VIVEKANAND EDUCATION SOCIETY'S POLYTECHNIC

Study Material

Program Code: All Program

Semester: First

Course Name: Basic Science (Physics)

Course Code: 22102

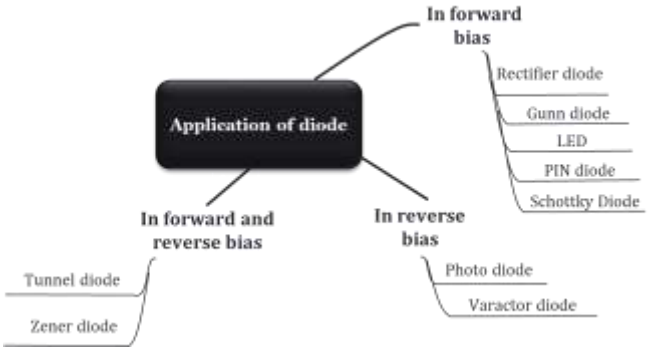
Topic Name: Electricity, Magnetism & Semiconductors

UO2f: Explain the I-V characteristics and applications of the given p-n junction diodes.

LO12: Student will be able to list different applications of given p-n junction diodes.

Course Expert: S. K. Rawat	**Date: 05/09/2020**

Concept Map:



Key words: p-n junction diode, applications of diode

Key Questions:

1. Applications of different types of diode.

Key Definition:

1. Applications of different types of diode.

Notes

P-N Junction Diode Applications

A p-n junction diode is a two terminal device that allows electric current in one direction and blocks electric current in another direction.

In forward bias condition, the diode allows electric current whereas in reverse bias condition, the diode does not allow electric current. P-N junction diode in the reverse-biased configuration is sensitive to light from a range between 400nm to 1000nm, which includes VISIBLE light. Therefore, it can be used as a photodiode. It can also be used as a solar cell.

Rectifier Diode

The conversion of alternating current into direct current is known as rectification. A p-n junction diode allows electric current when it is forward biased and blocks electric current when it is reverse biased. This action of p-n junction diode enables us to use it as a rectifier.

Gunn Diode

The gunn diode is also known as a transferred electron device(TED). It allows current in one direction at which its resistance is very low during forward bias and it doesn't allow the flow of current in reverse bias.

They are commonly used in electron oscillator circuits to create microwaves, including radar speed guns and automatic door openers.

LED

An LED diode stands for a light emitting diode. The LED emits light when it is forward biased and it emits no light when it is reverse biased. The intensity of light is proportional to the square of the current flowing through the device. A diode LED is a device that emits photons when current passes through it.

LEDs are extremely common these days and can be found everywhere in electronics.

Photo Diode

A photo diode is a device that generates current when it absorbs photons. When reverse biased, current will only flow through the photodiode with incident light creating photocurrent. The reverse bias causes the potential across the depletion region to increase and the width of the depletion region to increase. Therefore, these devices are handy in detecting photons across many different wavelengths.

In fact, all digital camera technology works by using an array of photo diodes, where each diode is considered a pixel.

PIN Diode

The PIN diode is a one type of photo detector, used to convert optical signal into an electrical signal. The PIN diode acts as a variable resistance when operated in forward bias. A high electric field is developed across the junction and this speeds up the transport of charge carriers from the P region to the N region.

These diodes are handy in high frequency circuits. They make great RF and microwave attenuators and switches.

Schottky Diode

A Schottky diode is one where the P-type material is removed and instead a metal is used with the N-type material to create the diode. It works in forward bias condition, when reverse biased, the diodes conduction stops very quickly and changes to blocking current flow, as for a conventional pn-junction diode.

The advantage is a lower forward voltage, which helps increase switching frequencies in certain applications. This in combination with faster recovery times makes them useful in circuits like switching power supplies.

Tunnel Diode

Tunnel diodes take advantage of the effect called quantum tunnelling. Due to Tunnelling, when the value of forward voltage is low value of forward current generated will be high. It can operate in forward biased as well as in reverse biased. Due to high doping, it can operate in reverse biased. They are useful in frequency converter and detector circuits.

Varactor Diode

The purpose of a varactor diode is to exploit the capacitance, which is voltage dependent, of the diode in reverse bias mode. In effect, they can be used as voltage controlled capacitors and are handy in oscillator and frequency multiplier circuits.

Zener Diode

Zener diodes are normal PN junction diodes operating in a reverse-biased condition. Working of the Zener diode is similar to a PN junction diode in forwarding biased condition, but the uniqueness lies in the fact that it can also conduct when it is connected in reverse bias above its threshold/breakdown voltage. This means that while they operate like other regular diodes (anode to cathode), they can also pass current in reverse (from cathode to anode) when the reverse bias voltage is reached.

Common types of semiconductor diodes:

- PN junction diode
- Rectifying diode – alternating current rectification,
- Stabilizing diode (Zener diode) – stabilization of voltage and current in electronic systems,
- Light Emitting Diode (LED) – emits light in the infrared or visible zone,
- Variable capacitance diode (Varactor diode) – its capacity depends on the voltage applied to it in the reverse bias,
- Switching diode – used in pulse electronic systems that require very fast switching times,
- Tunnel diode – specially designed diode characterized by the negative dynamic resistance region,
- Photodiode – diode that works as photodetector – it reacts to light radiation (visible, infrared or ultraviolet),
- Gunn diode – the component used in high-frequency electronics.
- Hot carrier diode (Schottky diode) - it used for very fast switching action.

Link to YouTube/ OER/ video/e-book:

1. https://www.physics-and-radio-electronics.com/electronic-devices-and-circuits/semiconductor-diodes/pnjunctiondiodeapplications.html
2. https://www.elprocus.com/p-n-junction-diode-theory-and-working/
3. https://www.rfwireless-world.com/ApplicationNotes/PN-junction-diode-applications.html
4. https://www.electricaltechnology.org/2018/12/types-of-diodes-their-applications.html
5. https://byjus.com/physics/diodes/

Key Take away:

1. Applications of different types of diode.

Formative Assessments

<22102> : <All Program> : < All Program >: <Electricity, Magnetism & Semiconductors>: <UO2f> : <LO12> : <Assessments> : <Formative>

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Assessment Type: Formative Assessments: Embedded questions in video/ PPT

Set 1		
Question No 1	Question No 2	Question No 3
A junction diode	A germanium diode	A germanium diode is used for
Understanding	Understanding	Understanding
a) can handle only small currents	a) has a lower forward bias voltage than a silicon diode	a) rectification
b) is similar to a vacuum diode but cannot rectify	b) has a higher forward bias voltage than a silicon diode	b) voltage stabilization
c) has one p-n junction	c) has the same forward bias voltage than a silicon diode	c) modulation
d) has two p-n junction diode	d) has same as silicon diode	d) amplification
Ans: < has one p-n junction >	Ans: < has a lower forward bias voltage than a silicon diode >	Ans: <rectification >

Set 2		
Question No 1	Question No 2	Question No 3
A Zener diode is used as	The diode in which impurities are heavily doped is	Which diode emits light when forward biased?
Understanding	Understanding	Understanding
a) an amplifier	a) varactor diode	a) LED
b) a voltage regulator	b) PIN diode	b) Gunn diode
c) a rectifier	c) tunnel diode	c) Schotkky diode
d) a multivibrator	d) zener diode	d) Zener diode
Ans: < a voltage regulator >	Ans: < tunnel diode >	Ans: < LED >

Practice Worksheets

<22102> : <All Program> : < All Program >: <Electricity, Magnetism & Semiconductors>: <UO2f> : <LO12> : <Assessments> : <Summative>

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A. Which of the following is an application of pn junction diode? a) It is used as switches in digital logic designs. b) It is used in clamping circuits in TV receivers as well as voltage multipliers c) It is used as rectifiers in DC power supply manufacturing. d) All of the above	B. The varactor diode is usually a) forward bias b) reverse biased c) unbaised d) holes and electronics
A	B
C. Light Emitting Diodes (LEDs) a) emit light of only one wavelength b) have very wide viewing angles c) are easily damaged above 5V d) All of the above	D. PIN diodes are used mainly for a) linear rectifiers b) fast switching devices c) voltage operated rectifiers d) light emitting devices
C	D
E. Schottky diodes are used for a) rectification b) stabilization c) switching signals d) very high frequency applications	F. A photodiode is operated under a) reverse bias condition b) forward bias condition c) no biased d) None of the above