

Semiconductor Devices and Logic Gates

Question1

When LED is manufactured by using aluminium gallium arsenide (AlGaAs), it emits

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Options:

A.

ultra-violet light

B.

infra red radiation

C.

green light

D.

blue light

Answer: B

Solution:

Aluminium Gallium Arsenide (AlGaAs) is a compound semiconductor material.

- LEDs made with **GaAs** or **AlGaAs** are typically used in **infrared emitters** because their bandgap corresponds to photon energies in the **infrared region**.
- These are widely used in remote control devices, optical fiber communication, etc.

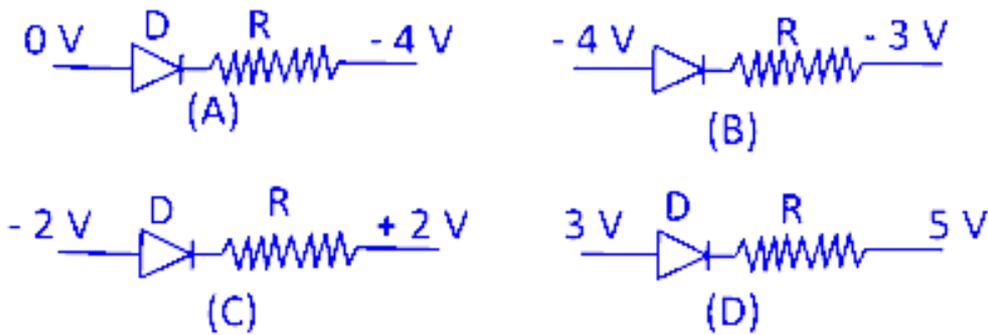
Correct Answer:

Option B: infra red radiation



Question2

Which of the following figure represents forward bias diode?



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Options:

A.

A

B.

C

C.

D

D.

B

Answer: A

Solution:

Answer: (A) 0 V and -4 V

A diode is forward-biased when the potential at the p-type side (anode, the flat side of the triangle) is higher than the potential at the n-type side (cathode, the line side).

- In option (A), the p-side is at 0 V and the n-side is at -4 V. Since $0\text{ V} > -4\text{ V}$, the diode is forward-biased.
 - In option (B), the p-side is at -4 V and the n-side is at -3 V. Since $-4\text{ V} < -3\text{ V}$, the diode is reverse-biased.
 - In option (C), the p-side is at -2 V and the n-side is at +2 V. Since $-2\text{ V} < +2\text{ V}$, the diode is reverse-biased.
 - In option (D), the p-side is at +3 V and the n-side is at +5 V. Since $+3\text{ V} < +5\text{ V}$, the diode is reverse-biased.
-

Question3

An AND gate is followed by a NOT gate in series. With two inputs 'A' and 'B', the Boolean expression for the output 'Y' will be

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Options:

A.

$$\overline{A + B}$$

B.

$$\overline{A \cdot B}$$

C.

$$A \cdot B$$

D.

$$A + B$$

Answer: B

Solution:



Step 1: Expression of AND gate

The output of the AND gate is:

$$A \cdot B$$

Step 2: NOT gate applied

The NOT gate inverts the AND output, so:

$$Y = \overline{A \cdot B}$$

Step 3: Match with options

- Option A: $\overline{A + B}$ → This is a NOR gate, not what we want.
- Option B: $\overline{A \cdot B}$ → This matches our result (a NAND gate).
- Option C: $A \cdot B$ → That would be just the AND output, without NOT.
- Option D: $A + B$ → That would be an OR gate output.

Correct answer: **Option B:** $\overline{A \cdot B}$

Final Answer:

$$\overline{A \cdot B}$$

(It is the NAND function.)

Question4

If p-n junction diode is forward biased, then

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Options:

A.

electric conduction is not possible.

B.

width of depletion layer decreases.

C.



width of depletion layer increases.

D.

barrier voltage increases.

Answer: B

Solution:

When a **p-n junction diode** is **forward biased**, the positive terminal of the battery is connected to the p-side, and the negative terminal is connected to the n-side.

- This reduces the **potential barrier** of the junction.
- As a result, the **depletion layer width decreases**, allowing charge carriers (electrons & holes) to cross the junction more easily, leading to current conduction.

Correct Answer:

Option B: width of depletion layer decreases.

Question5

In a certain 2 -inputs logic gate, when inputs $A = 0$ and $B = 0$, then output $C = 1$. And also when inputs $A = 0$, $B = 1$, then again output $C = 1$. The gate must be

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Options:

A.

OR

B.

AND

C.

NAND

D.

NOR

Answer: C

Solution:

NAND gate

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Question6

For a transistor, α_{dc} and β_{dc} are the current ratios, then the value of $\frac{\beta_{dc} - \alpha_{dc}}{\alpha_{dc} \times \beta_{dc}}$

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Options:

A. 2.5

B. 2

C. 1.5

D. 1

Answer: D

Solution:

Step 1: Recall the relations between α_{dc} and β_{dc} :

$$\beta_{dc} = \frac{\alpha_{dc}}{1 - \alpha_{dc}}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{1 + \beta_{dc}}$$

Step 2: Substitute

Consider the given fraction:

$$\frac{\beta - \alpha}{\alpha\beta}$$

Method A: Express in terms of β .

Using $\alpha = \frac{\beta}{\beta+1}$:

- Numerator:

$$\beta - \alpha = \beta - \frac{\beta}{\beta+1} = \frac{\beta(\beta+1) - \beta}{\beta+1} = \frac{\beta^2}{\beta+1}$$

- Denominator:

$$\alpha\beta = \frac{\beta}{\beta+1} \cdot \beta = \frac{\beta^2}{\beta+1}$$

Step 3: Simplify

$$\frac{\beta - \alpha}{\alpha\beta} = \frac{\frac{\beta^2}{\beta+1}}{\frac{\beta^2}{\beta+1}} = 1$$

 **Final Answer:**

1 (Option D)

Question 7

In a common emitter transistor amplifier circuit, the input resistance is $1.8\text{k}\Omega$ and output is obtained across a load resistance of $9\text{k}\Omega$. The alternating current gain is 70. Corresponding to an a.c. input voltage of 6 mV, the output voltage will be

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Options:

A. 0.7 V

B. 1.4 V

C. 2.1 V

D. 4.2 V

Answer: C

Solution:

AC input Current :

$$I_{in} = \frac{V_{in}}{R_{in}} = \frac{6 \times 10^{-3}}{1800} = 3.33 \times 10^{-6} \text{ A}$$

A. C output Current :

$$\begin{aligned} I_{out} &= \beta_{ac} \cdot I_{in} \quad (\beta_{ac} = A \cdot C \cdot \text{Current gain}) \\ &= 70 \times 3.33 \times 10^{-6} \\ &= 2.33 \times 10^{-4} \text{ A} \end{aligned}$$

A.C Output Voltage :

$$\begin{aligned} V_{out} &= I_{out} \cdot R_L \\ &= 2.33 \times 10^{-4} \times 9000 \\ &= 2.097 \\ &\approx 2.1 \text{ V} \end{aligned}$$

Question8

Applying forward bias to p-n junction, the potential barrier

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Options:

- A. increases.
- B. decreases.
- C. remains unchanged.
- D. becomes zero.

Answer: B

Solution:

When a **p–n junction diode** is forward biased, the external voltage applied reduces the built-in potential barrier. This makes it easier for charge carriers to cross the junction.

- At zero bias → barrier = built-in potential.
- With forward bias → barrier height **decreases**.
- Only when the forward bias is large enough (approximately equal to the built-in potential), significant current flows.

✓ **Correct Answer: Option B — decreases.**

Question9

The material used for solar cell should have band gap

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Options:

- A. equal to zero.
- B. less than 1.0 eV (non-zero).
- C. more than 1.8 eV .
- D. between 1.0 eV and 1.8 eV .

Answer: D

Solution:

For a material to be suitable for solar cells, its **band gap** should allow it to absorb a significant portion of the solar spectrum while still providing enough energy per photon to generate a useful voltage.

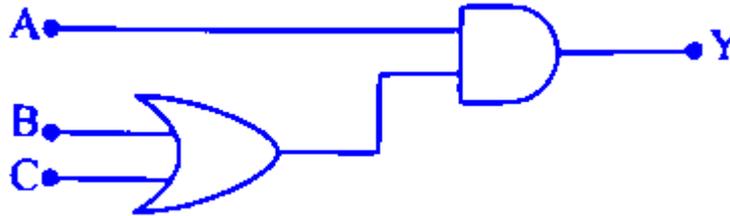
- If the band gap is **too small (< 1.0 eV)**, most of the absorbed photons will generate carriers with very little voltage, reducing efficiency.
- If the band gap is **too large (> 1.8 – 2.0 eV)**, many photons from the solar spectrum will not be absorbed at all, again reducing efficiency.
- The optimal band gap is typically in the range of **1.0 eV to 1.8 eV**.

👉 **Correct Answer: Option D (between 1.0 eV and 1.8 eV).**



Question10

One of the following values of inputs A, B and C respectively gives output (Y) of the following combination of logic gates as ' 1 ' is



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Options:

A. 0, 0, 0

B. 0, 1, 0

C. 1, 0, 0

D. 1, 0, 1

Answer: D

Solution:

A	B	C	B + C	Y = (B + C) · A
0	0	0	0	0
0	1	0	1	0
1	0	0	0	0
1	0	1	1	1

Question11

A piece of semiconductor is connected in series in an electric circuit. On increasing the temperature, the current in the circuit will



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Options:

- A. decrease.
- B. remain unchanged.
- C. increase.
- D. stop flowing.

Answer: C

Solution:

In a semiconductor, increasing temperature increases the number of charge carriers, which enhances conductivity. Thus, the current in the circuit will increase.

Question12

In a common emitter amplifier configuration, the current gain is 62 . The collector resistance and input resistance are $5\text{k}\Omega$ and 500Ω respectively. If the input voltage is 0.01 V , the output voltage will be

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Options:

- A. 0.62 V
- B. 6.2 V
- C. 62 V
- D. 620 V

Answer: B



Solution:

In a common emitter amplifier, the voltage gain A_v :

$$A_v = \beta \cdot \frac{R_c}{R_{in}}$$

$$\therefore A_v = 62 \cdot \frac{5000}{500} = 620$$

$$\therefore A_v = 620$$

Now, output voltage V_{out} is:

$$V_{out} = A_v V_{in}$$

$$\therefore V_{out} = 620 \times (0.01)$$

$$\therefore V_{out} = 6.2 \text{ V}$$

Question13

The logic gate for which the output goes 'HIGH' or ' 1 ' only when an odd number of 'HIGH' or ' 1 ' are at its input, is

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Options:

- A. OR gate
- B. NAND gate
- C. Ex-OR gate
- D. NOR gate

Answer: C

Solution:

The logic gate for which the output goes 'HIGH' ('1') only when an odd number of 'HIGH' or '1' are at its input is:

- OR → Output is 1 if **any** input is 1 (not necessarily odd).
- NAND → Output is 0 only when **all inputs are 1**.



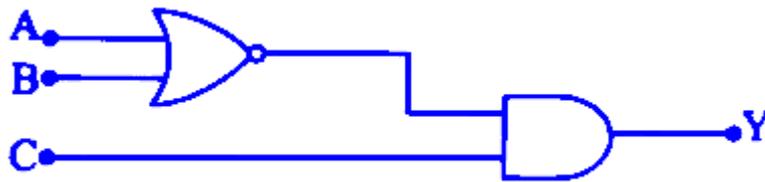
- Ex-OR (XOR) → Output is 1 when the number of 1s at the input is **odd**. ✓
- NOR → Output is 1 only if **all inputs are 0**.

👉 Therefore, the correct answer is:

Option C: Ex-OR gate ✓

Question14

To get output of the following logic circuit as '0' (zero), the inputs A, B, C should NOT be, respectively,



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Options:

- A. 1, 1, 0
- B. 0, 1, 0
- C. 1, 0, 1
- D. 0, 0, 1

Answer: D

Solution:

Truth table for the following logic circuit,

A	B	C	Y'	Y
0	0	0	1	0
0	0	1	1	1
0	1	0	0	0
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	0	0

Question15

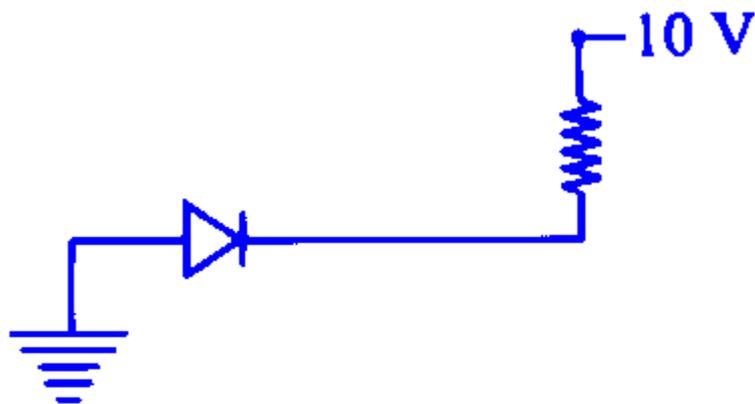
In which of the following figures, the p.n. junction diode is reverse biased?



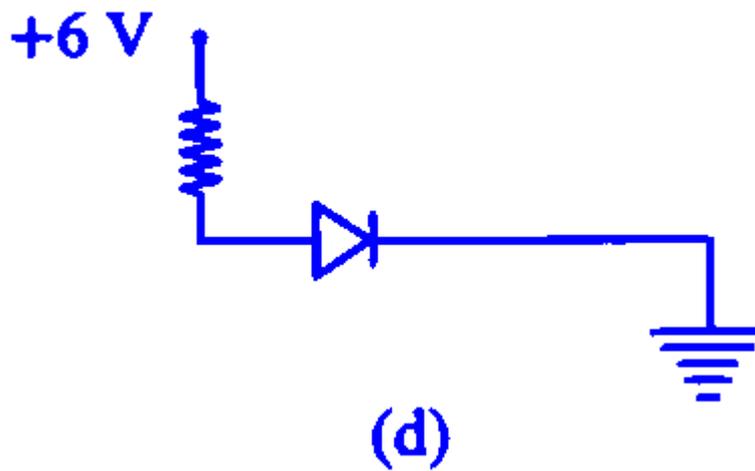
(a)



(b)



(c)



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Options:

- A. c
- B. d
- C. b
- D. a

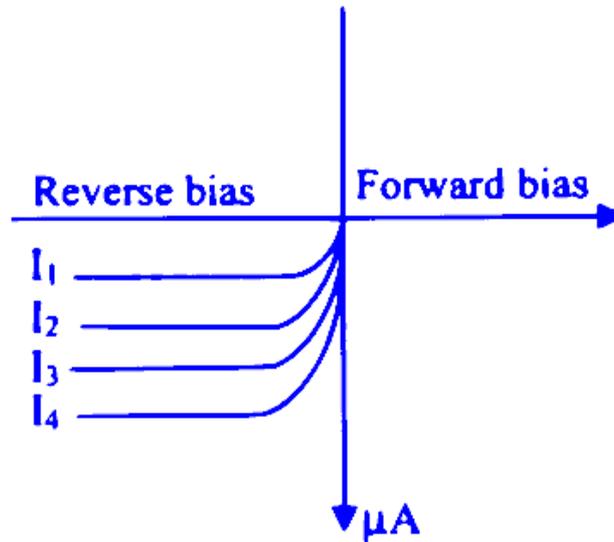
Answer: C

Solution:

For diode to be in reverse bias, p-side of diode needs to be connected at potential lower than potential to which n -side of diode is connected. This condition is satisfied in figure (b) only

Question16

I - V characteristics of photodiode for different illumination intensities I_1, I_2, I_3 and I_4 are drawn as follows. Then the maximum intensity among them is



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Options:

- A. I_1
- B. I_2
- C. I_3
- D. I_4

Answer: D

Solution:

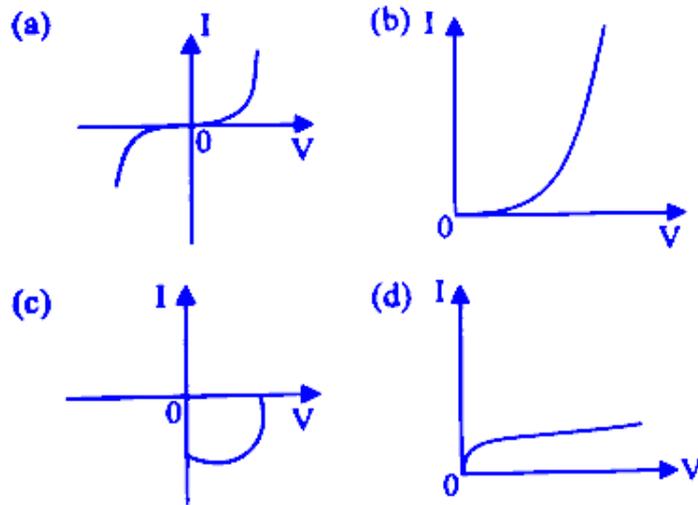
Photodiode is operated in reverse bias

Reverse saturation current \propto Intensity of illumination

$\therefore I_4$ is maximum intensity.

Question17

I – V characteristics of LED is shown correctly by graph



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Options:

- A. d
- B. b
- C. a
- D. c

Answer: B

Solution:

I-V characteristics of LED

Answer: (b) b

The I-V characteristic of an LED (Light Emitting Diode) is similar to a standard p-n junction diode. It has a high forward resistance below a certain threshold voltage (typically around 1.8V to 3V, depending on the color), where current is negligible, and a low forward resistance above this voltage, where current increases sharply. In the reverse bias condition, the current is very small until the breakdown voltage is reached. Graph (b) correctly illustrates this behavior, showing a clear knee voltage in the positive V region and minimal current in the negative V region.

Question18

By increasing the temperature, the specific resistance of a conductor and a semiconductor respectively

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Options:

- A. increases, increases.
- B. decreases, decreases.
- C. increases, decreases.
- D. decreases, increases.

Answer: C

Solution:

As the temperature increases, the conductors are usually more resistant to the flow of electricity, resulting in an increase in their specific resistance (resistivity). On the other hand, semiconductors tend to become less resistant to electrical flow, decreasing their specific resistance as the temperature increases.

Question19

Which of the following statements is TRUE for n-type semiconductor?

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Options:

- A. Holes are majority carriers and trivalent atoms are dopants.
- B. Electrons are majority carriers and trivalent atoms are dopants.
- C. Holes are minority carriers and pentavalent atoms are dopants.
- D. Electrons are minority carriers and pentavalent atoms are dopants.

Answer: C

Solution:

Creating n-type semiconductors involves adding pentavalent atoms, such as phosphorus, to a pure semiconductor crystal (e.g., silicon or germanium). These atoms introduce extra electrons, which become the majority charge carriers, while positively charged holes are the minority charge carriers.

Question20

In a common emitter transistor amplifier circuit, the current gain $\alpha = 0.8$. If the base current changes by $3\mu\text{ A}$ then the collector current changes by

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Options:

- A. $4\mu\text{ A}$
- B. $12\mu\text{ A}$
- C. $6\mu\text{ A}$
- D. $24\mu\text{ A}$

Answer: B

Solution:

We are asked:

A common-emitter transistor amplifier.

Given: current gain $\alpha = 0.8$.

If the base current changes by $\Delta I_B = 3\mu\text{ A}$, then what is the change in collector current ΔI_C ?

Step 1: Relationship between α and β

$$\alpha = \frac{I_C}{I_E}, \quad \beta = \frac{I_C}{I_B}$$

Relation:

$$\beta = \frac{\alpha}{1-\alpha}$$

Substitute $\alpha = 0.8$:

$$\beta = \frac{0.8}{1-0.8} = \frac{0.8}{0.2} = 4$$

Step 2: Incremental relation between ΔI_C and ΔI_B

We know:

$$\Delta I_C = \beta \Delta I_B$$

Therefore:

$$\Delta I_C = 4 \times (3\mu A) = 12\mu A$$

Final Answer:

The change in collector current is

Option B: $12\mu A$

Question21

In the case of common emitter transistor amplifier, the ratio of collector current to emitter current is 0.96 , then the current gain (β) of the amplifier is

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Options:

- A. 6
- B. 48
- C. 24
- D. 12

Answer: C

Solution:

Given:

For a common emitter transistor amplifier,

$$\frac{I_C}{I_E} = 0.96$$

We need to find the current gain β .



Step 1: Recall relations

- Emitter current: $I_E = I_B + I_C$
- Define:

$$\alpha = \frac{I_C}{I_E}$$

Here it is given that $\alpha = 0.96$.

- Relation between α and β :

$$\beta = \frac{\alpha}{1-\alpha}$$

Step 2: Substitute values

$$\beta = \frac{0.96}{1-0.96} = \frac{0.96}{0.04} = 24$$

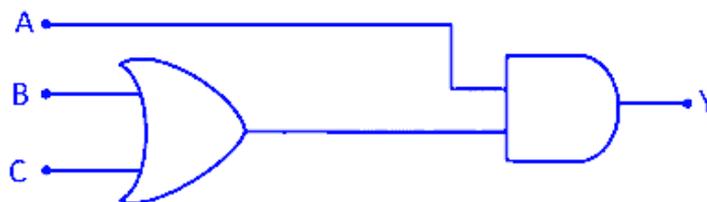
✔ **Final Answer:**

$$\beta = 24$$

Correct Option: C (24)

Question22

In the logic circuit given, A, B and C are the inputs and Y is the output. The output Y is **HIGH**



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Options:

- A. for all the HIGH inputs.
- B. for all the LOW inputs.
- C. when $A = 1, B = 0, C = 0$
- D. when $A = 1, B = 0, C = 1$

Answer: C

Solution:

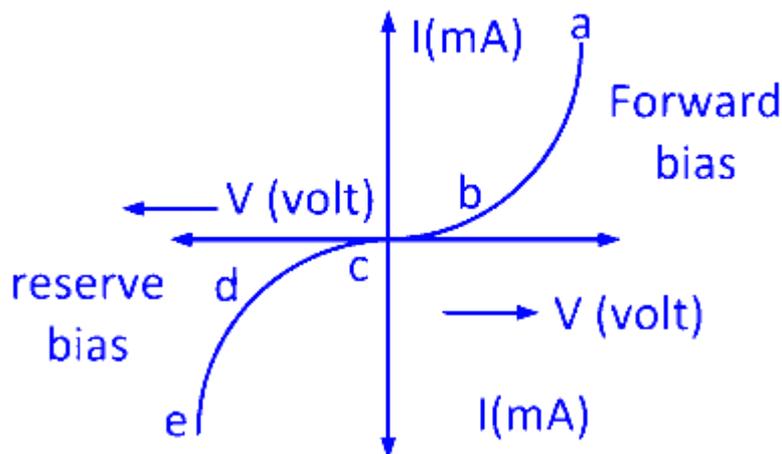
Truth table for the following logic circuit,

A	B	C	$\overline{B + C}$	Y
0	0	0	1	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	1	1
1	0	1	0	0
1	1	0	0	0
1	1	1	0	0

From the truth table, output Y is high only when A = 1, B = 0 and C = 0.

Question23

The graph given below represents I-V characteristics of zener diode. The part of the characteristics curve that is most relevant for its operation as a voltage regulator is



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Options:

A. ab



B. bc

C. cd

D. de

Answer: D

Solution:

1. Zener diode operation as voltage regulator

Answer: **(D) de**

The Zener diode acts as a voltage regulator when operated in the reverse bias breakdown region, which is the "Zener knee" region. In this region, the voltage across the diode (the Zener voltage) remains nearly constant even as the reverse current varies significantly. This constant voltage property is essential for stabilizing voltage in electronic circuits.

On the given graph, the region 'de' is in the reverse bias section and exhibits this nearly constant voltage characteristic, making it the most relevant part for the diode's operation as a voltage regulator.

Question24

In n-type semiconductor, free electrons donated by the impurity atoms occupy energy levels in

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Options:

A. the conduction band.

B. the valence band.

C. the band gap and are close to the conduction band.

D. the band gap and are close to the valence band.

Answer: C

Solution:

In an **n-type semiconductor**, a pentavalent impurity (donor atom, e.g., phosphorus in silicon) is added.



- These donor atoms contribute extra electrons.
- The donor electron requires a *very small* amount of energy (a few meV) to jump to the conduction band.
- This means donor energy levels lie **within the band gap, just below the conduction band**.

✔ Correct Answer:

Option C – the band gap and are close to the conduction band.

Question25

In a pure silicon crystal electron-hole concentration is 10^{16} per m^3 at 301 K . Now 10^{21} atoms of phosphorus are added per cubic metre. The new hole concentration in silicon is (in per m^3)

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Options:

- A. 10^5
- B. 10^{11}
- C. 10^{19}
- D. 10^{21}

Answer: B

Solution:

Step 1. Identify given data:

- Intrinsic carrier concentration at 301 K (intrinsic = electrons = holes):

$$n_i = p_i = 10^{16} \text{ m}^{-3}.$$

- Doping: $N_D = 10^{21} \text{ m}^{-3}$ of phosphorus (donors).
- We want new *hole concentration*.

Step 2. Law of mass action:

In thermal equilibrium for silicon:

$$n \cdot p = n_i^2,$$

where:

- n = electron concentration,
- p = hole concentration,
- n_i = intrinsic carrier concentration.

Step 3. Doping effect:

For an **n-type** semiconductor (phosphorus donor):

- The electron concentration in conduction band is approximately:

$$n \approx N_D \quad (\text{since } N_D \gg n_i).$$

Step 4. Calculate hole concentration:

$$p = \frac{n_i^2}{n} \approx \frac{n_i^2}{N_D}.$$

- Compute: $n_i^2 = (10^{16})^2 = 10^{32}$.
- Divide by $N_D = 10^{21}$:

$$p = \frac{10^{32}}{10^{21}} = 10^{11}.$$

Answer:

The new hole concentration is

$$\boxed{10^{11} \text{ m}^{-3}}$$

Option B.

Question26

In a common emitter transistor amplifier, the output voltage and input voltage have a phase difference of

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Options:

A. 0°

B. $\frac{\pi^\circ}{2}$



C. $\frac{3\pi}{4}$

D. π

Answer: D

Solution:

Step 1: Recall basic property

In a **common emitter (CE)** transistor amplifier:

- The voltage gain is negative.
- This means that the output signal is **inverted** relative to the input signal.

Step 2: Phase relationship

- A signal inversion corresponds to a **phase shift of 180° (or π radians)** between input and output.

Step 3: Match with options

- Option A: $0^\circ \rightarrow$ No shift. ❌
- Option B: $\pi/2 \rightarrow 90^\circ$. ❌
- Option C: $3\pi/4 \rightarrow 135^\circ$. ❌
- Option D: $\pi \rightarrow 180^\circ$. ✅

✅ **Correct Answer:**

Option D: π (i.e., 180° phase difference)

Question27

If a centre tap transformer is used with two p-n junction diodes for full wave rectification then output voltage of rectifier with respect to each diode is (secondary voltage of transformer = V_s)

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Options:



A. $2 V_s$

B. $(\frac{2}{3})V_s$

C. $(\frac{1}{2})V_s$

D. $(\frac{3}{2})V_s$

Answer: C

Solution:

Step 1: Recall operation of center tap full-wave rectifier

- The transformer secondary has a centre tap that acts as reference/ground.
- If the total secondary RMS voltage is given as V_s , we must clarify: does V_s mean the total secondary voltage (across entire secondary winding) or the half-winding voltage?
- Typically, if the transformer secondary is V_s , then each half (from centre tap to one end) is $V_s/2$.

Step 2: Voltage across each diode

- In positive half cycle:
- The upper half of secondary provides a positive half sinusoid wrt centre.
- One diode conducts, the other is reverse biased.
- In negative half cycle:
- The lower half becomes positive wrt centre.
- The other diode conducts, delivering voltage of half-secondary.

Thus, each diode delivers the voltage corresponding to **half of the transformer secondary voltage**.

Step 3: Output (full-wave rectified)

- Output peak voltage = peak of half-winding = $(V_s/2)_{\text{peak}}$.
- Output RMS = $(V_s/2)/\sqrt{2}$ (if V_s given as RMS across full secondary).
- So with respect to each diode, the output = $\frac{1}{2} V_s$.

Final Answer:

The correct option is:

Option C: $\frac{1}{2} V_s$.

Question28

If an alternating voltage is applied across a p-n junction diode in series with a load then

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Options:

- A. no voltage appears across load.
- B. a pulsating voltage appears across load.
- C. an a.c. voltage appears across load.
- D. a d.c. voltage appears across load which is not pulsating.

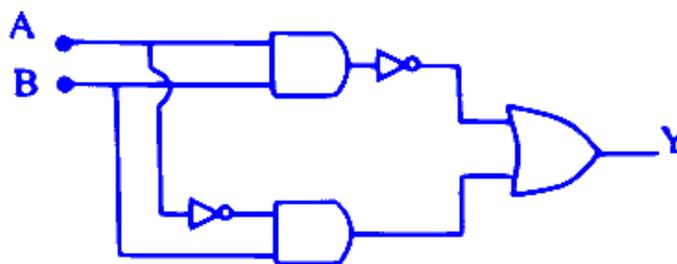
Answer: B

Solution:

A p-n junction diode conducts current primarily in one direction, allowing current to flow when it is forward-biased (positive voltage applied to the anode relative to the cathode) and blocking current when reverse-biased (negative voltage applied to the anode), except for negligible leakage current. Since a p-n junction diode only allows current to flow during the positive halfcycles of the AC input, the output voltage across the load will not be a constant DC voltage but rather a pulsating one. The voltage is zero during the negative half-cycles of the AC input and pulsates during the positive half-cycles.

Question29

In the following combination of logic gates, the output Y can be written in the terms of inputs A and B as



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Options:

A. $(A \cdot \bar{B}) + (\bar{A} \cdot B)$

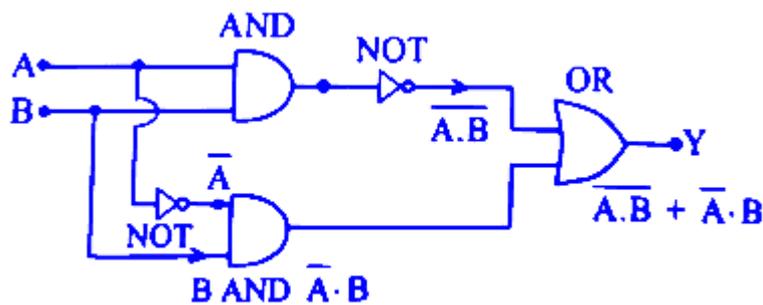
B. $(A \cdot B) + (\bar{A} \cdot B)$

C. $(\overline{A \cdot B}) + (\bar{A} \cdot B)$

D. $(\overline{A \cdot B}) + (A \cdot \bar{B})$

Answer: C

Solution:



$\therefore Y = (\overline{A \cdot B} + \bar{A} \cdot B)$

Question30

In common emitter mode of a transistor, the current gain is 8 . The input impedance is $25\text{k}\Omega$ and load resistance is $75\text{k}\Omega$. The power gain is

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Options:

A. 192

B. 112

C. 316

D. 224

Answer: A

Solution:

Step 1: Recall relationship

$$\text{Power gain } G_p = (\text{Current gain})^2 \times \frac{R_L}{R_{in}}.$$

Why?

- Input power $P_{in} = I_{in}^2 R_{in}$.
- Output current $= I_{out} = \beta \cdot I_{in}$.
- Output power $= I_{out}^2 \cdot R_L = (\beta^2 I_{in}^2) R_L$.
- So ratio $P_{out}/P_{in} = \beta^2 \cdot (R_L/R_{in})$.

Step 2: Plug in values

- Current gain $= \beta = 8$.
- $R_{in} = 25 \text{ k}\Omega$.
- $R_L = 75 \text{ k}\Omega$.

So:

$$G_p = 8^2 \times \frac{75}{25} = 64 \times 3 = 192$$

Final Answer:

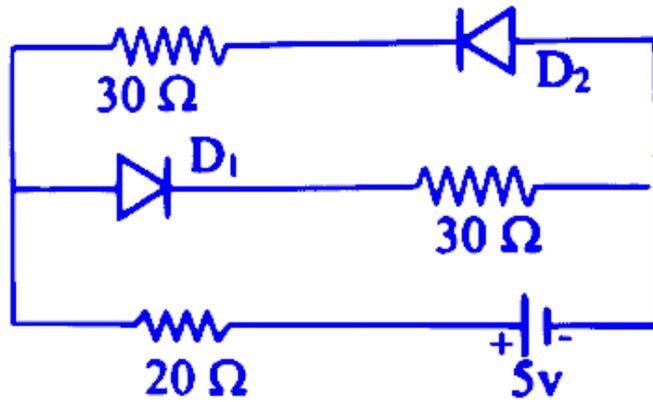
192

Correct Option: A (192)

Question31

If the internal resistance of cell is negligible then current flowing through the circuit is





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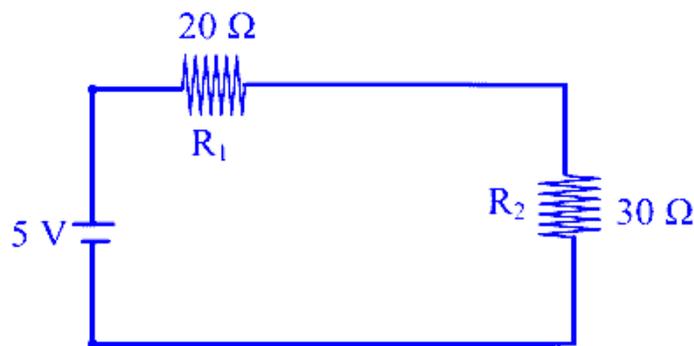
Options:

- A. 0.04 A
- B. 0.06 A
- C. 0.08 A
- D. 0.10 A

Answer: D

Solution:

In given circuit, the diode D_2 is connected in reverse biased. Hence, no current flows through resistance R_3 . As diode D_1 is ideal, the equivalent circuit can be given as,



$$\therefore I = \frac{V}{R_1 + R_2} = \frac{5}{20 + 30} = \frac{5}{50} = 0.10 \text{ A}$$

Question32

Which of the following logic gates is called as Universal gate?

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Options:

A. OR

B. X-OR

C. AND

D. NAND

Answer: D

Solution:

The correct answer is:

Option D: NAND

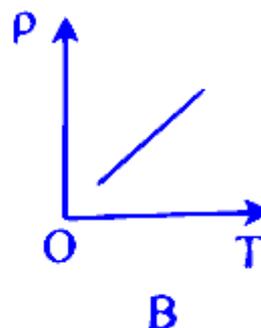
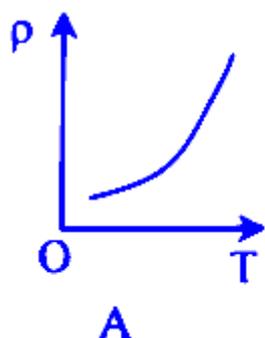
Explanation:

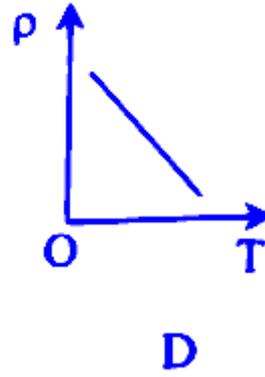
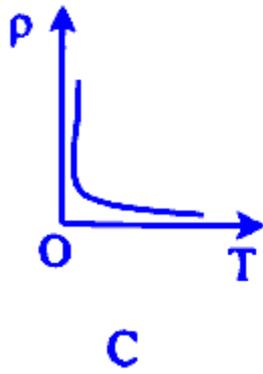
A **NAND gate** is called a *Universal Gate* because you can construct all other basic gates (AND, OR, NOT, NOR, XOR, XNOR) using only NAND gates. This property is not true for the other gates listed in the options.

So, the logic gate that is called a Universal gate is the **NAND gate** (Option D).

Question33

Which graph shows correctly the temperature (T). dependence of resistivity (ρ) of a semiconductor?





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Options:

- A. C
- B. A
- C. D
- D. B

Answer: A

Solution:

Graph (C) correctly represents the temperature (T) dependence of resistivity (ρ) of a semiconductor.

Question34

In an n-p-n transistor amplifier, the collector current is 8 mA . If 80% of the electrons from the emitter reach the collector, then (α and β are current ratios)

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Options:

- A. the base current is 20 mA .
- B. the emitter current is 2 mA .
- C. $\alpha = 0.8, \beta = 4.0$
- D. $\alpha = 4.0, \beta = 0.8$

Answer: C

Solution:

Given:

Collector current, $I_C = 8 \text{ mA}$

80% of electrons from emitter reach the collector;

So, $\alpha = 0.8$

Let's solve step by step:

Step 1: Find the emitter current, I_E

α is the ratio of collector current to emitter current:

$$\alpha = \frac{I_C}{I_E}$$

Given $I_C = 8 \text{ mA}$, $\alpha = 0.8$:

$$0.8 = \frac{8}{I_E}$$

So,

$$I_E = \frac{8}{0.8} = 10 \text{ mA}$$

Step 2: Find the base current, I_B

Current relation:

$$I_E = I_C + I_B \implies I_B = I_E - I_C = 10 - 8 = 2 \text{ mA}$$

Step 3: Find β (current gain in common emitter mode)

$$\beta = \frac{I_C}{I_B} = \frac{8}{2} = 4.0$$

Step 4: Summarize answers and match options

- **Option A:** the base current is 20 mA.

Incorrect. Base current is 2 mA, not 20 mA.

- **Option B:** the emitter current is 2 mA.

Incorrect. Emitter current is 10 mA.

- **Option C:** $\alpha = 0.8, \beta = 4.0$

Correct. These are the calculated values.

- **Option D:** $\alpha = 4.0, \beta = 0.8$

Incorrect.

Final answer:

Option C: $\alpha = 0.8, \beta = 4.0$

Question35

In an n-p-n transistor amplifier, the collector current is 9 mA . If 90% of the electrons emitted reach the collector, then

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Options:

A. $\alpha = 9, \beta = 0.9$

B. $\alpha = 0.9, \beta = 90$

C. $\alpha = 0.9, \beta = 9$

D. $\alpha = 90, \beta = 0.9$

Answer: C

Solution:

Given:

- Collector current, $I_C = 9$ mA
- 90% of the electrons emitted reach the collector (i.e., $\alpha = 0.9$)

Let's use the NCERT terminology and steps.

Step 1: Meaning of α and β

- α is the current gain in common base configuration:

$$\alpha = \frac{I_C}{I_E}$$

- β is the current gain in common emitter configuration:

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

or

$$\beta = \frac{\alpha}{1-\alpha}$$

Step 2: Using the data

Since 90% electrons emitted from the emitter reach the collector,

$$\alpha = 0.9$$

Step 3: Calculate β

The relationship is:

$$\beta = \frac{\alpha}{1-\alpha}$$

Put $\alpha = 0.9$:

$$\beta = \frac{0.9}{1-0.9} = \frac{0.9}{0.1} = 9$$

Step 4: Check options

Only **option C** matches:

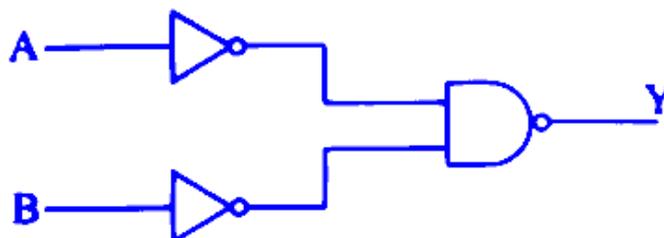
$$\alpha = 0.9, \beta = 9$$

Final Answer:

Option C: $\alpha = 0.9, \beta = 9$

Question36

The resultant logic gate from the combination of following gates is



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Options:

A. OR

B. NAND

C. AND

D. NOR

Answer: A

Solution:

From the circuit diagram,

$$Y = \overline{(\overline{A}) \cdot (\overline{B})} \quad \dots (i)$$

De Morgan's Law is given as,

$$\overline{A + B} = \overline{A} \cdot \overline{B} \quad \dots (ii)$$

$$Y = \overline{\overline{A + B}} \quad \dots [From(i)and(ii)]$$

$$Y = A + B$$

This is the equation for OR gate.

Alternate method:

A and B are given to two NOT gates. Let A' and B' be the outputs of the two NOT gates that are given to a NAND gate. We can write the truth table as shown below.

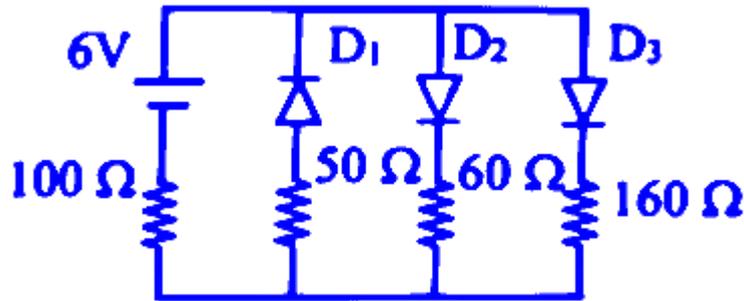
A	B	A'	B'	Y
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	1

This is truth table of OR gate.

Question37



In the following circuit shown in figure, three diodes are connected each with forward resistance 40Ω and infinite backward resistance. The current through 100Ω resistance is



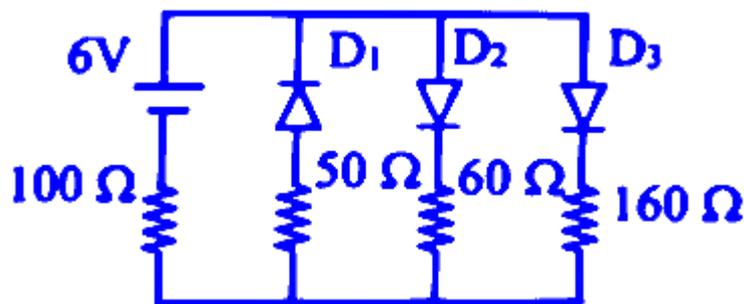
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Options:

- A. 18 mA
- B. 36 mA
- C. 9 mA
- D. 27 mA

Answer: B

Solution:



From the figure diode D_2 and D_3 are forward biased while D_1 is reverse biased.

Hence current will pass through D_2 and D_3 only.

D_2 and D_3 each have forward resistance 40Ω

Total resistance in the circuit

$$R = \frac{200 \times 100}{300} + 100 = \frac{500}{3}$$

$$I = \frac{V}{R} = \frac{6}{\frac{500}{3}} = \frac{18}{500} = 0.036 \text{ A} = 36 \text{ mA}$$

Question38

For an ideal diode, in forward and reverse biased condition the resistance is respectively

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Options:

- A. infinite, zero.
- B. infinite, infinite.
- C. zero, zero.
- D. zero, infinite.

Answer: D

Solution:

For an ideal diode:

- In **forward bias**, the diode conducts perfectly. Its resistance is taken as **zero**.
- In **reverse bias**, the diode does not conduct at all. Its resistance is taken as **infinite**.

So, the correct option is:

Option D: zero, infinite.

Question39

When an n-p-n junction transistor is used as an amplifier in common emitter mode,



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Options:

- A. the base emitter junction is reverse biased.
- B. the input impedance is high and the output impedance is low.
- C. input signal is applied between the base and emitter and the output is obtained between collector and emitter.
- D. the input voltage and the output voltage are in phase.

Answer: C

Solution:

Let's analyse each option based on **NCERT concepts of transistors in Common Emitter (CE) mode:**

Option A: The base-emitter junction is **NOT** reverse biased.

- In CE mode, **base-emitter is forward biased**, and **collector-base is reverse biased**.

Option B: *The input impedance is high and the output impedance is low.*

- In CE mode, **input impedance is low** (a few $k\Omega$) and **output impedance is high** (tens of $k\Omega$).

Option C: *Input signal is applied between the base and emitter and the output is obtained between collector and emitter.*

- This is **correct** as per textbook diagram and working:
- **Input:** between base and emitter
- **Output:** between collector and emitter.

Option D: The input voltage and output voltage are **NOT** in phase; they are **180° out of phase** in CE mode.

Final answer:

Option C is correct.

Input signal is applied between the base and emitter and the output is obtained between collector and emitter.

Question40



In a transistor (common emitter configuration) the ratio of power gain to voltage gain is (α and β are current ratios)

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Options:

A. $\frac{\beta}{\alpha}$

B. $\alpha\beta$

C. α

D. β

Answer: D

Solution:

Given:

- Common emitter configuration of a transistor.
- α and β are current ratios, where:
- $\alpha = \frac{I_C}{I_E}$
- $\beta = \frac{I_C}{I_B}$

Let us use the following relationships:

Voltage gain is given by:

$$A_v = \frac{V_{out}}{V_{in}}$$

Power gain is given by:

$$A_p = \frac{\text{Output Power}}{\text{Input Power}} = A_v \times A_i$$

where A_i is the current gain.

In common emitter configuration:

- Current gain $A_i = \beta$

Therefore,

$$A_p = A_v \times \beta$$

Thus, the ratio of power gain to voltage gain is:

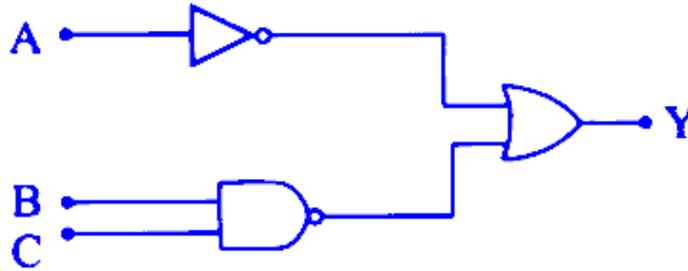
$$\text{Required Ratio} = \frac{A_p}{A_v} = \frac{A_v \times \beta}{A_v} = \beta$$

So, the correct answer is:

Option D: β

Question41

In a given logic circuit, the output Y when all the three inputs A, B, C are first low and then high will be respectively



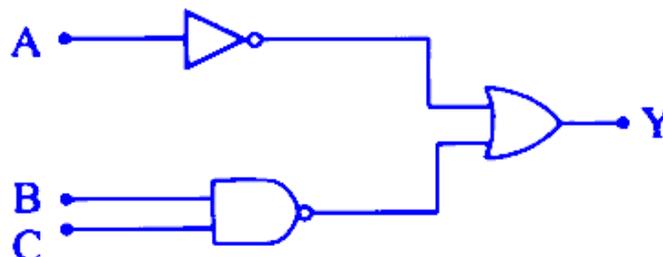
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Options:

- A. (0, 0)
- B. (0, 1)
- C. (1, 0)
- D. (1, 1)

Answer: C

Solution:



A	$X = \bar{A}$	B	C	$Z = \bar{B} \cdot \bar{C}$	$Y = X + Z$
0	1	0	0	1	1
1	0	1	1	0	0

Question42

In unbiased p-n junction diode

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Options:

- A. the potential is same everywhere.
- B. there is an electric field at the junction directed from the p -type side to the n -type side.
- C. there is an electric field at the junction directed from the *n*-type side to *p*-type side.
- D. the p-type side is at higher potential than the n-type side.

Answer: C

Solution:

Step 1: Recall what happens in an **unbiased p–n junction**.

- Due to diffusion of electrons and holes, a **depletion region** is formed at the junction.
- In this region, immobile positive ions are left in the *n*-side and immobile negative ions in the *p*-side.
- This sets up an **electric field** across the junction.

Step 2: Direction of the electric field.

- Positive ions are on the *n*-side, and negative ions are on the *p*-side.
- Electric field lines originate from **positive charge** (*n*-side) and terminate at **negative charge** (*p*-side).
- Therefore, the electric field is **directed from n-side to p-side**.



Step 3: Examine the options.

- **Option A:** Wrong, because potential is not same; there is built-in potential.
- **Option B:** Wrong, because field is not from p to n.
- **Option C:** Correct, field is from n-type side to p-type side.
- **Option D:** Wrong, because p-side is at *lower* potential than n-side in equilibrium.

Final Answer: Option C 

Question43

In a transistor amplifier, AC current gain is 64 , the load resistance is 5400Ω and the input resistance of the transistor is 540Ω . The voltage gain is

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Options:

- A. 540
- B. 600
- C. 640
- D. 6400

Answer: C

Solution:

Given:

AC current gain, $\beta_{ac} = 64$

Load resistance, $R_L = 5400 \Omega$

Input resistance, $R_{in} = 540 \Omega$

Voltage gain (A_v) in a common emitter transistor amplifier is given by:



$$A_v = \beta_{ac} \times \frac{R_L}{R_{in}}$$

Step 1: Calculate $\frac{R_L}{R_{in}}$

$$\frac{R_L}{R_{in}} = \frac{5400}{540} = 10$$

Step 2: Calculate A_v

$$A_v = 64 \times 10 = 640$$

Correct option: Option C (640)

Question44

In the depletion layer of reverse biased p-n junction, the

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Options:

- A. electric field is very small.
- B. potential is maximum.
- C. electric field is maximum.
- D. potential is zero.

Answer: C

Solution:

The correct answer is:

Option C: electric field is maximum.

Explanation:

- In the depletion layer of a reverse biased p-n junction, immobile ions create a strong electric field.
- This electric field opposes the flow of majority charge carriers.
- The electric field is strongest (maximum) across the depletion region because this is where the immobile charges are present.

Therefore, the correct answer is Option C.

Question45

For a common emitter transistor, if $\frac{I_C}{I_E} = 0.95$, then the current gain is

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Options:

A. 47.5

B. 44

C. 19

D. 15

Answer: C

Solution:

Given:

$$\frac{I_C}{I_E} = 0.95$$

In a common emitter transistor,

Current gain (β) is defined as:

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

But we have $I_E = I_C + I_B$, so:

$$I_B = I_E - I_C$$

Therefore,

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

Substitute $\frac{I_C}{I_E} = 0.95$,

$$\text{So, } I_C = 0.95I_E$$

Now,

$$\beta = \frac{I_C}{I_E - I_C} = \frac{0.95I_E}{I_E - 0.95I_E} = \frac{0.95I_E}{0.05I_E} = \frac{0.95}{0.05} = 19$$



Correct option: C) 19

Question46

In the case of constant ' α ' and ' β ' of a transistor (α and β are current ratios)

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Options:

A. $\beta < 1, \alpha > 1$

B. $\beta > 1, \alpha < 1$

C. $\alpha = \beta$

D. $\alpha = \beta^2$

Answer: B

Solution:

Given:

- α and β are current ratios of a transistor.

Definitions:

- α (alpha) is the **common base current gain**: $\alpha = \frac{I_C}{I_E}$
- β (beta) is the **common emitter current gain**: $\beta = \frac{I_C}{I_B}$

Relationship between α and β :

1. The emitter current I_E is the sum of collector current I_C and base current I_B :

$$I_E = I_C + I_B$$

2. Rearranging:

$$I_B = I_E - I_C$$

3. Now,

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

Divide numerator and denominator by I_E :



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

4. Rearranging,

$$\alpha = \frac{\beta}{1 + \beta}$$

Typical values:

- α is always less than 1, but close to 1 (usually 0.95 to 0.99).
- β is usually much greater than 1 (often 20 to 200 or more).

Now, let's check the options:

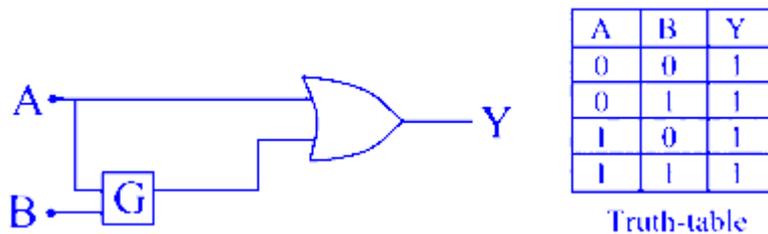
- **Option A:** $\beta < 1, \alpha > 1$ (INCORRECT; $\beta > 1$ and $\alpha < 1$)
- **Option B:** $\beta > 1, \alpha < 1$ (CORRECT)
- **Option C:** $\alpha = \beta$ (INCORRECT; they are related but not equal)
- **Option D:** $\alpha = \beta^2$ (INCORRECT; see actual relationship above)

Final Answer:

Option B: $\beta > 1, \alpha < 1$

Question47

To get the truth table shown from the following logic circuit, the logic gate G should be



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Options:

A. AND

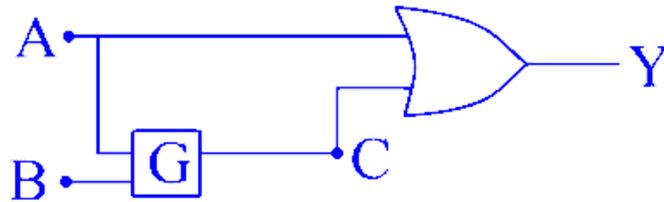
B. OR

C. NAND

D. NOR

Answer: C

Solution:



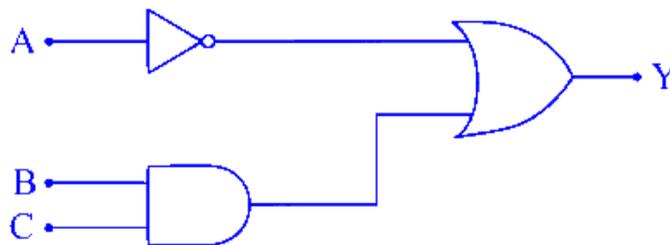
In the circuit, one input to the OR gate is A and the other input is the output of the gate G. Since Y is always 1 regardless of A and B, the gate G must output 1 when its input is fed into the OR gate. For this to happen, the output of G needs to be such that it outputs 1 when combined with A in the OR gate.

From the truth table, the logic gate G is a NAND gate, as the NAND gate will output 1 for all combinations except when both inputs are 1, which would then be overruled by the OR gate which outputs 1 if either input is 1.

A	B	G(A,B)	A + G(A,B)
0	0	1	1
0	1	1	1
1	0	1	1
1	1	0	1

Question48

The Boolean expression for the given combination of logic gates is



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Options:

A. $Y = (\bar{A} \cdot B) + C$

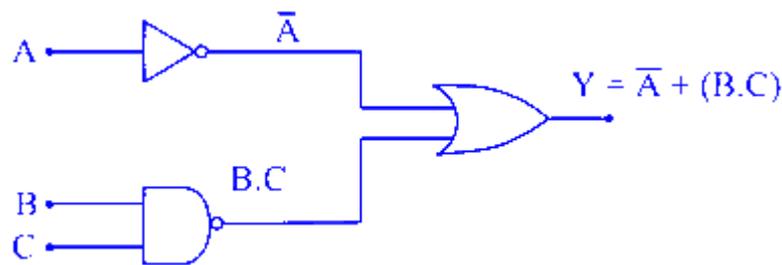
B. $Y = (\bar{A} + B) \cdot C$

C. $Y = \bar{A} + (B \cdot C)$

D. $Y = \bar{A} \cdot (B + C)$

Answer: C

Solution:



Question49

When a small amount of impurity atoms are added to semiconductor, then generally its resistivity

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Options:

A. may increase or decrease depending upon the percentage of doping.

B. increases.

C. decreases.

D. does not change.

Answer: C



Solution:

When a small amount of dopant is introduced into a pure (intrinsic) semiconductor, it creates additional **free charge carriers** (electrons in an n-type semiconductor or holes in a p-type semiconductor). These extra carriers **increase** the conductivity and therefore **decrease** the resistivity.

Hence, the correct statement is :

(C) decreases.

Question50

The input signal given to C.E. amplifier having a voltage gain of 126 is $V_i = 2 \cos \left(12t + \frac{\pi}{3} \right)$. The corresponding output signal will be

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Options:

A. $252 \cos \left(12t + \frac{4\pi}{3} \right)$

B. $252 \cos \left(12t + \frac{\pi}{3} \right)$

C. $63 \cos \left(12t + \frac{2\pi}{3} \right)$

D. $2 \cos \left(12t + \frac{5\pi}{3} \right)$

Answer: A

Solution:

$$V_i = 2 \cos \left(12t + \frac{\pi}{3} \right) \quad \dots \text{(given)}$$

$$\text{Voltage gain} = \frac{V_0}{V_i}$$

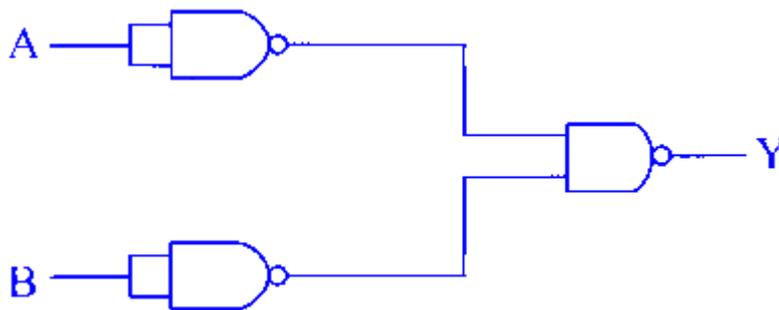
$$\begin{aligned} V_0 &= 126 \times 2 \cos \left(12t + \frac{\pi}{3} \right) \\ &= 252 \cos \left(12t + \frac{\pi}{3} \right) \end{aligned}$$

In CE amplifier, V_0 and V_i have a phase difference of π between them.

$$\begin{aligned} V_0 &= 252 \cos \left(12t + \frac{\pi}{3} + \pi \right) \\ &= 252 \cos \left(12t + \frac{4\pi}{3} \right) \end{aligned}$$

Question51

The truth table of the following circuit is



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Options:

A.

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

B.

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

C.

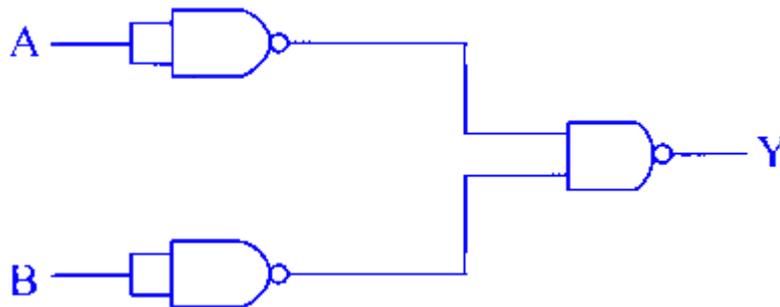
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

D.

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

Answer: C

Solution:



From the logic diagram,

$$Y = \overline{(\overline{A \cdot A}) \cdot \overline{B \cdot B}} = \overline{\overline{A} \cdot \overline{B}}$$

Using De-Morgan's law,

$$Y = \overline{\overline{A} + \overline{B}} = A + B$$

This is the equation for OR gate. Option C gives the truth table for OR gate.

Question52

If the p – n junction diode is unbiased,

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Options:

- A. n-type side has lower potential than p-type side.
- B. n-type side has same potential as p-type side.
- C. An electric field is established at the junction such that n side is at positive voltage relative to p -side.
- D. The potential across the junction is such that p -side is at positive voltage relative to n-side

Answer: C

Solution:

An electric field is established at the junction such that the n-side is at positive potential relative to the p-side.

Why this is correct

- When p-type and n-type materials are joined, **electrons diffuse from n to p** and **holes diffuse from p to n** .
- This diffusion leaves behind **immobile ions** :
 - Positive donor ions on the **n-side**
 - Negative acceptor ions on the **p-side**
- These fixed charges create a **depletion region** and an **internal electric field** .
- The electric field points from **n-side to p-side** , meaning:
 - **n-side is at higher (positive) potential**
 - **p-side is at lower (negative) potential**

Question53

For detecting light intensity we use



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Options:

- A. photodiode in reverse bias.
- B. photodiode in forward bias.
- C. LED in reverse bias.
- D. LED in forward bias.

Answer: A

Solution:

For **light detection**, a **photodiode** is operated in **reverse bias** so that when photons strike the junction, they generate electron-hole pairs that contribute to the reverse current. The small reverse current can then be accurately measured and is proportional to the incident light intensity.

Hence, the correct choice is :

(A) photodiode in reverse bias.

Question54

What is the current in the following junction diode circuit?



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Options:

- A. 10^{-1} A
- B. zero
- C. 10^{-2} A
- D. 5×10^{-3} A

Answer: B

Solution:

As the given junction is reverse biased, no current will flow in the following junction diode circuit.

Question55

A p-n junction diode as a rectifier converts

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Options:

- A. a.c. to d.c.
- B. d.c. to a.c.
- C. high voltage to low voltage.
- D. low voltage to high voltage.

Answer: A

Solution:

A p-n junction diode used as a rectifier is employed in converting **alternating current (a.c.)** to **direct current (d.c.)**.

Answer: (A) a.c. to d.c.

Question56

Two different logic gates giving output ' 1 ' for the inputs (1, 0) and then for (0, 1) are

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Options:

- A. 'AND', 'OR'
- B. 'OR', 'NOR'
- C. 'NAND', 'NOR'
- D. 'NAND', 'OR'

Answer: D

Solution:

We want to identify **two different logic gates** that both give output “1” for the two input pairs (1, 0) and (0, 1).

Let's check the outputs of common gates for those input pairs:

AND

$$\text{AND}(1, 0) = 0, \quad \text{AND}(0, 1) = 0.$$

Not suitable (does not produce “1”).

OR

$$\text{OR}(1, 0) = 1, \quad \text{OR}(0, 1) = 1.$$

Suitable (produces “1” for both).

NAND \equiv NOT(AND)

$$\text{AND}(1, 0) = 0 \implies \text{NAND}(1, 0) = 1, \quad \text{AND}(0, 1) = 0 \implies \text{NAND}(0, 1) = 1.$$

Suitable (produces “1” for both).

NOR \equiv NOT(OR)

$$\text{OR}(1, 0) = 1 \implies \text{NOR}(1, 0) = 0, \quad \text{OR}(0, 1) = 1 \implies \text{NOR}(0, 1) = 0.$$

Not suitable (does not produce “1”).

Hence the **two** gates that produce “1” for inputs (1, 0) and (0, 1) are **OR** and **NAND**.

Looking at the options:

- (A) 'AND', 'OR'
- (B) 'OR', 'NOR'
- (C) 'NAND', 'NOR'
- (D) 'NAND', 'OR'

The correct match is:

(D) NAND, OR.

Question57

In an extrinsic n-type semiconductor, the free electrons donated by the impurity atoms occupy energy levels in

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Options:

- A. the conduction band.
- B. the valance band.
- C. the band gap and are close to conduction band.
- D. the band gap and are close to valance band.

Answer: C

Solution:

In an **n-type** semiconductor, donor impurities introduce additional (donor) energy levels that lie **within the band gap** but very close to the **conduction band**. Consequently, electrons from these donor levels require only a small amount of energy to jump into the conduction band.

Hence, the correct answer is :

(C) the band gap and are close to conduction band.

Question58

For a transistor, current gain $(\beta) = 50$. To change the collector current by $350\mu\text{ A}$, the base current should be changed by

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Options:

A. $(\frac{50}{350})\mu A$

B. $(350 - 50)\mu A$

C. $(350 + 50)\mu A$

D. $(\frac{350}{50})\mu A$

Answer: D

Solution:

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

$$\therefore \Delta I_B = \frac{\Delta I_C}{\beta} = \frac{350}{50} \mu A$$

Question59

When n-p-n junction transistor is used as an amplifier in common emitter mode,

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Options:

A. the input impedance is high and the output impedance is low.

B. the base emitter junction is reverse biased.

C. input signal is applied between the base and emitter and output is obtained between collector and emitter.

D. the input voltage and output voltage are in phase.

Answer: C

Solution:

In the common emitter mode of an n-p-n junction transistor used as an amplifier, the correct statement is:



Option C

Input signal is applied between the base and emitter and output is obtained between collector and emitter.

Explanation:

Common Emitter Configuration:

In this configuration, the **emitter** terminal is common to both the input and output sides of the circuit.

The **input signal** is applied across the **base-emitter** junction.

The **output** is taken across the **collector-emitter** junction.

Biasing:

For proper operation, the base-emitter junction should be **forward-biased**, not reverse-biased as mentioned in Option B. Therefore, Option B is incorrect.

Phase Relationship:

The output voltage is **inverted** with respect to the input voltage, meaning they are 180 degrees out of phase. Hence, Option D is incorrect.

Impedance Characteristics:

The **input impedance** is generally low to moderate, not high, and the **output impedance** is generally moderate to high. Thus, Option A is incorrect.

In summary, the common emitter configuration is widely used due to its ability to amplify the input signal with phase inversion, making Option C the accurate description.

Question60

Assuming that junction diode is ideal, the current in arrangement shown in figure



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Options:

A. 2 mA



B. 20 mA

C. 30 mA

D. 10 mA

Answer: B

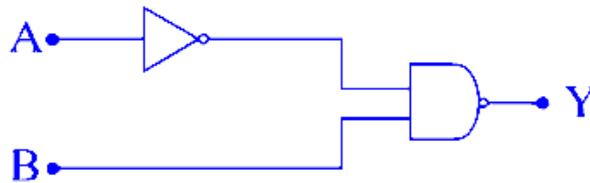
Solution:

For the given circuit, as the diode is forward biased, current will flow through it.

$$i = \frac{V}{R} = \frac{3-1}{100} = \frac{2}{100} = \frac{20}{1000} = 20 \text{ mA}$$

Question61

For the following digital logic circuit, the correct truth-table is



A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(P)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	0

(Q)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

(R)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(S)

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Options:

A. Q

B. P

C. S

D. R

Answer: D

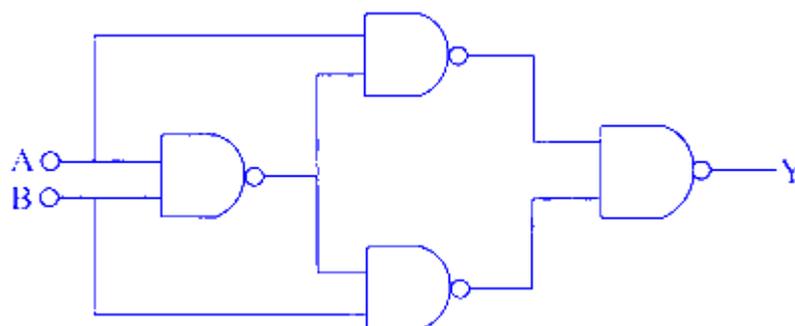
Solution:

$$y = \overline{\overline{A} \cdot B} = A + B$$

A	B	\overline{B}	$A + \overline{B}$
0	0	1	1
0	1	0	0
1	0	1	1
1	1	0	1

Question62

Following combination of gates is equivalent to



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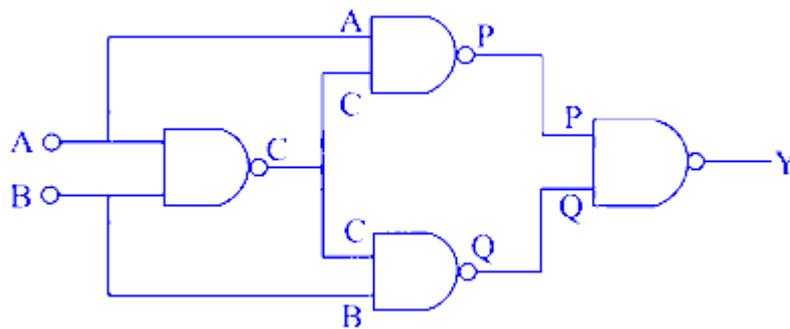


Options:

- A. NAND gate
- B. OR gate
- C. NOR gate
- D. X-OR gate

Answer: D

Solution:



A	B	$C = \overline{A \cdot B}$	$P = \overline{A \cdot C}$	$Q = \overline{C \cdot B}$	$Y = \overline{P \cdot Q}$
0	0	1	1	1	0
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	1	1	0

∴ Given combination of gates is equivalent to an X-OR gate.

Question63

If ' n_c ' and ' n_h ' are the number of electrons and number of holes respectively in a semiconductor heavily doped with phosphorous then

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Options:

A. $n_e \gg n_h$

B. $n_e \ll n_h$

C. $n_e \leq n_h$

D. $n_e = n_h$

Answer: A

Solution:

Phosphorus is a pentavalent impurity.

Hence, $n_e \gg n_h$.

Question64

A p-n junction diode cannot be used

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Options:

A. as a rectifier.

B. for converting light energy to electrical energy.

C. for getting light radiation.

D. for increasing the amplitude of an a.c. signal.

Answer: D

Solution:



A p-n junction diode cannot be used for increasing the amplitude of an a.c. signal.

Explanation:

Rectifier: A p-n junction diode is commonly used as a rectifier, which converts alternating current (A.C.) to direct current (D.C.), so Option A is incorrect.

Converting Light Energy to Electrical Energy: While a standard p-n junction diode does not perform this function, specialized types like photodiodes and solar cells, which are based on p-n junctions, can convert light energy to electrical energy. So, Option B can sometimes be correct, but in the context of a standard p-n junction, it is not typically used for this purpose.

Getting Light Radiation: Light Emitting Diodes (LEDs) are designed to emit light and are also based on p-n junction principles. Hence, Option C is not correct for a standard p-n junction diode.

Increasing the Amplitude of an A.C. Signal: A p-n junction diode does not amplify signals. Amplification is a function typically performed by transistors. Therefore, Option D is correct; a p-n junction diode cannot be used for this purpose.

Question65

In semiconductors at room temperature,

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Options:

- A. the valence band is completely filled and the conduction band partially filled.
- B. the valence band is completely filled.
- C. the conduction band is completely filled.
- D. the valence band is partially empty and the conduction band partially filled.

Answer: D

Solution:

In a semiconductor at room temperature, some electrons from the valence band are thermally excited across the band gap into the conduction band. Therefore:

The **valence band** is **not completely filled** (i.e., it is **partially empty**).

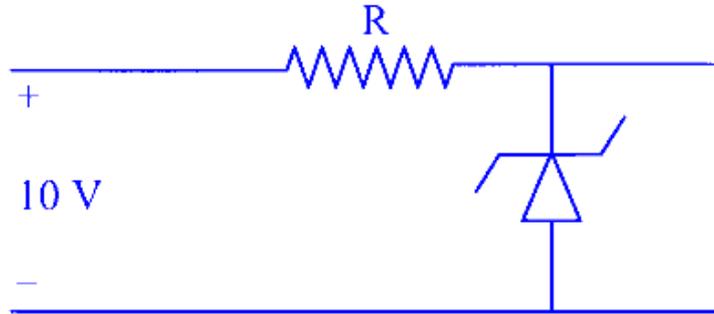
The **conduction band** is **not empty** (i.e., it is **partially filled**).

Hence, the correct statement is:

(D) The valence band is partially empty and the conduction band partially filled.

Question66

In the given circuit, Zener breakdown voltage is 8 V . If power of Zener diode is 1.6 W . The value of R is



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Options:

- A. 2Ω
- B. 4Ω
- C. 6Ω
- D. 10Ω

Answer: D

Solution:

$$V_z = 8 \text{ V} \quad \dots \text{ (given)}$$

$$P = V_z I$$

$$\therefore 1.6 = 8I$$

$$\therefore I = 0.2 \text{ A}$$

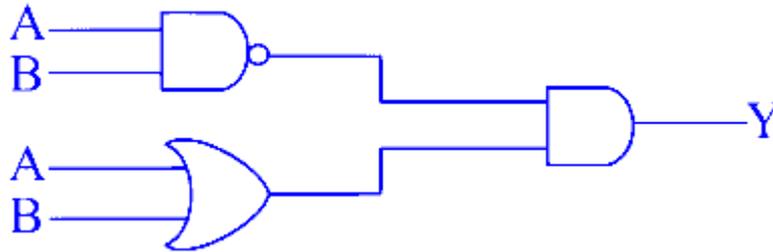
Voltage drop across Zener is 8 V . Hence the voltage drop across R will be $10 - 8 = 2 \text{ V}$.

$$R = \frac{V}{I} = \frac{2}{0.2} = 10 \Omega$$



Question67

The logic gate represented by following logic circuit is



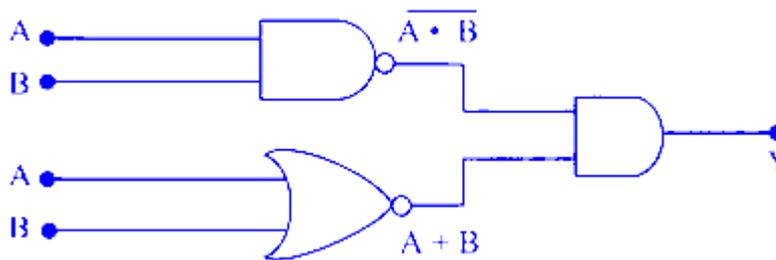
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Options:

- A. OR gate
- B. AND gate
- C. NOR gate
- D. X-OR gate

Answer: D

Solution:

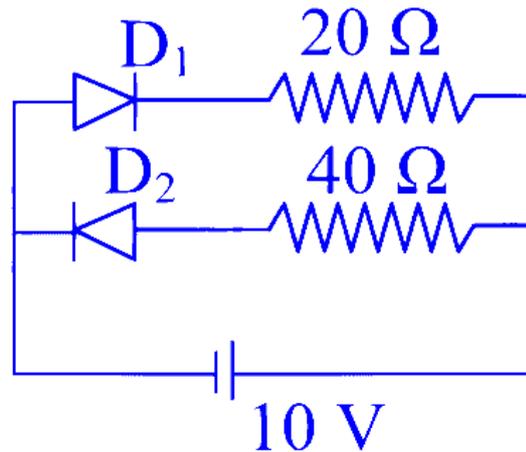


$$\begin{aligned}\therefore Y &= \overline{A \cdot B} \cdot (A + B) \\ \therefore Y &= (\overline{A} + \overline{B}) \cdot (A + B) \quad \dots (\because \overline{A \cdot B} = \overline{A} + \overline{B}) \\ \therefore Y &= \overline{A} \cdot B + \overline{B} \cdot A \\ \therefore Y &= A \cdot \overline{B} + B \cdot \overline{A}\end{aligned}$$

This represents XOR gate.

Question68

Two ideal diodes are connected to a battery as shown in the circuit. The current supplied by the battery is



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Options:

- A. zero
- B. 0.25 A
- C. 0.50 A
- D. 0.75 A

Answer: B

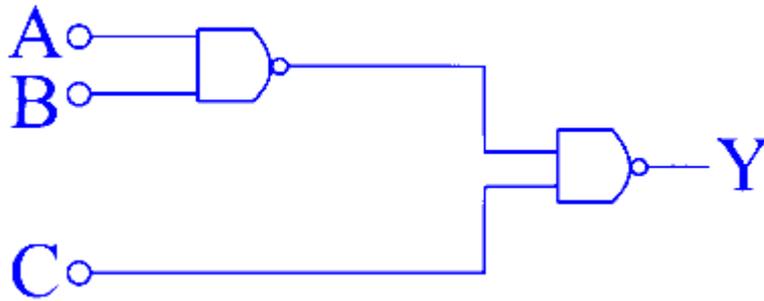
Solution:

In given circuit, the diode D₂ is connected in reverse bias. Hence, no current flows through 40Ω resistor.

$$\therefore I = \frac{V}{R} = \frac{10}{40} = 0.25 \text{ A}$$

Question69

What is the output Y in the following circuit, when all the three inputs A, B, C are first 'zero' and then 'one'?



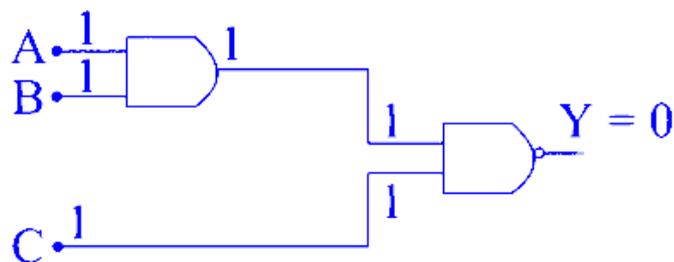
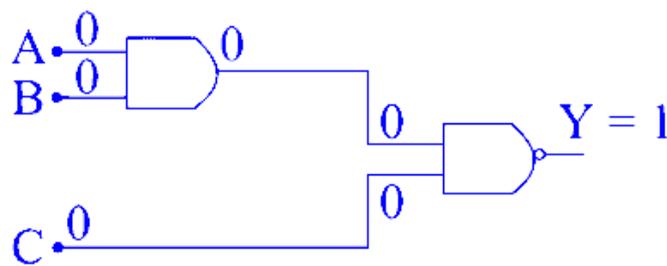
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Options:

- A. 0, 0
- B. 0, 1
- C. 1, 0
- D. 1, 1

Answer: C

Solution:



Question70

In the block diagram of simple rectifier circuit, from a variable a.c. voltage, constant d.c. voltage is obtained. The correct order of operation is

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Options:

- A. voltage regulator, diode rectifier, filter.
- B. diode rectifier, voltage regulator, filter.
- C. diode rectifier, filter, voltage regulator.
- D. filter, voltage regulator, diode rectifier.

Answer: C

Solution:

A typical simple rectifier + regulator circuit goes through the following stages:

Rectifier (diodes) – converts the incoming AC to pulsating DC.

Filter (e.g., capacitor filter) – smooths out the pulsating DC.

Voltage Regulator – maintains a steady DC output voltage despite load or supply variations.

Hence, the correct order is:

Diode Rectifier → **Filter** → **Voltage Regulator**.

Answer : (C) diode rectifier, filter, voltage regulator.

Question71

In the working of photodiode, the reverse current depends on



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Options:

- A. concentration of majority carriers.
- B. concentration of minority carriers.
- C. applied voltage.
- D. recombination of holes and electrons.

Answer: B

Solution:

In a **photodiode** under **reverse bias**, the current flowing is essentially the **photocurrent**, which arises primarily from **photo-generated minority carriers** in the depletion region. The incident light creates electron-hole pairs, and these carriers contribute to the (reverse) photocurrent. Hence, in a photodiode, the magnitude of the reverse current depends on the **concentration of minority carriers** generated by the incident light, rather than the applied voltage or the majority carriers.

Answer : (B) concentration of minority carriers.

Question72

The resultant gate and its Boolean expression in the given circuit is



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Options:

- A. OR, $A + B$
- B. AND, $A - B$

C. NOR, $A + B$

D. NAND, $\overline{A + B}$

Answer: A

Solution:

A NOR gate followed by a NOT gate results in an OR gate. The Boolean expression is $A + B$.

Question73

The current amplification factor of a transistor is 50 . The input resistance when used in common emitter mode is $1\text{k}\Omega$. The peak value for an a.c. input voltage of 0.01 V peak is

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Options:

A. $100\mu\text{ A}$

B. 0.01 mA

C. 0.25 mA

D. $500\mu\text{ A}$

Answer: D

Solution:

Given: $\beta = 50$, $R_i = 1\text{k}\Omega = 10^3\Omega$,

$V_i = 0.01\text{ V}$

$$\beta = \frac{I_C}{I_B} = 50 \Rightarrow I_C = 50 \times I_B$$

$$V_i = I_B \times R_i$$

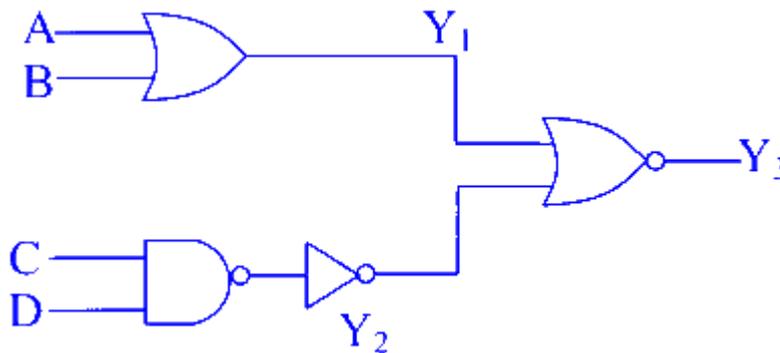


$$\therefore I_B = \frac{V_i}{R_i} = \frac{0.01}{10^3} = 10^{-5}$$

$$\therefore I_C = 50 \times 10^{-5} = 500 \times 10^{-6} \text{ A} = 500 \mu \text{ A}$$

Question 74

In the logic circuit diagram, when all the four inputs A, B, C, D are one, the outputs Y_1, Y_2, Y_3 are respectively (1, 1, 0). When all the inputs A, B, C, D are changed to 'zero', the outputs Y_1, Y_2, Y_3 respectively change to



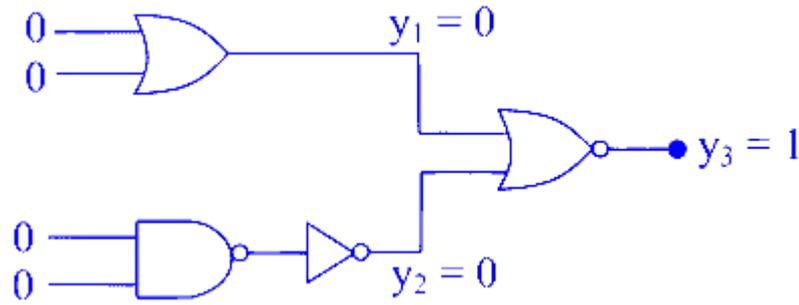
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Options:

- A. (0, 1, 0)
- B. (0, 0, 1)
- C. (1, 1, 0)
- D. (1, 1, 1)

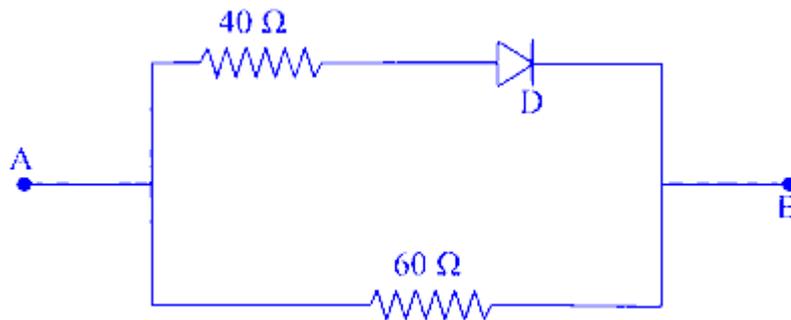
Answer: B

Solution:



Question75

For the diagram shown, the resistance between points A and B when the ideal diode ' D ' is forward biased is ' R_1 ' and that when reverse biased is ' R_2 '. The ratio $\frac{R_1}{R_2}$ is



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Options:

- A. $\frac{2}{3}$
- B. $\frac{2}{5}$
- C. $\frac{3}{2}$
- D. $\frac{5}{2}$

Answer: B

Solution:

When the diode is forward biased, current will flow through both the arms.

∴ The effective resistance is

$$R_1 = \frac{40 \times 60}{100} = \frac{2400}{100} = 24\Omega$$

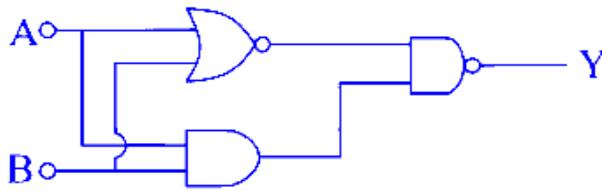
When the diode is reverse biased, current will flow only through the bottom arm.

∴ The effective resistance R_2 is 60Ω .

$$\therefore \frac{R_1}{R_2} = \frac{24}{60} = \frac{2}{5}$$

Question 76

The truth table for the given logic circuit is



A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1

(P)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(Q)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

(R)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

(S)

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Options:

- A. P
- B. Q
- C. R
- D. S

Answer: A

Solution:

From the logic circuit,

$$Y = \overline{(\overline{A + B}) \cdot (A \cdot B)}$$

Using De-Morgan's law, $\overline{A + B} = \overline{A} \cdot \overline{B}$

$$Y = \overline{(\overline{A} \cdot \overline{B}) \cdot (A \cdot B)}$$

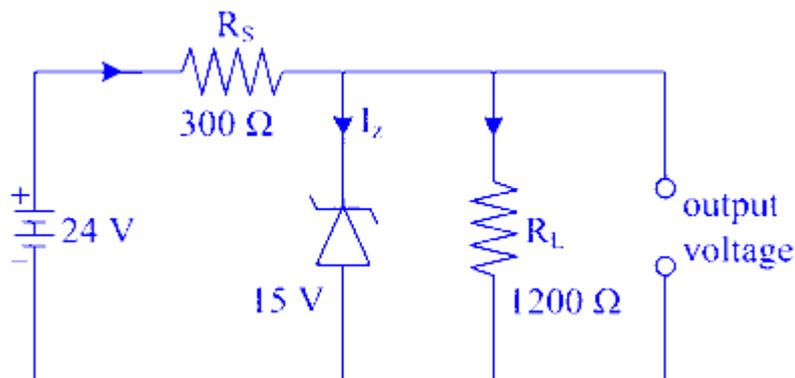
$$Y = \overline{(\overline{A} \cdot A) \cdot (\overline{B} \cdot B)}$$

$$Y = \overline{0 \cdot 0} = 1$$

∴ Output is always 1 .

Question 77

In the circuit diagram shown in figure, the current through the zener diode is



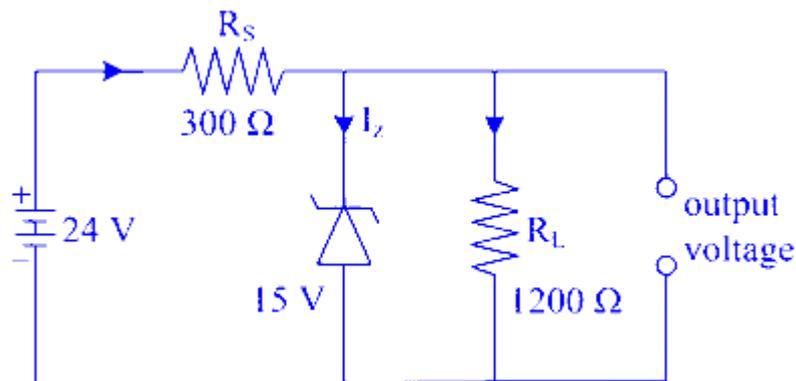
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Options:

- A. 30 mA
- B. 17.5 mA
- C. 15 mA
- D. 12.5 mA

Answer: B

Solution:



Potential difference across $1200\ \Omega$ resistor $V_{1200\ \Omega} = 15\ \text{V}$

\therefore current across $1200\ \Omega$ resistor,

$$I_{1200\ \Omega} = \frac{15}{1200}\ \text{A} = 12.5\ \text{mA}$$

Potential difference across $300\ \Omega$ resistor,

$$V_{300\ \Omega} = 24 - 15 = 9\ \text{V}$$

\therefore Current across $300\ \Omega$ resistor,

$$I_{300\ \Omega} = \frac{9}{300}\ \text{A} = 30\ \text{mA}$$

\therefore Current through zener diode,

$$I_z = 30 - 12.5 = 17.5\ \text{mA}.$$

Question 78

The depletion layer in p-n junction region is caused by

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Options:

- A. drift of electrons.
- B. migration of impurity ions.
- C. diffusion of charge carries.
- D. drift of holes.

Answer: C

Solution:

In a **p–n junction**, free electrons from the **n-side** diffuse into the **p-side** and holes from the **p-side** diffuse into the **n-side**, leaving behind fixed, oppositely charged ion cores near the junction. This region of immobile ions is called the **depletion region**. Hence, it is caused by the **diffusion** of charge carriers (electrons and holes).

Answer : (C) diffusion of charge carriers.

Question79

The collector supply voltage is 6 V and a voltage drop across a resistor of 600Ω in the collector circuit is 0.6 V , in a circuit of transistor connected in common emitter mode. If the current gain is 20 then the base current is

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Options:

- A. 0.25 mA
- B. 0.05 mA



C. 0.12 mA

D. 0.02 mA

Answer: B

Solution:

First, calculate the collector current, I_C , using Ohm's law. The voltage drop across the collector resistor, $R_C = 600 \Omega$, is given as 0.6 V.

$$I_C = \frac{V_{RC}}{R_C} = \frac{0.6 \text{ V}}{600 \Omega} = 0.001 \text{ A} = 1 \text{ mA}$$

The current gain, β , is given as 20. The relation between collector current I_C , base current I_B , and current gain β is:

$$I_C = \beta \cdot I_B$$

Rearranging for the base current I_B :

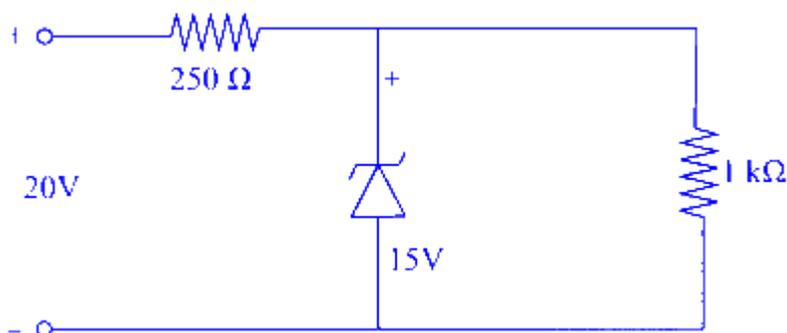
$$I_B = \frac{I_C}{\beta} = \frac{1 \text{ mA}}{20} = 0.05 \text{ mA}$$

Thus, the base current I_B is 0.05 mA.

Option B is correct: 0.05 mA.

Question80

A zener diode, having breakdown voltage 15 V is used in a voltage regulator circuit as shown. The current through the zener diode is



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Options:

A. 20 mA



B. 5 mA

C. 10 mA

D. 15 mA

Answer: B

Solution:

The voltage drop across $1\text{k}\Omega$ is 15 V

$$\therefore \text{The current through it is } I = \frac{15 \text{ V}}{1 \times 10^3 \Omega}$$

$$= 15 \times 10^{-3} \text{ A}$$

The voltage drop across $250\Omega = 20 - 15 = 5 \text{ V}$

\therefore the current through it

$$I = \frac{V}{R} = \frac{5}{250} = 20 \times 10^{-3} \text{ A}$$

The current through zener diode is,

$$I_z = (20 \times 10^{-3}) - (15 \times 10^{-3}) = 5 \text{ mA}$$

Question81

A semiconductor device X is connected in series with a battery and a resistor. The current of 10 mA is found to pass through the circuit. If the terminals of X are connected in reverse manner, the current drops to almost zero. X may be

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Options:

A. a zener diode

B. a p-n junction diode

C. an intrinsic semiconductor

D. an extrinsic semiconductor



Answer: B

Solution:

In a p-n junction diode, a very small, nearly zero current flows through the junction when it is reverse biased.

Question82

The Boolean expression for ' $x - OR$ ' gate $C = (A \oplus B)$ is equal to

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Options:

A. $(A \cdot B) + (\bar{A} \cdot \bar{B})$

B. $A + (\bar{A} \cdot \bar{B})$

C. $(A \cdot B) + \bar{B}$

D. $(\bar{A} \cdot B) + (A \cdot \bar{B})$

Answer: D

Solution:

The Boolean expression for an XOR (exclusive OR) gate, where the output is true if and only if exactly one of the inputs is true, is given by:

$$C = (A \cdot \bar{B}) + (\bar{A} \cdot B)$$

This expression represents the XOR operation between two variables A and B . It is equivalent to saying that C is true when either A is true and B is false, or A is false and B is true.

Thus, the correct option corresponding to this expression is:

Option D

$$(\bar{A} \cdot B) + (A \cdot \bar{B})$$

Question83



Which one of the following statements is true? A p-type semiconductor is doped with

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Options:

- A. trivalent impurity and electrons are majority carriers.
- B. pentavalent impurity and electrons are minority carriers.
- C. pentavalent impurity and holes are minority carriers.
- D. trivalent impurity and holes are majority carriers.

Answer: D

Solution:

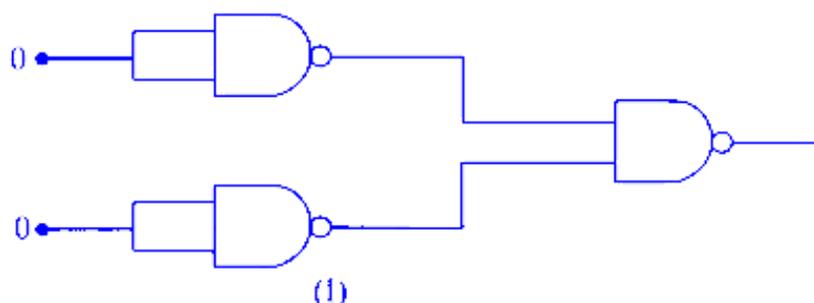
In a p-type semiconductor, the majority carriers are holes. This type of semiconductor is created by doping a pure semiconductor material, typically silicon or germanium, with a trivalent impurity. Trivalent impurities, such as boron, aluminum, or gallium, have three valence electrons. When these impurities are introduced into the semiconductor lattice, they create "holes," which are essentially the absence of an electron in the lattice structure. These holes act as positive charge carriers.

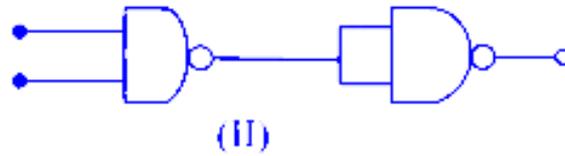
Therefore, the correct statement is:

Option D: Trivalent impurity and holes are majority carriers.

Question84

The combination of NAND gates is shown in figure (I) and (II). For the given inputs, the outputs in both the combinations are respectively.





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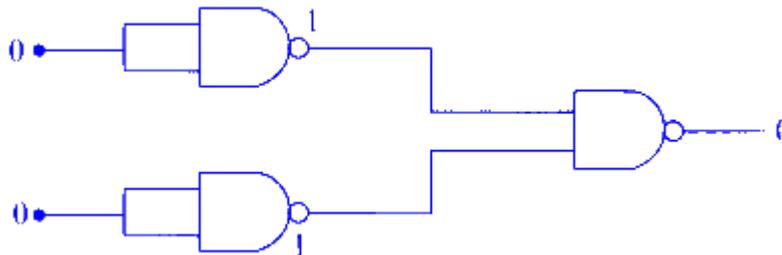
Options:

- A. 0, 0
- B. 0, 1
- C. 1, 0
- D. 1, 1

Answer: B

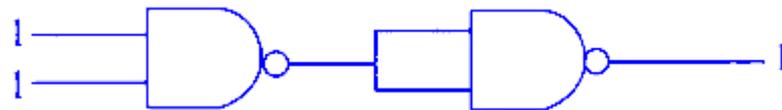
Solution:

In case I



Output : 0

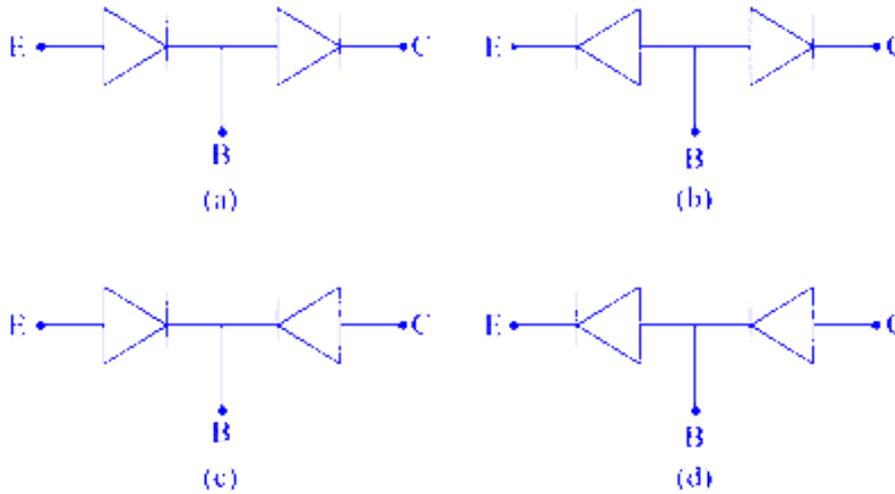
In case II



Output : 1

Question85

An n-p-n transistor can be considered to be equivalent to two diodes connected. The correct figure out of the following is



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Options:

- A. a
- B. b
- C. c
- D. d

Answer: B

Solution:

An n-p-n transistor can be modeled as two p-n junction diodes connected back-to-back with a common p-region (the base) .

How the diode model works for an NPN transistor

- The emitter–base junction is a p–n diode (base = p, emitter = n)
- The collector–base junction is another p–n diode (base = p, collector = n)
- The base is common to both diodes
- Both diodes have their p-side connected to the base

So, in the correct equivalent diagram:

- Both diode **anodes** are connected to **B (base)**
- The **cathodes** go to **E (emitter)** and **C (collector)** respectively

Correct option

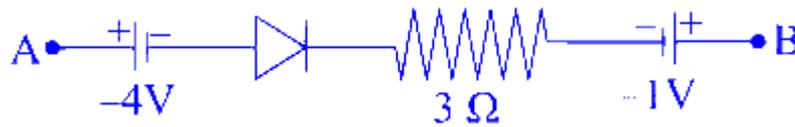
The figure that shows **two diodes with their p-sides joined at the base and n-sides going to emitter and collector** is:

Option (b)

This matches the physical structure and junction behavior of an **n-p-n transistor** .

Question86

Find the magnitude of current in the given circuit.



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Options:

- A. zero ampere
- B. 1 ampere
- C. 0.1 ampere
- D. 0.2 ampere

Answer: A

Solution:

As the p-side is at lower potential than the n side, the diode is reverse biased. Hence, no current will flow through the diode.

Question87



In common emitter transistor amplifier, load resistance is $6.5\text{k}\Omega$ and an input resistance is $1.3\text{k}\Omega$. If the current gain is 78 , the voltage gain is

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Options:

A. 780

B. 390

C. 260

D. 50

Answer: B

Solution:

The voltage gain (A_v) of a common emitter transistor amplifier can be calculated using the formula:

$$A_v = \beta \times \frac{R_L}{R_{in}}$$

where:

β is the current gain,

R_L is the load resistance,

R_{in} is the input resistance.

Given:

$$\beta = 78$$

$$R_L = 6.5\text{ k}\Omega = 6500\ \Omega$$

$$R_{in} = 1.3\text{ k}\Omega = 1300\ \Omega$$

Substitute these values into the formula:

$$A_v = 78 \times \frac{6500}{1300}$$

Calculate the fraction:

$$\frac{6500}{1300} = 5$$

So, the voltage gain is:

$$A_v = 78 \times 5 = 390$$

Therefore, the correct option is **Option B**: 390.

Question88

The potential barrier in p-n junction diode is due to

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Options:

- A. depletion of positive charges near the junction.
- B. accumulation of positive charges near the junction.
- C. depletion of negative charges near the junction.
- D. accumulation of positive and negative charges near the junction.

Answer: D

Solution:

In a p-n junction, electrons from the n side and holes from the p side diffuse across the junction and recombine, leaving behind **charged ion cores** :

Positively charged donor ions on the n side (since their electrons left),

Negatively charged acceptor ions on the p side (since they gained electrons).

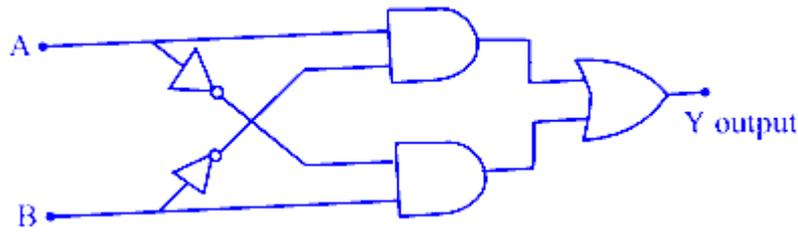
These opposite fixed charges accumulate in a thin region near the junction, creating an electric field that opposes further diffusion. This region is called the **depletion region**, and the resultant electric field is responsible for the **potential barrier**.

Hence, the potential barrier in a p-n junction is due to :

(D) accumulation of positive and negative charges near the junction.

Question89

The logic gate combination circuit shown in the figure performs the logic function of



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Options:

- A. OR gate
- B. NOR gate
- C. XOR gate
- D. NAND gate

Answer: C

Solution:

$$Y = A\bar{B} + \bar{A}B$$

∴ Combination represents an XOR gate

Question90

In semiconductors at room temperature,

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Options:

- A. the valence band is completely filled.
- B. the conduction band is completely empty.
- C. the conduction band is partially filled and the valence band is partially empty.

D. the valence band is completely filled and conduction band is partially empty.

Answer: C

Solution:

At room temperature, semiconductors exhibit thermal excitation of electrons from the valence band to the conduction band due to the relatively small energy gap between these bands (typically around 1 eV). This means that:

The valence band is not completely filled because some electrons have moved to the conduction band, leaving behind holes.

The conduction band is not completely empty because it now contains some thermally excited electrons.

Both the conduction band and the valence band are partially filled and partially empty, respectively.

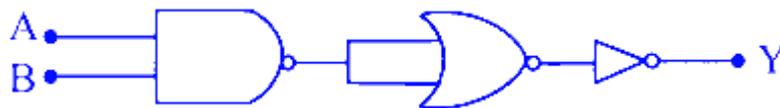
Therefore, the correct statement is:

Option C: The conduction band is partially filled and the valence band is partially empty.

Answer: Option C

Question91

The logic circuit in figure is equivalent to



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Options:

A. OR gate

B. AND gate

C. NOR gate

D. NAND gate

Answer: D



Solution:

The output of the NAND gate will be $\overline{A \cdot B}$.

The output of the NOR gate will be

$$\overline{\overline{A \cdot B} + \overline{A \cdot B}} = A \cdot B$$

The output of the NOT gate will be $\overline{A \cdot B}$

Thus, the given network is equivalent to a NAND gate.

Question92

In an NPN transistor 10^{10} electrons enter the emitter in 10^{-6} s and 2% electrons recombine with holes in base. The current ratios ' α ' and ' β ' of a transistor are respectively (nearly)

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Options:

- A. 0.98, 49
- B. 49, 0.98
- C. 0.49, 98
- D. 98, 0.49

Answer: A

Solution:

In an NPN transistor, the current amplification factors are defined as:

Alpha (α): It is the ratio of the collector current (I_C) to the emitter current (I_E) and is given by $\alpha = \frac{I_C}{I_E}$

Beta (β): It is the ratio of the collector current (I_C) to the base current (I_B) and is defined as $\beta = \frac{I_C}{I_B}$

To find these values, first, calculate the emitter current. The number of electrons entering the emitter is 10^{10} in 10^{-6} seconds:

The charge of one electron is approximately 1.6×10^{-19} coulombs. Therefore, the emitter current I_E is:



$$I_E = \frac{\text{Number of electrons} \times \text{Charge of one electron}}{\text{Time}} = \frac{10^{10} \times 1.6 \times 10^{-19}}{10^{-6}} = 1.6 \times 10^{-3} \text{ A}$$

Given that 2% of electrons recombine in the base, the remaining 98% reach the collector. Thus, the collector current I_C is:

$$I_C = 0.98 \times I_E = 0.98 \times 1.6 \times 10^{-3} = 1.568 \times 10^{-3} \text{ A}$$

The base current I_B can be found as:

$$I_B = I_E - I_C = 1.6 \times 10^{-3} - 1.568 \times 10^{-3} = 0.032 \times 10^{-3} \text{ A}$$

Now compute α and β :

Alpha (α):

$$\alpha = \frac{I_C}{I_E} = \frac{1.568 \times 10^{-3}}{1.6 \times 10^{-3}} = 0.98$$

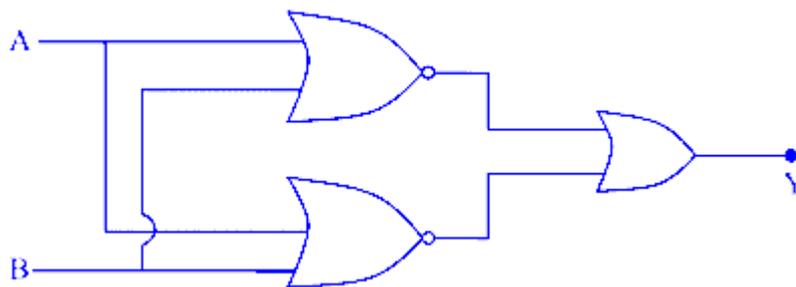
Beta (β):

$$\beta = \frac{I_C}{I_B} = \frac{1.568 \times 10^{-3}}{0.032 \times 10^{-3}} = 49$$

Therefore, the current gain ratios are $\alpha = 0.98$ and $\beta = 49$, which corresponds to Option A: 0.98, 49.

Question93

The output of following combination is same as that of



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Options:

- A. AND gate
- B. OR gate
- C. NAND gate
- D. NOR gate

Answer: D

Solution:

Considering the truth table for the given circuit,

A	B	$C = A + B$	$D = A + B$	$Y = C + D$
0	0	1	1	1
0	1	0	0	0
1	0	0	0	0
1	1	0	0	0

∴ The output of the given combination is same as that of a NOR gate.

Question94

In an n-p-n transistor, the collector current is 28 mA. If 80% of electrons reach the collector, its base current in mA is

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Options:

- A. 35
- B. 24
- C. 14
- D. 7

Answer: D

Solution:

In an n-p-n transistor, the collector current (I_c) is primarily due to the flow of electrons from the emitter to the collector. However, not all the electrons emitted by the emitter reach the collector; a small percentage of them recombine in the base. This percentage is given by the common base current gain (α), which in this case is 80% or 0.80.

The base current (I_b) can be calculated by knowing that the emitter current (I_e) is the sum of the collector current (I_c) and the base current (I_b). The relationship is given by the equation:

$$I_e = I_c + I_b$$

Given that α , which is the common base current gain, is the ratio of the collector current to the emitter current:

$$\alpha = \frac{I_c}{I_e}$$

Let's solve for I_e :

$$I_e = \frac{I_c}{\alpha} = \frac{28 \text{ mA}}{0.80} = 35 \text{ mA}$$

Now, we can find the base current using the initial relation between I_e , I_c , and I_b :

$$I_b = I_e - I_c = 35 \text{ mA} - 28 \text{ mA}$$

$$I_b = 7 \text{ mA}$$

Hence, the base current I_b is **7 mA**, which corresponds to Option D.

Question95

When the conductivity of a semiconductor is only due to the breaking of the covalent bonds, the semiconductor is called

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Options:

- A. donor
- B. intrinsic
- C. acceptor
- D. extrinsic

Answer: B

Solution:

The correct answer is Option B, intrinsic.

Intrinsic semiconductors are materials where the electrical conductivity is derived purely from the semiconductor itself, without any external doping. The conductivity in intrinsic semiconductors occurs because of the breaking of covalent bonds at higher temperatures, which creates electron-hole pairs. These electron-hole pairs contribute to the electrical conductivity.

Here's a brief explanation of each term to clarify the concepts:

Intrinsic Semiconductors (Option B): This is the pure form of a semiconductor, such as silicon or germanium, with no impurities added. The charge carriers (electrons and holes) are generated by thermal energy breaking the covalent bonds. Electrons are excited from the valence band to the conduction band, leaving behind holes in the valence band. Both the excited electrons and the holes contribute to the charge transport in intrinsic semiconductors.

Extrinsic Semiconductors (Option D): These are impure semiconductors intentionally 'doped' with impurities to alter their electrical properties. The addition of a small amount of dopant to a semiconductor can greatly increase its conductivity. There are two types of extrinsic semiconductors:

- **Donor (n-type) semiconductors (Option A):** These have been doped with elements that have more valence electrons than the semiconductor, typically five-valence electrons such as phosphorus or arsenic when doping silicon. These extra electrons can easily move to the conduction band and significantly increase the conductivity of the material.
- **Acceptor (p-type) semiconductors (Option C):** These are doped with elements that have fewer valence electrons (typically three valence electrons) than the semiconductor, such as boron or aluminum when doping silicon. These create holes (positive charge carriers) in the valence band by accepting electrons that jump from the valence band, thus increasing the conductivity.

To summarize, the answer is Option B, intrinsic, because this is the term used to describe a pure semiconductor where conductivity is due solely to its own lattice structure and not influenced by impurities or added elements.

Question96

For a common emitter configuration, if ' α ' and ' β ' have their usual meanings, the incorrect relation between ' α ' and ' β ' is

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Options:

A. $\frac{1}{\alpha} = \frac{1}{\beta} + 1$

B. $\alpha = \frac{\beta}{1-\beta}$

C. $\alpha = \frac{\beta}{1+\beta}$



$$D. \frac{1}{\beta} = \frac{1}{\alpha} - 1$$

Answer: B

Solution:

In a common emitter configuration, the parameters ' α ' (alpha) and ' β ' (beta) are related as follows:

α is the current gain in a common base configuration and β is the current gain in a common emitter configuration. The relationships between ' α ' and ' β ' are given by:

$$\beta = \frac{\alpha}{1-\alpha}$$

and

$$\alpha = \frac{\beta}{\beta+1}$$

Let's examine the given options one by one to determine the incorrect relation:

Option A: $\frac{1}{\alpha} = \frac{1}{\beta} + 1$

Rewriting this equation:

$$\frac{1}{\alpha} = \frac{1}{\beta} + 1$$

This can be written as:

$$\frac{1}{\alpha} = \frac{1+\beta}{\beta}$$

Therefore, this is a correct relation.

Option B: $\alpha = \frac{\beta}{1-\beta}$

We know that:

$$\alpha = \frac{\beta}{\beta+1}$$

Clearly, $\frac{\beta}{1-\beta}$ does not match this, so this is the incorrect relation.

Option C: $\alpha = \frac{\beta}{1+\beta}$

We know that:

$$\alpha = \frac{\beta}{\beta+1}$$

This is the correct relation.

Option D: $\frac{1}{\beta} = \frac{1}{\alpha} - 1$

Rewriting this equation:

$$\frac{1}{\beta} = \frac{1}{\alpha} - 1$$

This can be written as:



$$\frac{1}{\beta} = \frac{1-\alpha}{\alpha}$$

From the relation $\beta = \frac{\alpha}{1-\alpha}$, inverting both sides we get:

$$\frac{1}{\beta} = \frac{1-\alpha}{\alpha}$$

Therefore, this is a correct relation.

In conclusion, the incorrect relation between ' α ' and ' β ' is Option B: $\alpha = \frac{\beta}{1-\beta}$.

Question97

For emission of light, a light emitting diode (LED) is

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Options:

- A. always used in reverse biased condition
- B. never used in forward or reserve biased condition
- C. used both in forward and reverse biased condition depending upon its application
- D. always used in forward biased condition

Answer: D

Solution:

For a light-emitting diode (LED) to emit light, it must be used in a forward-biased condition. Therefore, the correct answer is:

Option D : always used in forward biased condition

When an LED is forward biased, the electrons in the n-type material have enough energy to cross the p-n junction and recombine with holes in the p-type material. This recombination process results in the release of energy in the form of photons, which is the light that we see emitted from the LED. On the other hand, when an LED is in reverse bias, it does not emit light because the potential barrier at the p-n junction is increased, preventing electron-hole recombination.

Question98

In semiconductors at room temperature,

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Options:

- A. the valence band is completely filled
- B. the conduction band is completely filled
- C. the condition band is partially filled and valence band is partially empty
- D. the valence band is completely filled and the conduction band is partially filled

Answer: A

Solution:

In semiconductors at room temperature, the behavior of electrons across the valence and conduction bands is crucial for understanding their electrical properties. Let's clarify the options given and identify the correct answer:

- **Option A: the valence band is completely filled**

At absolute zero temperature, the valence band is indeed completely filled with electrons, and the conduction band is empty. However, at room temperature, thermal energy excites some electrons from the valence band to the conduction band, creating holes (absence of electrons) in the valence band. Thus, while the valence band may still be considered "full" in a broader sense, it's more accurate to say it contains holes due to the excitation of electrons.

- **Option B: the conduction band is completely filled**

This is incorrect for semiconductors at room temperature. The conduction band becomes partially filled due to electron excitation from the valence band, but it is not completely filled under normal conditions.

- **Option C: the condition band is partially filled and valence band is partially empty**

This statement introduces a misunderstanding. While the concept of the conduction band being partially filled is correct, saying the valence band is "partially empty" might be misleading. The valence band is less than fully occupied due to the presence of holes, but it's a result of electron movement, not an inherent emptiness.

- **Option D: the valence band is completely filled and the conduction band is partially filled**

This option might seem correct at a glance, but it misrepresents the state of the valence band at room temperature. The valence band has holes (unoccupied states) due to electrons being excited to the conduction band, which contradicts the notion of being "completely filled."

Correct Understanding

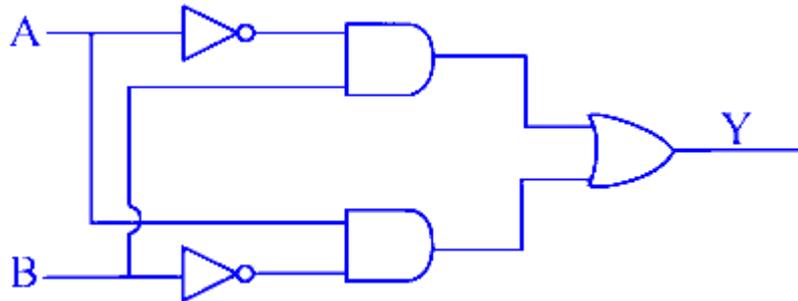


At room temperature, semiconductors have their valence band almost filled with some electrons excited to the conduction band, creating holes in the valence band. The conduction band is partially filled with these excited electrons. This scenario is crucial for the semiconductor's ability to conduct electricity, as both the excited electrons in the conduction band and the holes left behind in the valence band contribute to electrical conduction.

Given the explanations, the precise wording should reflect that the valence band has electrons but also contains holes due to thermal excitation, and the conduction band is partially filled with these excited electrons. The options provided do not perfectly capture this nuanced state. However, understanding semiconductors involves recognizing the excitation of electrons from the valence to the conduction band, leaving the valence band less than fully occupied (due to holes) and the conduction band partially occupied by electrons at room temperature.

Question99

The Boolean expression for the following combination is



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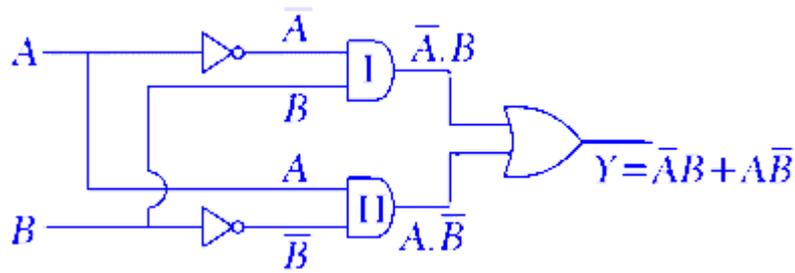
Options:

- A. $\overline{(A + B)} \cdot (A + B)$
- B. $\overline{(A \cdot B)} + (\bar{A} \cdot B)$
- C. $(\bar{A} \cdot B) + (A \cdot \bar{B})$
- D. $(\bar{A} + B) \cdot (A + \bar{B})$

Answer: C

Solution:

Let, obtain the output at each step first



Output at I AND gate = $\bar{A} \cdot B$

Output at II AND gate = $A \cdot \bar{B}$

\therefore Output at OR gate = $Y = \bar{A} \cdot B + A \cdot \bar{B}$

Question100

If the maximum efficiency of a full wave rectifier is $x\%$ and that of half-wave rectifier is $y\%$, then the relation between x and y is

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Options:

- A. $x = y$
- B. $x = 2y$
- C. $y = 2x$
- D. $y = 4x$

Answer: B

Solution:

We know that, efficiency of full wave rectifier = 0.8

efficiency of half wave rectifier = 0.4

According to question, $0.8 = x, 0.4 = y$

$\Rightarrow x = 2y$

Alternate solution We know that, efficiency of full wave rectifier is twice the efficiency of half wave rectifier. Therefore, $x = 2y$.

Question101

Doping of a semiconductor (with small impurity atoms) generally changes the resistivity as follows.

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Options:

- A. Decreases
- B. Does not change
- C. May increase or decrease depending on the dopant
- D. Increase

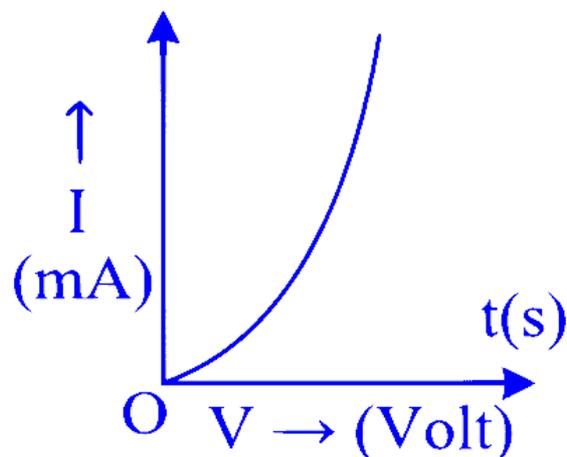
Answer: A

Solution:

Doping increases the charge concentration of an intrinsic semiconductor. This increases conductivity, and so resistivity decreases.

Question102

The following graph represents



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Options:

- A. forward bias characteristics of a solar cell
- B. reverse bias characteristics of a Zener diode
- C. reverse bias characteristics of a photodiode
- D. forward bias characteristics of a LED

Answer: D

Solution:

With increasing voltage, the LED's current rises, leading to light emission due to charge carrier recombination.

Question103

If two inputs of a NAND gate are shorted, the resulting gate is

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Options:

- A. an OR gate
- B. an AND gate
- C. a NOT gate
- D. a NOR gate

Answer: C

Solution:

When the two inputs of a NAND gate are shorted, the resulting gate behaves as a NOT gate. This is because a NAND gate outputs the opposite of the AND operation. When both inputs are the same (due to shorting), the

NAND gate essentially inverts that single input signal.

To illustrate :

- If the input is 0 (0 AND 0), a regular AND gate would output 0, but a NAND gate outputs the opposite, which is 1.
- If the input is 1 (1 AND 1), a regular AND gate would output 1, but a NAND gate outputs the opposite, which is 0.

So, with both inputs shorted, the NAND gate effectively becomes a NOT gate, inverting whatever single input it receives.

Therefore, the correct answer is :

Option C : a NOT gate.

Question104

On increasing the reverse bias to a large value in a P-N junction diode, current

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Options:

- A. increase slowly.
- B. remains fixed.
- C. suddenly increases.
- D. decreases slowly.

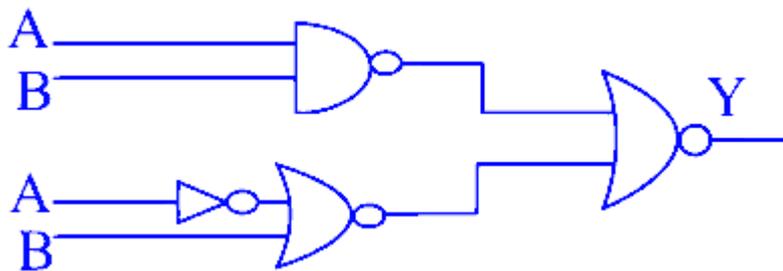
Answer: C

Solution:

When the reverse voltage increases beyond the breakdown voltage, the current suddenly increases.

Question105

In the following digital logic circuit, the output Y will be '1' for inputs



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Options:

- A. A = 0, B = 0
- B. A = 0, B = 1
- C. A = 1, B = 0
- D. A = 1, B = 1

Answer: D

Solution:

∴ There are two NOR gates, one NOT gate, and one NAND gate.

∴ Output of NAND gate: $\overline{A \cdot B}$

Output of NOT and NOR Gate: $\overline{\overline{A} + B}$

Final output: $\overline{\overline{A \cdot B} + \overline{\overline{A} + B}}$

So, the output Y is 1 only if the input A and B is 1.

$$A = 1$$

$$B = 1$$

$$Y = \overline{1 \cdot 1 + \overline{1 + 1}}$$

$$Y = 1$$

Question106

Which one of the following statements is **WRONG** regarding LED?

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Options:

- A. LEDs are energy efficient
- B. LEDs have long time if properly manufactured.
- C. Brightness of light emitted by LED cannot be controlled.
- D. Colours produced by LED do not fade out.

Answer: C

Solution:

The statement that is **WRONG** regarding LED is:

Option C: Brightness of light emitted by LED cannot be controlled.

This statement is incorrect because the brightness of LEDs can indeed be controlled. The brightness of an LED is directly proportional to the current passing through it. Thus, by adjusting the current, we can dim or brighten an LED. This can be achieved by various methods such as pulse-width modulation (PWM), which rapidly turns the LED on and off to control the average amount of light being emitted without changing its color, or by using a current limiting resistor or a constant current source to directly adjust the current. Advanced lighting systems also make use of digital controls to regulate the intensity of LED lighting.

Let's briefly evaluate the other options to understand why they are considered correct:

Option A: LEDs are energy efficient - This is true. LEDs use much less energy compared to traditional incandescent bulbs for the same amount of light output, making them a more energy-efficient lighting solution.

Option B: LEDs have long life if properly manufactured - This statement is correct as well. LEDs can have a very long lifespan, often up to 25,000-50,000 hours, provided they are well-manufactured and used within their specified operating conditions.

Option D: Colours produced by LED do not fade out - LEDs maintain their color throughout their lifespan. Unlike some traditional lighting options that can change color as the filament wears out or the gas in the bulb is depleted, LEDs do not suffer from this issue and thus the colors remain consistent.

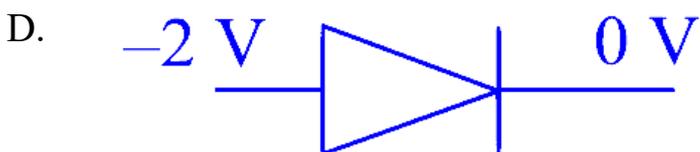
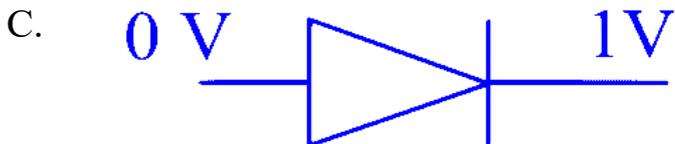
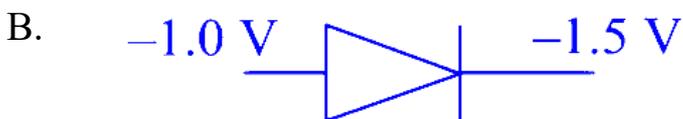
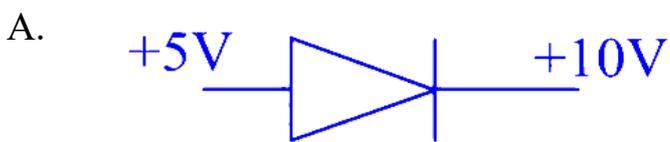


Question107

In which figure, the junction diode is forward biased?

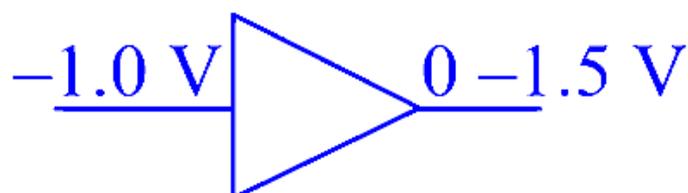
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Options:



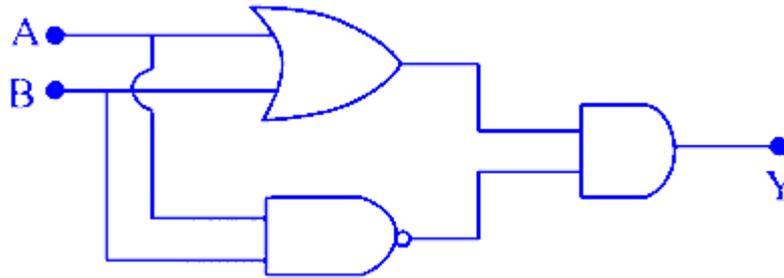
Answer: B

Solution:



Question108

The following logic gate combination is equivalent to



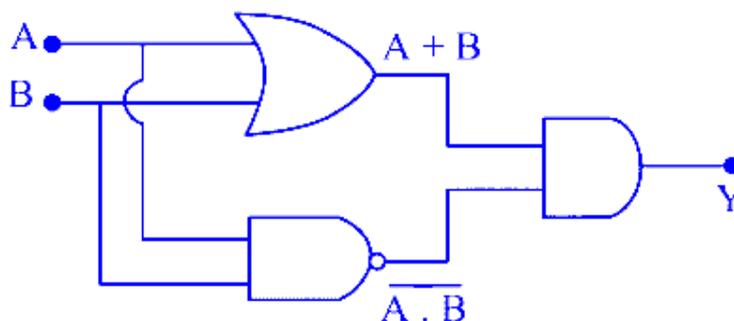
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Options:

- A. NAND gate
- B. OR gate
- C. XOR gate
- D. NOT gate

Answer: C

Solution:



$$\therefore Y = \overline{A \cdot B} \cdot (A + B)$$

$$\therefore Y = (\overline{A} + \overline{B}) \cdot (A + B) \quad \dots (\because \overline{A \cdot B} = \overline{A} + \overline{B})$$

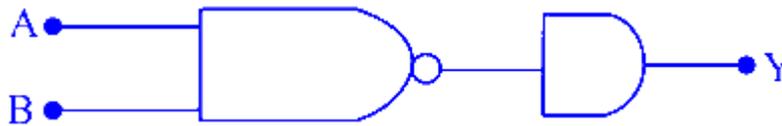
$$\therefore Y = \overline{A} \cdot B + \overline{B} \cdot A$$

$$\therefore Y = A \cdot \overline{B} + B \cdot \overline{A}$$

This represents XOR gate.

Question109

The logic gate combination circuit shown in the figure performs the logic function of



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Options:

- A. AND gate
- B. NAND gate
- C. OR gate
- D. XOR gate

Answer: A

Solution:

[Note: The gate at the output in the circuit is AND gate. It requires minimum two inputs. As, there is only one input the gate is not operational.]

Question110

When forward bias is applied to a p-n junction, then what happens to the potential barrier (V_B) and the width (X) of the depletion region?



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Options:

- A. V_B increase, X decreases
- B. V_B decreases, X increase
- C. V_B increase, X increase
- D. V_B decreases, X decreases

Answer: D

Solution:

When a p-n junction is forward biased, the applied voltage opposes the built-in electric field, so:

- Potential barrier V_B decreases
- Depletion width X decreases

Correct option: V_B decreases, X decreases (D)

Question111

In the study of transistor as an amplifier if $\alpha = \frac{I_C}{I_E} = 0.98$ and $\beta = \frac{I_C}{I_B} = 49$, where I_C , I_B and I_E are collector, base and emitter current respectively then $\left(\frac{1}{\alpha} - \frac{1}{\beta}\right)$ is equal to

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Options:

- A. zero
- B. $\frac{1}{2}$



C. 2

D. 1

Answer: D

Solution:

$$\begin{aligned}\frac{1}{\alpha} - \frac{1}{\beta} &= \frac{1}{0.98} - \frac{1}{4.9} \\ &= 1.204 - 0.204 = 1\end{aligned}$$

Question112

If p - n junction diode is in forward bias then

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Options:

- A. width of depletion layer increases
- B. electric conduction is not possible at all
- C. barrier voltage increases
- D. width of depletion layer decreases

Answer: D

Solution:

For a p - n junction diode in forward bias :

- The applied forward voltage **opposes the built-in potential barrier** , so
👉 **barrier voltage decreases** .
- As the barrier reduces, majority carriers cross the junction easily, so
👉 **the depletion layer width decreases** .

Therefore, the **correct option is D** :

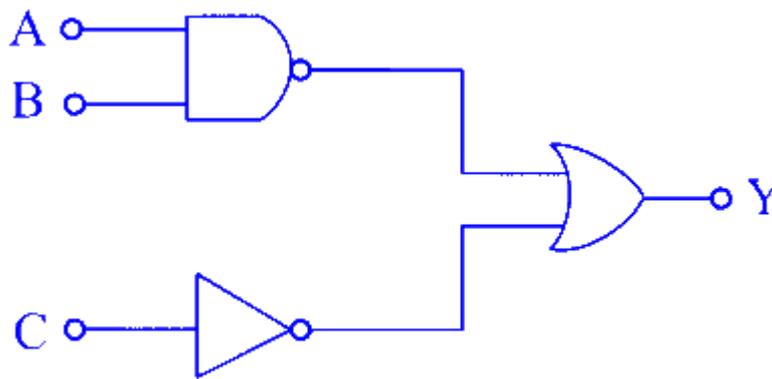


✓ Width of depletion layer decreases

(Options A, B, and C are incorrect because forward bias promotes conduction by *reducing* both barrier height and depletion width.)

Question113

In the digital circuit the inputs are as shown in figure. The Boolean expression for output Y is



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Options:

A. $\overline{A + B + C}$

B. $\overline{A \cdot B \cdot C}$

C. $\overline{A \cdot B} + \overline{C}$

D. $\overline{A + B} \cdot \overline{C}$

Answer: C

Solution:

In the given circuit, there is AND, NOR and a NOT gate.

Output of AND gate: $\overline{A \cdot B}$

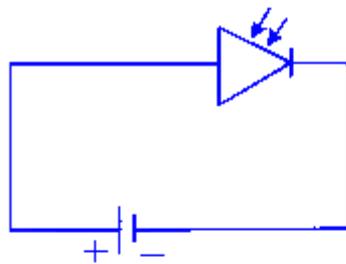
Output of NOT gate: \overline{C}

∴ The boolean expression will be:

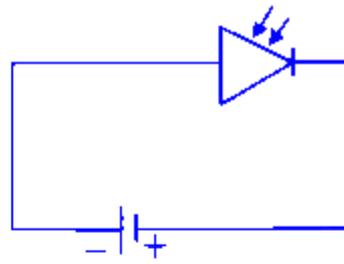
$$\overline{A \cdot B} + \overline{C}$$

Question114

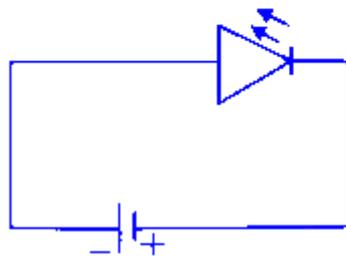
Identify the correct circuit diagrams for the normal operation from the following.



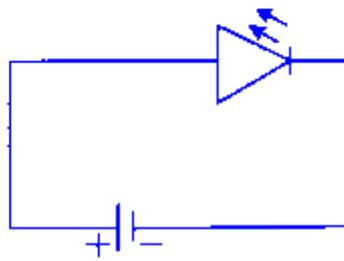
(A)



(B)



(C)



(D)

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Options:

A. (A), (B)

B. (B), (C)



C. (A), (C)

D. (B), (D)

Answer: D

Solution:

Option (B) is photodiode and option (D) is LED with reverse and forward biasing respectively. Therefore both will operate properly.

Question115

In energy band diagram of insulators, a band gap and the conduction band is respectively

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Options:

A. very low and partially filled.

B. very high and completely filled.

C. very high and empty.

D. very low and empty.

Answer: C

Solution:

The correct answer is C

Explanation:

For **insulators** in the energy band diagram:

- The **band gap** between the valence band and conduction band is **very high** (large forbidden energy gap).
- Because of this large gap, electrons cannot easily jump to the conduction band.
- Hence, the **conduction band is empty** at ordinary temperatures.

So,

👉 **Band gap:** very high

👉 **Conduction band:** empty

✓ **Option C: very high and empty**

Question116

In the case of NAND gate, if A and B are the inputs and Y is the output then

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Options:

A. $Y = A \cdot B$

B. $Y = \overline{A - B}$

C. $Y = \overline{A + B}$

D. $Y = \overline{A \cdot B}$

Answer: D

Solution:

Answer: (d) $Y = \overline{A \cdot B}$

The NAND gate is a combination of an AND gate followed by a NOT gate (inverter). The AND operation is represented by the multiplication symbol (\cdot), and the NOT operation is represented by an overline ($\overline{\quad}$) over the expression. Therefore, the Boolean expression for a NAND gate with inputs A and B and output Y is $Y = \overline{A \cdot B}$.

Question117

A pure Si crystal has 4×10^{28} atoms per m^3 . It is doped by 1 ppm concentration of antimony. The number of free electrons available will be

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Options:

A. $4 \times 10^{34} \text{ m}^{-3}$

B. $4 \times 10^{28} \text{ m}^{-3}$

C. $4 \times 10^{22} \text{ m}^{-3}$

D. $4 \times 10^{20} \text{ m}^{-3}$

Answer: C

Solution:

Given: Density of Si atoms = 4×10^{28} atoms / m^3

After doping with 1 ppm of Sb,

$$\text{No. of Sb atoms} = \frac{4 \times 10^{28}}{10^6}$$

$$= 4 \times 10^{22}$$

The above number of Sb atoms donates 1 electron each.

\therefore The total number of free electrons will be $4 \times 10^{22} \text{ m}^{-3}$

Question118

The output of an 'OR' gate is connected to both the inputs of a 'NAND' gate. The combination will serve as



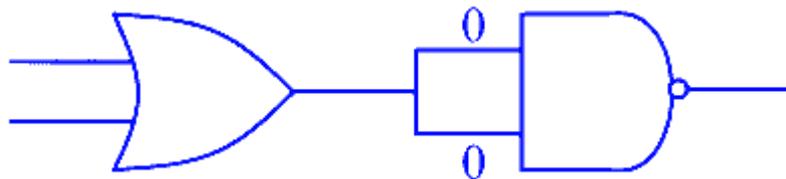
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Options:

- A. OR gate
- B. NOT gate
- C. NOR gate
- D. AND gate

Answer: C

Solution:



Output of OR gate	Output of NAND gate
0	1
1	0
1	0
1	0

Truth table of a NOR gate

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

The output matches with that of a NOR gate.

∴ The combination represents a NOR gate.

Question119

Which one of the operations of $n - p - n$ transistor differs from that of $p - n - p$ transistor?

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Options:

- A. The emitter-base junction is reversed biased in $n - p - n$ transistor.
- B. The emitter injects minority carriers into the base region of the $p - n - p$ transistor.
- C. The emitter injects holes into the base of the $p - n - p$ transistor and electrons into the base region of $n - p - n$ transistor.
- D. The emitter injects holes into the base of $n - p - n$ transistor.

Answer: C

Solution:

Answer: (C) The emitter injects holes into the base of the p-n-p transistor and electrons into the base region of n-p-n transistor.

In an n-p-n transistor, the majority charge carriers are electrons, while in a p-n-p transistor, the majority charge carriers are holes. The emitter-base junction is forward-biased in both n-p-n and p-n-p transistors.

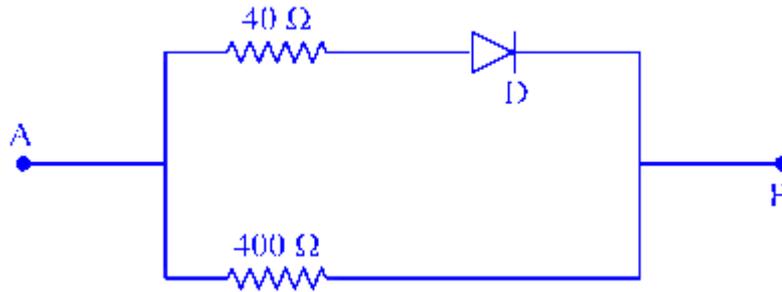
- In an n-p-n transistor, the n-type emitter injects electrons into the p-type base region.
- In a p-n-p transistor, the p-type emitter injects holes into the n-type base region.

Therefore, the type of charge carrier injected by the emitter into the base region is the key difference in their operation.

Question120

For the diagram shown, the resistances between points A and B when ideal diode D is forward biased is ' R_1 ' and that when reverse biased is ' R_2 '. The ratio $R_1 : R_2$ is





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Options:

A. 2 : 1

B. 1 : 1

C. 1 : 2

D. 1 : 4

Answer: C

Solution:

When the diode is forward biased, current will flow through both the arms.

∴ The effective resistance is

$$R_1 = \frac{40 \times 400}{40 + 400} = \frac{16000}{440} = 36.36 \Omega$$

When the diode is reverse biased, current will flow through the bottom arm only

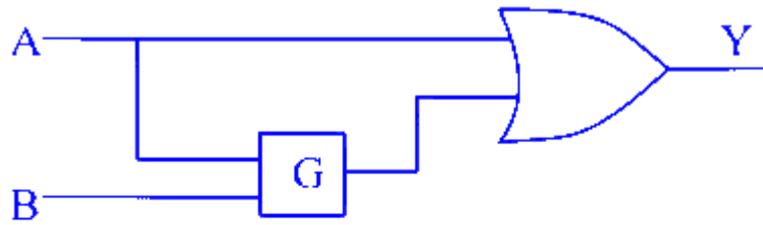
∴ The effective resistance R_2 is 400Ω.

$$\therefore \frac{R_1}{R_2} = \frac{36.36}{400} = \frac{1}{11}$$

Question121

To obtain the truth-table shown, from the following logic circuit, the gate G should be





A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

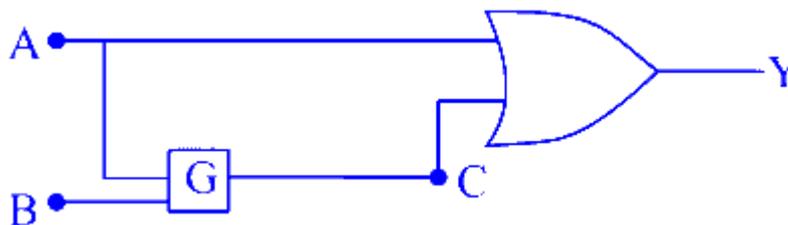
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Options:

- A. AND
- B. NAND
- C. OR
- D. NOR

Answer: D

Solution:



The truth table for given configuration is as shown below,

Case	A	B	C	$A + C = Y$
I	0	0	C_1	$0 + C_1 = 1$

Case	A	B	C	$A + C = Y$
II	0	1	C_2	$0 + C_2 = 0$
III	1	0	C_3	$1 + C_3 = 1$
IV	1	1	C_4	$1 + C_4 = 1$

Considering case (I), in order to have output (Y) as 1, C_1 has to be 1. For input values, $A = 0$ and $B = 0$, if C_1 is to be high, the gate G could be either NAND or NOR.

Considering case (II), in order to have output (Y) as 0, C_2 has to be 0. For input values, $A = 0$ and $B = 1$. If C_2 is to be 0, the gate must be NOR.

Question122

In insulators

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Options:

- A. valence band is empty and conduction band is filled with electrons.
- B. conduction band is empty and valence band is completely filled with electrons.
- C. valence band is partially filled.
- D. conduction band is partially filled with electrons.

Answer: B

Solution:

The correct answer for the description of electronic bands in insulators is:

Option B: conduction band is empty and valence band is completely filled with electrons.

In insulators, there is a large energy gap between the valence band and the conduction band. The valence band is the band of electron orbitals that electrons occupy at absolute zero temperature, and it's usually filled with electrons in an insulator. The conduction band is the band above the valence band where an electron may be excited to in order to conduct electricity. In insulators, this conduction band is empty because the energy gap (band gap) between the valence band and the conduction band is so large that electrons in the valence band do not normally have enough energy to jump into the conduction band under room temperatures or normal conditions. Hence, there is no electrical conductivity in insulators under these conditions.

Let's break down the incorrect options:

Option A: In insulators, the valence band is not empty. It is filled with electrons, which is in direct contradiction to what this option states.

Option C: In insulators, the valence band is completely filled, not partially filled. It is the complete filling of the valence band which contributes to their insulating properties, combined with the large energy gap to the conduction band.

Option D: The conduction band in insulators is not partially filled; it is empty due to the energy required to move electrons from the valence band to the conduction band being prohibitively large for thermal excitation.

Question123

Identify the mismatch out of the following.

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Options:

- A. Zener diode - voltage regulator.
- B. Photodiode-optocouplers.
- C. Solar cell - Electrical energy into light.
- D. Light emitting diode - optical communication.

Answer: C

Solution:

Solar cell converts light energy into electrical energy.

Question124

In the reverse biasing of a p-n junction diode :

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Options:

- A. the width of the depletion layer decreases.
- B. the width of the depletion layer increases.
- C. the number of minority charge carriers increase.
- D. the number of majority charge carriers increase.

Answer: B

Solution:

In a p-n junction diode :

- **Reverse Biasing** : This occurs when the p-type material is connected to the negative terminal of the battery and the n-type material to the positive terminal. In reverse bias, the built-in potential barrier increases, which tends to widen the depletion region.

Given this, let's evaluate the options :

Option A : The width of the depletion layer decreases.

- This is incorrect. In reverse bias, the width of the depletion layer increases.

Option B : The width of the depletion layer increases.

- This is correct. In reverse bias, the depletion layer widens as the potential barrier across the junction increases.

Option C : The number of minority charge carriers increase.

- This is not necessarily true. While the flow of minority carriers constitutes the reverse current, reverse bias does not increase their number.

Option D : The number of majority charge carriers increase.

- This is incorrect. Reverse biasing does not increase the number of majority charge carriers.

The correct answer is Option B : the width of the depletion layer increases.

Question125

In a transistor, in common emitter configuration, the ratio of power gain to voltage gain is



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Options:

A. α

B. $\frac{\beta}{\alpha}$

C. $\beta\alpha$

D. β

Answer: D

Solution:

Power gain = Voltage gain \times Current gain

$$\therefore \frac{\text{Power Gain}}{\text{Voltage Gain}} = \text{Current gain} = \beta$$

Question126

If the frequency of the input voltage is 50 Hz, applied to a (a) half wave rectifier and (b) full wave rectifier. The output frequency in both cases is respectively

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Options:

A. 50 Hz, 50 Hz

B. 50 Hz, 100 Hz

C. 100 Hz, 100 Hz

D. 100 Hz, 50 Hz

Answer: B



Solution:

The key aspect in understanding this question is to grasp how rectifiers work and how they affect the output frequency given an input frequency.

(a) Half-wave rectifier: A half-wave rectifier converts only one half of the AC input signal into DC output. Regardless of whether it's the positive or the negative half of the AC cycle that gets rectified, the result is that for every cycle of the AC input, there's a corresponding pulse in the output. Thus, if the input frequency is 50 Hz, the output frequency remains at 50 Hz as well. Each cycle of the input produces one pulse of output.

(b) Full-wave rectifier: A full-wave rectifier, on the other hand, converts both the positive and negative halves of the AC input signal into DC output. This means that for each cycle of the input AC signal, you get two pulses of the DC output. Consequently, if the input frequency is 50 Hz, the output frequency is doubled, resulting in a 100 Hz output frequency. Each cycle of the input results in two output pulses due to the rectification of both the positive and negative half-cycles.

Therefore, the correct answer to the question is:

Option B: 50 Hz, 100 Hz

This means that for a half-wave rectifier, the output frequency is the same as the input frequency (50 Hz), and for a full-wave rectifier, the output frequency is double the input frequency (100 Hz).

Question127

For an intrinsic semiconductor (n_h and n_e are the number of holes per unit volume and number of electrons per unit volume respectively)

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Options:

A. $n_h < n_e$

B. $n_h = n_e$

C. $n_h = \frac{n_c}{2}$

D. $n_h > n_e$

Answer: B

Solution:



Answer: (B) $n_h = n_e$

For an intrinsic (pure) semiconductor, the number of electrons in the conduction band (n_e) is equal to the number of holes in the valence band (n_h) because electrons are excited from the valence band to the conduction band in pairs, leaving behind one hole for every electron.

Question128

A 5.0 V stabilized power supply is required to be designed using a 12 V DC power supply as input source. The maximum power rating of zener diode is 2.0 W. The minimum value of resistance R_s in Ω connected in series with zener diode will be

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Options:

- A. 16.5
- B. 17.5
- C. 18.5
- D. 15.5

Answer: B

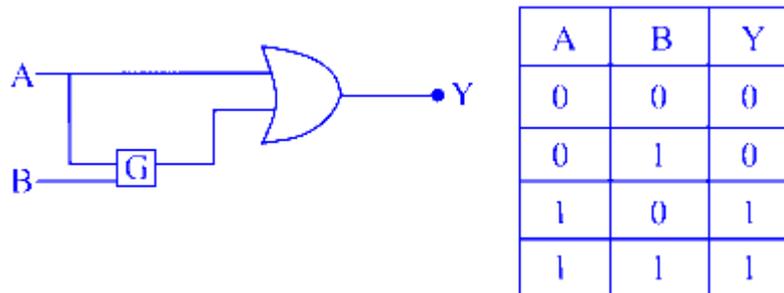
Solution:

Using the series resistance formula for a zener diode

$$R_s = \frac{(V_S - V_Z)}{I_{Z_{\max}}}$$
$$I_{Z_{\max}} = \frac{P_Z}{V_Z} = \frac{2}{5} = 400 \text{ mA}$$
$$\therefore R_s = \frac{(12 - 5)}{400 \times 10^{-3}} = \frac{7}{400} \times 10^3$$
$$= 17.5 \Omega$$

Question129

To get the truth table shown, from the following logic circuit, the Gate G should be



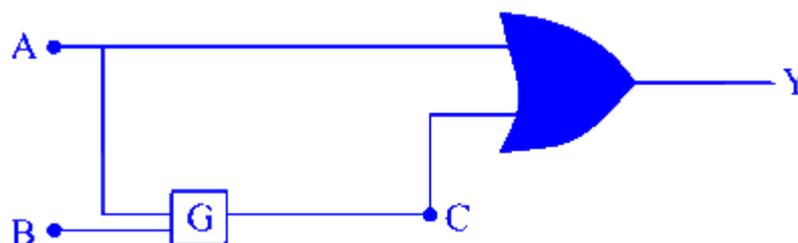
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Options:

- A. OR
- B. AND
- C. NOR
- D. NAND

Answer: B

Solution:



Truth table for Y, with the possible values of C is,

A	C	Y
0	0	0
0	0	0

A	C	Y
1	0, 1	1
1	0, 1	1

For gate G

	A	B	C
(I)	0	0	0
(II)	0	1	0
(III)	1	0	0, 1
(IV)	1	1	0, 1

G is not a NOT gate as NOT gate takes only one input. (II) indicates G is not a OR gate as OR gate would give high output for the inputs in (II). Also, (II) indicates it is not a XOR gate as XOR would also give high output for inputs in (II). Hence, the given truth table is satisfied only by AND gate.

Question130

For a NAND gate, the inputs and outputs are given below.

Input A	Input B	Output Y
0	1	C
0	0	D
1	0	E
1	1	F

The values taken by C, D, E, F are respectively

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Options:

A. 0, 1, 0, 0

B. 1, 1, 1, 0

C. 1, 0, 1, 1

D. 0, 1, 0, 1

Answer: B

Solution:

For the NAND gate, the truth table is

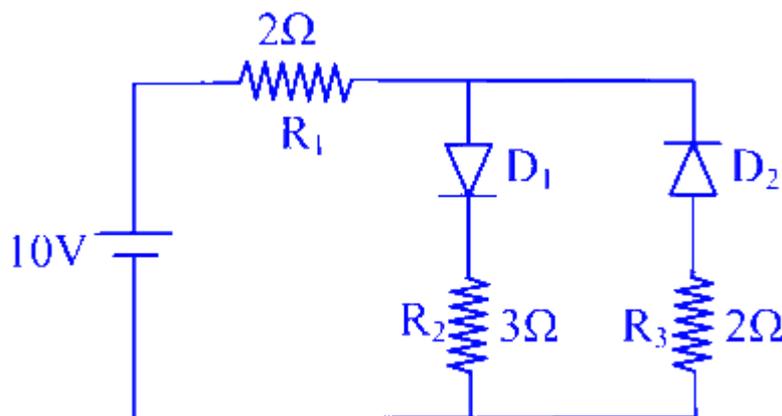
Input A	Input B	Output $Y = \overline{AB}$	
0	1	1	C
0	0	1	D
1	0	1	E
1	1	0	F

Thus $C = 1, D = 1, E = 1$ and $F = 0$

For a NAND gate, there is a high output for a low input and a low output for high input.

Question131

The given circuit has two ideal diodes D_1 and D_2 connected as shown in the figure. The current flowing through the resistance R_1 will be



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Options:

- A. 7 A
- B. 3.3 A
- C. 2 A
- D. 2.5 A

Answer: C

Solution:

Diode D_1 is forward biased and diode D_2 is reverse biased. Hence no current will flow in the branch of D_2 .

∴ The total effective resistance in the circuit is

$$2 + 3 = 5\Omega$$

$$\therefore \text{Current } I = \frac{10}{5} = 2 \text{ A}$$

$$\therefore \text{Current through } R_1 = 2 \text{ A}$$

Question 132

Choose the correct statement. In conductors

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Options:

- A. valance band and conduction band overlap each other.
- B. valance band and conduction band are separated by large energy gap.
- C. valance band and conduction band are separated by a small energy gap.
- D. a very small number of electrons are available for electrical conduction.

Answer: A

Solution:

The correct statement about conductors is:

Option A: Valance band and conduction band overlap each other.

In conductors, the valence band and the conduction band overlap, allowing electrons to flow freely with very little energy input. This overlapping creates a situation where there is no energy gap, making it easy for electrons to move and conduct electricity. This characteristic is what distinguishes conductors from other materials like semiconductors and insulators.

Here's a brief explanation for the incorrect options:

Option B: Valence band and conduction band are separated by a large energy gap. This is characteristic of insulators where a large energy band gap prevents electrons from easily moving from the valence band to the conduction band.

Option C: Valence band and conduction band are separated by a small energy gap. This is characteristic of semiconductors. In semiconductors, a small energy gap exists which requires some energy, often thermal, to move electrons from the valence band to the conduction band.

Option D: A very small number of electrons are available for electrical conduction. This statement is generally true for semiconductors at low temperatures but not for conductors. In conductors, a sufficient number of electrons are already present in the conduction band for electrical conduction.

Question133

For a transistor, the current ratio $\alpha_{dc} = \frac{69}{70}$, the current gain β_{dc} is

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Options:

A. 67

B. 69

C. 71

D. 66

Answer: B

Solution:

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}} = 69$$



Question134

The input a.c. voltage of frequency 60 Hz is applied to half-wave rectifier and also to full-wave rectifier. The output frequency in case of half-wave rectifier and that in case of full wave rectifier is respectively.

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Options:

- A. 120 Hz, 60 Hz
- B. 60 Hz, 120 Hz
- C. 60 Hz, 60 Hz
- D. 120 Hz, 120 Hz

Answer: B

Solution:

In a half-wave rectifier, only one half of the input AC voltage is allowed through during each cycle. Since the input frequency is 60 Hz, the output frequency will also be 60 Hz because it passes for one half of each cycle.

For a full-wave rectifier, both halves of the input AC voltage are used, effectively doubling the frequency of the output waveform. As a result, the output frequency will be $2 \times 60 \text{ Hz} = 120 \text{ Hz}$.

Therefore, the correct answer is:

Option B: 60 Hz, 120 Hz.

Question135

A p-n junction photodiode is fabricated from a semiconductor with a band gap of 2.5 eV. It can detect a signal of wavelength [Planck's constant = $6.6 \times 10^{-34} \text{ Js}$, $c = 3 \times 10^8 \text{ m/s}$, $e = 1.6 \times 10^{-19} \text{ C}$]

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Options:

A. 6000 nm

B. 6000 Å

C. 5000 Å

D. 4000 nm

Answer: C

Solution:

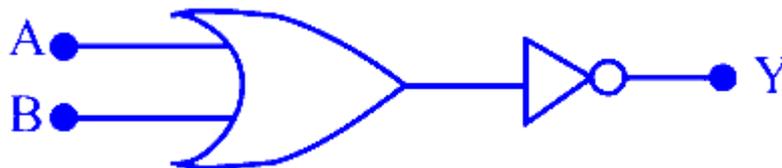
The wavelength corresponding to 2.5 eV is given by

$$\text{Energy (eV)} = \frac{12400}{\lambda(\text{Å})}$$
$$\therefore \lambda = \frac{12400}{2.5} = 5000\text{Å}$$

To get detected, the signal should have energy greater than 2.5 eV or wavelength less than 5000Å.

Question136

For the output of the following logic circuit to be '1', the values of inputs A and B should be respectively



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Options:

- A. 0 and 1
- B. 0 and 0
- C. 1 and 1
- D. 1 and 0

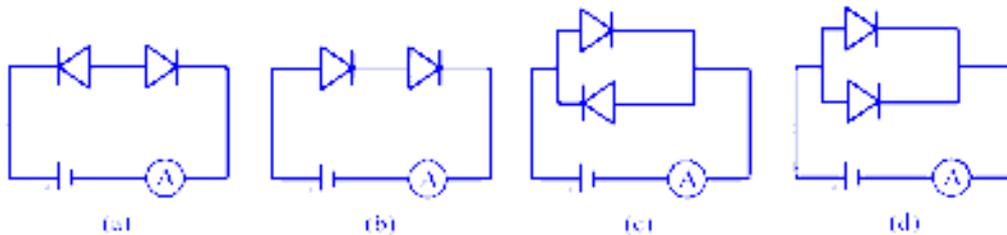
Answer: B

Solution:

For output Y to be '1', the output of the OR gate should be '0'. This is possible only when both the inputs are zero.

Question137

Two identical ideal diodes are connected to an ammeter and a d.c source (1 volt) as shown. In which one of the following circuits, ammeter will not show any deflection?



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Options:

- A. (d)
- B. (a)
- C. (b)
- D. (c)

Answer: B

Solution:

In circuit (a) the two diodes are in series and one of the diodes is reverse biased. Hence no current will flow in the circuit and ammeter will not show any deflection.

Question138

When the temperature of a semiconductor is increased, its resistance and electric conductivity respectively.

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Options:

- A. increases and decreases
- B. decreases and decreases
- C. increases and increases
- D. decreases and increases

Answer: D

Solution:

In a semiconductor, the behavior of resistance and electric conductivity with the change in temperature is distinct from that in conductors. As the temperature of a semiconductor is increased, more electrons gain enough thermal energy to jump from the valence band to the conduction band. This increase in charge carriers (electrons and holes) enhances the material's conductivity.

Consequently, the resistance of the semiconductor decreases because resistance is inversely proportional to the number of charge carriers. Since conductivity is the reciprocal of resistance, the increase in the number of charge carriers due to the higher temperature leads to an increase in conductivity.

Therefore, when the temperature of a semiconductor is increased:

- Resistance decreases
- Electric conductivity increases

So, the correct answer is:

Option D: decreases and increases

Question139

For a two input AND gate, the four entries are shown in the truth table. Identify the correct ones out of these (A, B = input, Y = output)

Entry	A	B	Y
1	0	1	0
2	1	0	0
3	1	1	1
4	0	0	1

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Options:

- A. 1 and 2 only
- B. 1, 2 and 3 only
- C. 1, 3 and 4 only
- D. 2 and 4 only

Answer: B

Solution:

For a 2-input AND gate, the output rule is:

Y = 1 only when both inputs A and B are 1
Otherwise, Y = 0

Correct AND gate truth table

A	B	Y
0	0	0
0	1	0

1	0	0
1	1	1

Check each given entry

1. $A=0, B=1 \rightarrow Y=0$ Correct
2. $A=1, B=0 \rightarrow Y=0$ Correct
3. $A=1, B=1 \rightarrow Y=1$ Correct
4. $A=0, B=0 \rightarrow Y=1$ Incorrect (should be 0)

Correct entries

1, 2, and 3 only

Correct option: B

Question140

In a CE transistor, a change of 8.0 mA in the emitter current produces a change of 7.8 mA in the collector current. What change in the base current is necessary to produce the same change in the collector current?

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Options:

- A. $200\mu\text{A}$
- B. $50\mu\text{A}$
- C. $100\mu\text{A}$
- D. $150\mu\text{A}$

Answer: A

Solution:

In a Common Emitter (CE) transistor configuration, the relationship between the emitter current (I_E), collector current (I_C), and base current (I_B) can be described using the following equations:

$$I_E = I_B + I_C$$

$$I_C = \beta I_B$$

Given in the problem, the change in emitter current (ΔI_E) is 8.0 mA and the change in collector current (ΔI_C) is 7.8 mA.

Since, in CE configuration, the emitter current is the sum of the base and collector currents, we can express the change in emitter current as:

$$\Delta I_E = \Delta I_B + \Delta I_C$$

We need to find the change in the base current (ΔI_B). Let's rearrange the above equation to solve for ΔI_B :

$$\Delta I_B = \Delta I_E - \Delta I_C$$

Substituting the given values:

$$\Delta I_B = 8.0 \text{ mA} - 7.8 \text{ mA} = 0.2 \text{ mA}$$

Recall that $1 \text{ mA} = 1000 \mu\text{A}$:

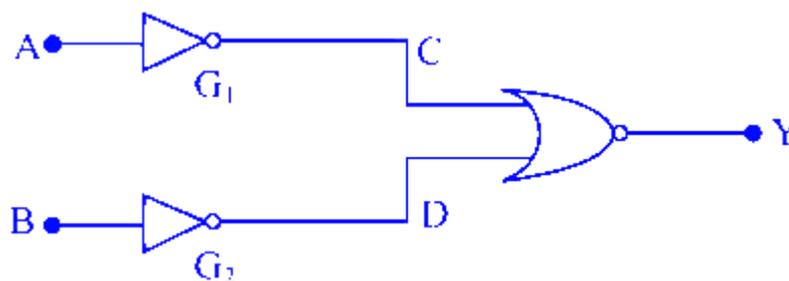
$$0.2 \text{ mA} = 0.2 \times 1000 \mu\text{A} = 200 \mu\text{A}$$

Therefore, the change in the base current necessary to produce the same change in the collector current is:

Option A: $200 \mu\text{A}$

Question 141

The resultant gate and its Boolean expression in the given circuit is



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Options:

A. NOR, $\overline{A + B}$

B. AND, $A \cdot B$

C. OR, $A+B$

D. NAND, $\overline{A \cdot B}$

Answer: B

Solution:

Truth table :

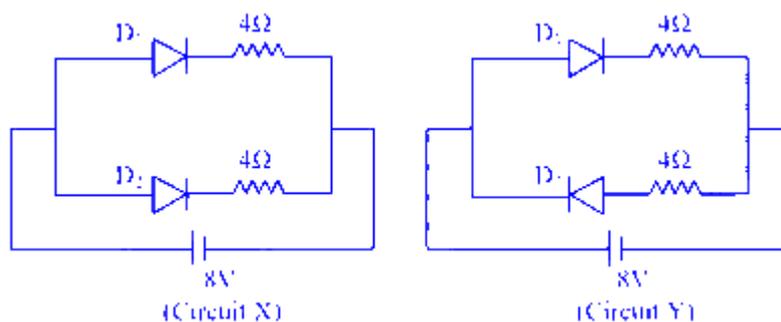
A	B	C	D	Y
0	0	1	1	0
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

This is truth table of AND gate.

$\therefore Y = A \cdot B$

Question142

What are the values of the currents flowing in each of the following diode circuits X and Y respectively? (Assume that the diodes are ideal)



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Options:

A. 1 A, 2 A

B. 2 A, 1 A

C. 4 A, 2 A

D. 2 A, 4 A

Answer: C

Solution:

In circuit X, both the diodes are forward biased and hence both will conduct.

The two resistances of 4Ω each are in parallel. Their equivalent resistance is 2Ω . Hence the current

$$I = \frac{v}{R} = \frac{8}{2} = 4A$$

In the circuit Y, the diode D_1 is forward biased but diode D_2 is reverse biased. Hence only diode D_1 will conduct. The resistance is 4Ω .

$$\text{Hence } I = \frac{8}{4} = 2 A$$

Question143

In common emitter amplifier, a change of 0.2 mA in the base current causes a change of 5 mA in the collector current. If input resistance is $2\text{ k}\Omega$ and voltage gain is 75, the load resistance used in the circuit is

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Options:

A. $8\text{ k}\Omega$

B. $4\text{ k}\Omega$



C. 12 k Ω

D. 6 k Ω

Answer: D

Solution:

To solve this problem, we can use the following relationships in a common emitter amplifier:

1. Current gain (β) is given by the ratio of the change in collector current (ΔI_C) to the change in base current (ΔI_B):

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

2. Voltage gain (A_V) is given by the product of current gain (β) and the ratio of load resistance (R_L) to input resistance (R_{in}):

$$A_V = \beta \times \frac{R_L}{R_{in}}$$

Let's compute β first:

$$\Delta I_C = 5 \text{ mA}$$

$$\Delta I_B = 0.2 \text{ mA}$$

$$\beta = \frac{5 \text{ mA}}{0.2 \text{ mA}} = \frac{5}{0.2} = 25$$

Next, we know the voltage gain (A_V) is 75 and the input resistance (R_{in}) is 2 k Ω :

$$A_V = 75$$

$$R_{in} = 2 \text{ k}\Omega = 2000 \Omega$$

We can now use the voltage gain formula to solve for the load resistance (R_L):

$$A_V = \beta \times \frac{R_L}{R_{in}}$$

$$75 = 25 \times \frac{R_L}{2000}$$

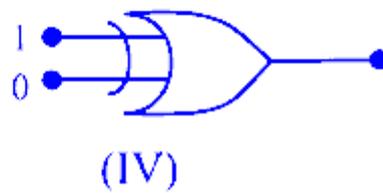
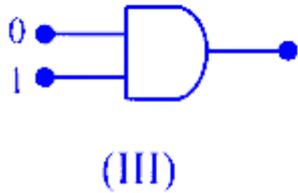
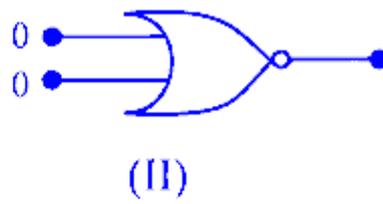
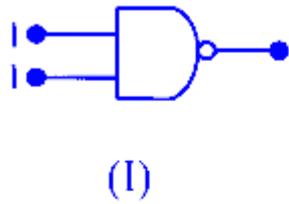
$$R_L = \frac{75 \times 2000}{25} = \frac{150000}{25} = 6000 \Omega = 6 \text{ k}\Omega$$

Therefore, the load resistance used in the circuit is 6 k Ω . The correct answer is:

Option D: 6 k Ω

Question144

Which of the following gates will give an output '1' for the given inputs?



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Options:

- A. II and III
- B. I and IV
- C. I and III
- D. II and IV

Answer: D

Solution:

- (I) NAND gate gives output ' 0 ' when inputs are 1, 1
- (II) NOR gate gives output ' 1 ' when inputs are 0, 0
- (III) AND gate gives output ' 0 ' when inputs are 0, 1
- (IV) EX-OR gate gives output ' 1 ' when inputs are 1, 0

∴ Ans. II and IV

Question145

For a common-emitter amplifier, the voltage gain is 40. Its input and output impedances are 100Ω and 400Ω , respectively. The power gain

of the CE amplifier will be

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Options:

A. 450

B. 400

C. 300

D. 500

Answer: B

Solution:

Power gain = (voltage gain) × (current gain)

$$\text{Current gain} = \frac{\text{output current}}{\text{Input current}} = \frac{\frac{V_0}{z_0}}{\frac{V_i}{z_i}}$$

$$= \frac{V_0}{V_i} \cdot \frac{z_i}{z_0} = \frac{40 \times 100}{400} = 10$$

$$\text{Power gain} = 40 \times 10 = 400$$

Question146

Choose the correct statement. In semiconductors valance band and conduction band

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Options:

A. is separated by large energy gap.

B. is separated by small energy gap:

C. is almost empty.

D. overlap each other.

Answer: B

Solution:

The correct statement regarding semiconductors is that their valence band and conduction band are separated by a small energy gap. Therefore, the correct choice is:

Option B: is separated by small energy gap.

In semiconductors, the energy gap between the valence band (where the electrons occupy at lower energy levels) and the conduction band (where electrons can move freely, allowing the material to conduct electricity) is relatively small, typically less than 3 eV. This small energy gap allows electrons to be easily excited from the valence band to the conduction band with an increase in temperature or upon exposure to light, making semiconductors capable of conducting electricity under certain conditions.

Option A is incorrect because a large energy gap is characteristic of insulators, not semiconductors. Insulators have energy gaps usually greater than 3 eV, which prevents electrons from easily moving to the conduction band, thereby inhibiting electrical conductivity.

Option C is incorrect because it doesn't accurately describe the state of the bands in semiconductors. The valence band in semiconductors is typically full, and the conduction band can have electrons, albeit significantly less than metals.

Option D is incorrect because it describes a characteristic of metals or some special kinds of materials like semimetals or graphene, where valence and conduction bands overlap, allowing for free movement of electrons and therefore good electrical conductivity. This is not the case for semiconductors.

Question147

A logic gate which gives output 'HIGH' only when its two input terminals are at different logic levels with respect to each other is

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Options:

A. NOR gate

B. OR gate

C. AND gate

D. X-OR gate

Answer: D

Solution:

The correct answer is **Option D: X-OR gate**. Here's why:

Let's analyze each gate:

1. X-OR gate (Exclusive OR):

The X-OR gate produces a 'HIGH' output only when its inputs are different. This is precisely what the question describes. Here's the truth table:

Input A	Input B	Output
0	0	0
0	1	1
1	0	1
1	1	0

2. OR gate:

An OR gate produces a 'HIGH' output if *any* of its inputs are 'HIGH'. It doesn't specifically require the inputs to be different.

3. AND gate:

An AND gate produces a 'HIGH' output only when *all* of its inputs are 'HIGH'. It doesn't care if the inputs are different.

4. NOR gate:

A NOR gate is the inverse of an OR gate. It produces a 'HIGH' output only when *all* of its inputs are 'LOW'.

In summary, the X-OR gate is the only gate that satisfies the condition of producing a 'HIGH' output when its inputs are at different logic levels.

Question148

Choose the **FALSE** statement from the following.

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Options:

- A. Generally, in conductors the valence and conducting bands overlap.
- B. The resistivity of a semiconductor increases with increase in temperature
- C. The conductivity of a semiconductor increase with increase in temperature
- D. Substances with energy gap of the order of 10 eV are insulators

Answer: B

Solution:

Let's analyze each statement to determine which is false:

Option A: Generally, in conductors the valence and conducting bands overlap.

This statement is correct. In conductors, the valence band and the conduction band overlap which allows electrons to move freely and conduct electricity.

Option B: The resistivity of a semiconductor increases with increase in temperature.

This statement is false. In semiconductors, as the temperature increases, more electrons gain enough energy to jump the energy gap and move to the conduction band, thus decreasing the resistivity (and increasing the conductivity).

Option C: The conductivity of a semiconductor increases with increase in temperature.

This statement is correct. As mentioned in the explanation for Option B, with an increase in temperature, more charge carriers are available in the conduction band, which increases the conductivity of the semiconductor.

Option D: Substances with energy gap of the order of 10 eV are insulators.

This statement is correct. Substances with a large energy gap (typically greater than 5 eV) are insulators because it is very difficult for electrons to move from the valence band to the conduction band.

Therefore, the FALSE statement is:

Option B: The resistivity of a semiconductor increases with increase in temperature.

Question149

In an n-p-n transistor 200 electrons enter the emitter in 10^{-8} second. If 1% electrons are lost in the base, then the current that enters the emitter and the current amplification factor are respectively [$e = 1.6 \times 10^{-19}$ C]

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Options:

- A. 2×10^{-10} A and 49
- B. 3.2×10^{-9} A and 99
- C. 1.6×10^{-19} A and 90
- D. 1.7×10^{-11} A and 70

Answer: B

Solution:

To solve this problem, we'll first calculate the current entering the emitter and then determine the current amplification factor. Given that the charge of an electron is 1.6×10^{-19} C, and 200 electrons enter the emitter in 10^{-8} seconds, we can calculate the emitter current.

The current entering the emitter (I_E) is given by:

$$I_E = \frac{n \cdot e}{t}$$

where

n is the number of electrons,

e is the charge of an electron, and

t is the time.

Substituting the given values:

$$I_E = \frac{200 \times 1.6 \times 10^{-19}}{10^{-8}}$$

Calculating this gives:

$$I_E = \frac{320 \times 10^{-19}}{10^{-8}} = 320 \times 10^{-11} = 3.2 \times 10^{-9} \text{ A}$$

Next, we know that 1% of the electrons are lost in the base. This means 99% of the electrons reach the collector. The collector current (I_C) can be calculated as:

$$I_C = 0.99 \cdot I_E$$

So,

$$I_C = 0.99 \cdot 3.2 \times 10^{-9} \text{ A}$$

Calculating this, we get:

$$I_C = 3.168 \times 10^{-9} \text{ A}$$

The current amplification factor (β) is given by the ratio of the collector current to the base current. First, let's find the base current (I_B). The base current can be found using:

$$I_B = I_E - I_C$$

Substituting the known values:

$$I_B = 3.2 \times 10^{-9} \text{ A} - 3.168 \times 10^{-9} \text{ A} = 0.032 \times 10^{-9} \text{ A} = 3.2 \times 10^{-11} \text{ A}$$

The current amplification factor (β) is:

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

Substituting the known values:

$$\beta = \frac{3.168 \times 10^{-9}}{3.2 \times 10^{-11}}$$

Calculating this, we get:

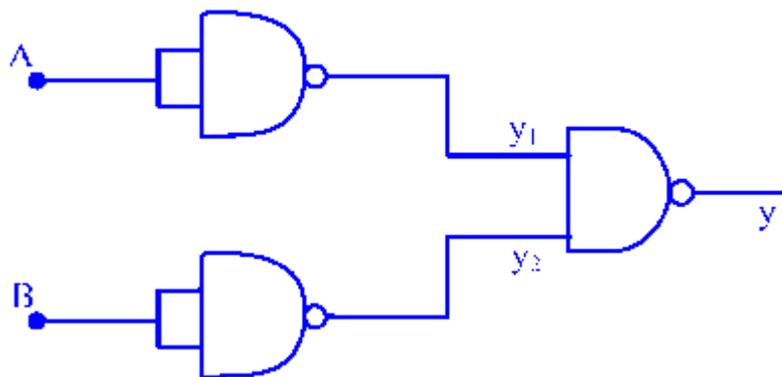
$$\beta = 99$$

Therefore, the current that enters the emitter is $3.2 \times 10^{-9} \text{ A}$ and the current amplification factor is 99. The correct option is:

Option B: $3.2 \times 10^{-9} \text{ A}$ and 99

Question150

Combination of NAND gates is shown in the figure. It is equivalent to



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Options:

A. AND gate

B. NOR gate



C. OR gate

D. X-OR gate

Answer: C

Solution:

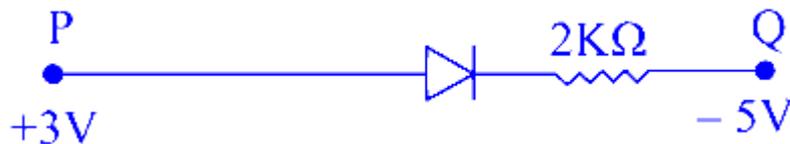
The two NAND gates whose two inputs are joined together behave like NOT gates. The truth table can be written as

A	B	y_1	y_2	y
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	1

We see that the output y is '1' if A or B or both are '1'. Hence it behaves as OR gate.

Question151

In an ideal junction diode, the current flowing through PQ is



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Options:

A. 2×10^{-3} A

B. 2×10^{-2} A

C. 4×10^{-3} A

D. 10^{-3} A



Answer: C

Solution:

The diode is forward biased. The potential difference between P and Q is $(3 - (-5)) = 8 \text{ V}$.

$$I = \frac{V}{R} = \frac{8}{2 \times 10^3} = 4 \times 10^{-3} \text{ A}$$

Question152

LED is manufactured using zinc selenide then it emits.

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Options:

- A. infrared radiations
- B. yellow light
- C. blue light
- D. green light

Answer: C

Solution:

An LED made from zinc selenide (ZnSe) emits **blue light** .

Correct answer: C — blue light

Why:

The color emitted by an LED depends on the **band gap** of the semiconductor material. Zinc selenide has a **wide band gap** , corresponding to photons in the **blue region** of the visible spectrum.

Question153

In a pure silicon, number of electrons and holes per unit volume are $1.6 \times 10^{16} \text{ m}^{-3}$. If silicon is doped with Boron in a way that on

doping hole density increases to $4 \times 10^{22} \text{ m}^{-3}$. Then electron density in doped semiconductor will be

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Options:

A. $6.4 \times 10^{-9} \text{ m}^{-3}$

B. $6.4 \times 10^9 \text{ m}^{-3}$

C. $6.4 \times 10^{-10} \text{ m}^{-3}$

D. $6.4 \times 10^{10} \text{ m}^{-3}$

Answer: B

Solution:

$$n_i = 1.6 \times 10^{16} \text{ m}^{-3}, n_h = 4 \times 10^{22} \text{ m}^{-3}$$

$$n_e n_h = n_i^2$$

$$\begin{aligned} \therefore n_e &= \frac{n_i^2}{n_h} = \frac{(1.6 \times 10^{16})^2}{4 \times 10^{22}} = \frac{1.6 \times 1.6 \times 10^{32}}{4 \times 10^{22}} \\ &= 6.4 \times 10^9 \text{ m}^{-3} \end{aligned}$$

Question154

For a transistor, $\frac{1}{\alpha_{DC}} - \frac{1}{\beta_{DC}}$ is equal to [α_{DC} and β_{DC} are current amplification factors]

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Options:

A. three

B. two



C. zero

D. one

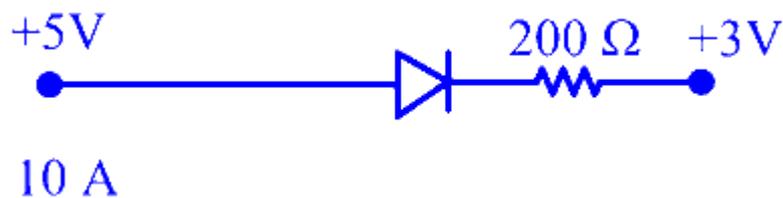
Answer: D

Solution:

$$\frac{1}{\alpha_{DC}} - \frac{1}{\beta_{DC}} = \frac{I_e}{I_c} - \frac{I_e}{I_c}$$
$$\frac{I_e - I_b}{I_c} = \frac{I_c}{I_c} = 1$$

Question155

The current in the following circuit is



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Options:

A. 10 A

B. zero

C. 0.025 A

D. 10^{-2} A

Answer: D

Solution:

The diode is forward biased.

Potential difference = $5 - 3 = 2$ V

$$I = \frac{V}{R} = \frac{2}{200} = 10^{-2} \text{ A}$$

Question156

The output of an 'OR' gate is 'one'

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Options:

- A. only when both inputs are 'one'.
- B. only when both inputs are 'zero'.
- C. only when either input is 'zero'.
- D. if either or both inputs are 'one'.

Answer: D

Solution:

The output of an OR gate is 1 when at least one input is 1 .

So it is 1 if either or both inputs are 'one' .

Correct answer: D

Question157

In the case of insulators, a band gap and conduction band is respectively

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Options:

- A. very high empty.
- B. very low, partially filled
- C. very high, completely filled
- D. very low, empty.

Answer: A

Solution:

In the case of **insulators** :

- The **band gap** is very **high**
- The **conduction band** is **empty**

This is because electrons cannot easily jump from the valence band to the conduction band due to the large energy gap.

Correct answer: A — very high, empty

Question158

A rectifier is used to

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Options:

- A. convert a.c. to d.c.
- B. amplify a weak signal
- C. generate intermittent voltage
- D. convert d.c. to a.c.

Answer: A

Solution:

A **rectifier** is a device used to **convert alternating current (a.c.) into direct current (d.c.)** .



✓ Correct answer: A = convert a.c. to d.c.

Question159

Two different logic gates moving output '0' for the inputs (0, 1) and then for (1, 0) are

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Options:

- A. AND', 'NAND
- B. NAND', 'NOR
- C. OR', 'AND
- D. NOR', 'AND

Answer: D

Solution:

In AND gate, output is 1 only if both the inputs are '1'. Hence output will be '0' for (0, 1) and (1, 0)

In NOR gate, output is '1' only if both the inputs are '0'. Hence, output will be '0' for (0, 1) and (1, 0)

Question160

The frequency of a given a.c. signal is 'N' Hz. When it is connected to a half wave rectifier, the number of output pulses given by the rectifier in 1 second is

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Options:

A. $\frac{N}{4}$

B. $\frac{N}{2}$

C. N

D. 2N

Answer: C

Solution:

Frequency = N

For each wave, a positive pulse is given as output

Hence, N output pulses are given out.

Question161

Silicon and copper are cooled from 300 K to 100 K, the specific resistance (resistivity)

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Options:

A. increases in both copper and silicon

B. decreases in both copper and silicon

C. decreases in copper and increases in silicon

D. increases in copper and decreases in silicon

Answer: C

Solution:

Resistivity of conductors increases with temperature and that of semiconductor decreases with temperature.

When temperature is decreased, the resistivity of copper will decrease while that of silicon was increase.



Question162

A transistor having $\alpha = 0.8$ is connected in common emitter configuration. When the base current changes by 6 mA, then the change in collector current is

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Options:

- A. 12 mA
- B. 24 mA
- C. 0.66 mA
- D. 1.5 mA

Answer: B

Solution:

To determine the change in collector current (ΔI_C) in a transistor connected in common emitter configuration, we can use the relation between the base current (I_B), collector current (I_C), and the current gain (β).

Firstly, the relationship between α and β is given by:

$$\beta = \frac{\alpha}{1-\alpha}$$

Given $\alpha = 0.8$, substitute into the formula:

$$\beta = \frac{0.8}{1-0.8} = \frac{0.8}{0.2} = 4$$

The change in collector current is related to the change in base current by:

$$\Delta I_C = \beta \cdot \Delta I_B$$

Substitute $\beta = 4$ and $\Delta I_B = 6$ mA into the equation:

$$\Delta I_C = 4 \cdot 6 \text{ mA} = 24 \text{ mA}$$

Thus, the change in collector current is 24 mA.

Option B: 24 mA is the correct answer.

Question163

In an intrinsic semiconductor, at an ordinary temperature, the correct relation between the number of electrons per unit volume n_e and number of holes per unit volume n_h .

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Options:

A. $n_e = n_n$

B. $n_e > n_n$

C. $n_e < n_h$

D. $n_e = n_h = 0$

Answer: A

Solution:

In an intrinsic semiconductor, the number of electrons per unit volume (n_e) is equal to the number of holes per unit volume (n_h) at thermal equilibrium. This is because intrinsic semiconductors are pure materials with no impurities; hence, every electron that is excited from the valence band to the conduction band leaves behind a hole, maintaining a balance between the number of electrons and holes.

Hence, the correct relation is:

$$n_e = n_h$$

Therefore, the correct answer is:

Option A:

$$n_e = n_h$$

Question164

A transistor has a voltage gain A . If the amount βA of its output is applied to the input of the transistor, then the transistor becomes



oscillator, when

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Options:

A. $\beta A = 0$

B. $\beta A = 1$

C. $\beta A = \infty$

D. $\beta = 0$

Answer: B

Solution:

The voltage gain of oscillator circuit is given by

$$A_f = \frac{A}{1 - A\beta}$$

where, A is the voltage gain without feedback and β is called feedback factor.

For sustained oscillation, from Barkhausen criterion

$$A\beta = 1$$

Question165

At absolute zero temperature, pure silicon behaves as

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Options:

A. non-metal

B. insulator

C. metal

D. extrinsic semiconductor

Answer: B

Solution:

The pure silicon has negative temperature coefficient of resistivity.

At absolute zero temperature, its resistance becomes infinite and acts like an insulator.

Question166

In common emitter amplifier, input resistance is 1000Ω , peak value of input signal voltage is 5 mV and $\beta = 60$. The peak value of output current is

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Options:

A. $3 \times 10^{-4}\text{ A}$

B. $0.5 \times 10^{-4}\text{ A}$

C. $2 \times 10^{-5}\text{ A}$

D. $1 \times 10^{-5}\text{ A}$

Answer: A

Solution:

To find the peak value of the output current in a common emitter amplifier, first, we need to understand how the input signal voltage is related to the base current, and how the base current is amplified to find the collector current (output current). The given parameters are:

- Input resistance, $R_{in} = 1000\Omega$
- Peak value of input signal voltage, $V_{in(peak)} = 5\text{ mV}$
- Current gain, $\beta = 60$

The base current (I_B) can be calculated using Ohm's law. The input voltage is related to the base current through the input resistance as follows:

$$I_{B(\text{peak})} = \frac{V_{in(\text{peak})}}{R_{in}}$$

Plugging in the values:

$$I_{B(\text{peak})} = \frac{5 \text{ mV}}{1000\Omega} = \frac{5 \times 10^{-3} \text{ V}}{1000\Omega} = 5 \times 10^{-6} \text{ A}$$

Now, to find the peak value of the output current ($I_{C(\text{peak})}$), we use the current gain (β). The collector current is related to the base current as follows:

$$I_C = \beta \times I_B$$

Thus, for the peak values:

$$I_{C(\text{peak})} = \beta \times I_{B(\text{peak})}$$

$$I_{C(\text{peak})} = 60 \times 5 \times 10^{-6} \text{ A} = 3 \times 10^{-4} \text{ A}$$

Therefore, the correct answer is:

Option A: $3 \times 10^{-4} \text{ A}$

Question167

When a small amount of impurity atoms are added to a semiconductor, then generally its resistivity

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Options:

- A. may increase or decrease depending upon the percentage of doping
- B. increases
- C. decreases
- D. does not change

Answer: C

Solution:

The conductivity of a semiconductor is given by

$$\sigma = n_e e \mu_e + n_h e \mu_h$$



where, n_e & n_h = number of electrons and holes per unit volume

and μ_e & μ_h = mobility of electrons and holes.

When impurity atoms are added in a semiconductor, then the concentration of holes and electrons increases. So, the conductivity increases and hence the resistivity ($\rho = \frac{1}{\sigma}$) of semiconductor decreases.

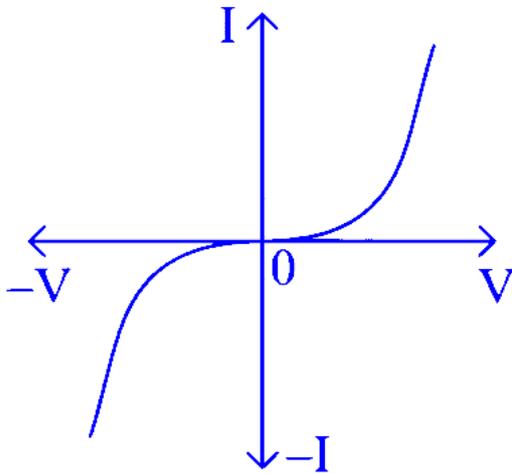
Question168

$V - I$ characteristics of LED is shown correctly by graph

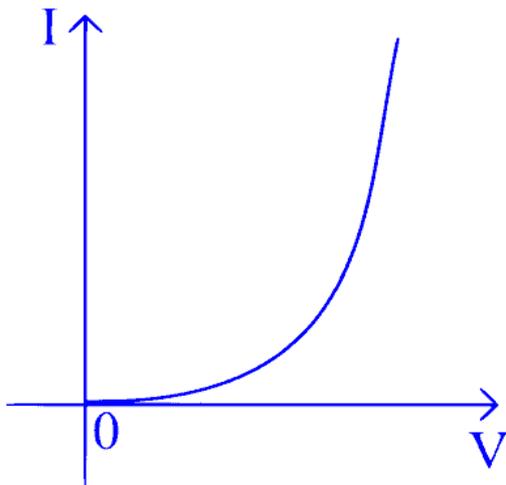
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Options:

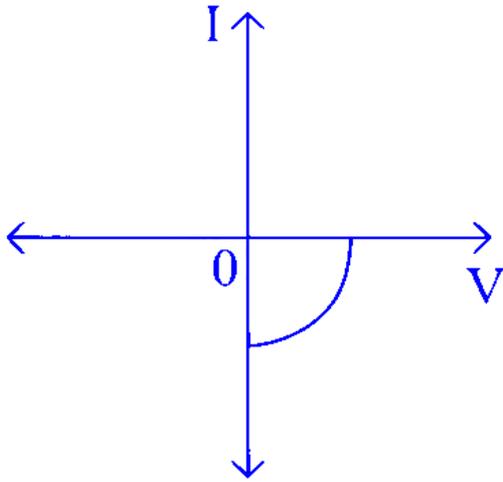
A.



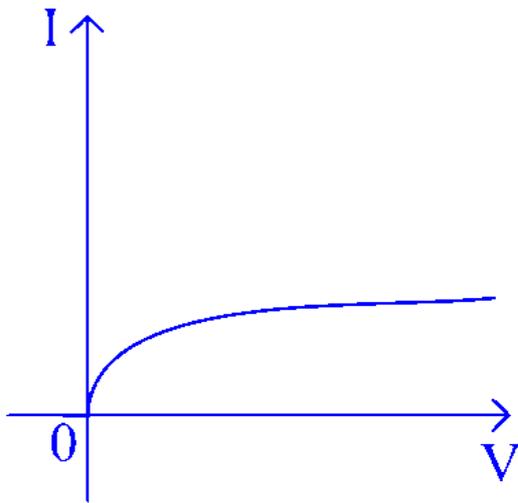
B.



C.



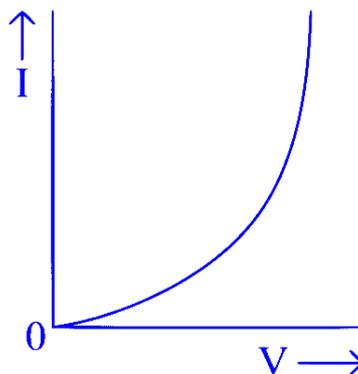
D.



Answer: B

Solution:

Since, an LED is forward biased diode, so its characteristics are those of forward bias, i.e., Here, option (a) is characteristics of a diode in forward and reverse bias. Option (c) → characteristics of solar cell.



Option (d) → reverse bias characteristics 1 drawn in first quadrant can be photodiode or Zener diode.

Question169

Which of the following regions of a transistors are, respectively, heavily dopped and lightly dopped?

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Options:

- A. Collector and emitter
- B. Base and emitter
- C. Emitter and base
- D. Emitter and collector

Answer: C

Solution:

In a transistor, emitter region is highly doped because it injects charge carriers toward base and collector region.

Collector region is moderately doped because in recombination of charge carriers takes place in this region.

Base region are lightly doped, so that recombination of charge carriers is small.

Question170

In case of p - n junction diode, the width of depletion region is

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Options:

- A. decreased with heavy doping



- B. increased by reverse biasing
- C. decreased with light doping
- D. increased by forward biasing

Answer: B

Solution:

In case of $p - n$ junction diode, when it is reverse biased, the reverse voltage supports the barrier potential and hence the width of the depletion layer increases. In forward biasing, the width decreases as the forward voltage opposes the potential barrier. The width of the depletion region increases, if the diode is further doped heavily as the movement of charge carrier decreases. Also, when the $p - n$ junction is light doped, the width of depletion region increases, due to increase in the potential barrier.

Question171

In the study of transistor as an amplifier, the ratio of collector current to emitter current is 0.98 then the ratio of collector current to base current will be

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Options:

- A. 99
- B. 49
- C. 50
- D. 98

Answer: B

Solution:

The ratio of collector current to emitter current at constant collector base voltage is the current the amplification factor and given by

$$\alpha = \frac{I_C}{I_E} = 0.98 \quad (\text{given})$$



The ratio of collector current to the base current at constant collector-emitter voltage is given by

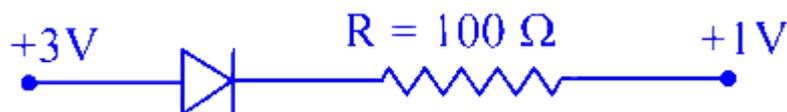
$$\beta = \frac{I_C}{I_B}$$

These are related as $\beta = \frac{\alpha}{1-\alpha}$

$$\Rightarrow \beta = \frac{0.98}{1-0.98} = \frac{0.98}{0.02} = 49$$

Question172

Assuming that the junction diode is ideal, the current in the arrangement shown in figure is



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Options:

- A. 30 mA
- B. 40 mA
- C. 20 mA
- D. 10 mA

Answer: C

Solution:

In the given circuit, the diode is forward biased, hence the current will flow through it



Now, applying KVL in the above circuit,

$$\begin{aligned} +3 - 100i - (+1) &= 0 \\ \Rightarrow 3 - 1 &= 100i \\ \Rightarrow i &= \frac{2}{100} = 0.02 \text{ A} \\ & i = 20 \text{ mA} \end{aligned}$$

Hence, the current flow in the circuit is 20 mA .

Question173

. For a transistor, the current ratio ' β_{dc} ' is defined as the ratio of

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Options:

- A. collector current to emitter current.
- B. collector current to base current.
- C. base current to collector current.
- D. emitter current to collector current.

Answer: B

Solution:

The current amplification factor of a transistor for direct current (DC) is the ratio of collector current (I_C) to the base current (I_B) in common emitter configuration i.e.,

$$B_{DC} = \frac{I_C}{I_B}$$

However, the ratio of collector current to the emitter current gives the value of current amplification factor in common base configuration, i.e.,

$$\alpha_{DC} = \frac{I_C}{I_E}$$
