Subject Name & Code:

BASIC ELECTRONICS ENGINEERING- BE01R00111

LAB MANUAL QUIZ SOLUTION

Experiment – 1

**Q-1: List out the functions of the multimeter.**

Answer:

Based on the lab manual, a Digital Multimeter (DMM) can measure the following quantities:

- DC Voltage
- AC Voltage
- DC Current
- AC Current
- Resistance
- Temperature
- Frequency
- Capacitance
- Continuity (with a buzzer)
- Transistor gains (hFE)

Q-2: Draw a simple circuit diagram by placing voltmeter and ammeter to measure voltage and current respectively.

Answer:
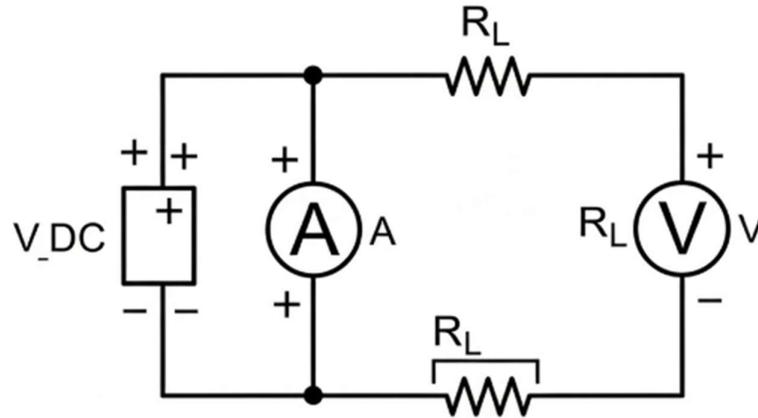
Q-3: Which parameters of signal can be measured using CRO?

Answer:

Using a Cathode Ray Oscilloscope (CRO), the following parameters of a signal can be measured:

- **Amplitude** (Peak-to-Peak Voltage, Vp-p)

- **Frequency** (f) and **Time Period** (T)

- **Phase difference** between two signals

- **DC level** of a signal

- **Shape and waveform** (e.g., Sine, Square, Triangular)

Q-4: Give the max range of voltage and frequency that your CRO can measure.

Answer:

(Note: The specific maximum range depends on the model of the CRO used in your lab. The manual does not specify a single model. A typical educational CRO might have ranges similar to the following. You should confirm these values with the specifications of the CRO you used.)

- **Maximum Voltage Range:** Typically **20 Volts per Division (V/Div)**. With 8 vertical divisions, the maximum peak-to-peak voltage that can be displayed is approximately **160 Vp-p**.

- **Maximum Frequency Range:** Typically **20 MHz** or **25 MHz**.

Experiment – 2

Q-1: Give applications of P-N junction diode.

Answer:

Based on the principles covered in the lab manual, the P-N junction diode has the following applications:

- **Rectification:** Converting Alternating Current (AC) to Direct Current (DC), as used in power supplies (e.g., half-wave and full-wave rectifiers).

- **Clipping Circuits:** Used to remove or "clip off" a portion of the input signal waveform above or below a certain level.

- **Clamping Circuits:** Used to shift the entire input signal waveform to a different DC level without distorting its shape.

- **Reverse Current Protection:** Used in circuits to block current flow in the reverse direction, protecting sensitive components.

- **Switching:** Can be used as an electronic switch in digital logic circuits due to its low resistance in forward bias and very high resistance in reverse bias.

Q-2: Define Forward breakdown voltage.

Answer:

The term "Forward breakdown voltage" is not standard for a regular P-N junction diode. In forward bias, the diode starts conducting after a **Cut-in Voltage** (or Threshold Voltage). The term "Breakdown" is associated with the **reverse bias** operation.

However, if referring to the forward characteristic, the key definition is:
Cut-in Voltage: It is the minimum forward voltage (approximately 0.7 V for Silicon and 0.3 V for Germanium) that must be applied across the diode before it starts conducting significantly.

Q-3: Define PIV

Answer:

PIV stands for **Peak Inverse Voltage**.
It is the **maximum reverse bias voltage** that a diode can withstand without entering the breakdown region and getting damaged.

Experiment – 3

Q-1: Give applications of zener diode.

Answer:

Based on the lab manual, the Zener diode has the following primary applications:

- **Voltage Regulation:** It is used to provide a constant output voltage in a circuit, regardless of variations in the input voltage or the load current.

- **Voltage Reference:** It provides a stable and precise reference voltage in electronic circuits, such as in power supplies and measuring instruments.

- **Overvoltage Protection:** It is used to protect sensitive components from voltage spikes by shunting excess voltage when it exceeds the Zener (breakdown) voltage.

- **Waveform Clipping:** It can be used in clipping circuits to limit the voltage swing of a signal to a specific level.

Q-2: Differentiate zener breakdown & Avalanche breakdown voltage.

Answer:

Feature	Zener Breakdown	Avalanche Breakdown
Doping Level	The diode is **heavily doped**.	The diode is **lightly doped**.
Depletion Region	The depletion region is **very thin**.	The depletion region is **comparatively wider**.
Breakdown Mechanism	Breakdown occurs due to a strong electric field that ruptures covalent bonds directly (**Field Ionization**).	Breakdown occurs due to charge carriers gaining high kinetic energy and colliding with atoms, creating new electron-hole pairs (**Impact Ionization**).

Feature	Zener Breakdown	Avalanche Breakdown
Voltage Level	Occurs at **lower reverse voltages** (typically below 5V).	Occurs at **higher reverse voltages**.
Temperature Coefficient	Has a **negative temperature coefficient** (breakdown voltage decreases with an increase in temperature).	Has a **positive temperature coefficient** (breakdown voltage increases with an increase in temperature).

Q-3: Define PIV

Answer:

PIV stands for **Peak Inverse Voltage**.
It is the **maximum reverse bias voltage** that a diode can withstand without entering the breakdown region and getting damaged. For a Zener diode used as a voltage regulator, the PIV is effectively its Zener voltage (Vz).

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Experiment – 4

Q-1: Write the limitations of half wave rectifier.

Answer:

Based on the lab manual and theory, the half-wave rectifier has the following limitations:

- **Low Rectification Efficiency:** The theoretical maximum efficiency is only 40.6%, which is very low.

- **High Ripple Factor:** The output is a highly pulsating DC, meaning it contains a large AC component, which is undesirable for most electronic applications.

- **Poor Transformer Utilization:** The output is only present for half of the input cycle, meaning the transformer is underutilized, leading to a larger and more costly transformer for a given power output.

- **Low Output Voltage:** The average DC output voltage (V_dc) is low because only one half-cycle of the input is used.

Q-2: Derive the value of ripple factor for half wave rectifier circuit.

Answer:

The ripple factor (γ) is defined as the ratio of the RMS value of the AC component to the DC component in the output.

Step 1: Define the Ripple Factor.

$$\gamma = \frac{V_{rms}(ac)}{V_{dc}}$$

Where $V_{rms}(ac)$ is the RMS value of the AC component (ripple) in the output.

Step 2: Express AC component in terms of total RMS and DC values.
The total output voltage can be considered as the sum of a DC value and an AC value. The RMS value of the total output voltage (V_{rms}) is given by:

$$V_{rms} = \sqrt{V_{dc}^2 + V_{rms}(ac)^2}$$

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Step 3: Rearrange the equation to solve for $V_{rms}(ac)$.

$$V_{rms}(ac) = \sqrt{V_{rms}^2 - V_{dc}^2}$$

Step 4: Substitute back into the Ripple Factor formula.

$$\gamma = \frac{\sqrt{V_{rms}^2 - V_{dc}^2}}{V_{dc}} = \sqrt{(\frac{V_{rms}}{V_{dc}})^2 - 1}$$

Step 5: Use standard values for a half-wave rectified sine wave.
For a half-wave rectifier with a sinusoidal input of maximum amplitude V_m:

- The average value (DC voltage), $V_{dc} = \frac{V_m}{\pi}$

- The RMS value, $V_{rms} = \frac{V_m}{2}$

Step 6: Substitute these values into the equation.

$$\frac{V_{rms}}{V_{dc}} = \frac{V_m/2}{V_m/\pi} = \frac{\pi}{2}$$

$$\gamma = \sqrt{(\frac{\pi}{2})^2 - 1} = \sqrt{\frac{\pi^2}{4} - 1} = \sqrt{\frac{\pi^2 - 4}{4}} = \sqrt{\frac{9.8696 - 4}{4}} = \sqrt{\frac{5.8696}{4}} = \sqrt{1.4674}$$

$$\boxed{\gamma \approx 1.21}$$

Q-3: Draw the circuit for negative half wave rectifier.

Answer:

Negative Half-Wave Rectifter
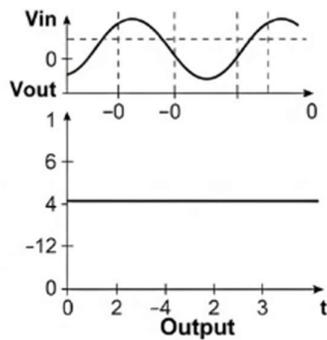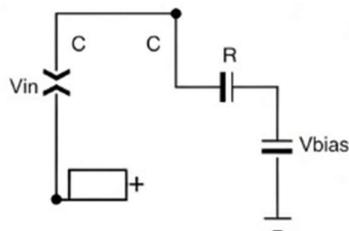
Input   0V

Output   0V
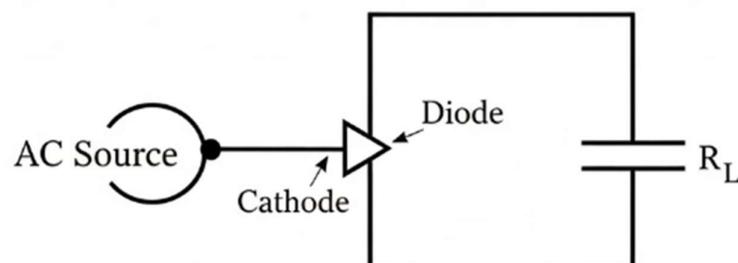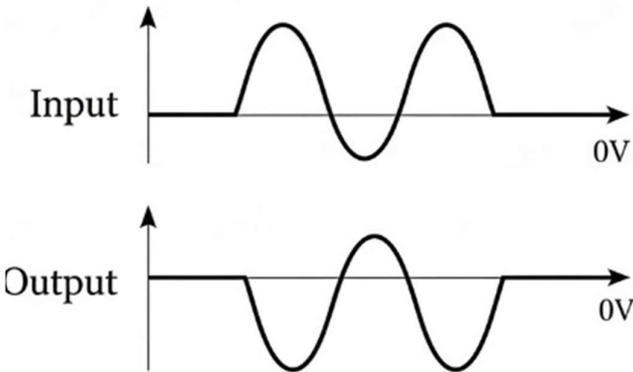
Experiment – 5

Q-1: Draw the circuits for positive biased positive clamping and negative biased positive clamping.

Answer:

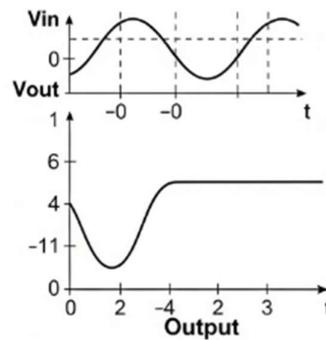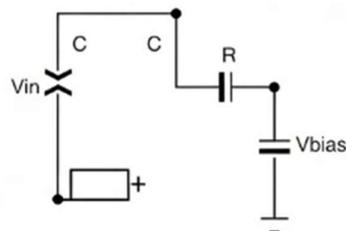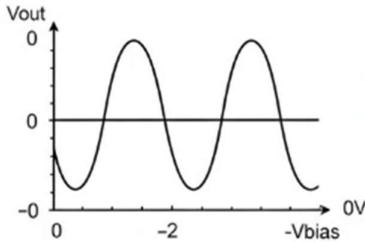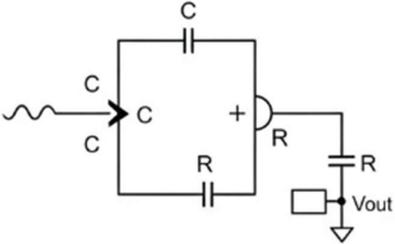**Biased Positive Clampers**

Q-2: Draw the circuits for positive biased positive clamping and negative biased positive clamping.
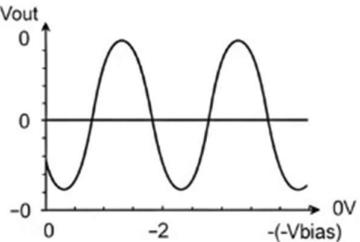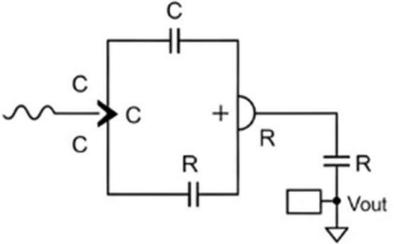
Answer:

Biased Negative Clampers

Positive Bised Negative Clamper
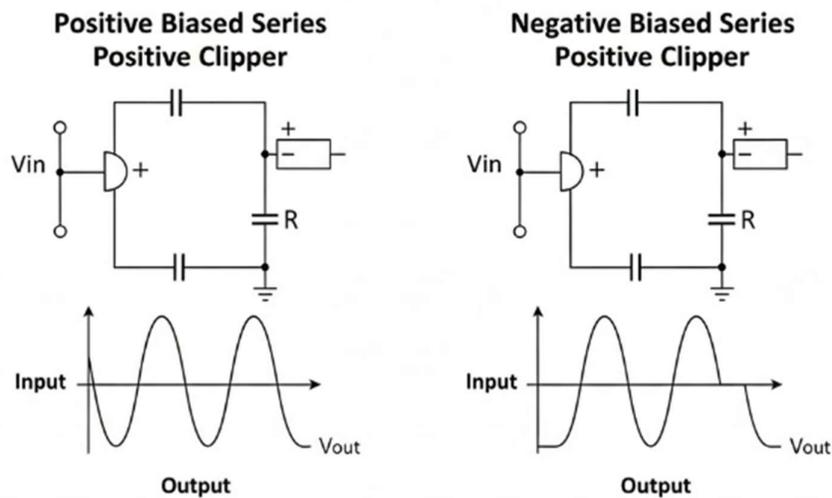

Negative Bised Negative Clamper

Experiment – 6

Q-1: Draw the circuits for biased (positive & negative) series positive clipping.
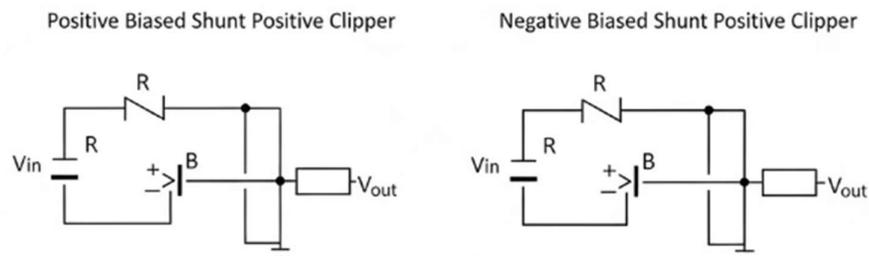
Answer:

Biased Series Positive Clippers

Q-2: Draw the circuits for biased (positive & negative) shunt positive clipping.

Answer:

Biased Shunt Positive Clippers

Input

Input
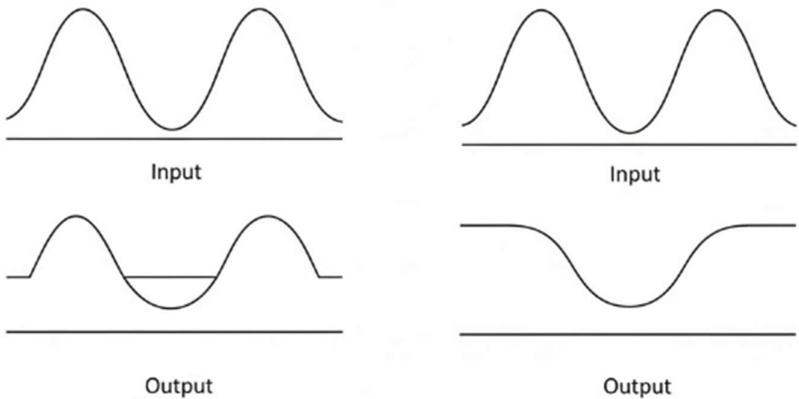
Q-3: Draw the circuits for biased (positive & negative) series negative clipping.

Answer:

Positive Biased
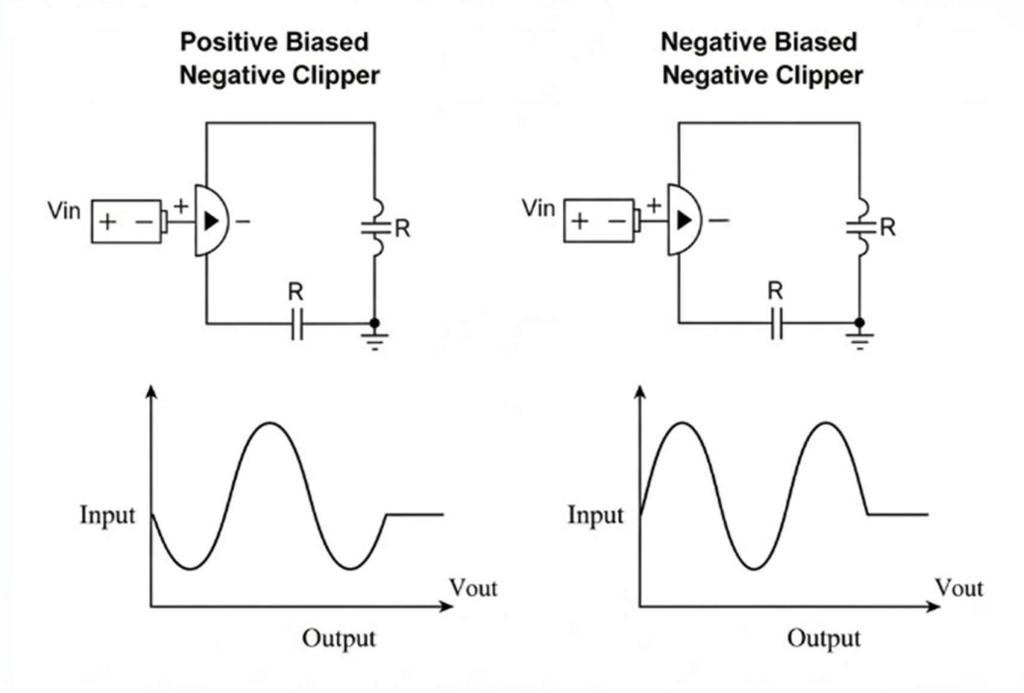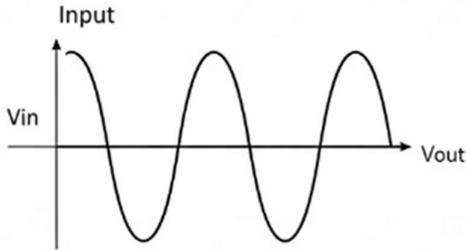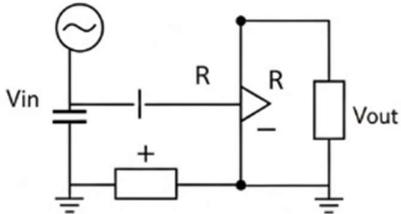Negative Clipper

Negative Biased
Negative Clipper

Q-4: Draw the circuits for biased (positive & negative) shunt negative clipping.

Answer:

Positive Biased Shunt Negative Clipper

Negative Biased Shunt Negative Clipper
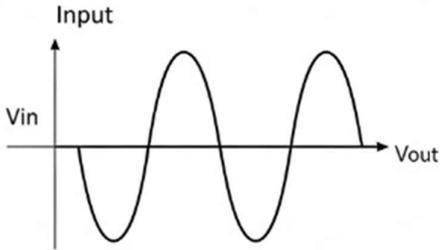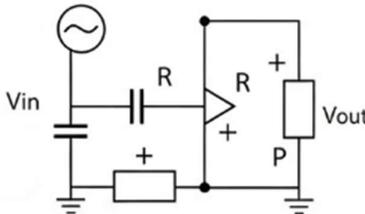
Experiment – 7

Q-1: Enlist the input output terminals for Common Emitter configuration of BJT.

Answer:

- **Input Terminal:** Base (B)
- **Output Terminal:** Collector (C)
- **Common Terminal:** Emitter (E)

Q-2: Which parameters should keep constant while measuring input characteristics in CE configuration?

Answer:

While measuring the input characteristics (I_B vs. V_{BE}), the **Collector-Emitter Voltage (V_{CE})** must be kept constant.

Q-3: Which parameters should keep constant while measuring output characteristics in CE configuration?

Answer:

While measuring the output characteristics (I_C vs. V_{CE}), the **Base Current (I_B)** must be kept constant.

Q-4: What will be the biasing condition for Cut-off, Active and Saturation region of BJT?

Answer:

- **Cut-off Region:**
    - Base-Emitter (B-E) Junction: **Reverse Biased**
    - Base-Collector (B-C) Junction: **Reverse Biased**
- **Active Region:**

- o Base-Emitter (B-E) Junction: **Forward Biased**

- o Base-Collector (B-C) Junction: **Reverse Biased**

- **Saturation Region:**

  - o Base-Emitter (B-E) Junction: **Forward Biased**

  - o Base-Collector (B-C) Junction: **Forward Biased**

Q-5: What is the range of β?

Answer:

The current amplification factor (β or h_{FE}) for a BJT in the Common Emitter configuration typically ranges from **20 to 200** for general-purpose transistors, and can be higher for specific types.

Experiment – 8

Q-1: Enlist the input output terminals for Common Base configuration of BJT.

Answer:

- **Input Terminal:** Emitter (E)
- **Output Terminal:** Collector (C)
- **Common Terminal:** Base (B)

Q-2: Which parameters should keep constant while measuring input characteristics in CB configuration?

Answer:

While measuring the input characteristics (I_E vs. V_{EB}), the **Collector-Base Voltage (V_{CB})** must be kept constant.

Q-3: Which parameters should keep constant while measuring output characteristics in CB configuration?

Answer:

While measuring the output characteristics (I_C vs. V_{CB}), the **Emitter Current (I_E)** must be kept constant.

Q-4: What is the value of β?

Answer:

The symbol β represents the Common Emitter current gain. Its value is **not fixed** and varies from one transistor to another. For a general-purpose transistor, β typically ranges from **20 to 200**. The exact value for a specific transistor must be determined from its datasheet or by measurement.

Q-5: Derive relation between β and γ.

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Answer:

This question refers to the relationship between the Common Emitter current gain (β) and the Common Base current gain (α), which is denoted by the Greek letter alpha, not gamma. I will derive the relation between β and α.

Step 1: Define the currents in a BJT.
By Kirchhoff's Current Law (KCL), the emitter current is the sum of the base and collector currents:

$$I_E = I_C + I_B$$

Step 2: Define the current gains.

- Common Base Current Gain: $\alpha = \dfrac{I_C}{I_E}$

- Common Emitter Current Gain: $\beta = \dfrac{I_C}{I_B}$

Step 3: Express I_B in terms of I_E and I_C.
From the KCL equation:

$$I_B = I_E - I_C$$

Step 4: Substitute into the formula for β.

$$\beta = \frac{I_C}{I_B} = \frac{I_C}{I_E - I_C}$$

Step 5: Divide the numerator and denominator by I_E.

$$\beta = \frac{\dfrac{I_C}{I_E}}{\dfrac{I_E}{I_E} - \dfrac{I_C}{I_E}} = \frac{\alpha}{1 - \alpha}$$

Step 6: Rearrange the relation to solve for α.
Starting from $\beta = \dfrac{\alpha}{1-\alpha}$:

$$\beta(1 - \alpha) = \alpha$$
$$\beta - \beta\alpha = \alpha$$
$$\beta = \alpha + \beta\alpha$$
$$\beta = \alpha(1 + \beta)$$
$$\boxed{\alpha = \frac{\beta}{1 + \beta}}$$

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Experiment – 9

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Q-1: Derive the equation for the output loop to find the output/ load current for NPN transistor.

Answer:

This derivation is based on the output loop (Collector-Emitter loop) of a Common Emitter NPN transistor circuit.

Step 1: Draw/Identify the Output Loop.
The output loop consists of the DC supply voltage V_{CC}, the collector resistor R_C, and the transistor between the collector and emitter terminals.

Step 2: Apply Kirchhoff's Voltage Law (KVL).
Traversing the loop, the sum of the voltage drops must equal the supply voltage.

$$V_{CC} = V_{R_C} + V_{CE}$$

Where V_{R_C} is the voltage drop across the collector resistor R_C.

Step 3: Express the resistor voltage using Ohm's Law.
The voltage across R_C is given by $V_{R_C} = I_C R_C$, where I_C is the collector current.

Step 4: Substitute into the KVL equation.

$$V_{CC} = I_C R_C + V_{CE}$$

Step 5: Solve for the output/load current (I_C).
Rearranging the equation to solve for I_C:

$$I_C R_C = V_{CC} - V_{CE}$$

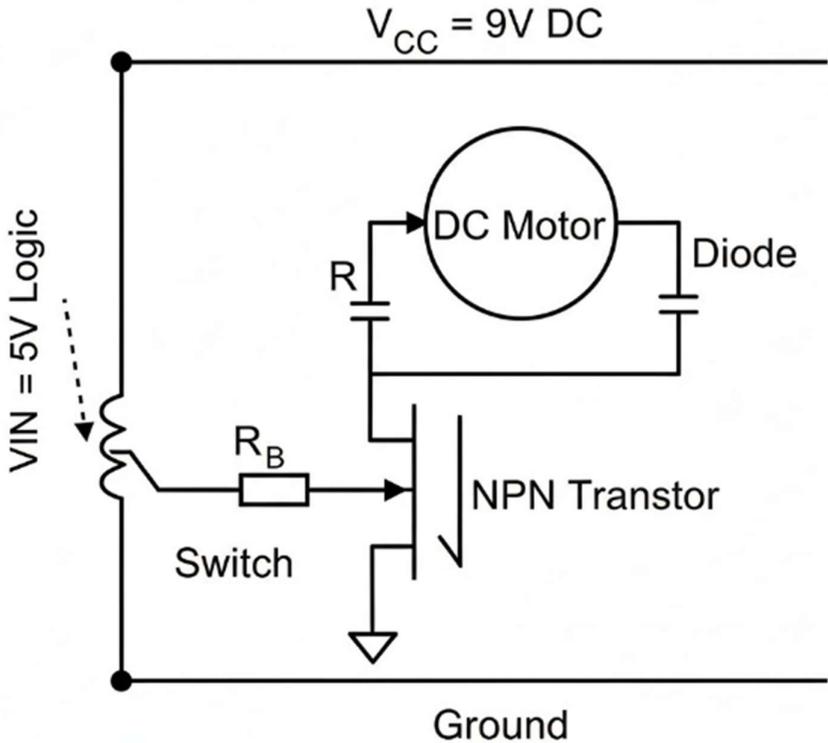$$\boxed{I_C = \frac{V_{CC} - V_{CE}}{R_C}}$$

- **When the transistor is in CUTOFF:** $I_C \approx 0$, so $V_{CE} = V_{CC}$.

- **When the transistor is in SATURATION:** $V_{CE} = V_{CE(sat)} \approx 0.2V$, so $I_C = I_{C(sat)} \approx \frac{V_{CC}}{R_C}$.

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Q-2: Draw the circuit for transistor working as a switch to ON-OFF another device (except LED)

Answer:

Experiment – 10

Q-1: What are the advantages of FET?

Answer:

Based on the theory in the lab manual, the advantages of a Field Effect Transistor (FET) over a Bipolar Junction Transistor (BJT) are:

- **Very High Input Impedance:** The input gate-to-source junction is reverse-biased, leading to an extremely high input resistance (typically in the order of $M\Omega$ or higher). This causes negligible loading on the preceding circuit.

- **Voltage-Controlled Device:** The output current (drain current, I_D) is controlled by the input voltage (gate-source voltage, V_GS), making it easier to interface with other high-impedance circuits and sensors.

- **Better Thermal Stability:** It is less sensitive to temperature changes compared to a BJT.

- **High Power Gain:** Due to its high input impedance and reasonable output impedance, it can provide high power gain.

- **Low Noise:** FETs generate less internal noise, making them suitable for use in the input stages of sensitive amplifiers (e.g., in radio receivers).

Q-2: What are the disadvantages of FET?

Answer:

The disadvantages of a FET are:

- **Lower Gain-Bandwidth Product:** Compared to BJTs, FETs generally have a lower gain-bandwidth product.

- **Slower Switching Speeds:** They are generally slower than BJTs when used in switching applications.

- **Higher Cost:** They can be more expensive to manufacture than BJTs.

- **Susceptibility to Damage:** The gate is insulated by a very thin layer of material (in MOSFETs), making it susceptible to damage from electrostatic discharge (ESD).

Q-3: What is transconductance?

Answer:

Transconductance (g_m) is a key parameter of FETs (and other active devices) that measures the effectiveness of the device in converting an input voltage change into an output current change.

It is defined as the **ratio of the small change in the output drain current (ΔI_D) to the corresponding small change in the input gate-source voltage (ΔV_GS), while keeping the drain-source voltage (V_DS) constant.**

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} \text{ at constant } V_{DS}$$

Its unit is Siemens (S).

Q-4: Relation between μ, g $_m$ and r_d?

Answer:

The question contains a typo. The correct relation is between the Amplification Factor (μ), the transconductance (g_m), and the drain resistance (r_d).

The Amplification Factor (μ) is given by the product of the transconductance (g_m) and the drain resistance (r_d).

$$\mu = g_m \cdot r_d$$

Where:

- μ (Amplification Factor) $= \frac{\Delta V_{DS}}{\Delta V_{GS}}$ at constant I_D

- g_m (Transconductance) $= \frac{\Delta I_D}{\Delta V_{GS}}$ at constant V_DS

- r_d (Drain Resistance) $= \frac{\Delta V_{DS}}{\Delta I_D}$ at constant V_GS

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