

For Viva-Voce (Source: Preplexity AI)

1. Diode Characteristics of LED, Silicon, and Zener Diodes

Overview:

- **Silicon Diode:** Exhibits low current until the forward voltage exceeds $\sim 0.7V$, beyond which current rises sharply (known as the “knee” in the characteristic curve).
- **LED:** Like a silicon diode, but emits light when forward biased. Forward voltage is usually $1.8\text{--}3V$, depending on color and composition.
- **Zener Diode:** In forward bias, behaves like a regular diode. In reverse bias, sharply conducts at a specific voltage called the Zener voltage, useful for voltage regulation.

Viva Questions & Answers:

- *Q: What is the knee voltage of a silicon diode?*
A: Approximately $0.7V$.
- *Q: Why do Zener diodes conduct in reverse bias?*
A: They are specially doped to allow controlled breakdown at the Zener voltage for voltage regulation purposes.
- *Q: Why doesn't an LED light up in reverse bias?*
A: Because current does not flow; thus, no energy is released as light.
- *Q: What is Zener impedance?*
A: The dynamic resistance of a Zener diode in the breakdown region.
- *Q: Why does an LED's color depend on its material?*
A: Different semiconductor materials emit different wavelengths when electrons recombine with holes.

2. Half Wave and Full Wave Rectifiers Using Semiconductor Diodes

Overview:

- **Half-wave rectifier:** Uses a single diode, allowing current only during one half of the AC cycle, resulting in a pulsating DC output.
- **Full-wave rectifier:** Uses either two diodes with a center-tapped transformer or four diodes in a bridge configuration, converting both halves of the AC cycle to DC, giving a smoother output compared to a half-wave rectifier.

Viva Questions & Answers:

- *Q: What is the main disadvantage of a half-wave rectifier?*
A: Low efficiency; only half of the input waveform is used, leading to more ripple.

- *Q: Why is the full-wave rectifier's output smoother?*
A: Both halves of the AC input are used, reducing gaps in the output.
- *Q: What is the function of a filter capacitor in a rectifier circuit?*
A: To smooth out ripples in the rectified output, providing more constant DC.
- *Q: What is Peak Inverse Voltage (PIV)?*
A: The maximum voltage a diode can withstand in reverse bias without breakdown.

3. Transistor DC Analysis and Characteristics (Voltage Divider Bias)

Overview:

- **Voltage Divider Bias:** Uses two resistors to fix the base voltage of a transistor, making the operating point less sensitive to transistor gains ($\beta\beta$). Offers excellent stability.
- **Input Characteristics:** Graph of base current (I_B/I_B) vs base-emitter voltage (V_{BE}/V_{BE}).
- **Output Characteristics:** Graph of collector current (I_C/I_C) vs collector-emitter voltage (V_{CE}/V_{CE}) for different base currents.

Viva Questions & Answers:

- *Q: Why is voltage divider bias preferred?*
A: Provides stable operating point independent of transistor $\beta\beta$.
- *Q: What is the purpose of the emitter resistor in this biasing method?*
A: Stabilizes the operating point against variations in temperature and $\beta\beta$.
- *Q: How is the Q-point (operating point) determined?*
A: By DC analysis using KVL in base and collector circuits.
- *Q: What happens to I_C/I_C as V_{BE}/V_{BE} increases?*
A: I_C/I_C increases exponentially once V_{BE}/V_{BE} exceeds threshold ($\sim 0.7V$ for silicon BJTs).

4. Transistor AC Analysis Using Voltage Divider Bias

Overview:

- **AC Analysis:** Focuses on the transistor's response to small AC signals superimposed on the DC operating point. Involves calculating voltage gain, input/output impedance, and frequency response.
- **Voltage Divider Bias:** Ensures the transistor remains active and amplifies the AC input signal correctly.

Viva Questions & Answers:

- *Q: What is voltage gain in a common-emitter amplifier?*
A: The ratio of output voltage to input voltage for small AC signals.

- *Q: Why are coupling capacitors used?*
A: To block DC components, allowing only AC to pass through.
- *Q: What determines the amplifier's bandwidth?*
A: The frequency response, mainly set by internal and external capacitances and resistances.
- *Q: Why is AC load line different from DC load line?*
A: The AC load line takes into account the effect of load resistor, which may differ from the DC configuration.

5. Implementation of a 2-bit Comparator Using LM324

Overview:

- An LM324 contains four independent op-amps. As comparators, they compare two input voltages and output a high or low signal depending on which input is greater. A 2-bit comparator outputs signals representing which input value is larger.

Viva Questions & Answers:

- *Q: What is a comparator?*
A: A circuit that compares two input voltages and outputs a logic signal indicating which is higher.
- *Q: Why is LM324 suitable for comparators?*
A: It has four built-in op-amps, wide operating voltage range, and low power consumption.
- *Q: How does a 2-bit comparator circuit work?*
A: It compares two 2-bit binary numbers and outputs signals indicating greater, lesser, or equal conditions.
- *Q: What is the function of the inverting and non-inverting terminals?*
A: The comparator output goes high when the voltage at the non-inverting terminal exceeds the inverting terminal and low otherwise.

6. Implementation of a 3-bit Parallel ADC Using LM324 and 74LS148N

Overview:

- **3-bit Parallel (Flash) ADC:** Uses comparators (LM324 op-amps) and a priority encoder (74LS148N). Analog input is compared with reference voltages; comparator outputs are fed to the encoder, which converts them to a 3-bit digital code.
- **Working Principle:** Seven comparators compare the input voltage with fixed reference voltages. The encoder outputs the code corresponding to the highest comparator triggered.

Viva Questions & Answers:

- *Q: What is a flash ADC?*
A: An analog-to-digital converter that uses parallel comparators to convert an analog signal to a digital code in one step.

- *Q: What role does the 74LS148N play?*

A: It acts as an 8-to-3 priority encoder, converting active comparator outputs to a 3-bit output code.

- *Q: Why use parallel comparators?*

A: For very fast conversion, suitable for applications where speed is critical.

- *Q: How many comparators are needed for a 3-bit ADC?*

A: $2^3 - 1 = 8 - 1 = 7$ comparators for a 3-bit output.