Semiconductor Devices and Logic Gates

Question1

10^{10} electrons enter the emitter of a junction transistor in a time of 0.4μ s. If 5% of the electrons are lost in the base, then the collector current is

TG EAPCET 2025 (Online) 2nd May Evening Shift

Options:

A.

3.0 mA

B.

3.2 mA

C.

3.6 mA

D.

3.8 mA

Answer: D

Solution:

Given:

- Number of electrons entering emitter per second (or per given time)

  $N_E = 10^{10}$ electrons in $t = 0.4\,\mu s$

- 5% of electrons are **lost in the base**.

So, only 95% of electrons reach the collector.

- ### Step 1: Find the emitter current

Total charge entering emitter in $0.4\,\mu s$:

$$Q_E = N_E \times e = 10^{10} \times 1.6 \times 10^{-19} = 1.6 \times 10^{-9}\,C$$

Emitter current:

$$I_E = \frac{Q_E}{t} = \frac{1.6\times10^{-9}}{0.4\times10^{-6}} = 4.0\,mA$$

Step 2: Find the collector current

Since 5% are lost, 95% reach collector:

$$I_C = 0.95\,I_E = 0.95 \times 4.0\,mA = 3.8\,mA$$

✅ **Final Answer:**

$$\boxed{I_C = 3.8\,mA}$$

Correct option: D (3.8 mA)

Question2

An electron in n-region of a $p-n$ junction moves towards the junction with a speed of $5 \times 10^5\ \mathrm{ms}^{-1}$. If the barrier potential of the junction is 0.45 V , then the speed with which the electron enters the p-region after penetration through the barrier is

(Charge of the electron $= 1.6 \times 10^{-19}\mathrm{C}$ and mass of the electron $= 9 \times 10^{-31}$ kg)

TG EAPCET 2025 (Online) 2nd May Evening Shift

Options:

A.

$3 \times 10^5\ \mathrm{ms}^{-1}$

B.

$5 \times 10^5\ \mathrm{ms}^{-1}$

- C.

$4 \times 10^5 \text{ ms}^{-1}$

D.

$6 \times 10^5 \text{ ms}^{-1}$

Answer: A

Solution:

According to conservation of energy

$$
\begin{aligned}
& \frac{1}{2} m_e v_i^2 = \frac{1}{2} m_e v_f^2 + eV_b \\
\Rightarrow \quad & \frac{1}{2} m_e v_f^2 = \frac{1}{2} m_e v_i^2 - eV_b \\
\Rightarrow \quad & v_f^2 = v_i^2 = \frac{2eV_b}{m_e} \\
& = \left(5 \times 10^5\right)^2 - \frac{2 \times 1.6 \times 10^{-19} \times 0.4}{9 \times 10^{-31}} \\
& = 9 \times 10^{10} \\
& \Rightarrow v_f = \sqrt{9 \times 10^{10}} = 3 \times 10^5 \text{ m/s}
\end{aligned}
$$

Question3

The power gain and voltage gain of a transistor connected in common emitter configuration are 1800 and 60 respectively. If the change in the emitter current is 0.62 mA , then the change in the collector current is

TG EAPCET 2025 (Online) 2nd May Morning Shift

Options:

A.

0.60 mA

B.

0.58 mA

- C.

0.52 mA

D.

0.48 mA

Answer: A

Solution:

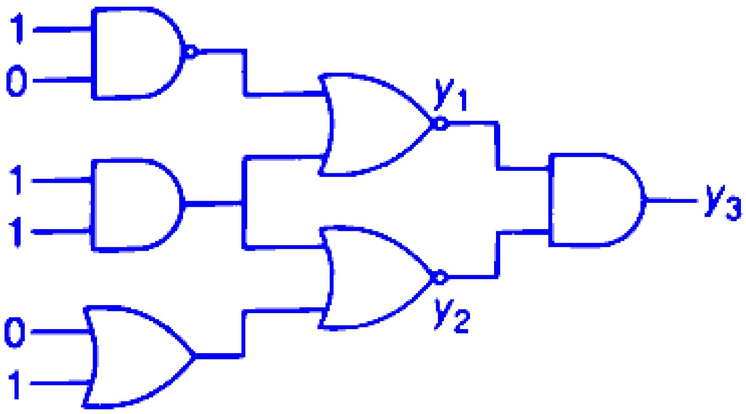
Power gain $=$ Current $\times$ Voltage gain

$\Rightarrow 1800 =$ Current gain $(\beta) \times 60$

$$
\begin{aligned}
& \Rightarrow \quad \beta = \frac{1800}{60} \Rightarrow \beta = 30 \\
& \Rightarrow \quad \frac{\Delta I_C}{\Delta I_B} = 30 \Rightarrow \frac{\Delta I_B - \Delta I_B}{\Delta I_B} = 30 \\
& \Rightarrow \quad \frac{\Delta I_E}{\Delta I_B} - 1 = 30 \\
& \Rightarrow \quad \frac{0.62}{\Delta I_B} = 31 \\
& \Rightarrow \quad \Delta I_B = \frac{0.62}{31} = 0.02 \text{ mA} \\
& \therefore \quad \Delta I_C = \Delta I_E - \Delta I_B = 0.62 - 0.02 \\
& \qquad = 0.60 \text{ mA}
\end{aligned}
$$

Question4

Six logic gates are connected as shown in the figure. The values of y_1, y_2 and y_3 respectively are



TG EAPCET 2025 (Online) 2nd May Morning Shift

- **Options:**

A.

$(0,1,0)$

B.

$(1,0,0)$

C.

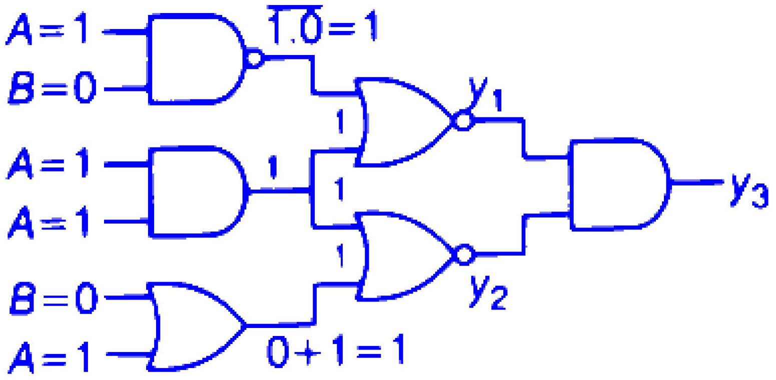
$(0,0,1)$

D.

$(0,0,0)$

Answer: D

Solution:



$$y_1=\overline{1+1}=\overline{1}=0$$
$$y_2=1+1=\overline{1}=0$$
$$y_3=y_1\cdot y_2=0.0=0$$

Question5

Match the devices given in List-I with their uses given in List-II.

List-I	List -II
a Transistor	e Filter circuit
b Diode	f Voltage regulator

▪

c Zener diode	g Rectifier
d Capacitor	h Amplifier

The correct answer is

TG EAPCET 2024 (Online) 11th May Morning Shift

Options:

A. $a-h, b-g, c-e, d-f$

B. $a-h, b-f, c-e, d-g$

C. $a-h, b-g, c-f, d-e$

D. $a-e, b-h, c-g, d-f$

Answer: C

Solution:

Transistor Transistors are commonly used as amplifiers to increase the amplitude of a signal.

(b) Diode Diode are used in rectifier circuits to convert

alternating current (AC) to direct current (DC).

(c) Zener diode Zener diodes are used in voltage regulator circuits to maintain a constant voltage.

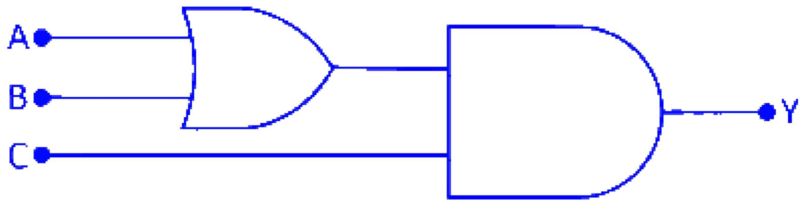
(d) Capacitor Capacitors are used in filter circuits to smooth out fluctuations in voltage by filtering out noise.

So, the correct matching is Transistor : Amplifier Diode : Rectified Zener diode : Voltage regulator Capacitor : Filter circuit

----

Question6

To get output 1 for the following logic circuit, the correct choice of the inputs is



▪

TG EAPCET 2024 (Online) 11th May Morning Shift

Options:

A. $A=1, B=1, C=0$

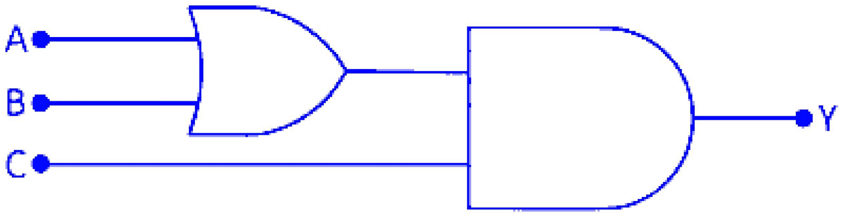
B. $A=0, B=1, C=0$

C. $A=1, B=0, C=1$

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

Answer: C

Solution:



From left side, the first gate is OR gate and next one is AND gate. So, the outpur of OR gate is $A+B$ and the output of AND gate $Y=(A+B) \cdot C$. We know that, for AND gate, the output will be 1 if both inputs are 1 . So,

$A+B=1$ and $C=1$

For $A+B=1$, either of the inputs must be one.

Therefore, from the given option (c) is the correct answer.

$A=1, B=0$ and $C=1$

Question7

In an n-type semiconductor, electrons are majority charge carriers and holes are minority charge carriers. The charge of an n-type semiconductor is

TG EAPCET 2024 (Online) 10th May Evening Shift

Options:

A. negative

B. positive

C. neutral

D. depends on the dopant

Answer: C

Solution:

An n-type semiconductor, after being doped with donor atoms, has electrons as the majority charge carriers. However, the semiconductor remains electrically **neutral** overall.

Here's why:

Initially, the semiconductor material is intrinsically neutral, with an equal number of protons (positive charge) and electrons (negative charge).

Doping introduces donor atoms, which have more electrons than necessary to form bonds with the host atoms. These extra electrons become free carriers.

Despite the increased number of free electrons, the donor atoms themselves are neutral because they provide one more electron in their outer shell but don’t remove the existing positive charges in the nucleus.

Thus, even though there is an excess of free electrons compared to holes, the n-type semiconductor as a whole is charge **neutral** because the additional electrons are matched by the additional positive charge in donor atom's nucleus.

Therefore, the answer is:

Option **C**: neutral

Question8

The region in the output voltage versus input voltage graph where a transistor can be used as an amplifier is

TG EAPCET 2024 (Online) 10th May Evening Shift

Options:

A. active region

B. cut-off region

C. saturation region

- D. passive region

Answer: A

Solution:

In the output voltage versus input voltage graph of a transistor, the region where a transistor can be used as an amplifier is the **active region** (Option A).

In the active region, the transistor acts as a linear amplifier. The base-emitter junction is forward-biased, and the collector-base junction is reverse-biased. This configuration allows the transistor to amplify small input signals into larger output signals while maintaining proportionality and phase characteristics.

Explanation:

Active Region:

Base-Emitter Junction: Forward-Biased

Collector-Base Junction: Reverse-Biased

Used for Amplification

Proportional relationship between input and output voltage

Cut-off Region (Option B):

Both junctions are reverse-biased.

The transistor is off, and no current flows between collector and emitter.

Saturation Region (Option C):

Both junctions are forward-biased.

The transistor is fully on, allowing maximum current to flow between collector and emitter.

Not suitable for amplification as it works like a closed switch.

Passive Region (Option D):

This term is not typically used in the context of transistor operation regions.

Therefore, the **active region** is crucial for the amplification function of transistors.

Question9

The voltage gain of a transistor in common emitter configuration is 160 . The resistances in base and collector sides of the circuit are $1 \mathrm{k} \Omega$ and $4 \mathrm{k} \Omega$ respectively. If the change in base current is 100μ A, then the change in output current is

TG EAPCET 2024 (Online) 10th May Morning Shift

Options:

A. 4 mA

B. 4μ A

C. 40 mA

D. 40μ A

Answer: A

Solution:

Given,

Voltage gain $= 160 = \frac{V_{\text{out}}}{V_{\text{in}}}$

$I_C = ?$

Base current, $I_B = 100\mu$ A

Load resistance, $R_L = 4\text{k}\Omega$

Input resistance, $R_I = 1\text{k}\Omega$

Voltage gain $= \beta \frac{R_L}{R_I}$

where β is current gain

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

$$160 = \frac{I_C}{I_B} \cdot \frac{R_L}{R_I}$$

$$160 = \frac{I_C}{100\mu \text{ A}} \cdot \frac{4\text{k}\Omega}{1\text{k}\Omega}$$

$$I_C = 4 \times 10^{-3} \text{ A}$$

$$I_C = 4 \text{ mA}$$

Question10

Normally a capacitor is connected across the output terminals of a rectifier to

TG EAPCET 2024 (Online) 10th May Morning Shift

Options:

A. convert AC to DC

B. convert DC to AC

C. to get a varying DC output

D. to get a steady DC output

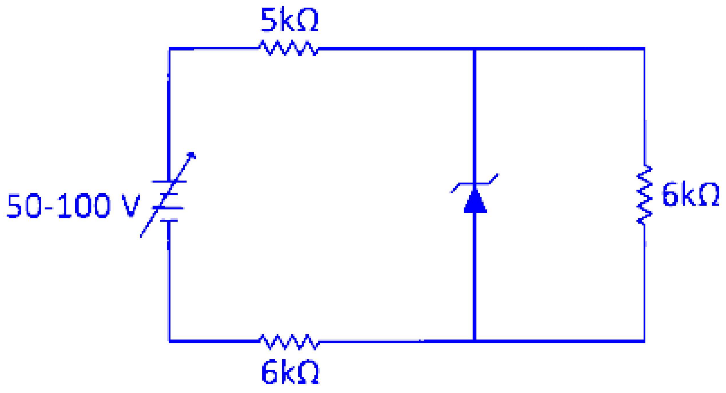
Answer: D

Solution:

The presence of the capacitor across the output terminal of rectifier eliminates the pulsation and fluctuation in the output voltage. The capacitor hold charge during the charging phase and discharging slowly during the discharging phase, maintaing relative constant voltage across load.

Question11

A zener diode of zener voltage 30 V is connected in circuit as shown in the figure. The maximum current through the zener diode is



TG EAPCET 2024 (Online) 9th May Evening Shift

- **Options:**

A. 5 mA

B. 14 mA

C. 9 mA

D. 7 mA

Answer: A

Solution:

Given, $V_z = 30\text{ V}, V_{\max} = 100\text{ V}$

Voltage drop across zener branch and its parallel branch will be the same i.e.,

Current in $6\text{k}\Omega$ resistor,

$i_1 = \frac{30\text{ V}}{6\text{k}\Omega} = 5\text{ mA}$

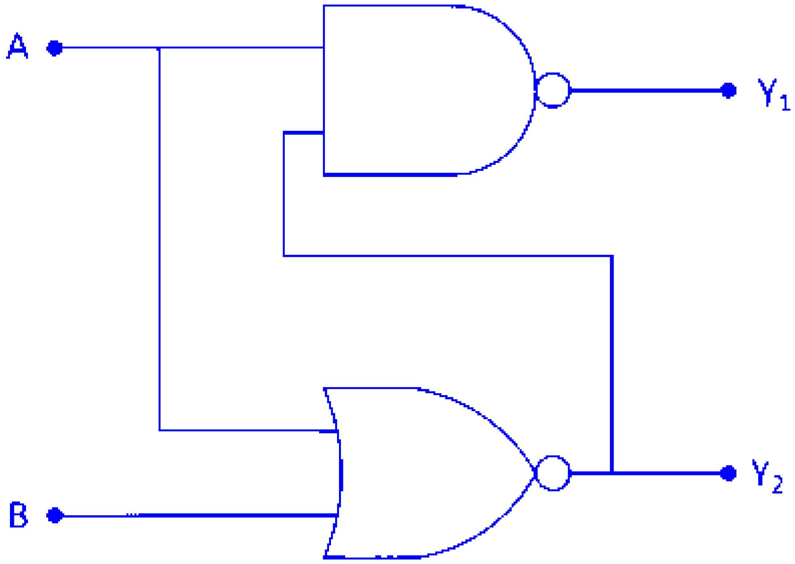
Current through rest of resistor $= \frac{V - V_z}{R_z}$

$$= \frac{70\text{ V}}{7\text{k}\Omega} = 10\text{ mA}$$

$\therefore I_{\text{mener}} \quad = 10\text{ mA} - 5\text{ mA} = 5\text{ mA}$

Question12

Two logic gates are connected as shown in the figure. If the inputs are $A = 1$ and $B = 0$, then the values of Y_1 and Y_2 respectively are



TG EAPCET 2024 (Online) 9th May Evening Shift

Options:

A. 1,1

B. 1,0

C. 0,1

D. 0,0

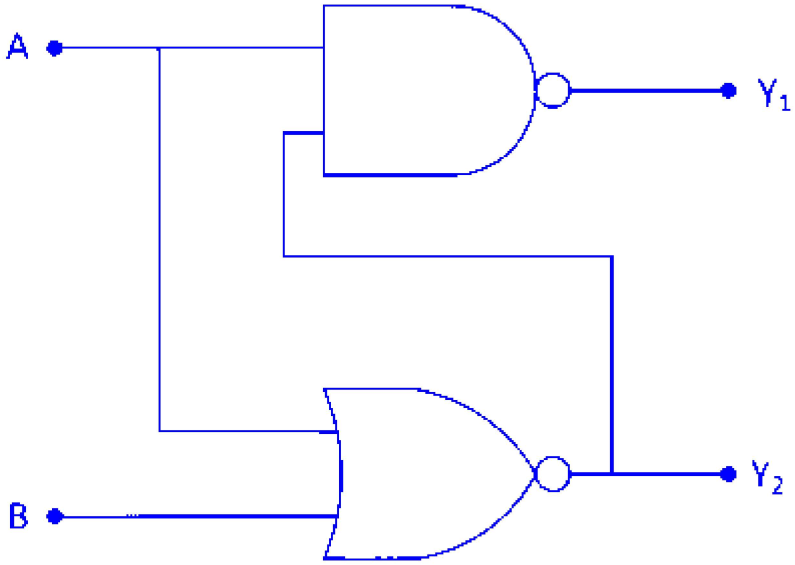
Answer: B

Solution:

From diagram

$Y_1 = \overline{A \cdot (\overline{A + B})}$

$Y_2 = \overline{A + B}$



Truth table,

A	B	Y_1	Y_2
0	0	1	1
0	1	1	0
1	0	1	0
1	1	0	0

Question13

The concentration of electrons in an intrinsic semiconductor is $6 \times 10^{15}\ \mathrm{m}^{-3}$. On doping with an impurity, the electron concentration increases to $4 \times 10^{22}\ \mathrm{m}^{-3}$. In thermal equilibrium, the concentration of the holes in the doped semiconductor is

TG EAPCET 2024 (Online) 9th May Morning Shift

Options:

A. $18 \times 10^{-8}\ \mathrm{m}^{-3}$

B. $1.5 \times 10^{-7}\ \mathrm{m}^{-3}$

C. $9 \times 10^{8}\ \mathrm{m}^{-3}$

D. $\frac{2}{3} \times 10^{7}\ \mathrm{m}^{-3}$

Answer: C

Solution:

In an intrinsic semiconductor, the concentration of electrons (n_i) and holes (p_i) are equal and given by:

$n_i = p_i = 6 \times 10^{15}\,\mathrm{m}^{-3}$.

When the semiconductor is doped with an impurity, the electron concentration increases to $4 \times 10^{22}\,\mathrm{m}^{-3}$, which is denoted by n. The product of the electron concentration (n) and the hole concentration (p) in a semiconductor at thermal equilibrium is given by:

$n \cdot p = n_i^2$.

To find the hole concentration (p) in the doped semiconductor, use the above relationship:

Calculate n_i^2:

$n_i^2 = (6 \times 10^{15}\,\mathrm{m}^{-3})^2 = 36 \times 10^{30}\,\mathrm{m}^{-6}$.

Using the relation $n \cdot p = n_i^2$, solve for p:

$p = \frac{n_i^2}{n} = \frac{36 \times 10^{30}\,\mathrm{m}^{-6}}{4 \times 10^{22}\,\mathrm{m}^{-3}}$.

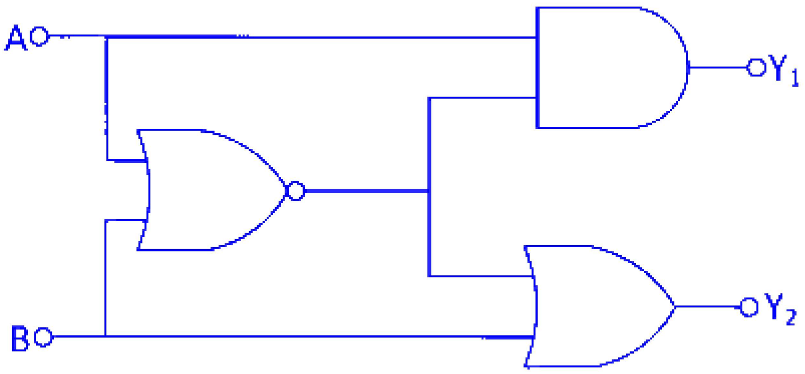
Calculate p:

$p = \frac{36}{4} \times 10^{30-22}\,\mathrm{m}^{-3} = 9 \times 10^{8}\,\mathrm{m}^{-3}$.

Therefore, the concentration of holes in the doped semiconductor is $9 \times 10^{8}\,\mathrm{m}^{-3}$, which corresponds to **Option C**.

Question14

Three logic gates are connected as shown in the figure. If the inputs are $A = 1$ and $B = 1$, then the values of Y_1 and Y_2 respectively are



TG EAPCET 2024 (Online) 9th May Morning Shift

Options:

A. 0,0

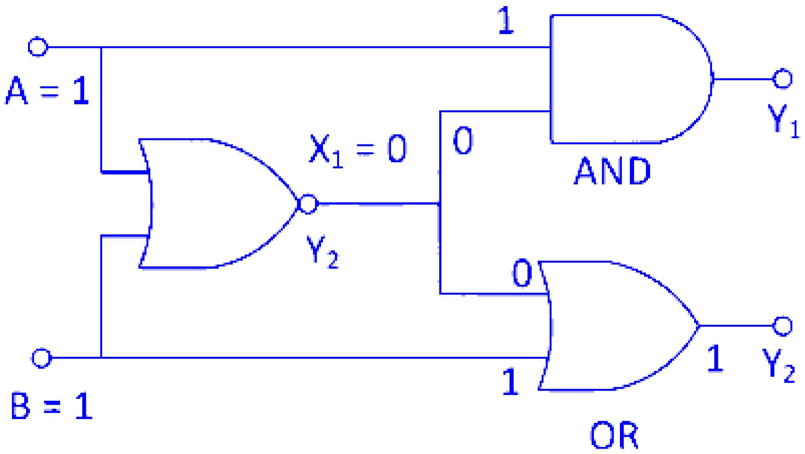
B. 0,1

C. 1,0

D. 1,1

Answer: B

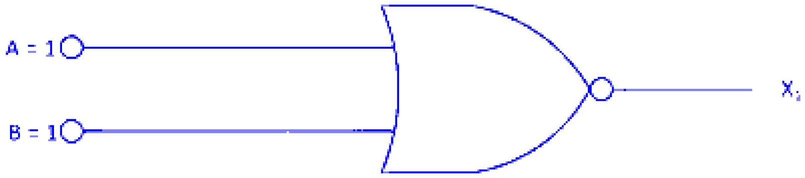
Solution:



Given, inputs are

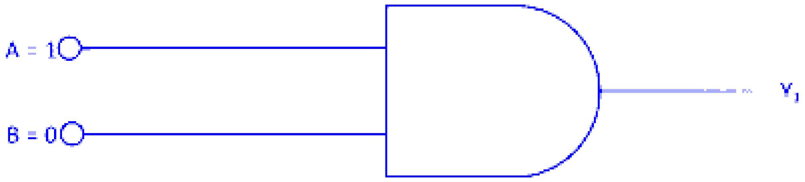
- $A = 1 \Rightarrow B = 1$

NOR GATE



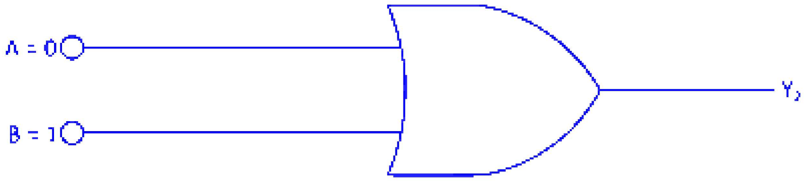
When inputs $A = 1$ and $B = 1$, then NOR gate will gives output of $X_1 = 0$

AND GATE



When inputs $A = 1$ and $B = 0$, then AND gate will gives output of $Y_1 = 0$.

OR GATE



When inputs $A = 0$ and $B = 1$, then gate wil gives output of $Y_2 = 1$

Thus, value of $Y_1 = 0$ and $Y_2 = 1$.

Question15

If the ratio of electron and hole currents in a semiconductor is $7/4$ and the ratio of drift velocities of electrons and holes is $5/4$, then ratio of concentrations of electrons and holes will be

TS EAMCET 2023 (Online) 12th May Evening Shift

Options:

A. $5 : 7$

B. $7 : 5$

C. $5 : 9$

D. $9 : 5$

- **Answer: B**

Solution:

The ratio of electron to hole current is:

$\frac{I_e}{I_h} = \frac{7}{4}$

The ratio of the drift velocities of electrons to holes is:

$\frac{v_{de}}{v_{dh}} = \frac{5}{4}$

In semiconductors, the drift current (I) is proportional to the product of the charge carrier concentration (n) and the drift velocity (v_d). This relationship is expressed as:

$I \propto n \cdot v_d$

Thus, for electron and hole currents, we can write:

$I_e \propto n_e \cdot v_{de}$

$I_h \propto n_h \cdot v_{dh}$

By dividing the expression for electron current by the expression for hole current, we get:

$\frac{I_e}{I_h} = \frac{n_e \cdot v_{de}}{n_h \cdot v_{dh}}$

Substituting in the given ratios:

$\frac{n_e}{n_h} = \frac{I_e \cdot v_{dh}}{I_h \cdot v_{de}}$

$\frac{n_e}{n_h} = \frac{7}{4} \cdot \frac{4}{5} = \frac{7}{5}$

Thus, the ratio of the concentration of electrons to holes is $\frac{7}{5}$ or $7 : 5$.

Question16

When a semiconductor is doped with donor impurity

TS EAMCET 2023 (Online) 12th May Evening Shift

Options:

A. the hole concentration decreases and electron concentration increases

B. the hole concentration increases and electron concentration decreases

C. both hole concentration and electron concentration increase

D. both hole concentration and electron concentration decrease

Answer: A

Solution:

Intrinstic semiconductor are those material where the charge carrier (holes and electrons) are in equal number.

Donor impurity will provide its excess electron to other atom of crystal structure.

Hence, when a semiconductor is doped with a donor impurities, it will increase the concentration of electron and at the same time decreases the holes. Concentration by favouring electron-holes pairing.

Question17

In a transistor, the base current is 10μ A and the emitter current is 1 mA , then the collector current is

TS EAMCET 2023 (Online) 12th May Morning Shift

Options:

A. 990μ A

B. 100μ A

C. 1010μ A

D. 90μ A

Answer: A

Solution:

In a transistor, the currents are related by specific equations. Here's how to determine the collector current when the base and emitter currents are known:

Base current (I_b): 10 μA

Emitter current (I_e): 1 mA = 1000 μA

In a transistor, the relationship between the currents is defined by the equation:

$I_e = I_c + I_b$

- Where I_c is the collector current. To find the value of I_c, rearrange the equation:

$$I_c = I_e - I_b$$

Substitute the given values:

$$\begin{aligned} I_c &= 1000\,\mu\text{A} - 10\,\mu\text{A} \\ &= 990\,\mu\text{A} \end{aligned}$$

Thus, the collector current is $990\,\mu$A.

Question18

If the output of a NAND gate is given as input to a NOT gate, the resultant gate is

TS EAMCET 2023 (Online) 12th May Morning Shift

Options:

A. AND

B. OR

C. NOR

D. NOT

Answer: A

Solution:

Output of NAND gate = Input of NOT gate

So, the output will be an AND gate.
