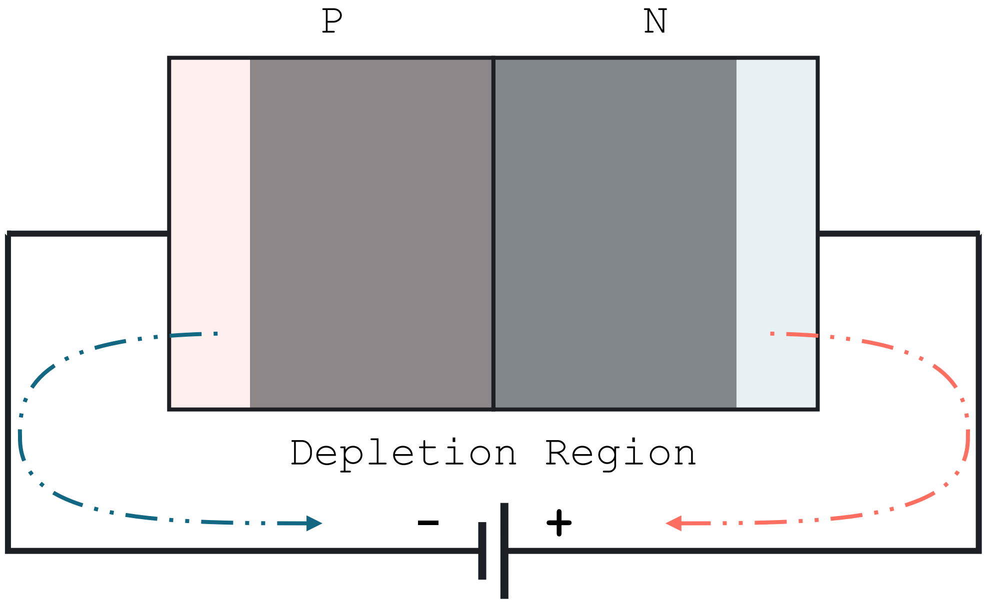
REVERSE BIAS

Reverse bias increases the depletion region and **prevents** current from flowing in a PN junction.



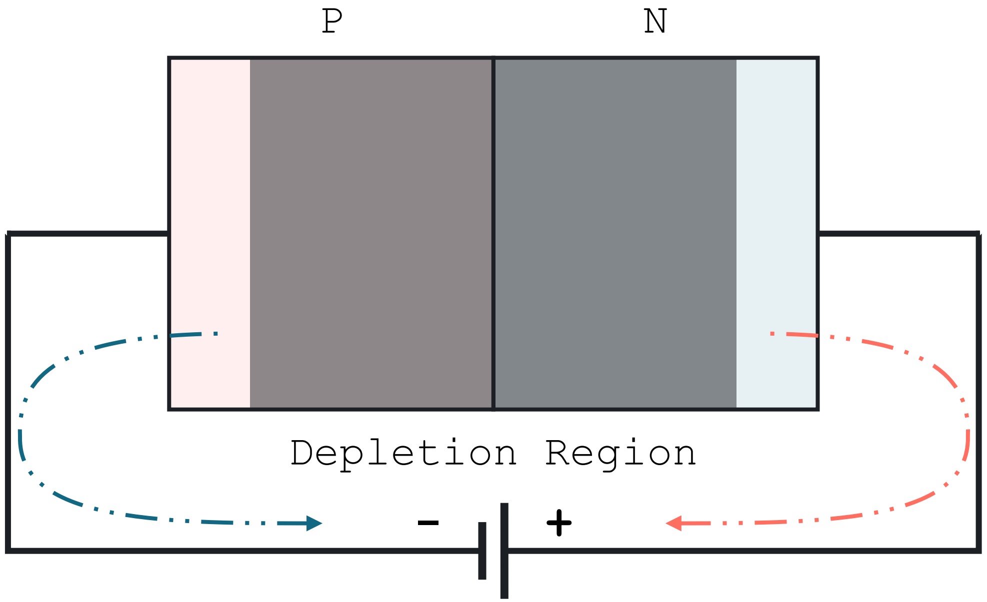
REVERSE SATURATION CURRENT

Reverse saturation current is the small current that flow through a reversed-biased PN junction due to thermally generated **minority carriers**.



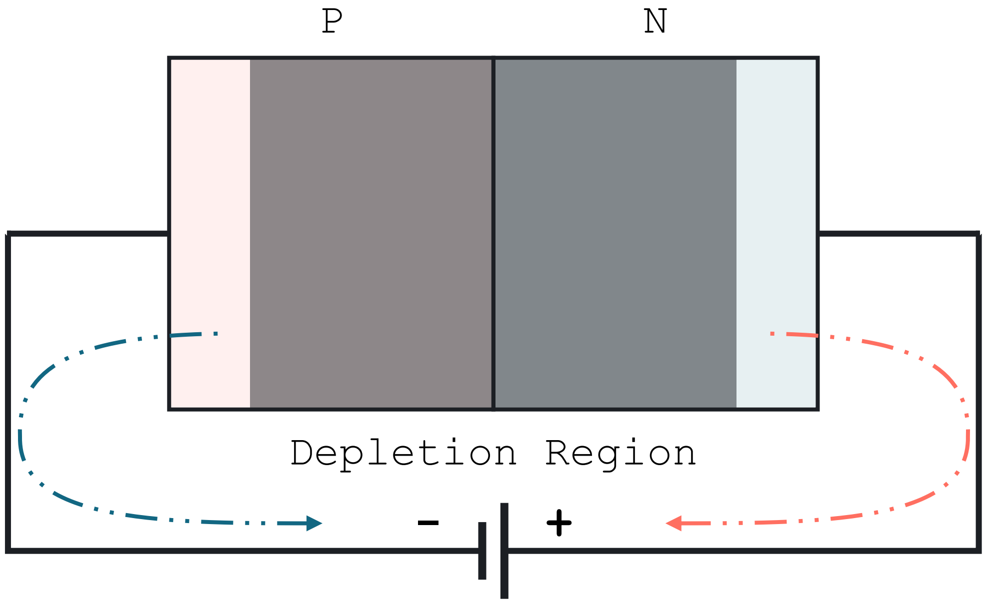
SURFACE-LEAKAGE CURRENT

Surface-leakage current is the unwanted current that flows along the surface of a semiconductor device due to **impurities** and **imperfections** in the crystal structure.



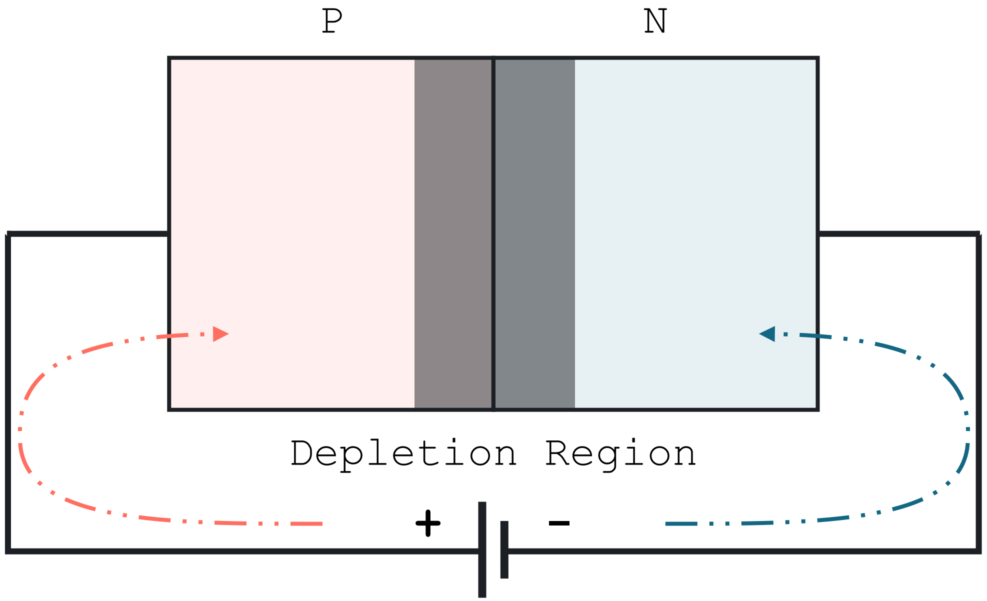
BREAKDOWN VOLTAGE

Breakdown voltage is the highest reverse voltage a diode can withstand without breaking down or being **damaged** – typically around 50V for standard small-signal diodes.



FORWARD BIAS

Forward bias decreases the depletion region and **allows** current to flow in a PN junction.



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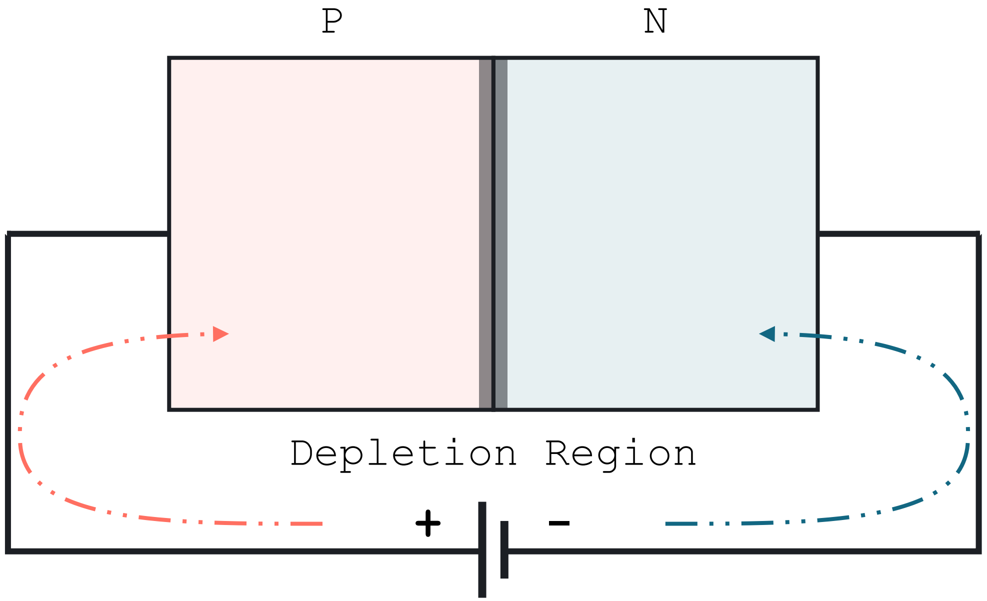

TEMPERATURE DEPENDECE OF DIODE VOLTAGE

The forward voltage drop across a diode decreases as the junction temperature increase.

Formula

$$\frac{\Delta V}{\Delta T} = -2m\mathrm{V}/{}^{\circ}\mathrm{C}$$

For every 1℃ increase in junction temperature, the forward voltage drops by about $2m$V.

This is due to increased carrier activity at higher temperature, which make it easier for current to flow.

EXERCISE

initial voltage, V_i

initial temp, T_i

final voltage, V_f

Assuming a barrier potential of 0.7V at an ambient temperature of 25°C. Determine the barrier potential of a silicon diode when the junction temperature is

- 100°C
- 0°C
- 50°C

final temp, T_f

@ 50°C

$$V_{50°C} = -2m(50-25) + 0.7$$

$$\boxed{V_{50°C} = 0.65V}$$

ans

Solution

$$\overset{-2mV/°C}{\cancel{\frac{\Delta V}{\Delta T}}} = \frac{V_f - V_i}{T_f - T_i}$$

$$V_f = -2mV(T_f - T_i) + V_i$$

@ 100°C

$$V_{100°C} = -2m(100-25) + 0.7$$

$$\boxed{V_{100°C} = 0.55V}$$

ans

@ 0°C

$$V_{0°C} = -2m(0-25) + 0.7$$

$$\boxed{V_{0°C} = 0.75V}$$

ans

LABORATORY