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Name: Kashish Valecha
Roll no: 27
Batch: F2
Subject: Basic Electronics

Assignment-1

Q1. Discuss formation of PN junction diode, along with the VI characteristics.

A pn junction diode is a semiconductor device created by joining a p-type semiconductor region with an n-type semiconductor region. with an n-type semiconductor region.

Process:

1. Doping:

- p-type region: Doped with acceptor impurities (e.g., boron, aluminium) that have one less valence electron than the semiconductor atoms. This creates an excess of holes.

- n-type region: Doped with donor impurities (eg, phosphorus, arsenic) that have one more ~~less~~ valence electron than the semiconductor atoms. This creates an excess of electrons.

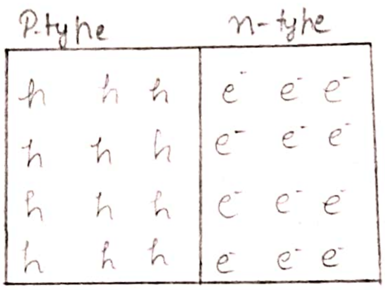
2. Joining:

- When the p-type and n-type regions are joined, the excess electrons from the n-type regions diffuse into the p-type region, and the excess holes from the p-type region diffuse into the n-type region.

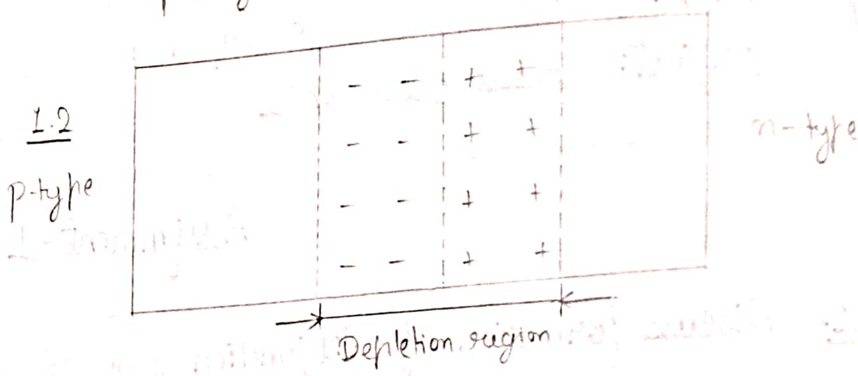
Diagrams:

Q1.

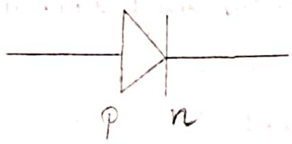
1.1



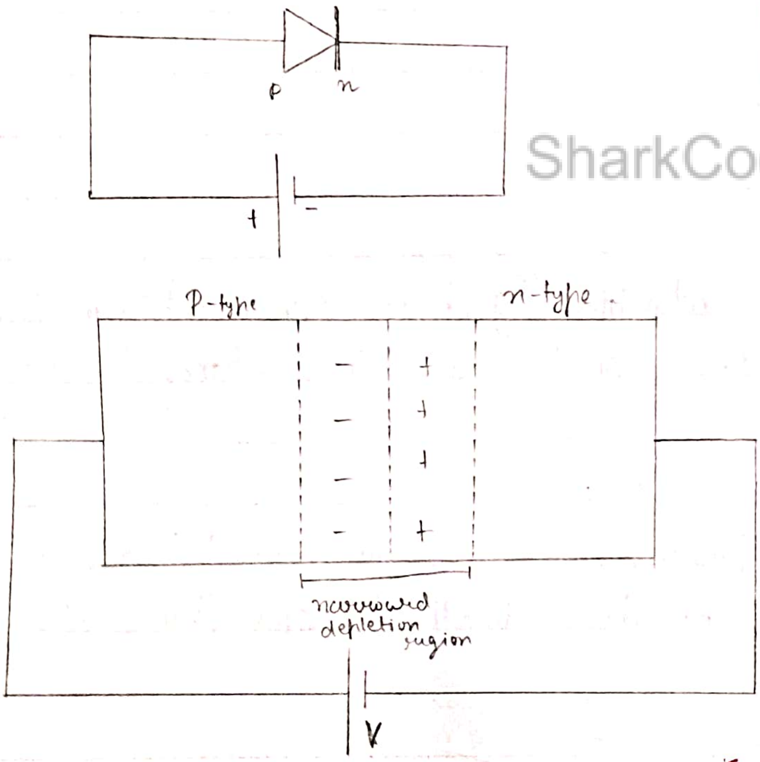
1.2 p-n junction



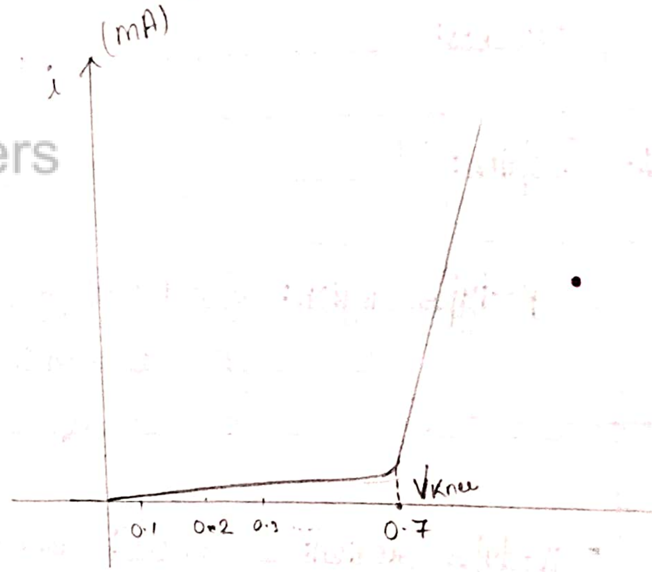
1.3 Symbol of diode :-



1.4 Forward Bias Condition



1.5 VI - Characteristics of forward Bias



3. Depletion Region:

- As electrons and holes diffuse across the junction, they recombine, leaving behind a region near the junction that is depleted of charge carriers. This region is called the depletion region or space charge region.

- In the depletion region, there is a net positive charge due to the ionized acceptor atoms on the n-side and a net negative charge due to the ionized donor atoms on the p-side. This creates an electric field that opposes further diffusion of charge carriers.

VI Characteristics of a pn Junction Diode

The VI (voltage-current) characteristics of a pn junction diode show how the current through the diode varies with the applied voltage.

Key Points:

1. Forward Bias:

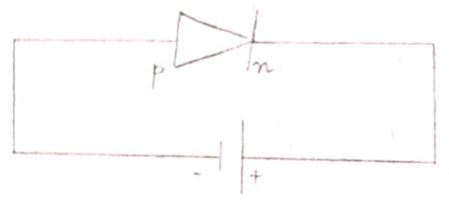
- When the positive terminal of a battery is connected to the p-side and the negative terminal to the ~~n-type~~ n-side, the diode is said to be forward biased.

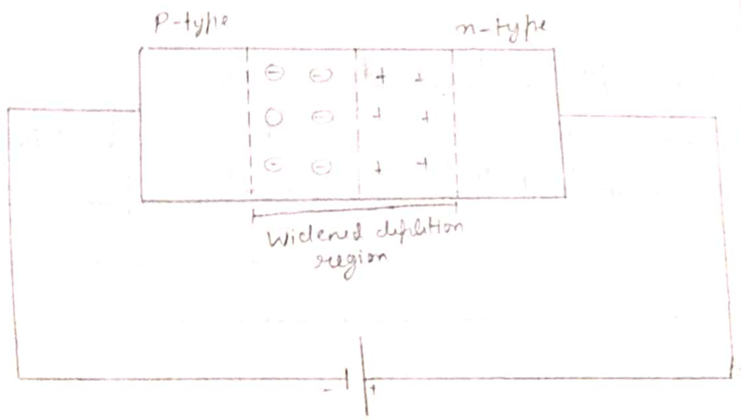
- The applied voltage reduces the width of depletion region, making it easier for charge carriers to flow across the junction.

- The diode conducts current in the forward direction.

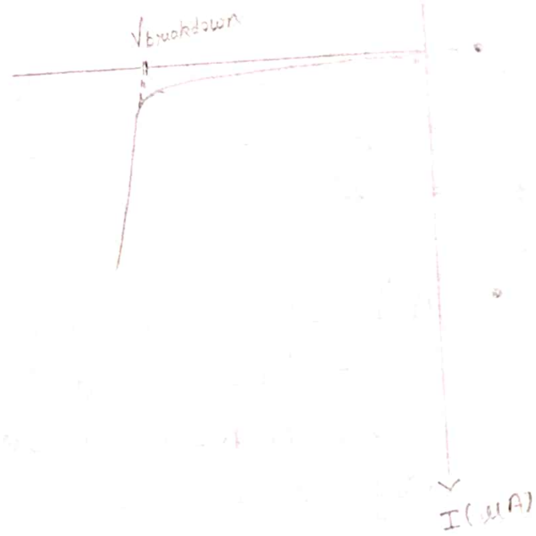
- The VI characteristics in the forward bias region is exponential.

1.6 Reverse Bias Condition





1.7 VI characteristics of reverse bias



2. Reverse Bias:

- When the negative terminal of a battery is connected to the p-side and the positive terminal to the n-side, the diode is said to be reserved biased.

- The applied voltage increases the width of the depletion region, making it more difficult for charge carriers to flow across the junction.

- The diode conducts very little current in the reverse direction.

- The VI characteristics in the reverse bias region is almost flat.

3. Breakdown Voltage:

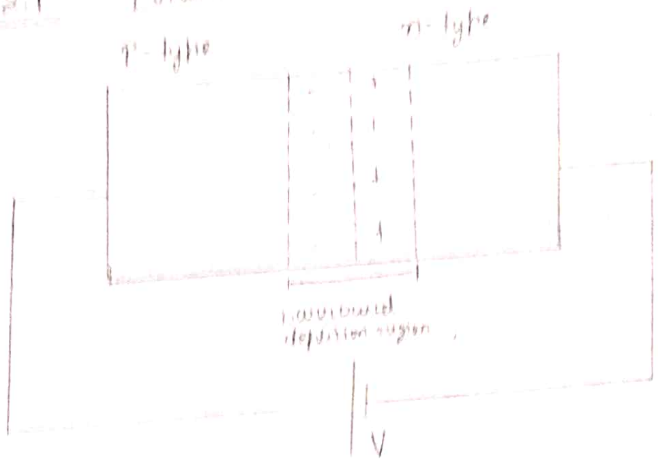
- If the reverse bias voltage is increased beyond a certain value, known as the breakdow voltage, the diode breaks down and conducts a large current.

- This breakdown can be due to either avalanche breakdown or Zener breakdown

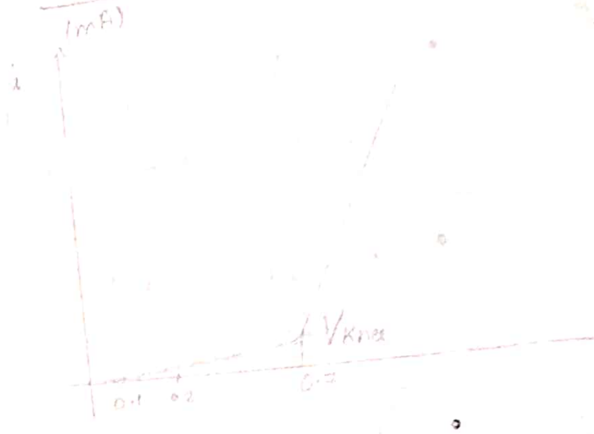
Applications of pn junction diodes:

- Rectification
- Switching
- Voltage regulation
- Light-Emitting diodes (LEDs)
- Photodiodes

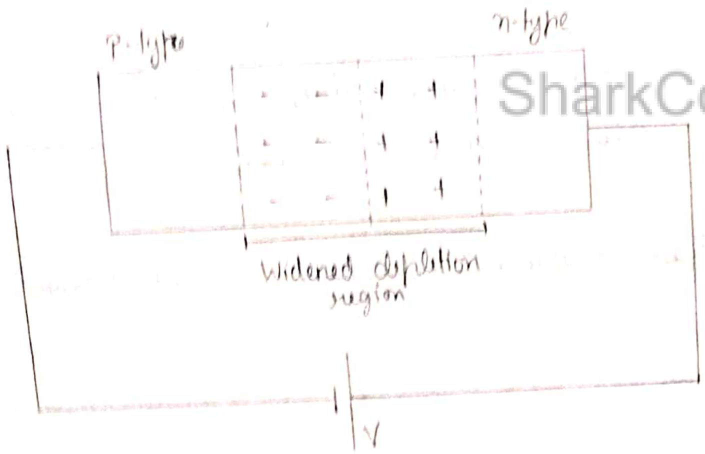
2.1 Forward Bias Condition



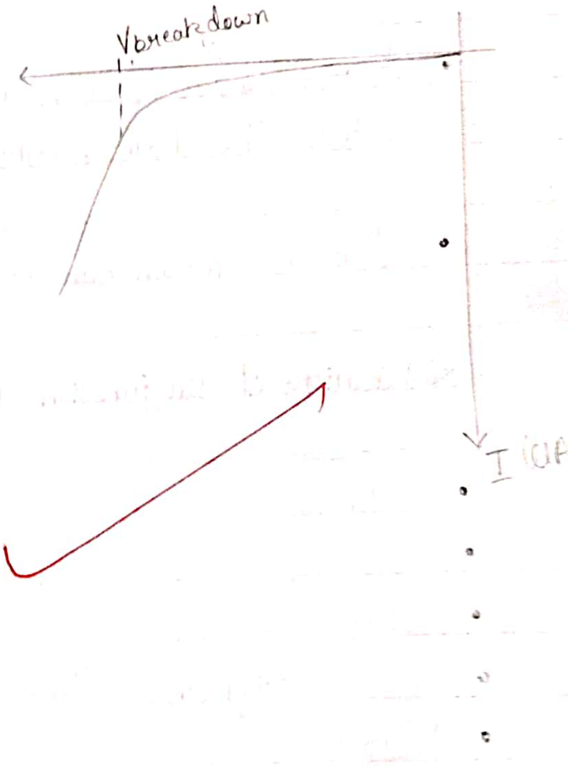
2.2 VI - Characteristics of forward



2.3 Reverse Bias Condition



2.4 VI - Characteristics of reverse



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Q2. Explain biasing and its types.

Biasing is the process of providing DC voltage which helps in the functioning of the circuit. It involves applying DC voltages to the component's terminal to provide a steady current or voltage. This current or voltage is known as bias.

There are two types of biasing:-

1. Forward Bias:

- When the positive terminal of a battery is connected to the p-side and the negative terminal to the n-side, the diode is said to be forward biased.
- The applied voltage reduces the width of depletion region, making it easier for charge carriers to flow across the junction.

- The diode conducts current in the forward ~~bias~~ direction.
- The VI characteristics in the forward bias region exponential.

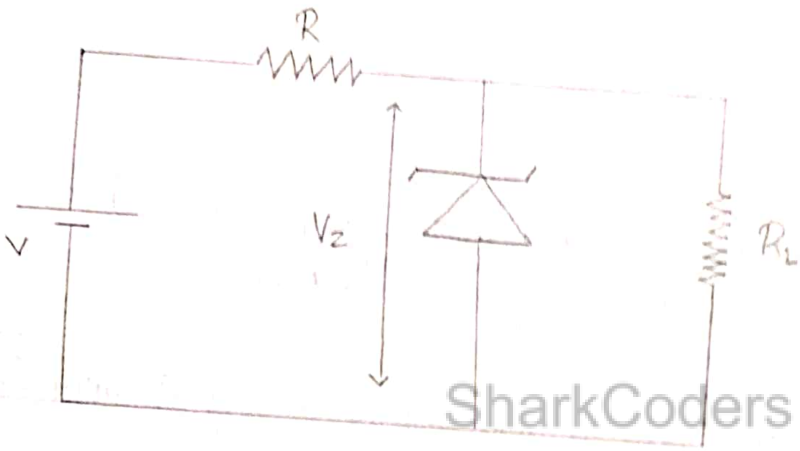
2. Reverse Bias:

- When the negative terminal of a battery is connected to the ~~#~~ p-side and the positive terminal to the n-side, the diode is said to be reversed biased.
- The applied voltage increases the width of the depletion region, making it more difficult for charge carriers to flow across the junction.
- The diode ~~conducts~~ very little current in the reverse direction.
- The VI characteristics in the reverse bias region is almost flat.

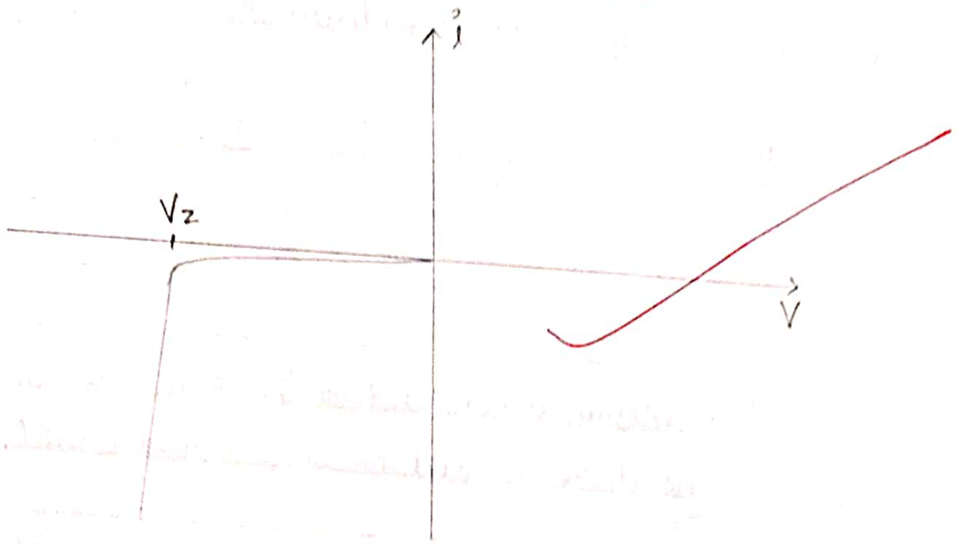
03 Zener Diode

3.1 Symbol

3.2 Circuit Diagram



3.3 V-I Characteristics of Zener diode



Q.3. Explain zener diode, its construction, VI characteristics and application.

Regulating Voltage: Zener diodes are specially designed to maintain a constant voltage across their terminals when operated in reverse bias. They are used as voltage regulators to provide a stable voltage source to circuits.

Construction:

A zener diode is a special type of pn junction diode designed to operate in the breakdown region under reverse bias conditions. It is constructed similarly to a regular pn junction. This heavy doping creates a narrow depletion region, which lowers the breakdown voltage.

VI Characteristics:

The VI characteristics of a Zener diode are unique:

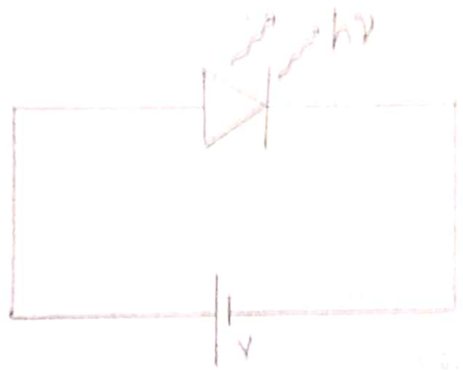
- Forward Bias: Similar to a regular diode, it conducts current in the forward direction.
- Reverse Bias: When the diode is reverse biased, the current remains very low until the breakdown voltage is reached.
- Breakdown Region: Once the breakdown voltage is reached, the diodes enters the breakdown region. In this region, the current increases rapidly while the voltage remains relatively constant. This constant voltge characteristics is the key feature of Zener diode.

Applications:

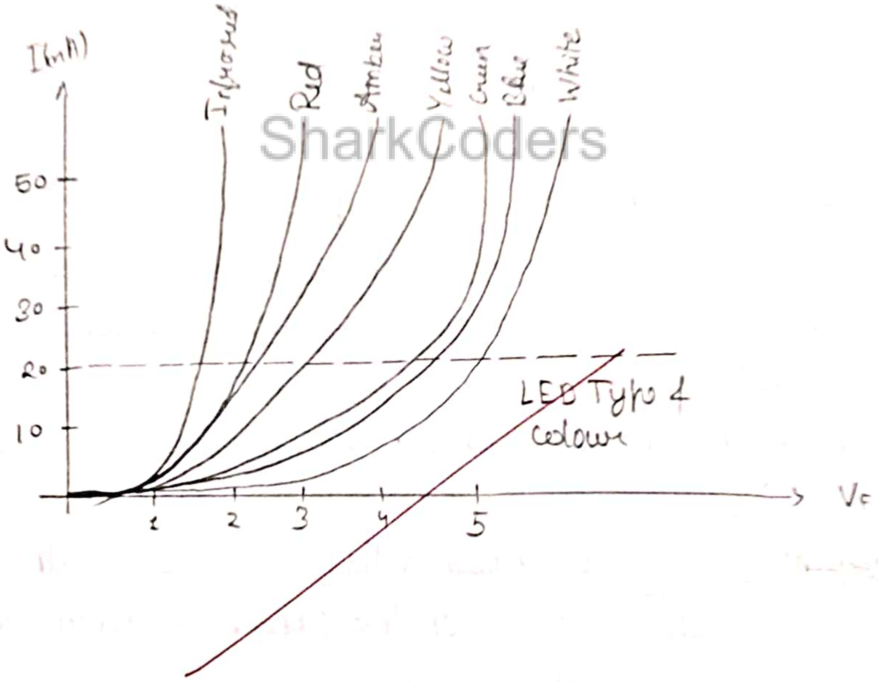
- Voltage Regulation: Zener diodes can be used as voltage regulators regulators to maintain a constant output voltage from a varying input voltage

Q4. LED

4.1 Circuit Diagram of LED



4.2 V.I characteristics of LED



- Clipping and Clamping: Zener diodes can be used to clip or clamp voltage waveforms to a specific level.
- Refrence Voltage: Zener Voltage diodes can provides a stable refrence voltage for other circuit components.
- Series Voltage Regulators: Zenerdiodes can be used in series with a resistor to create a simple voltage regulator.
- Noise Reduction: Zener diodes can be used to reduce noise in electronics circuit

Q.4. Discuss LED and its applications.

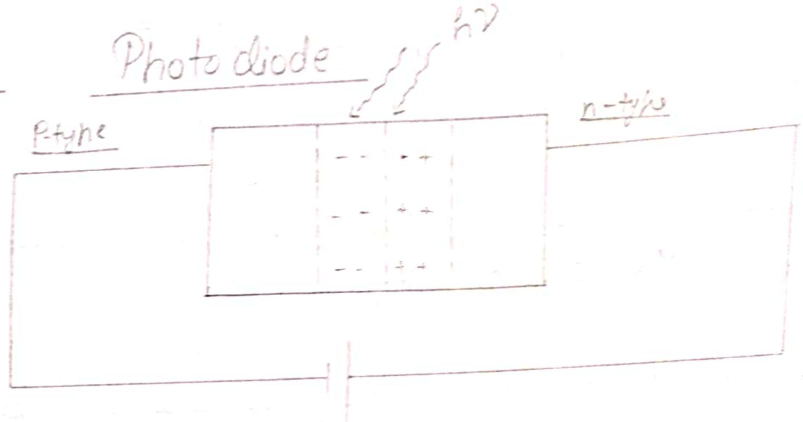
LED(s) (Light Emitting Diodes)

Construction:
An LED is a semiconductor device that emits light when a current is passed through it. It is especially a pn junction diode with a specific material composition that allows for the emission of light. The most common materials used for LED's are gallium arsenide (GaAs), gallium phosphide (GaP), and gallium nitride (GaN).

Principle of Operation:
When a forward bias voltage is applied to an LED, electrons from the n-type region recombine with holes from the p-type region. This recombination process releases energy in the form of light. The color of the emitted light depends on the energy gap of the semiconductor material used.

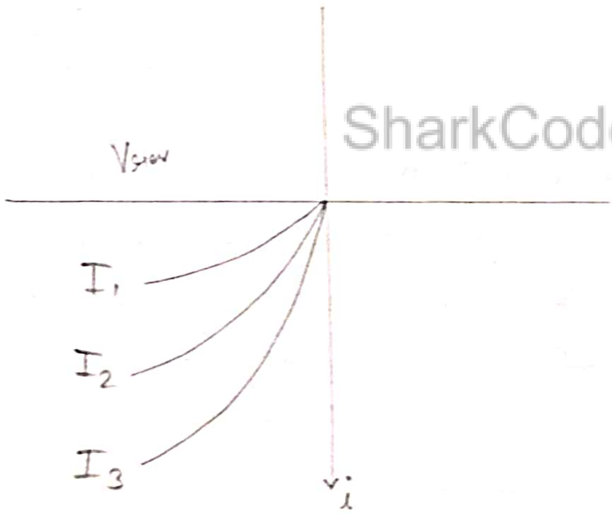
Q5 Photo diode

5.1 ⇒ Circuit



5.2 Symbol:

5.3 VI characteristics of photodiode



· Intensity of light incident :-

$I_3 > I_2 > I_1$

Application:
LEDs have become ubiquitous in modern technology due to their numerous advantages, including:

- Energy Efficiency: LEDs are significantly more energy-efficient than traditional incandescent and fluorescent bulbs.
- Long Lifespan: LEDs have a much longer lifespan than traditional bulbs, making them a cost-effective choice in the long run.
- Durability: LEDs are most durable and resistant to shock and ~~voltage~~ vibration than traditional ~~bulbs~~ bulbs.
- Instant On/Off: LEDs turn on and off instantly, without any warm-up time.

- Wide Range of Colors: LEDs are available in a wide range of colors, from red to blue and even white.

Q5. Explain photodiode & its application.

Photodiodes

Construction:
A photodiode is a semiconductor device that converts light energy ~~et~~ into electrical energy. It is essentially a pn junction region of a photodiode is typically exposed to light, allowing photons to interact with the semiconductor material.

Principle of Operation:
When light strikes the junction region of a photodiode, the energy of the photons can cause electrons to be excited from the valence band to the conduction band. This process is known as photogeneration. The resulting electron-hole pairs can then

be collected by the applied bias voltage, producing a current.

Types of Photodiodes:

There are several types of photodiodes, each with its own characteristics and applications:

- Pin Photodiode: A pin photodiode has an intrinsic layer between the p and n regions. This intrinsic layer increases the sensitivity of the photodio[de] to light.

- Avalanche Photodiode (APD): An APD is designed to operate in the breakdown region. When a photon generates an electron-hole pair it can trigger a cascade of additional electron-hole pairs, resulting in a significa[nt] amplification of the photocurrent.

- Schottky Photodiode: A schottky photodiode is formed by a metal-semiconductor junction. It has a faster response time compared to pn junctn junction diode.

- Phototransistor: A phototransistor is a combination of a photodiode and a bipolar junction transistor. It provides higher current gain than a photodiode alone.

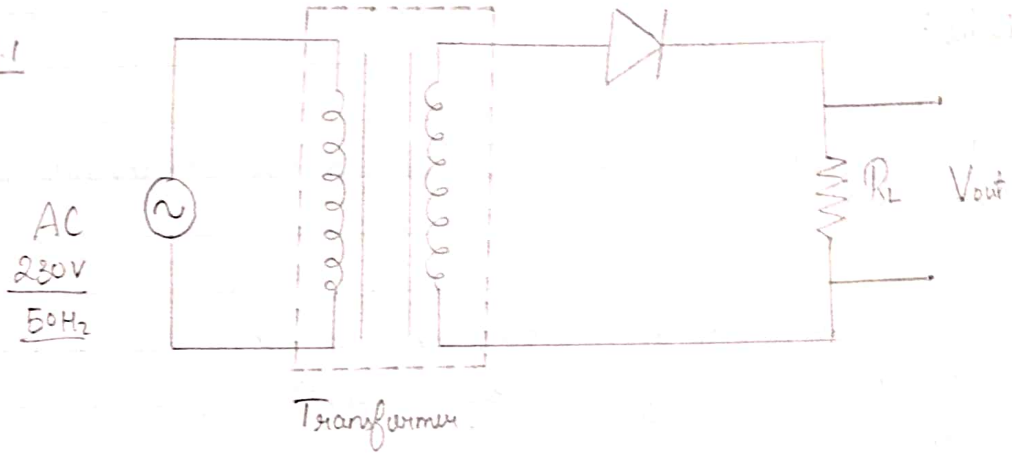
Applications:

Photodiodes have a wide range of applications, including:

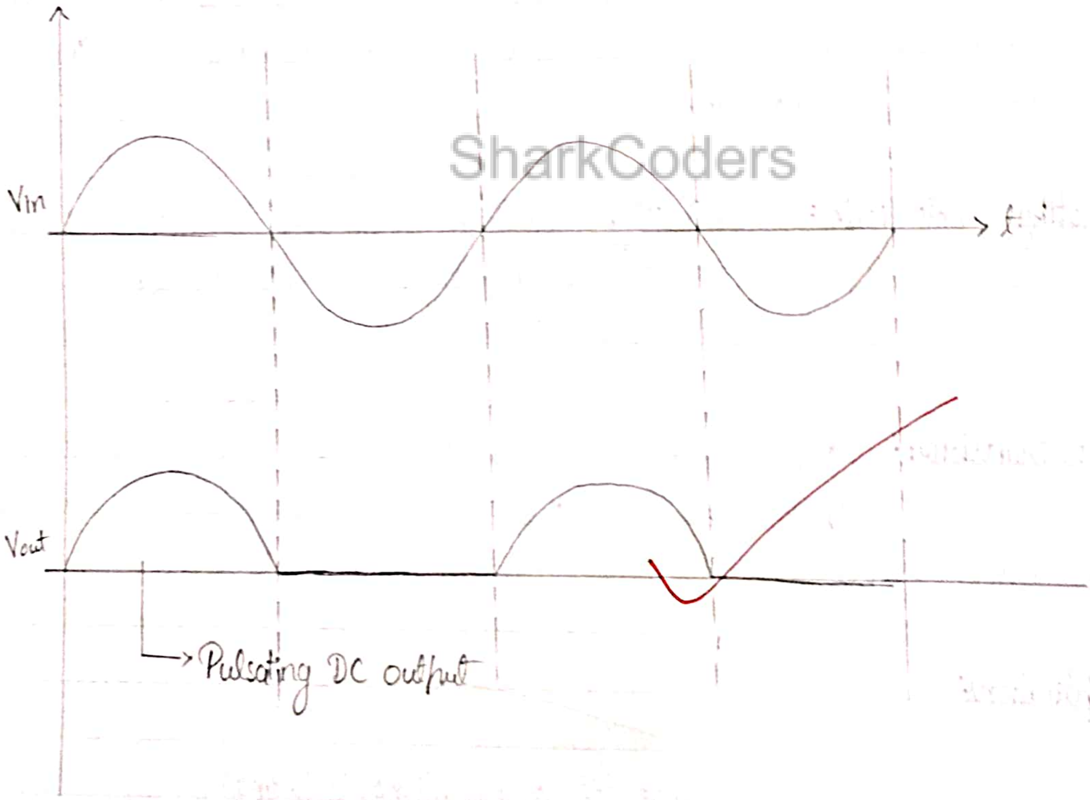
- Optical Communications: Photodiodes are used in optical fiber communication systems to detect the light signal.

Q6 Half-Wave Rectifier

6.1



6.2 Waveforms



- Image Sensors: Photodiodes are used in digital cameras, video cameras, and other imaging device to capture light & convert it into electrical signals
- Optical Measurements: Photodiodes can be used to measure light intensity, wave-length, and other optical parameters.
- Optical Sensing: Photodiodes are used in various sensing applications, such as smoke detection, flame detection & motion detection.
- Solar Cells: Solar cells are essentially large-area photodiodes that convert sunlight into electricity.

Q6. Discuss Half Wave Rectifier circuits along with neat output waveforms.

Half Wave Rectifier Circuit:

A half-wave rectifier circuit is a simple electronic ~~device~~ circuit that converts an alternating current (AC) input signal into a direct current (DC) output signal. It allows only one half of the AC waveform to pass through, hence the name "half-wave."

Components:

A typical half-wave rectifier circuit consists of:

- Diode: A diode is a semiconductor device that allows current to flow in only one direction. In a half-wave rectifier, a ~~signal~~ single diode is used.

- Load Resistor: The load resistor is connected to the output of the rectifier and represents the device or circuit that will be powered by the DC output.

Circuit Operation

1. Positive Half-Cycle:

- During the positive half-cycle of the AC input signal, the diode is forward biased, allowing current to flow through it and the load resistor.
- The output voltage across the load resistor is equal to the input voltage during this half cycle.

2. Negative Half-Cycle:

- During the negative half-cycle of the AC input signal, the diode is reverse biased, preventing current from flowing.
- As a result, the output voltage is zero during this half-cycle.

Output Waveform:

The output waveform of a half-wave rectifier is a pulsating DC waveform. It consists of only the positive half-cycles of the input AC signal, with the negative ~~half-wave~~ half-cycle being clipped to zero.

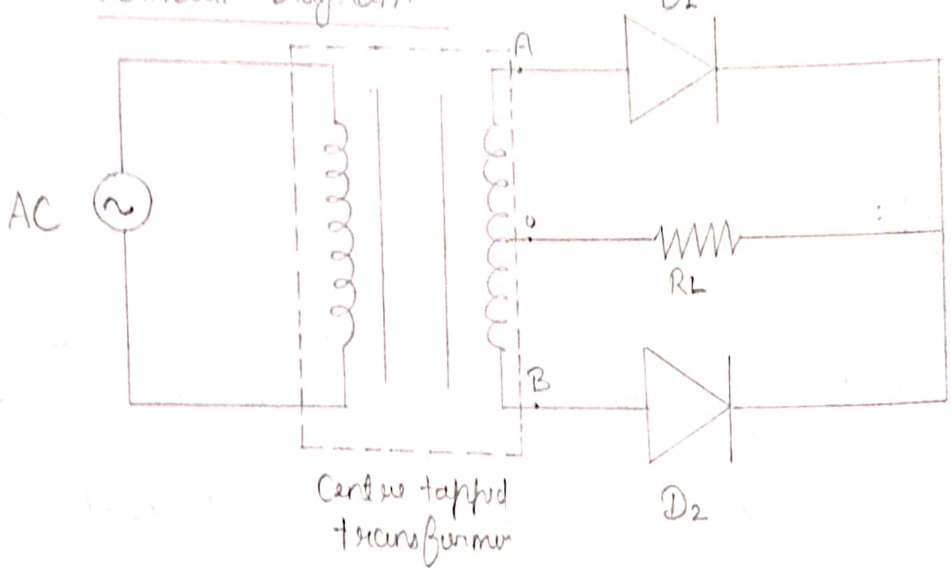
Applications

Half-wave rectifier circuits are commonly used in:

- Power supplies for small electronic devices.

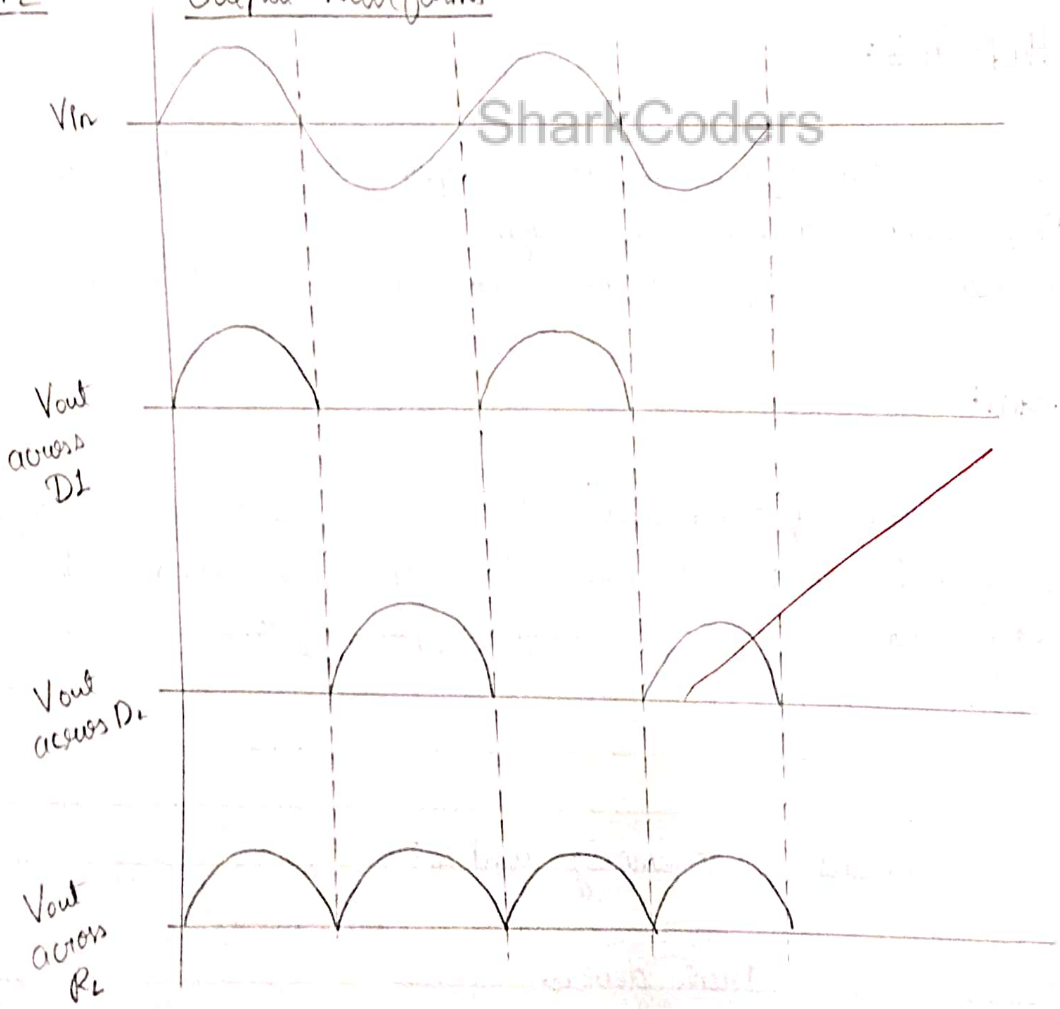
Q7 Full Wave Rectifier (Centre Tapped)

7.1 Circuit Diagram



D1 → diode 1
D2 → diode 2
RL → Load resistance

7.2 Output Waveforms



- Battery charger
- Signal detention circuits.

While half-wave rectifiers are simple and inexpensive, they are often less efficient than full-wave rectifiers, which utilize both halves of the AC waveform. For applications that require a more efficient and ripple-free DC output, full-wave rectifiers are generally preffered.

Q7. Explain Full Wave Rectifier (Centre Tapped), also discuss the various parameters of Full Wave Rectifier.

Full Wave Rectifier (Centre-Tapped):

A full wave rectifier circuit is designed to convert the entire AC input signal into a DC output signal, utilizing both the positive and negative half-cycles. A centre-tapped transformer is used to create two secondary windings, each with half the voltage of the primary winding.

Components:

- Centre-tapped transformer - A transformer with a secondary winding divided into two equal halves, with a centre tap.
- Two diodes - Two diodes are connected in series with the two halves of the secondary winding.

Circuit Operation:

1. Positive Half-Cycle:
   - During the positive half-cycle of the AC input signal, one

diode is forward biased while the other is reverse biased.

- Current flows through the forward-biased diode and the load resistor, producing a positive output voltage.

2. Negative Half-Cycle:

- During the negative half-cycle of the AC input signal, the roles of the diodes are reversed.
- The other diode becomes forward-biased, and current flows through it and the load resistor, producing a positive output voltage.

Output Waveform:

The output waveform of a full-wave rectifier is a pulsating DC waveform with a frequency twice that of the input AC signal. This is because both halves of the AC waveform are rectified, resulting in a more continuous DC output.

Parameters of a Full-Wave Rectifier:

1. Ripple Factor: This is a measure of the AC component present in the DC output. $\Rightarrow \gamma = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1}$

2. Efficiency: The efficiency of a rectifier is the ratio of the DC output power to the AC input power. A higher efficiency means less power is wasted as heat. $\Rightarrow \frac{P_{dc}}{P_{ac}} = \eta = 67.2\%$

3. Regulation: This refers to the ability of the rectifier to maintain a constant DC output voltage despite variations in the input voltage or load current.

4. PIV (Peak Inverse Voltage): This is the maximum voltage that the diodes can withstand without breaking down. The diodes must have a PIV rating higher than the peak voltage of the secondary winding. → PIV = 2Vm

Applications:

Full-wave rectifiers are widely used in power supplies for various electronics devices, including:

- Audio amplifiers
- Televisions
- Computers
- Power tools
- Medical equipment.

Q8. Discuss advantages, disadvantages & applications of (HWR) Half Wave Rectifier, Full Wave Rectifier (FWR) & Bridge Rectifier.

Half Wave Rectifier:

Advantages:

- Simple Construction ⇒ Half-wave rectifiers are relatively simple to construct, requiring only a single diode and a load resistor. This simplicity can lead to lower costs and easier implementation.

- Low Cost ⇒ Due to their simplicity, half-wave rectifiers are generally less expensive than full-wave rectifiers.

• Suitable for Low-Power Applications ⇒ Half-wave rectifiers are often sufficient for low power applications where the ripple voltage & efficiency are not critical factors.

Disadvantages:

• Inefficient Power Utilization ⇒ Half-wave rectifiers only utilize one half of the input AC waveform, leading to inefficient power utilization. This can result in lower overall efficiency and increased power consumption.

• High Ripple Voltage ⇒ The output waveform of a half wave rectifier contains a significant ripple voltage, which can be undesirable for many applications. This ripple voltage can cause noise and instability in sensitive circuits.

• Limited Applications ⇒ Due to their inefficiencies and limitations, half-wave rectifiers are generally not suitable for high-power or ~~eri~~ critical applications where a clean, ripple-free DC output is required.

Full Wave Rectifier (Centre Tapped):

Advantages:

• High Efficiency ⇒ Full-wave rectifiers utilize both halves of the input AC waveform, resulting in higher efficiency compared to Half-Wave Rectifiers. This means less power is wasted as heat, leading to improve ~~or~~ overall performance.

- Lower Ripple Voltage ⇒ The output waveform of a full-wave rectifier has a lower ripple voltage than a half-wave rectifier. This is because both ~~half~~ halves of the AC waveform are rectified, resulting in a more continuous DC output.

- Can be Used with a Wider Range of Input Voltages ⇒ Full-wave rectifiers can be used with a wider range of input voltages compared to half-waves rectifier. This is due to the centre-tapped transformer, which allows for a more balanced distribution of the input voltage.

Disadvantages:

- More Complex Construction ⇒ Full-wave rectifiers require two diodes and a centre-tapped transformer, making them more complex to construct than half-wave rectifiers.

- Higher Cost ⇒ The additional components in a full-wave rectifier can increase the overall cost compared to a half-wave rectifier.

- Potential for Traformer Saturation ⇒ If the load current is too high, the centre-tapped transformer can become saturated, leading to distorted output waveforms and reduced efficiency.

Bridge Rectifier:

Advantages:

- Higher Efficiency ⇒ Bridge rectifiers are more efficient than centre-tapped full-wave rectifiers because they do not require a center-tapped full wave rectifiers, making them more suitable for portable and compact applications.

- Reduced Ripple => The output ripple voltage is lowered compared to half-wave rectifiers, resulting in a smoother DC output.

- Simpler Design => The bridge rectifier circuit typically uses four diodes, which is a relatively simple and cost-effective configuration.

Disadvantages:

- Higher Voltage drop => The voltage drop across the diodes in a bridge rectifier is higher than in a half-wave rectifier, resulting in a lower DC output voltage.

- Increased Power Dissipation => Due to the higher voltage drop and current flow, the diodes in a bridge rectifier dissipate more power, leadings to higher heat generation.

- Requires four diodes => While the bridge rectifier is simple, it requires four diodes, which can increase the cost and complexity of the circuit compared to a half-wave rectifier.

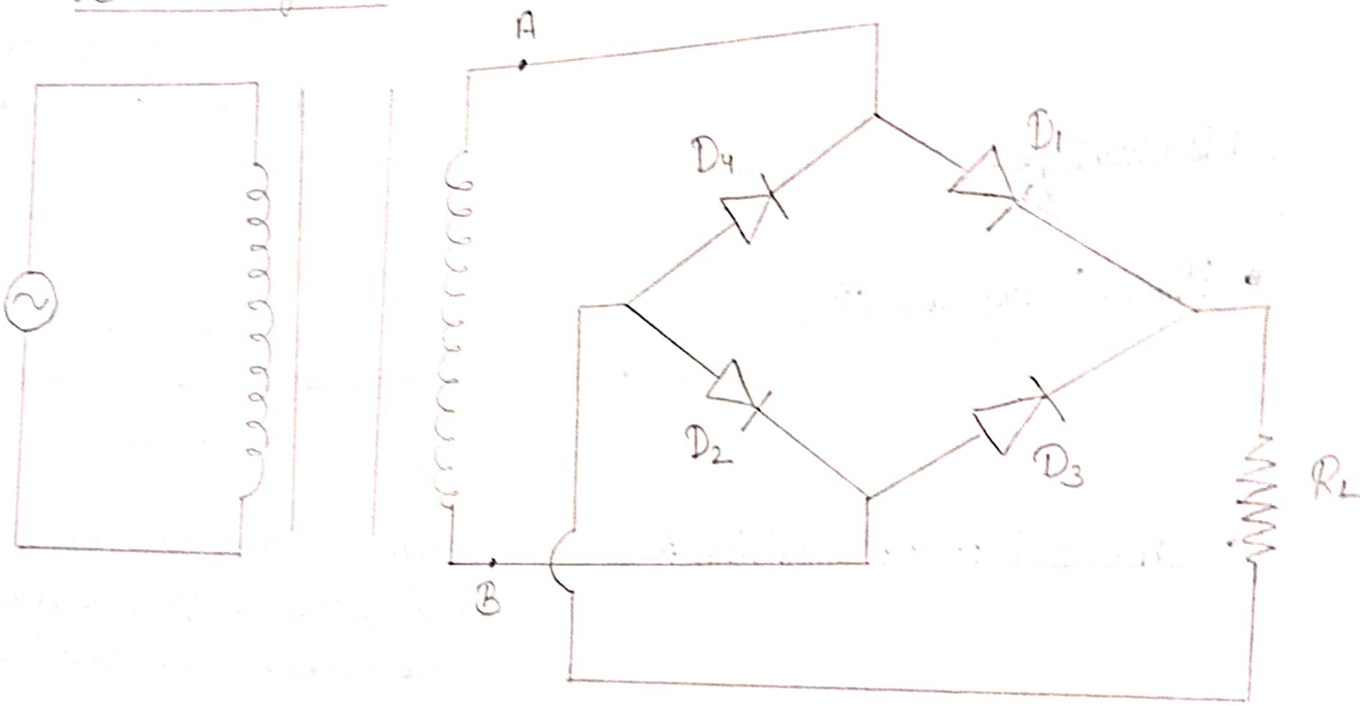
Q9. Explain construction, working & waveform of Bridge Rectifier.

Construction of a Bridge Rectifier:

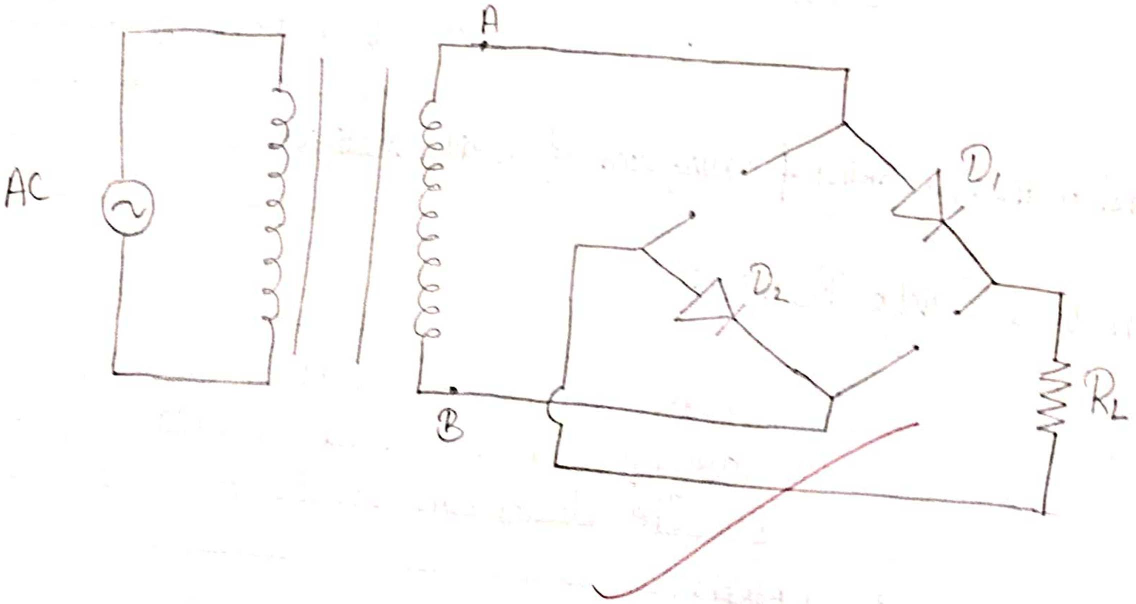
A bridge rectifier typically consists of four diodes connected in a specific configuration. These diodes are arranged in a diamond or bridge shape, hence the name "bridge rectifier." The diodes can be discrete components or integrated into a single package.

9. Bridge Rectifier

9.1 Circuit Diagram



9.2 Diagram for +ve half cycle



• flow of curr...
$A \rightarrow D_1 \rightarrow R_L$

Working of a Bridge Rectifier:

1. Input AC Signal: An alternating current (AC) signal is applied to the input terminals of the bridge rectifiers.

2. Positive Half-Cycle: During the positive half-cycle of the input signal, diodes D1 and D2 conduct, while diodes D3 and D4 are reverse-biased and do not conduct. The current flows from the positive terminal of input source, through D1, to the load, and then through D2 back to the negative terminal of the input source.

3. Negative Half-Cycle: During the negative half-cycle of the input signal, diodes D3 and D4 conduct, while diodes D1 and D2 are reverse biased. The current flows from the negative terminal of the input source, through D3, to the load, and then through D4 back to the positive terminal of the input source.

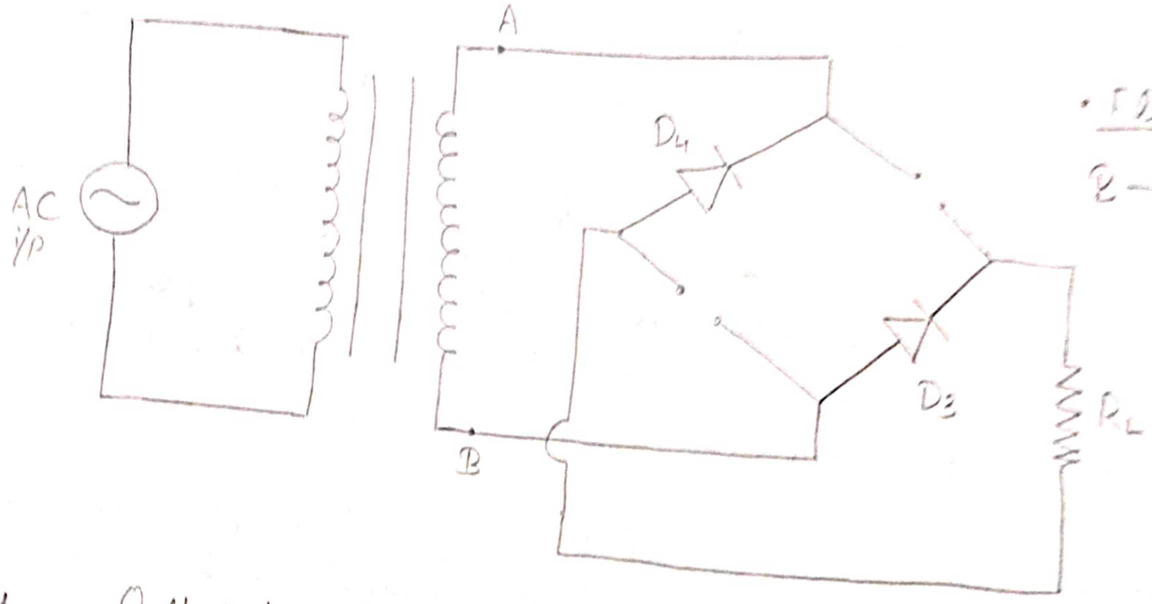
4. Output DC Voltage: In both cases, the current flowing through the load is always in the same direction, resulting in a direct current (DC) output voltage.

Waveform of a Bridge Rectifier:

The output waveform of a bridge rectifier is a pulsating DC voltage. It consists of a series of positive half cycles from the input AC signal. The negative half-cycles are inverted and rectified, resulting in positive DC output. However, the output voltage is not perfectly smooth and contains a ripple component. To reduce the ripple, a filter capacitor is often connected in parallel with the load.

In the diagram we can see that the output waveform of a bridge rectifier is a series of positive pulses with a ripple component.

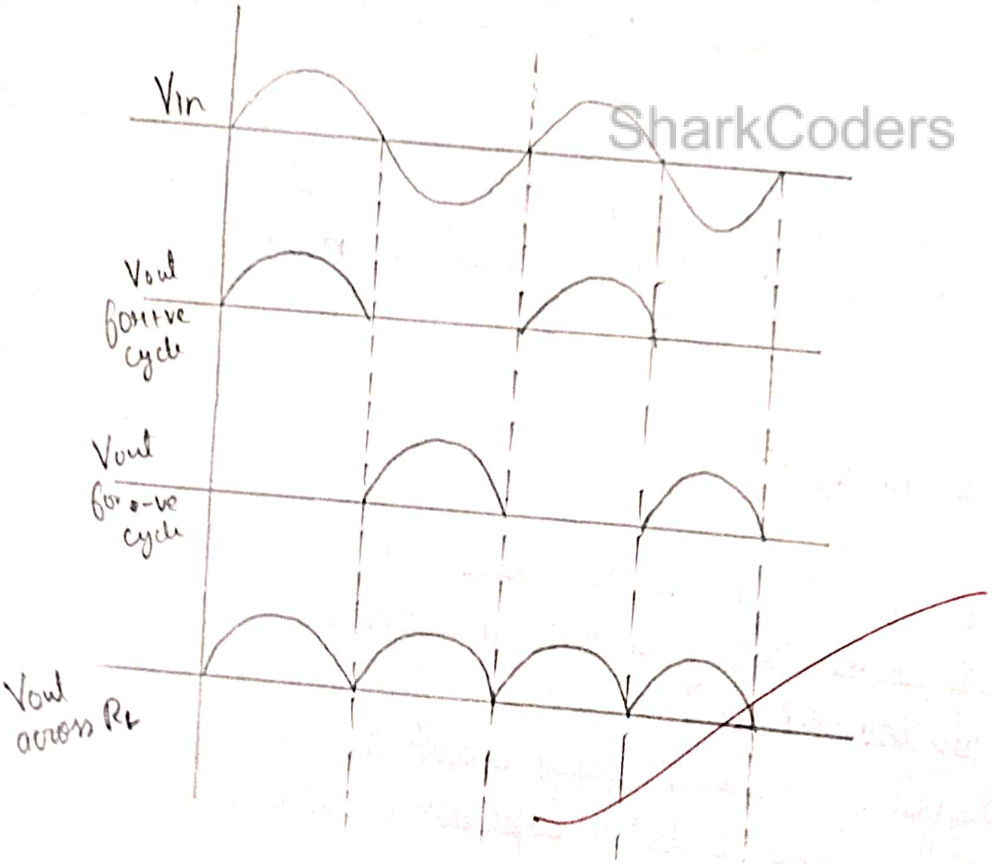
9.3 Diagram for -ve half cycle



• Flow of current

B → D_2 → R_L → ...

9.4 Output Waveforms



The ripple can be reduced by using a filter capacitor, which stores energy during the positive half-cycles and releases it during the negative half-cycles, smoothing out the output voltage.

Q10. Explain rectifier with capacitor filter circuit, also draw the diagram for it.

Rectifier with Capacitor Filter Circuit

Understanding the components:

- Rectifier: A circuit that converts alternating current (AC) to direct current (DC).
- Capacitor: An electronic component that stores electrical energy in an electric field.

How it Works:

1. Rectification → The rectifier, typically a bridge rectifier, converts the AC input into a pulsating DC voltage. This pulsating DC has a ripple, which is the variation in voltage over time.

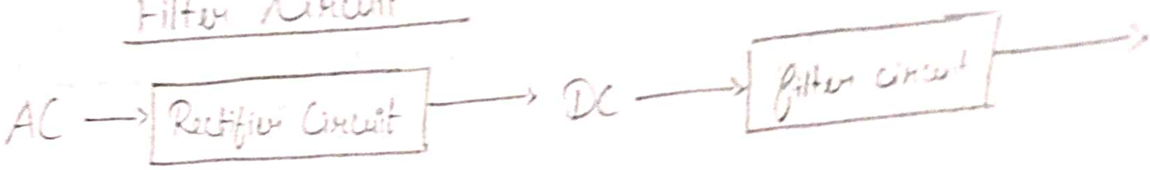
2. Filtering → The capacitor is connected in parallel with the load. When the rectifier output voltage rises, the capacitor discharges slowly, providing a relatively constant DC voltage to the load.

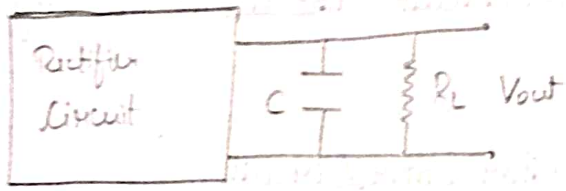
The Role of the Capacitor:

- Smoothing → The capacitor acts as a reservoir, storing energy during the peak of the rectifier output and releasing it during the troughs. This helps to smooth out the ripples, providing a more stable DC voltage.

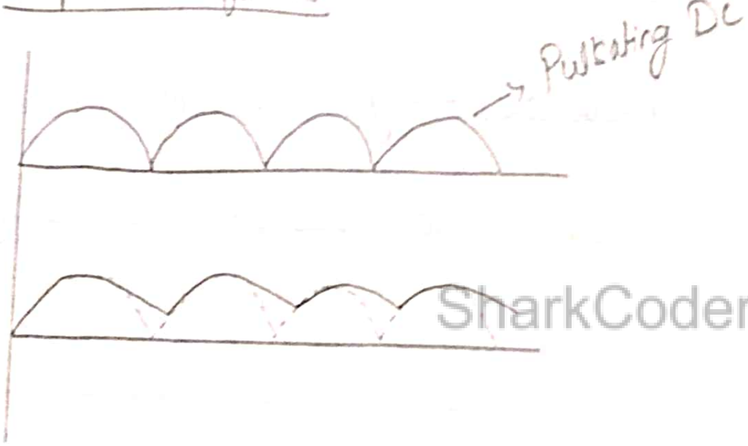
Q10 Filter Circuit

10.1





10.2 Output waveforms:



after use of filter circuit

- Reducing Ripple → The larger the capacitance, the more effective the filtering. A larger capacitor can store more charge, resulting in a smaller ripple.

- Improving Load Regulation → The capacitor helps to maintain a relatively constant DC voltage to the load, even if the load current varies.

Benefits of Using a Capacitor Filter:

- Improved DC Quality → Reduces the ripple voltage, providing a smoother DC output.

- Increased Efficiency → Can improve improve the overall efficiency of the power supply.

- Better Load Regulation → Maintains a more stable DC voltage to the load.

Q11. Explain Voltage Regulation Power supply with block diagram.

Voltage Regulator

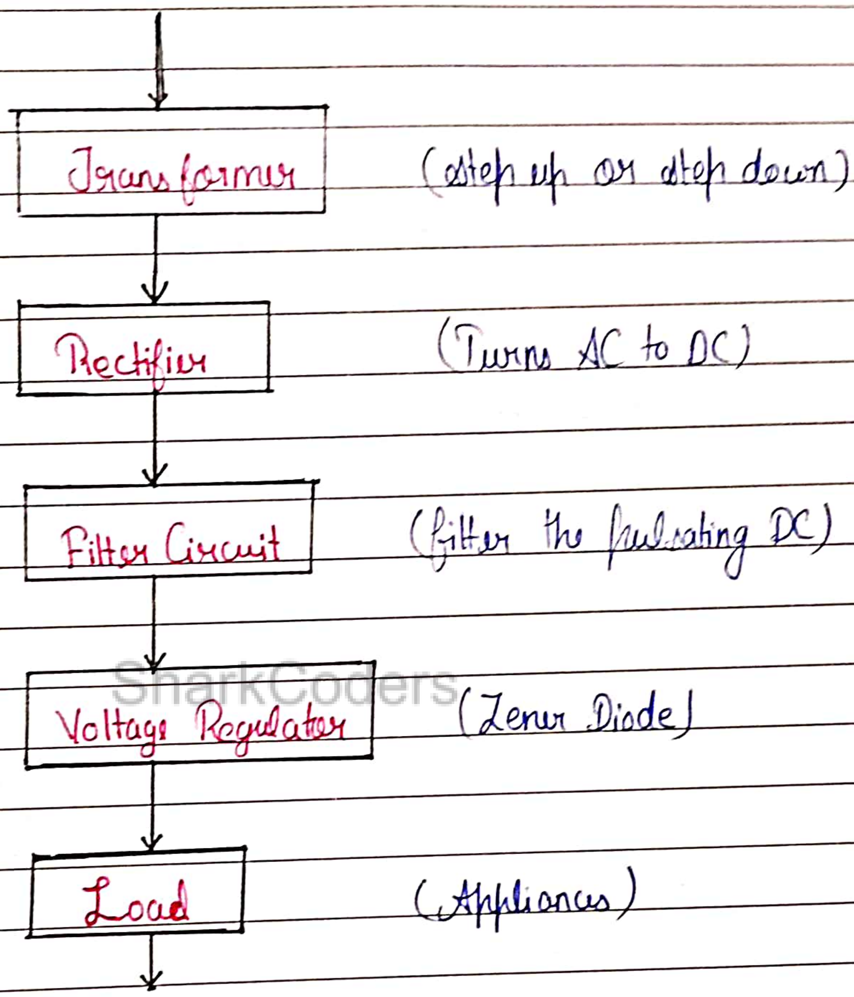
Voltage regulation in a power supply ensures that the output voltage remains constant despite fluctuations in the input voltage or load. This is crucial for many electronic devices that require a stable voltage source to function correctly.

The core component of the power supply, the voltage regulator maintains a constant output voltage. It can be either linear or switching:-

- Linear Regulator: Uses a transistor to control the output voltage by dropping excess voltage as heat.

- **Switching Regulator:** Uses a switching element (like a transistor or MOSFET) to efficiently convert the input voltage to the desired output voltage.

Block Diagram:



- **Transformer:** electrical devices that change the voltage of alternating current (AC) electricity. They are crucial components in power grids, allowing for efficient transmission of electricity over long distances and for adapting the voltage to suit different applications.

- **Rectifiers:** electronic devices that convert AC to DC current. This conversion is essential for many electronic devices & systems that require a steady, undirectional flow of current

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- Filter Circuit: electronic ~~device~~ circuits designed to selectively pass ~~or~~ or block electrical signals of different frequencies. They are essential components in various electronic systems, from audio equipment to communication systems.

- Voltage Regulator: electronic circuits designed to maintain a constan DC voltage output regardless of fluctuation in the input voltage or load current.

- Load: components or device that consumes electrical power. It can be as simple as a light bulb or as complex as a ~~a~~ factory machinery.

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Assignment - 2

Name: Kashish Valecha

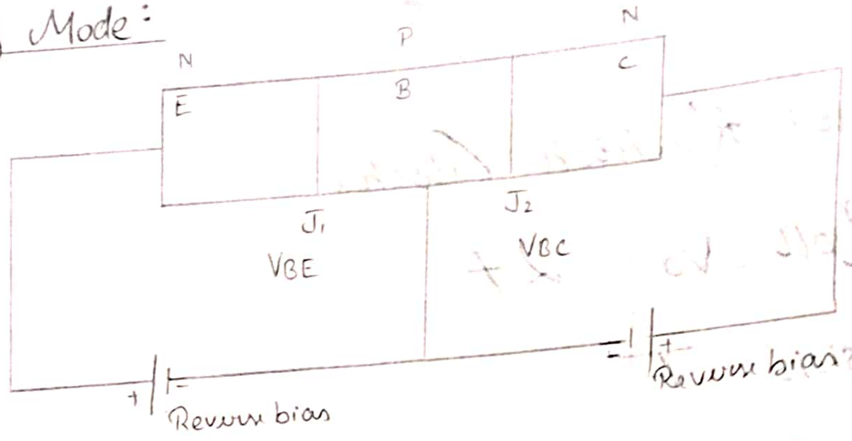
Roll No: 27

Division: F

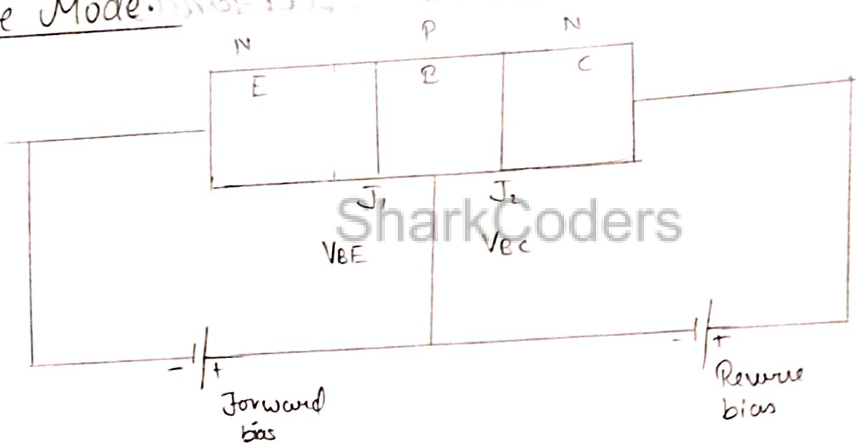
Subject: Basic Electronics

Diagrams:-

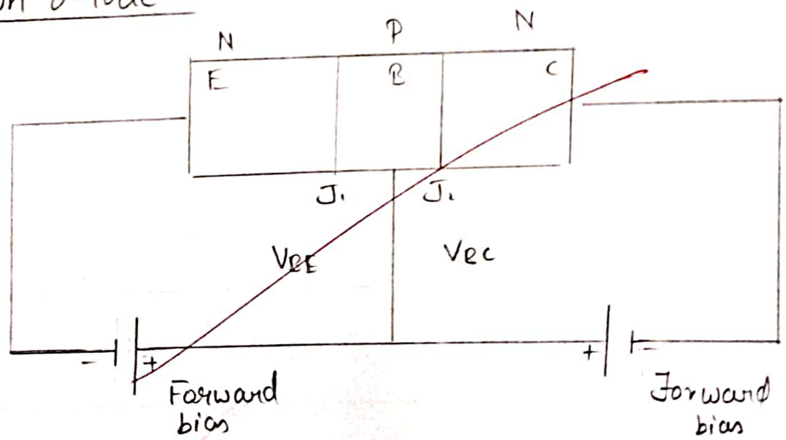
1.1: Cutoff Mode:



1.2: Active Mode:



1.3: Saturation Mode:



Q1. Explain the different modes of transistor with neat diagrams.

A transistor is a semiconductor device, can operate in three primary modes:

1. <u>Cutoff Mode</u>

- Condition: Base-emitter junction is reverse biased, and base-collector junction is emitter either reverse biased or open.

- Behavior: No current flows through the transistor. It behaves like an open switch.

2. <u>Active Mode</u>

- Condition: Base-emitter junction is forward biased, and base-collector junction is reverse biased.

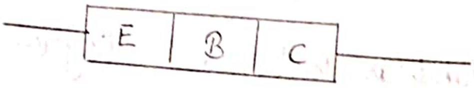
- Behaviour: The transistor amplifies the input signal. The collector current is proportional to the base current, providing a current gain.

3. <u>Saturation Mode</u>

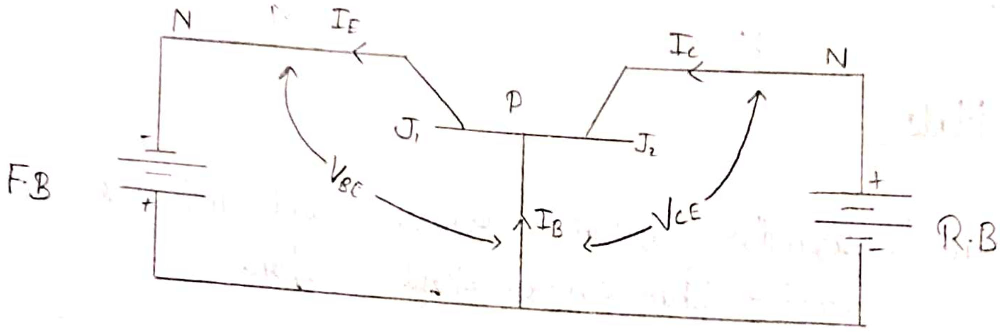
- Condition: Both base-emitter and base collector junctions are forward bias.

- Behaviour: The transistor acts as a closed switch. The collector current reaches its maximum value, independent of the base current.

Q2. → 2.1



2.2 Schematic Diagram



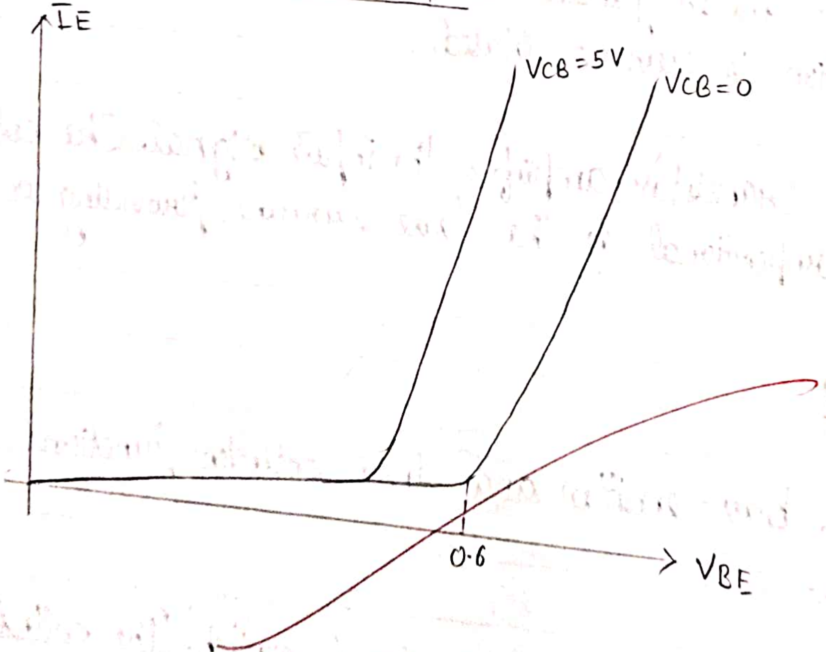
F.B → forward bias , I_C →

R.B → reverse bias , I_B →

V_{BE} → , I_E →

V_{CE} →

2.3 Input Characteristics



Key Points:

- The mode of operation of a transistor depends on the biasing conditions of its junction.
- The active mode is the most common mode used in amplifiers & oscillators.
- The cutoff mode is used in switching circuits.
- The saturation mode is used in digital circuits as a switch.

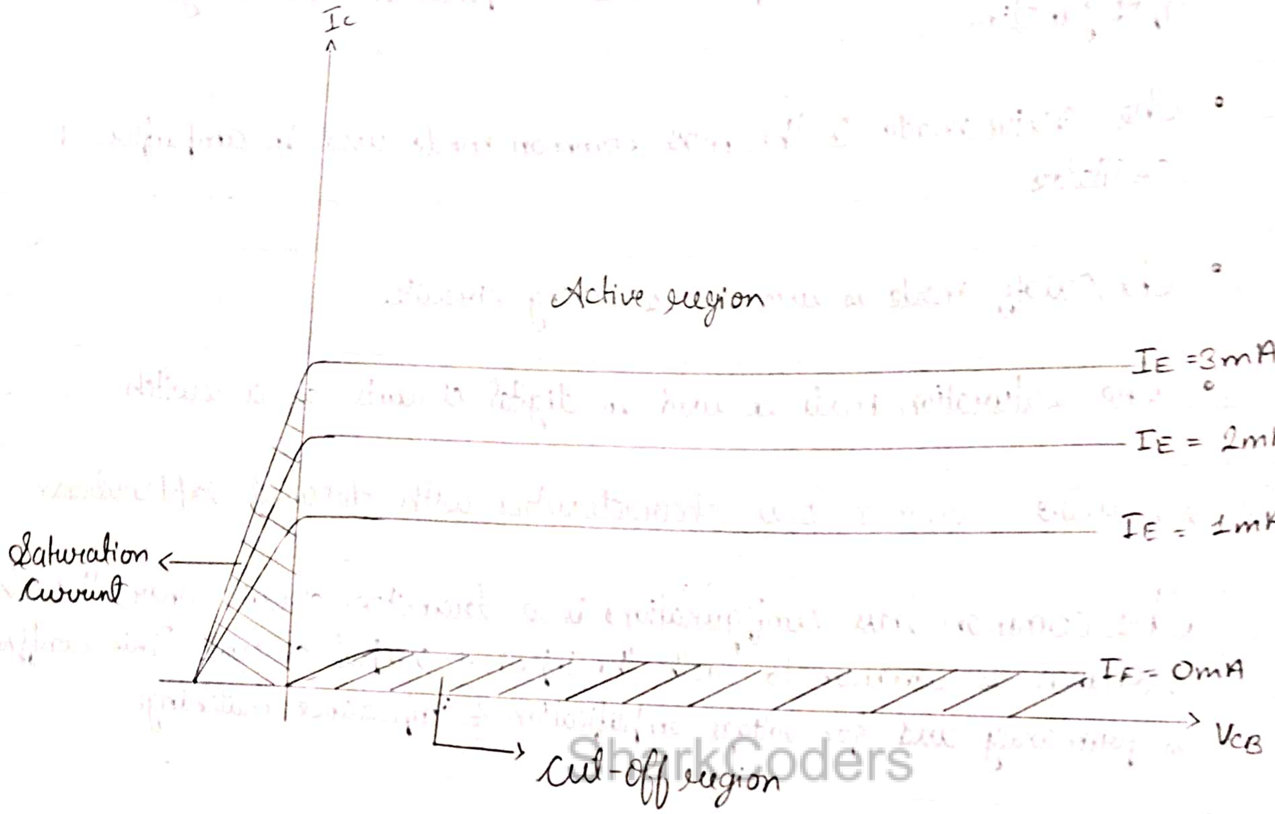
Q2. Describe Common Base characteristics with detailed explanation.

The common base configuration is a transistor circuit where the base terminal is common to both the input & output circuit. This configuration is primarily used for voltage amplification & impedance matching.

Input Characteristics:

- Input Variables → I_E, V_{BE} at V_{CB} = constant
- Input Current (I_B) → The base current is very small compared to the emitter current.
- Input Voltage (V_B) → The input voltage is typically a few tents of a volt.
- Input Resistance (R_{in}) → The input resistance is relatively high, typically in the range of megaohms.

2.4 Output Characteristics



- If we increase V_{CB} breakdown voltage would decrease.

Output Characteristics:

- Output Variables → I_C, V_{CB} at I_E = const.
- Output Current (I_c) → The collector current is largely independent of the collector voltage.
- Output Voltage (V_c) → The output voltage can vary over a wide range.
- Output Resistance (R_{out}) → The output resistance is relatively low, typically in the range of a few hundred ohms.
- When $I_E = 0$ the input region will act as open circuit so, only J_2 junction is left which is reverse biased (as in diagram) so, if we increase V_{CB} which will inturn increase I_C.

Cutoff Mode:

- Input current I_B = Zero
- Output current I_C = zero
- Votage gain = Zero.

Active Mode:

- Input current I_B = Small
- Output current I_C = Large
- Voltage gain = High
- Current gain = Close to 1

Activation Mode:

- Input current (I_E) = High
- Output current (I_C) = Maximum
- Voltage Gain = Low
- Current Gain = Close to 1.

Applications

- Voltage amplifiers: Due to its high voltage gain, the common base configuration is often used in voltage amplifiers.

- Impedance matching: The common base configuration can be used to match the impedance of a high-impedance source to a low impedance load.

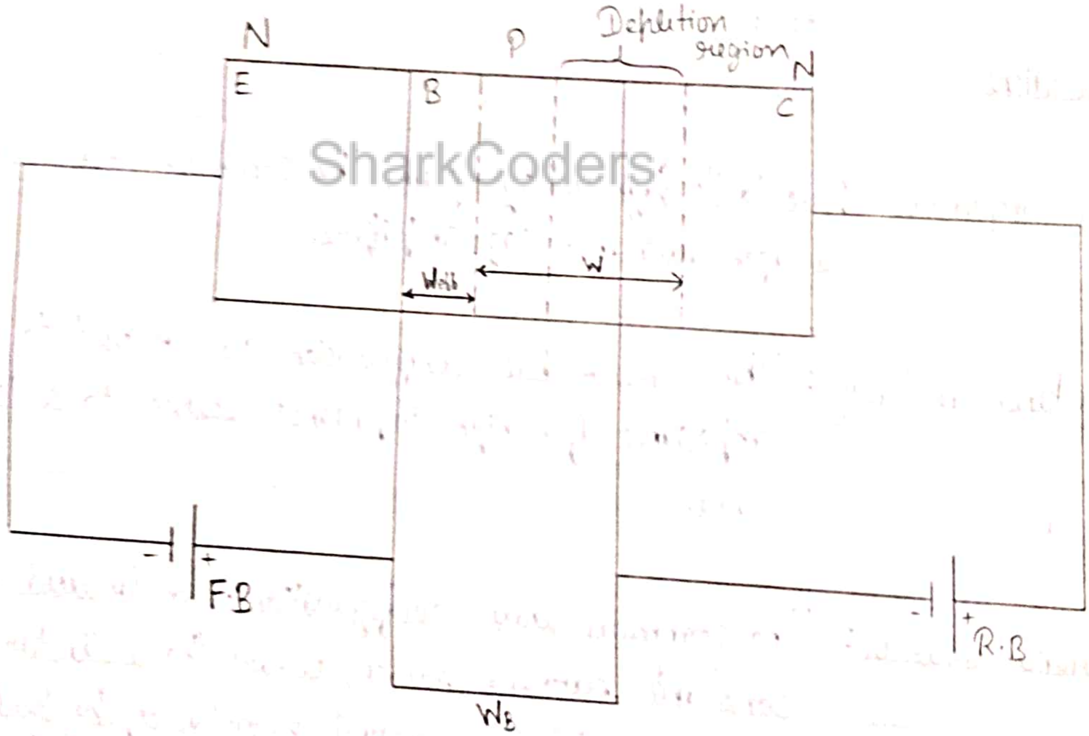
- Current sources: The common base configuration can be used to create a constant current source, where the collector current remains relatively constant regardless of the load.

Q3. Explain Early Effect or Base Width Modulation

Early Effect (Base Width Modulation)

Early effect also known as base width modulation, is a phenomenon that occurs in Bipolar Junction Transistors (BJTs) at high collector-emitter voltages. It causes a change in the transistor's characteristics, primarily affecting its current gain & output resistance.

Q2 Early Effect



Weff :- effective width (Reduced Base width)
WB :- Base width
W :- increased base width due to depletion region.

Mechanism :

1. Reverse Bias :- When the collector-emitter voltage (V_{CE}) increases, the base-collector junction becomes more reverse biased.

2. Depletion Region :- The reverse bias causes a wider depletion region to form at the base-collector junction.

3. Base Width Narrowing :- As the depletion region widens, it effectively narrows the base region of transistor.

4. Increased Carrier Injection :- With a narrower base region, more minority carriers (electrons in an NPN ~~transite~~ transistor, holes in a PNP transistor) can diffuse from the emitter to the collector.

5. Increased Collector Current :- The increased injection of minority carriers leads to a larger collector current (I_C).

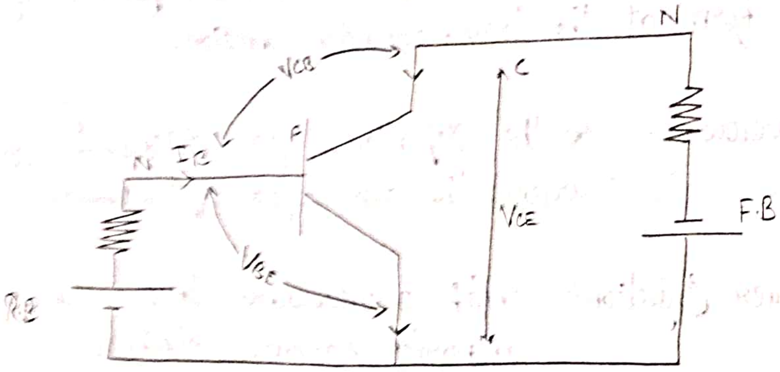
Impact on Transistor Characteristics :

1. Decreased Current Gain : Early effect causes a decrease in the transistor's current gain. This is because the increased collector current is not directly proportional to base current due to the base width narrowing.

2. Decreased Output Resistance : The output resistance of the transistor decreases due to early effect. This is because the change in collector current with respect to collector voltage becomes more significant.

Q. → 4.1

4.1 Schematic Diagram:



4.2 Input Characteristics

Implications:

- Circuit Design:- Early effect must be considered in circuit design, especially for high-power or high-frequency applications.
- Transistor Selection:- Transistors with a low early effect coefficient (V_A) are preffered for applications where high current gain & high output resistance are important.
- Biasing:- Careful baising can help to minimize the effects of early effect.

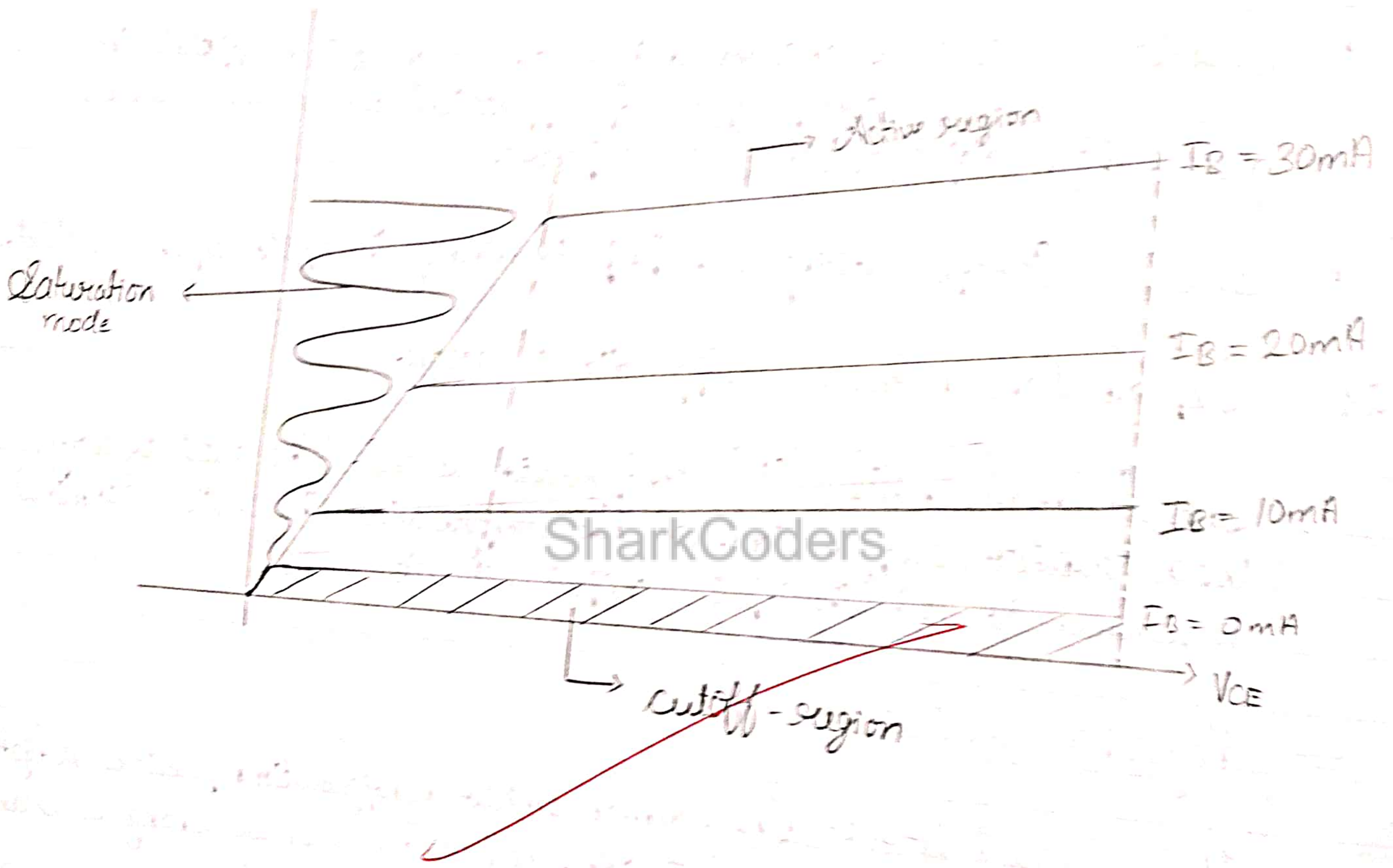
Q4. Explain Common Emitter configuration in detail.

The Common Emitter (CE) configuration is one of the most widely used transistor configurations. In this configuration, the emitter terminal is common to both the input & output circuits.

Key Characteristics:

- High Current Gain:- The common emitter configurations provides a high current gain, meaning that a small change in base current can produce a large change in collector current.
- Medium Input Impedance:- The input impedance of a common emitter amplifier is moderate, typically in the range of a few kilohms to a few hundred kilohms.
- Medium Output Impedance:- The output ~~signal~~ impedance of a common emitter amplifier is also moderate, typically in the range of a few kilohms to a few hundread kilohms.

44 Output Characteristics



- 180-Degree Phase Shift: The output signal of a common emitter amplifier is also moderate 180 degree out of

Input Characteristics:

- Input Variable :- I_B, V_{BE} at V_{CE} = const
- Input Current (I_B) :- The base current is very small compared to the collector current.
- Input Voltage (V_B) :- The input voltage is typically a few tenths of a vol
- Input Resistance (R_{in}) :- The input resistance is moderately, typically in the range of a few kilohms to a few hundread kilohms.

Output Characteristics:

- Output Variable :- I_C, V_{CE} at I_B = const
- Output Current (I_C) :- The collector current is largely dependent on the base current.
- Output Voltage (V_C) :- The output voltage can vary over a wide range.
- Output Resistance (V_{out}) :- The output resistance is moderately, typically in the range

~~Cutoff Mode:~~

Cutoff Mode

- Input current (I_B) = Zero
- Output current (I_C) = Zero
- Voltage gain = zero

Active Mode

- Input current = Small
- Output current = Large
- Voltage gain = High
- Current gain = High

Saturation Mode

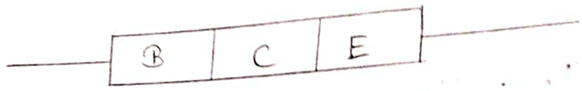
- Input current = High
- Output current = Maximum
- Voltage gain = Low
- Current gain = Low

Applications:

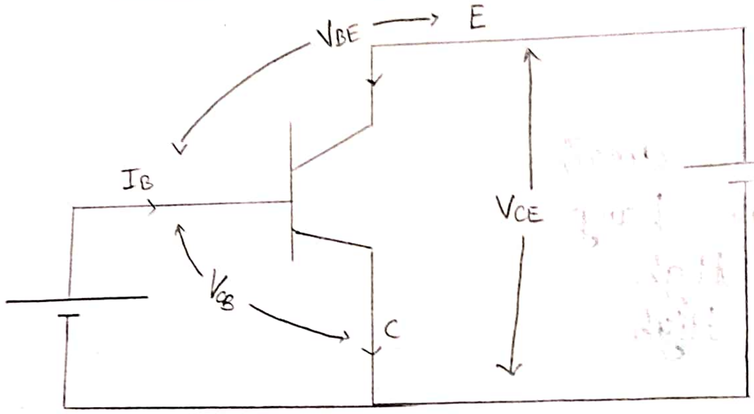
- Voltage Amplifiers: The common emitter configuration is commonly used in voltage amplifiers due to its high current gain and moderate input & output impedance.

- Current Amplifiers: It can also be used in current amplifiers, where the output current is a ~~scale~~ scaled up version of the input current.

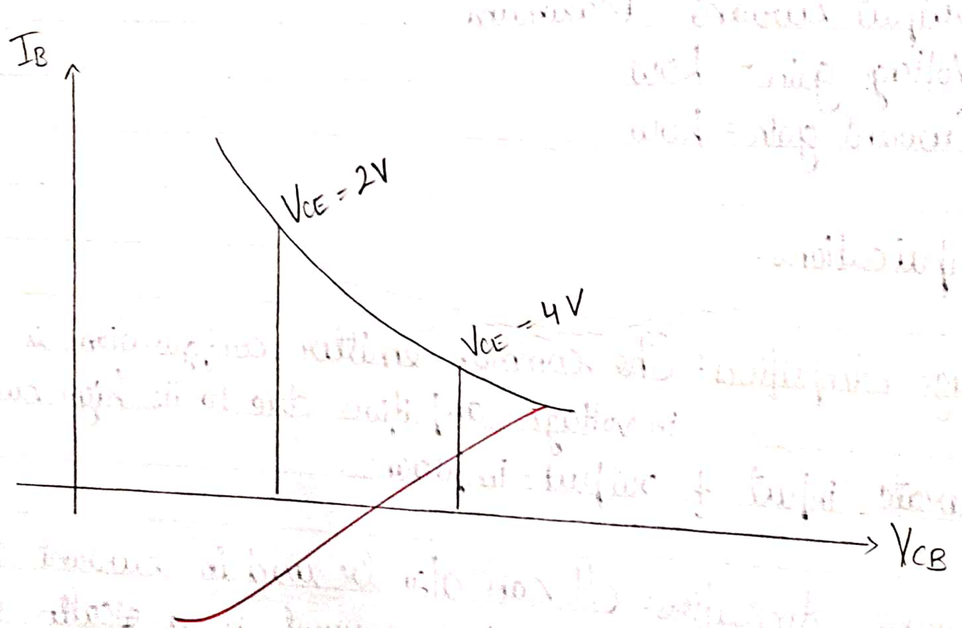
Q5 → 5.1



5.2 Schematic Diagram



5.3 Input Characteristics of CC



- Oscillators: The common emitter configuration is used in ~~a~~ many types of oscillators, such as the Colpitts oscillators and the Hartley oscillator.

Q5. Explain Common Collector configuration in detail.

The common collector configuration, also known as the emitter follower, is a transistor circuit where the collector terminal is common to both the input & output circuits. The configuration is primarily used for impedance matching and voltage buffering.

Key Characteristics:

- High Input Impedance:- The common collector configuration has a very high input impedance, making it ideal for driving high-impedance sources without significant loading.

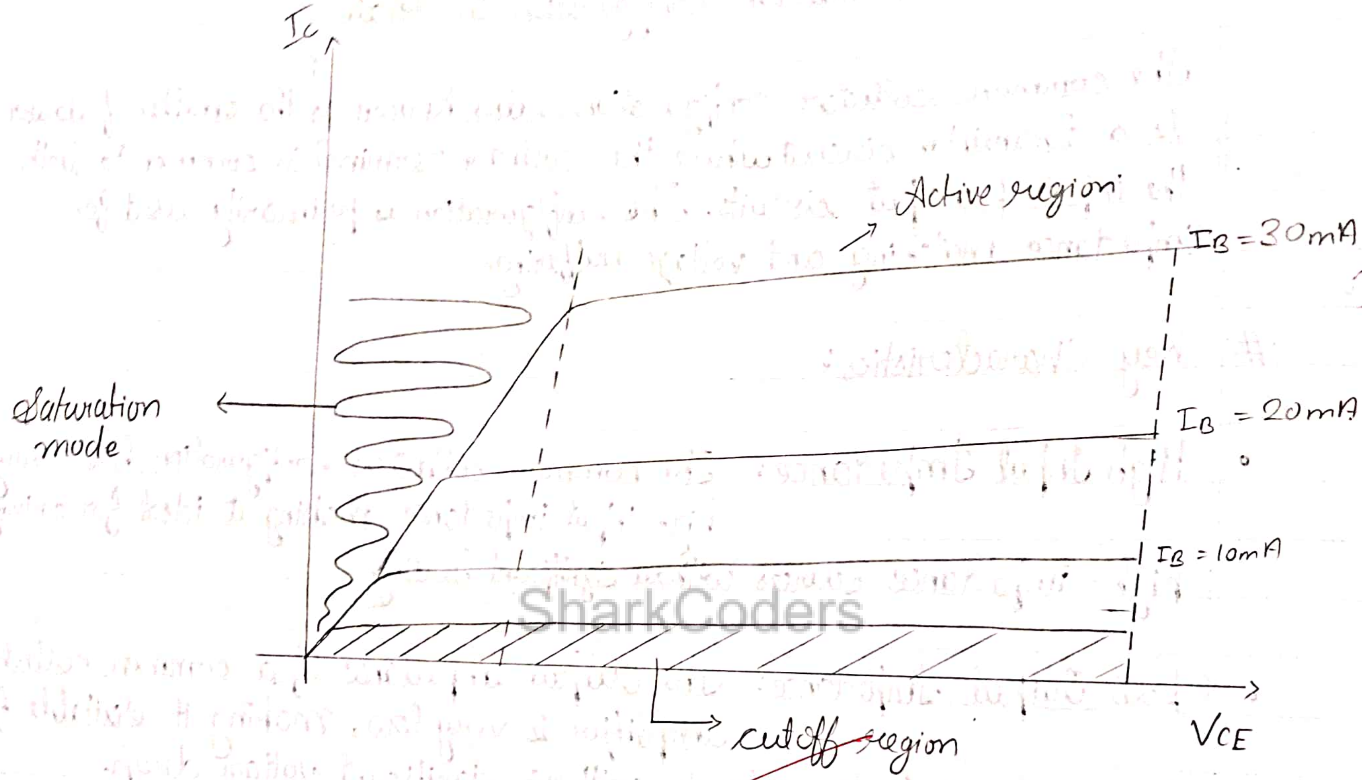
- Low Output Impedance:- The output impedance of a common collector amplifier is very low, making it suitable for driving low-impedance loads without significant voltage drop.

- Unity Voltage Gain:- The voltage gain ~~in~~ of a common collector amplifier is approximately unity, meaning the output voltage is nearly equal to the input voltage.

- Current Gain:- The common collector configuration provides a high current gain, allowing it to amplify the current of a signal.

- Phase Shift: There is no phase shift between the input & output signals in a common collector amplifier.

5.4 Output Characteristics of CC



Input Characteristics:

- Input Variable:- I_B, V_{CB} at V_{CE} = const

- Input Current (I_B):- The base current is very small compared to emitter current.

- Input Voltage (V_B):- The input voltage can vary over a wide range.

- Input Resistance (R_{in}):- The input resistance is very high, typically in the range of megaohms.

Output Characteristics:

Output Variables:- I_C, V_{CE} at V_{CB} = const.

Output Current (I_C):- The collector current is largely dependent on the base current.

Output Voltage (V_C):- The output voltage is approximately equal to input voltage.

Output Resistance (R_{out}):- The output resistance is very low, typically in the range of a few tens of Ohms.

Cutoff mode:

- Input current = zero
- Output current = zero
- Voltage gain = zero

Active Mode:

- Input Current = Small
- Output Current = Large
- Voltage Gain = Approximately unity
- Current Gain = High.

Saturation Mode :

- Input Current = High
- Output Current = Maximum
- Voltage Gain = Low
- Current Gain = Low

Applications:

- Impedance Matching:- The common collector configuration is commonly used to match the impedance of a high-impedance source to a low-impedance load.

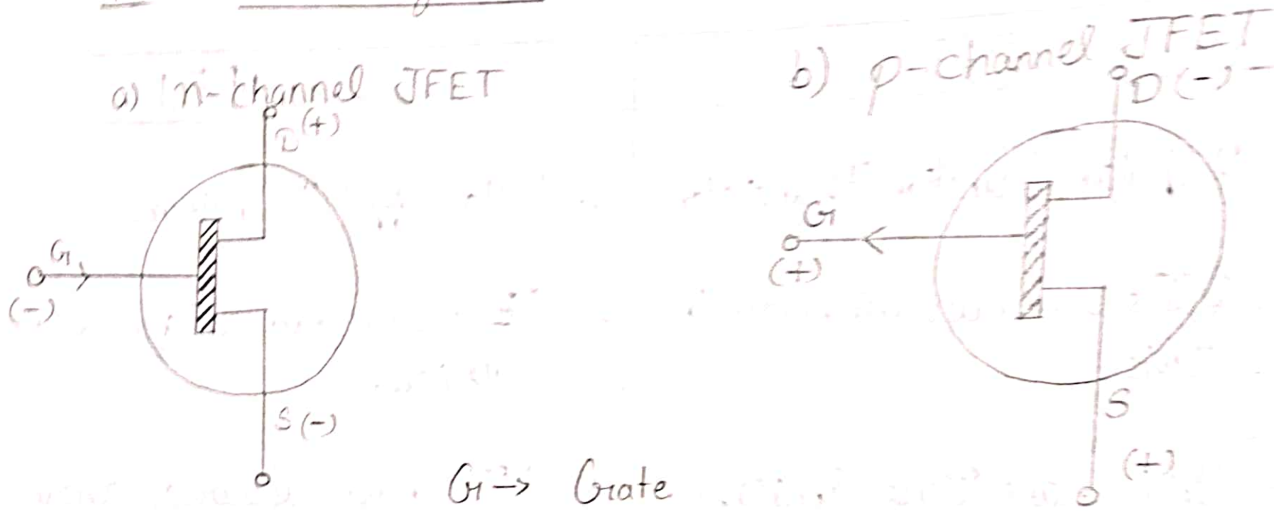
- Voltage Buffering:- It can also be used as a voltage buffer to isolate a high impedance source from a low-impedance, ~~for~~ preventing the load from affecting the source's output voltage.

- Current Amplifiers:- The common collector configuration can be used to amplify the current of a signal, specially when driving low impedance loads.

Q6. Diffrentiate between BJT & FET.

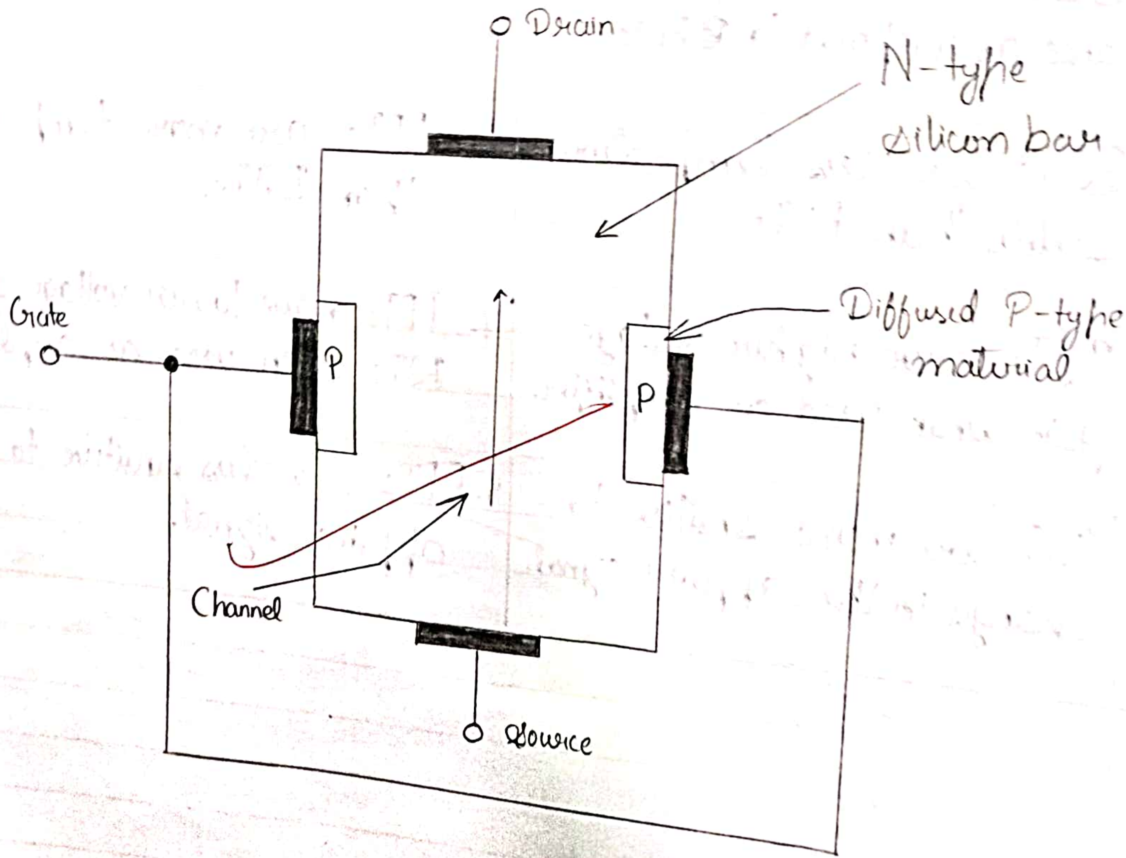
BJT	FET
1. Bipolar Junction Transistor	1. Feild Effect Transistors
2. BJTs are current-controlled devices	2. FETs are ~~are~~ voltage-controlled devices.
3. BJTs have Base, Emitter & collector terminals.	3. FETs have source, drain & gate terminals.
4. BJTs are larger in size.	4. FETs are smaller than BJTs.
5. BJTs have lower input imped-ance as compared to ~~B~~ FETs	5. FETs have higher input impedance.
6. BJTs are less temprature stable than FETs	6. FETs are more temprature stable than BJTs.
7. BJTs have higher voltage gain when used as amplifier.	7. FETs have lower voltage gain ~~wh~~ than BJTs when used as amplifier.
8. BJTs are more sensitive to changes in the applied signal.	8. FETs are less sensitive to changes in th applied signal.

Q7 → 7.1 JFET symbol



G → Gate
D → Drain
S → Source

7.2 Construction of JFET



Q7. Explain the classification of FET also draw the symbols of FET along with the basic construction of FET.

Field-Effect Transistor (FET)

FET stands for Field-Effect Transistor. It's a type of semiconductor device that controls the flow of electric current through a channel using an electric field applied to a gate terminal. This is different from bipolar junction transistor (BJTs), which controls current flow using a current applied to the base terminal.

Key Components of a FET:

- Channel: The main path for current flow.
- Gate: A terminal that controls the channel's conductivity.
- Source: The terminal where current enters the channel.
- Drain: The terminal where current ~~exist~~ exits the channel.

Classification of FETs:

1. Junction Field-Effect Transistor (JFET):-

   - Construction: A JFET consists of a semiconductor channel that is controlled by a gate junction.

   - JFET
     - n-channel JFET
     - P-channel JFET

- Operation: A JFET operates by controlling the width of a semiconductor channel using a reverse-biased p-n junction. This gate junction creates a electric field that ~~depends~~ depletes the channel of majority carriers, thereby reducing its conductivity

- Basic Operation:

1. No Gate Voltage → When there is no voltage applied to gate, the channel is fully conductive, and current can flow freely between the source and drain terminals.

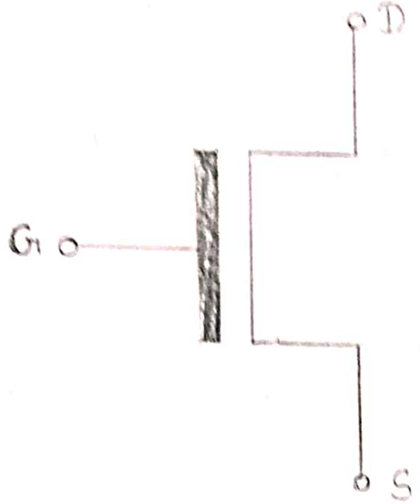
2. Negative Gate Voltage → Applying a negative voltage to the gate creates a reverse bias widens the depletion region, effectively narrowing the channel. As the channel narrows, fewer majority carriers can flow through it, reducing the drain current.

3. Increasing Negative Gate Voltage → As the negative gate voltage increases, the depletion region widens further, narrowing the channel even more. This results in a further reduction in drain current.

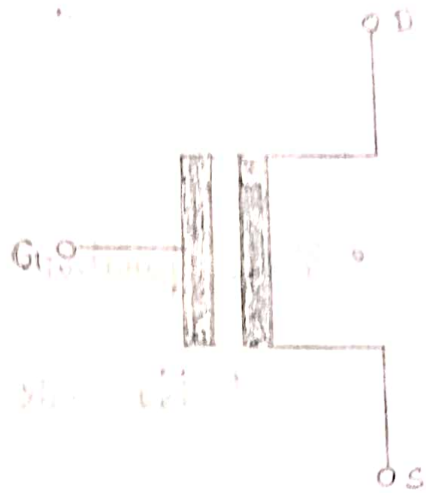
4. Pinch off → At a sufficiently high negative gate voltage, the channel is completely depleted, and no current can flow. This condition is known as pinch-off.

7.3 MOSFET Symbol:

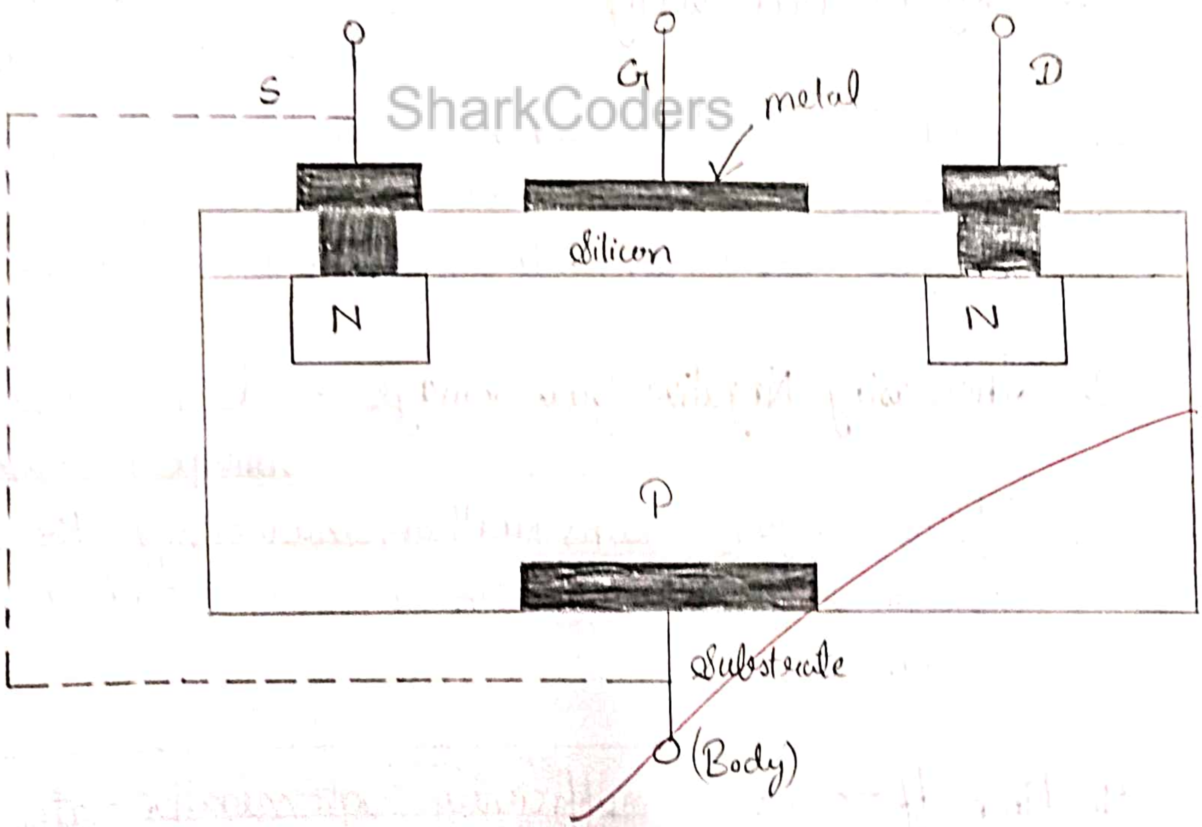
a) Enhancement Mode



b) Depletion Mode



6.4 Construction of MOSFET



- JFET Application:-
    - → Amplifiers
    - → Mixers
    - → Oscillators
    - → Switching Circuits

2. Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET):-

- Construction: A MOSFET consists of a semiconductor channel that is isolated from the gate by an ~~insulting~~ insulating oxide layer. The gate metal controls the channel's conductivity

- MOSFET
    - Enhancement-mode MOSFET
    - Depletion-mode MOSFET

- Operation: A MOSFET is a type of field-effect transistor that controls the flow of current through a semiconductor channel using an electric field applied to a gate terminal. The gate is separated from the channel by a thin layer of insulating oxide.

- Basic Operation:

    1. Enhancement-Mode MOSFET:-

        - No Gate Voltage → In an enhancement-mode MOSFET, the channel is initially non-conduc

- Positive Gate Voltage → Applying a positive voltage to the gate creates an electric field that attracts minority carriers to the channel-gate interface. This creates a conductive channel.

- Increasing Gate Voltage → As the gate voltage increases, more minority carriers are attracted to the chanel, increasing its conductivity.

- Cut-off → When the gate voltage is zero or negative, the channel is non-conductive, and no current flows.

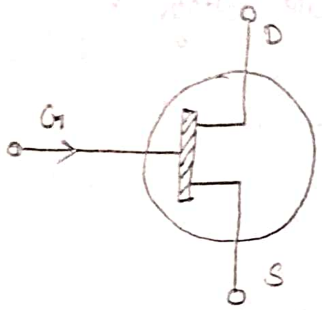
- MOSFET Applications:

  → Digital Circuits
  → Analog Circuits
  → Power Electronics

Q8. Describe the construction ~~& working~~ of n-chanel JFET.

N-channel JFET is a type of FET where the majority carriers are electrons. It consists of a semiconductor bar (usually n-type silicon) with two p-type regions diffused or implanted into the ends, forming the gate ~~terminals~~ terminals. The source and drain terminals are connected to the opposite ends of the n-type channel.

Q8 → 8.1 Symbol of n-channel JFET



8.2 Construction of n-channel JFET