Semiconductor Devices and Logic Gates

Question1

At absolute zero temperature, an intrinsic semiconductor behaves as

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Options:

A.

conductor

B.

superconductor

C.

insulator

D.

intrinsic semiconductor

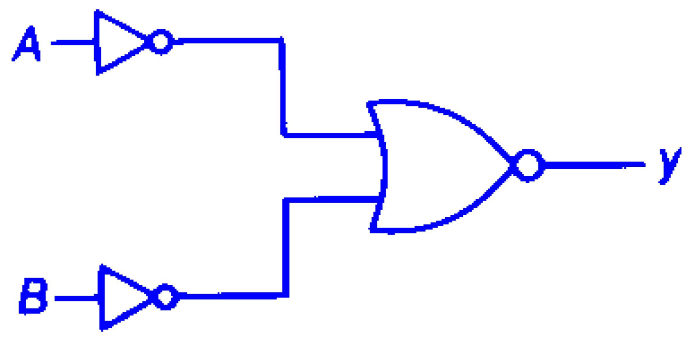
Answer: C

Solution:

At absolute zero temperature, an intrinsic semiconductor behave as an insulator.

Question2

The logic gate equivalent to the combination of logic gates shown in the figure is



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Options:

A.

AND

B.

NOR

C.

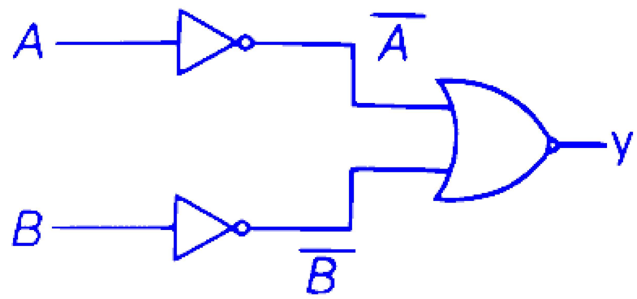
OR

D.

NAND

Answer: A

Solution:



$$y = \overline{\bar{A} + \bar{B}} = \bar{\bar{A}} \cdot \bar{\bar{B}} = AB$$
$$= \text{ Output of AND gate}$$

Question3

In the given options, the diode that is forward biased is

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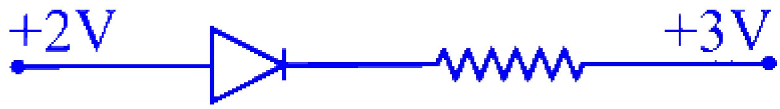
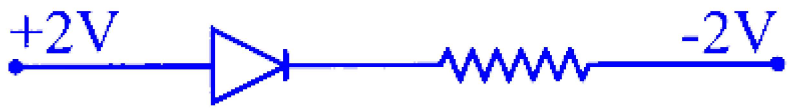
Options:

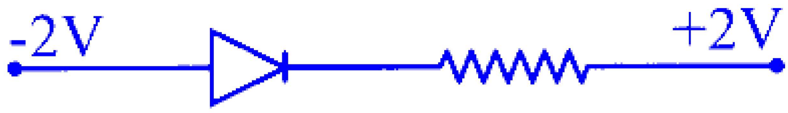
A.



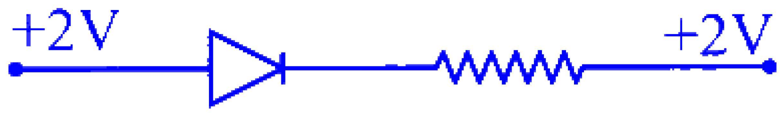
B.



C.



D.



Answer: B

Solution:

A p-n junction diode is in forward biased if p-side is connected with more positive voltage than n-side.

Question4

In a common emitter transistor amplifier the resistance of collector is $3 \mathrm{k}\Omega$. If the current amplification factor is 100 and the base resistance is $2 \mathrm{k}\Omega$, then the power gain of the transistor is

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Options:

A.

150

B.

10000

C.

1500

D.

15000

Answer: D

Solution:

$$\begin{aligned} & \text{Power gain } = \text{ Current gain } \times \text{Voltage gain} \\ & = \beta \times \left(\beta \frac{V_{\text{out}}}{V_{\text{in}}}\right) \\ & = \beta^2 \frac{V_C}{V_B} \\ & = 100^2 \times \frac{3 \times 10^3}{2 \times 10^3} \\ & = 10000 \times \frac{3}{2} = 15000 \end{aligned}$$

Question5

If X, Y and Z are the sizes of the emitter, base and collector of a transistor respectively, then

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Options:

A.

$X > Z > Y$

B.

$X > Y > Z$

C.

$Z > X > Y$

D.

$Z > Y > X$

Answer: C

Solution:

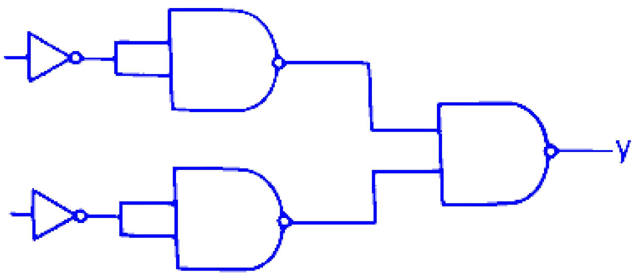
In a transistor size of collector is largest, size of emitter is moderate and size of base is smallest.

$\therefore$ Collector > Emitter > Base

$\Rightarrow \quad Z > X > Y.$

Question6

The logic gate equivalent to the circuit given in the figure is



Options:

A.

NAND

B.

OR

C.

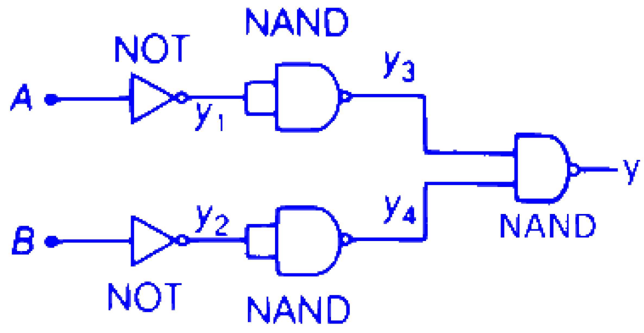
AND

D.

NOR

Answer: A

Solution:



Truth table of above combination is;

A	B	Y_1	Y_2	Y_3	Y_4	Y
0	0	1	1	0	0	1
1	0	0	1	1	0	1
0	1	1	0	0	1	1
1	1	0	0	1	1	0

Output Y resembles output of an NAND gate

Question7

In common emitter amplifier of a transistor, if the ratio of the voltage gain and current amplification factor is 4 , then the ratio of the collector and base resistances is

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Options:

A.

16 : 1

B.

1 : 16

C.

1 : 4

D.

4 : 1

Answer: D

Solution:

The question tells us that the voltage gain divided by the current amplification factor (β) equals 4.

We know that the formula for voltage gain in a common emitter amplifier is $A_V = \frac{\beta \times R_C}{R_B}$, where R_C is collector resistance and R_B is base resistance.

So if we divide A_V by β, we get:
$\frac{A_V}{\beta} = \frac{\frac{\beta \times R_C}{R_B}}{\beta}$

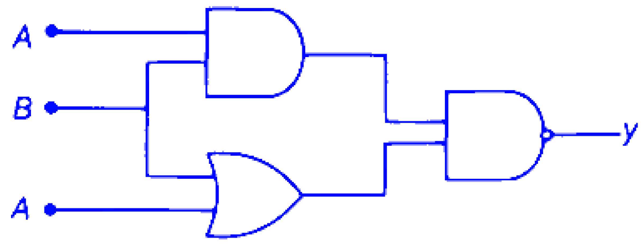
This simplifies to:
$\frac{R_C}{R_B}$

The question gives $\frac{A_V}{\beta} = 4$, so:
$\frac{R_C}{R_B} = 4$

This means the ratio of collector resistance to base resistance is 4:1.

Question8

If three logic gates are connected as shown in the figure, then the correct truth table of the circuit is



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Options:

A.

A	B	y
0	0	1
0	1	0
1	0	0
1	1	1

B.

A	B	y
0	0	1
0	1	1
1	0	1
1	1	0

C.

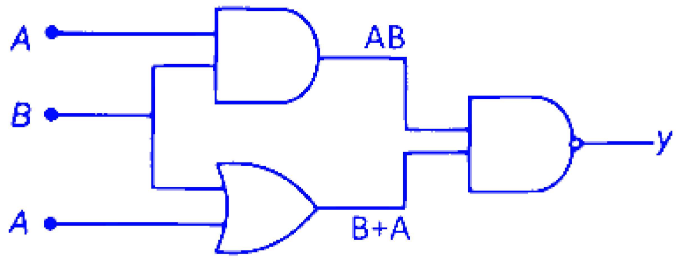
A	B	y
0	0	0
0	1	0
1	0	0
1	1	1

D.

A	B	y
0	0	0
0	1	1
1	0	1
1	1	0

Answer: B

Solution:



$$Y = \overline{AB \cdot (B+A)}$$
$$= \overline{AB} + \overline{B+A}$$
$$= \bar{A} + \bar{B} + \bar{B} \cdot \bar{A}$$
$$= \bar{A} + \bar{B}(1+\bar{A}) = \bar{A} + \bar{B}$$

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

Question9

The voltage gain and the current amplification factor of a transistor in common emitter configuration are 300 and 60 respectively. If the collector resistance is $5 \mathrm{k}\Omega$, then the base resistance is

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Options:

A.

5kΩ

B.

25kΩ

C.

2kΩ

D.

1kΩ

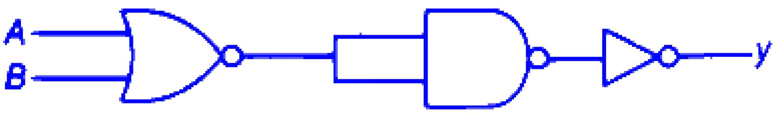
Answer: D

Solution:

$$
\begin{aligned}
& A_V=300, \beta=60 \\
& A_V=\beta \cdot \frac{R_C}{R_B} \\
& 300=60 \times \frac{5 \times 10^3}{R_B} \\
& R_B=10^3 \Omega=1 \mathrm{~K} \Omega
\end{aligned}
$$

Question10

The logic gate equivalent to the circuit shown in the figure is



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Options:

A.

AND

B.

NAND

C.

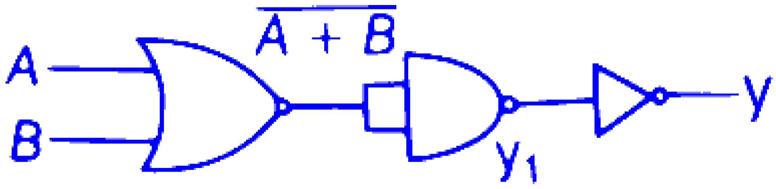
NOR

D.

OR

Answer: C

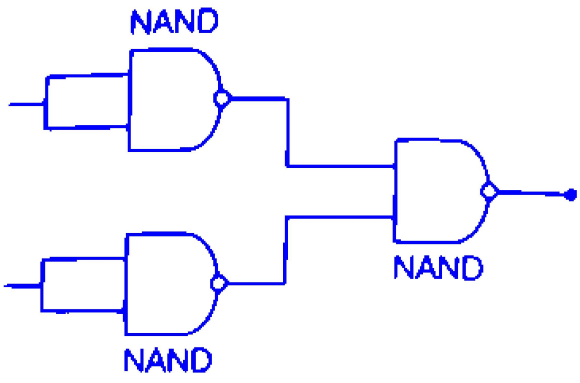
Solution:



$$y_1 = \overline{\overline{A+B}} = A+B$$
$$\therefore \quad y = \overline{y_1} = \overline{A+B} = \text{ Output of NOR gate.}$$

Question11

When three NAND logic gates are connected as shown in the figure, then the logic gate equivalent to the circuit is



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Options:

A.

NOT

B.

AND

C.

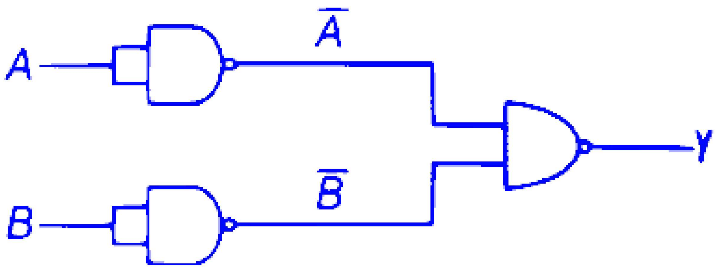
OR

D.

NOR

Answer: C

Solution:



$$\begin{aligned} Output, Y &= \overline{\bar{A} \cdot \bar{B}} \\ &= \bar{\bar{A}} + \bar{\bar{B}} = A + B \\ &= \text{Output of OR gate} \end{aligned}$$

Question12

The device used for voltage regulation is

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Options:

A.

Zener diode

B.

photo diode

C.

light emitting diode

D.

solar cell

Answer: A

Solution:

The correct answer is:

✅ **Option A: Zener diode**

Explanation:

A **Zener diode** is specifically designed to operate in the reverse breakdown region and maintain a nearly constant voltage across it, even when the current or load varies. Therefore, it is commonly used for **voltage regulation** in electronic circuits.

Question13

A transistor has 3 impurity regions of different doping levels. In the order of increasing doping level, the regions are

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Options:

A.

emitter, base, collector

B.

collector, base, emitter

C.

base, emitter, collector

D.

base, collector, emitter

Answer: D

Solution:

In a transistor, base region is lightly doped, emitter region is highly doped and collector region is moderately doped.

Question14

A transistor works as an amplifier when

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Options:

A.

emitter-base junction is forward biased and base-collector junction is reverse biased.

B.

both emitter-base and base-collector junctions are forward biased.

C.

both emitter-base and base-collector junctions are reverse biased.

D.

emitter-base junction is reverse biased and base-collector junction is forward biased.

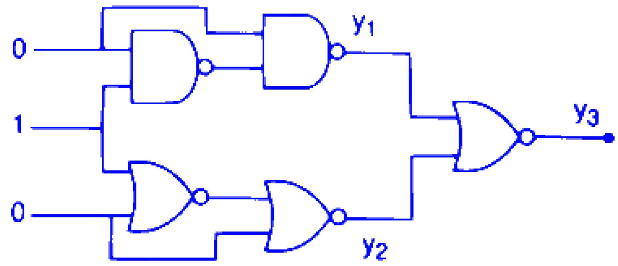
Answer: A

Solution:

A transistor works as an amplifier when emitter-base junction is in forward biased and base-collector junction is in reverse biased.

Question15

If five logic gates are connected as shown in the figure, then the values of y_1, y_2 and y_3, are respectively



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Options:

A.

1, 1, 1

B.

0, 0, 1

C.

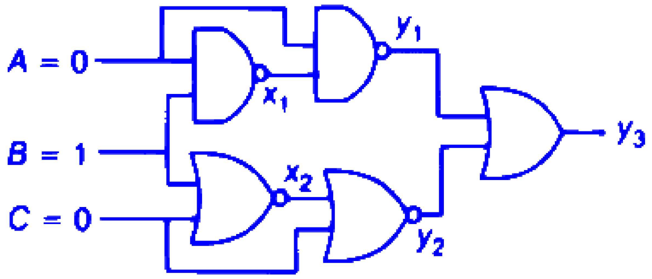
1, 1, 0

D.

1, 0, 1

Answer: C

Solution:



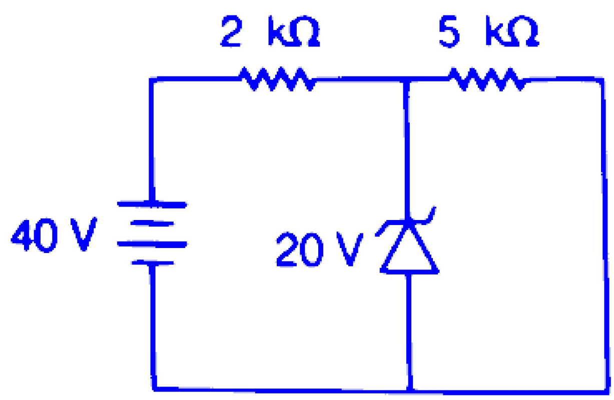
Truth table for given input is

A	B	C	x_1	x_2	y_1	y_2	y_3
0	1	0	1	0	1	1	0

So, $\langle y_1, y_2, y_3 \rangle = \langle 1, 1, 0 \rangle$

Question16

A Zener diode of breakdown voltage 20 V is connected as shown in the given circuit. The current through Zener diode is



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Options:

A.

10 mA

B.

4 mA

C.

6 mA

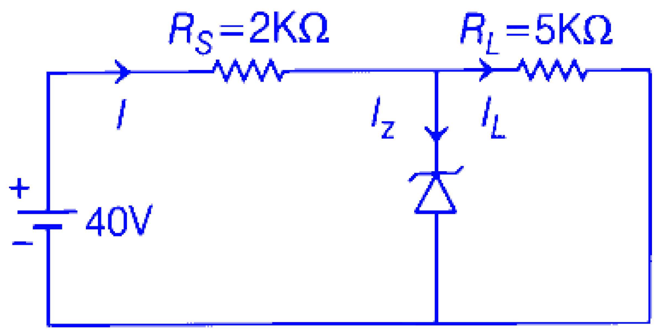
D.

8 mA

Answer: C

Solution:

$V_Z = 20 \text{ V}$



$$\begin{aligned} I &= \frac{V - V_Z}{R_s} = \frac{40 - 20}{2 \times 10^3} \\ &= \frac{20}{2 \times 10^3} = 10^{-2} \text{ A} = 10 \text{ mA} \\ I_L &= \frac{V_Z}{R_L} = \frac{20}{5 \times 10^3} \\ &= 4 \times 10^{-3} \text{ A} = 4 \text{ mA} \\ \therefore I_Z &= I - I_L = 10 - 4 = 6 \text{ mA} \end{aligned}$$

Question17

The voltage gains of two amplifiers connected in series are 8 and 12.5 . If the voltage of the input signal is 200μ V, then the voltage of the output signal is

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Options:

A.

50μ V

B.

20μ V

C.

20 mV

D.

50 mV

Answer: C

Solution:

Total voltage gain

$$A = A_1 \times A_2 = 8 \times 12.5 = 100.0$$
$$A = 100$$

$$\therefore \text{ Since, } A = \frac{V_{\text{out}}}{V_{\text{in}}}$$

$$\Rightarrow \quad V_{\text{out}} = A \times V_{\text{in}} = 100 \times 200 \times 10^{-6}$$
$$= 0.02 \text{ V} = 20 \times 10^{-3} \text{ V}$$
$$= 20\text{mV}$$

Question18

In the diodes show in the diagrams, which one is reverse biased?

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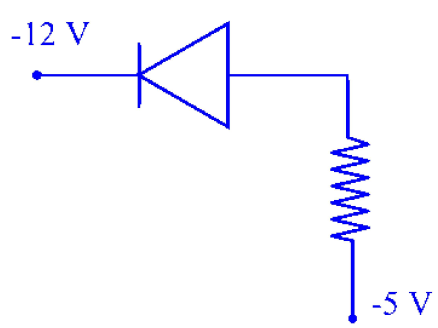
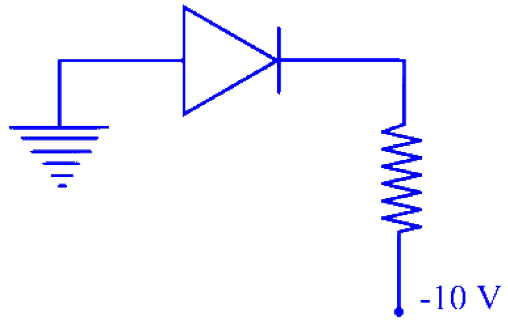
Options:

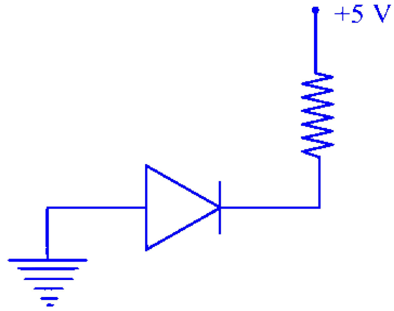
A.



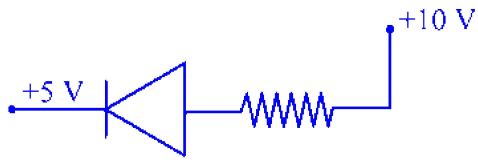
B.



C.

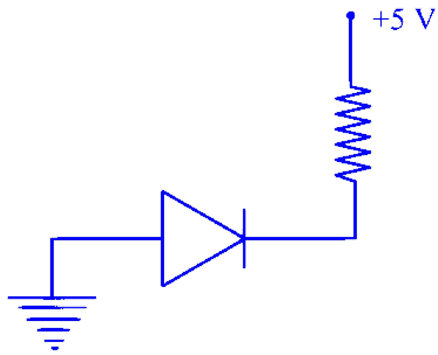


D.



Answer: C

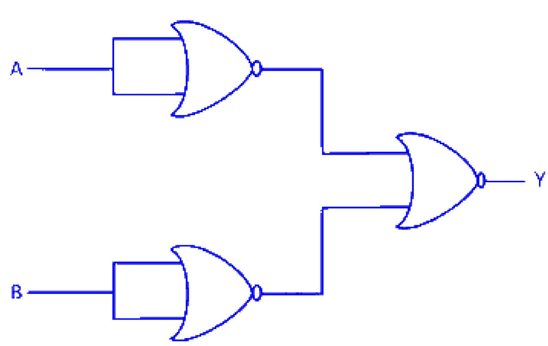
Solution:



For reverse biasing of an ideal diode, the potential of n-side should be higher than potential of p-side.

Question19

The following configuration of gates is equivalent to



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Options:

A. NAND

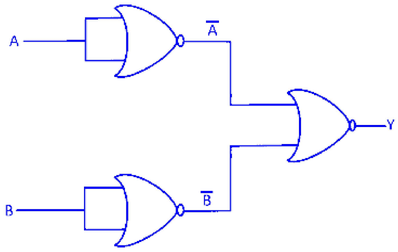
B. XOR

C. AND

D. OR

Answer: C

Solution:

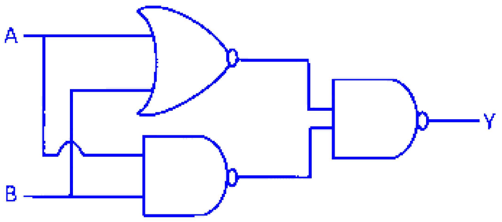


Output,

$$Y = \overline{\bar{A} + \bar{B}} = \bar{\bar{A}} + \bar{\bar{B}}$$
$$= AB$$
$$= \text{Output of AND gate}$$

Question20

Truth table for the given circuit is



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Options:

A.

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

B.

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

C.

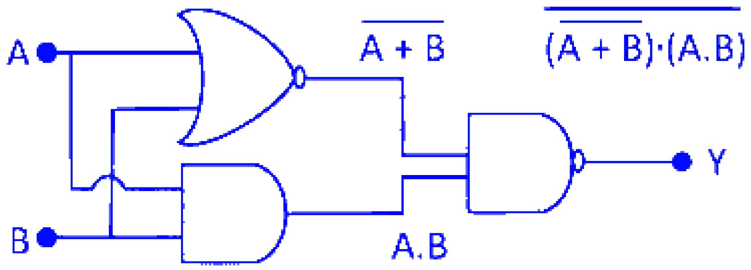
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1

D.

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

Answer: C

Solution:



We know that, two inputs A and B are given then, Boolean expression for NOR gate $= \overline{A+B}$

Boolean expression for AND gate $= A \cdot B$

So, Boolean expression for Y (NAND

$$\begin{aligned} \text{gate }) &= \overline{(\overline{A+B}) \cdot (A \cdot B)} \\ Y &= \overline{((\overline{A+B}) + \cdot (A \cdot B)} \\ Y &= \overline{(\overline{A+B})} + (\overline{A \cdot B}) \\ Y &= A + B + \bar{A} + \bar{B} \\ Y &= 1 \quad (\therefore A + \bar{A} = 1) \end{aligned}$$

So, output Y will always be 1 .

Truth table:

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

Question21

If R_C and R_B are respectively the resistances of in collector and base sides of the circuit and β is the current amplification factor, then the voltage gain of a transistor amplifier in common emitter configuration is

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Options:

A. $\beta R_C R_B$

B. $\frac{\beta}{R_C R_B}$

C. $\frac{\beta R_B}{R_C}$

D. $\frac{\beta R_C}{R_B}$

Answer: D

Solution:

Given:

Collector side resistance: R_C

Base side resistance: R_B

Current amplification factor: β

We know that the voltage gain of a transistor amplifier can be calculated as:

Voltage gain $=$ Current gain $\times \frac{\text{Output resistance}}{\text{Input resistance}}$

In a common emitter configuration, the voltage gain A_V is derived as follows:

$A_V = \frac{\Delta I_C}{\Delta I_B} \times \frac{R_C}{R_B} = \frac{\beta \cdot R_C}{R_B}$

This equation shows that the voltage gain is the product of the current gain and the ratio of the collector resistance to the base resistance.

Question22

The current gain of a transistor in common emitter configuration is 80 . The resistances in collector andbase sides of the circuit are $5 \mathrm{k}\Omega$ and $1 \mathrm{k}\Omega$ respectively. If the input voltage is 2 mV , the output voltage is

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Options:

A.

4 V

B.

0.4 V

C.

0.8 V

D.

8 V

Answer: C

Solution:

The output voltage in a common emitter transistor configuration can be determined using the formula for voltage gain, A_V. The equation for voltage gain in this configuration is given by:

$A_V = -\beta\left(\frac{R_C}{R_{\text{in}}}\right)$

Here, the current gain (β) is 80, the resistance on the collector side (R_C) is $5\,\text{k}\Omega$, and the resistance on the base side (R_{in}) is $1\,\text{k}\Omega$. Plugging in the values:

$A_V = -80\left(\frac{5000}{1000}\right) = -80 \times 5 = -400$

The negative sign indicates an inversion in the phase between the input and output signals.

Now, to find the output voltage (V_{out}), multiply the voltage gain by the input voltage ($V_{\text{in}} = 2\,\text{mV} = 2 \times 10^{-3}\,\text{V}$):

$V_{\text{out}} = A_V \times V_{\text{in}}$

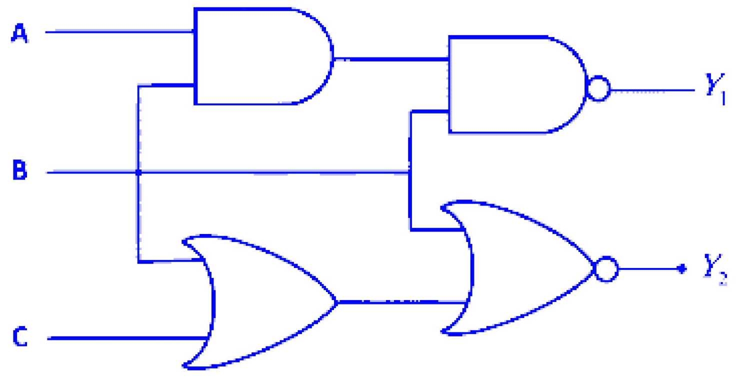
Calculating the output voltage:

$V_{\text{out}} = -400 \times 2 \times 10^{-3} = -0.8\,\text{V}$

Therefore, the output voltage is $-0.8\,\text{V}$, indicating the output is inverted with respect to the input voltage.

Question23

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



Options:

A. 1,0

B. 1,1

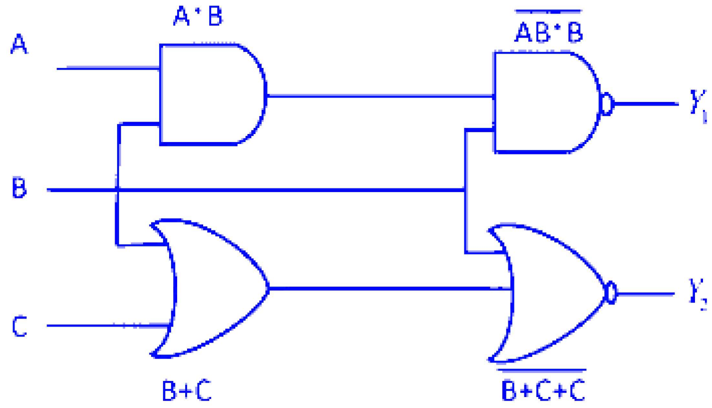
C. 0,1

D. 0,0

Answer: D

Solution:

The combination of logic gate is as follows.



For $Y_1 = \overline{A \cdot B \cdot B} = \overline{A \cdot B}$

For $Y_2 = \overline{B + C + C} = \overline{B + C}$

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

$Y_1 = 1, Y_2 = 0$

Question24

Pure silicon at 300 K has equal electron and hole concentration of $1.5 \times 10^{16}\ \mathrm{m}^{-3}$. If the hole concentration increases to $3 \times 10^{22}\ \mathrm{m}^{-3}$, then electron concentration in the silicon is

Options:

A. $0.75 \times 10^9 \text{ m}^{-3}$

B. 750 m^{-3}

C. 75 m^{-3}

D. $7.5 \times 10^9 \text{ m}^{-3}$

Answer: D

Solution:

Given:

Initial electron and hole concentration in pure silicon at 300 K:

$n_h = n_e = 1.5 \times 10^{16} \text{ m}^{-3}$

After doping, the new hole concentration becomes:

$n_h' = 3 \times 10^{22} \text{ m}^{-3}$

Using the mass action law, the relationship between electron and hole concentrations is:

$n_e n_h = n_e' n_h'$

We need to find the new electron concentration n_e'. Rewriting the equation for n_e':

$n_e' = \frac{(n_e)^2}{n_h'}$

Substitute the known values:

$n_e' = \frac{(1.5 \times 10^{16})^2}{3 \times 10^{22}}$

Calculating the above expression:

$n_e' = 7.5 \times 10^9 \text{ m}^{-3}$

Thus, the electron concentration in the silicon after doping is $7.5 \times 10^9 \text{ m}^{-3}$.

Question25

In $n-p-n$ transistor circuit, the collector current is 10 mA . If 95% of the electrons emitted reach the collector, then the base current is nearly

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Options:

A. 5.3 mA

B. 53 mA

C. 35 mA

D. 0.53 mA

Answer: D

Solution:

Given:

Collector current, $I_C = 10\,\text{mA}$

95% of the electrons emitted reach the collector

First, let's determine the emitter current I_E:

$I_C = 95\%\,\text{of}\,I_E$

So,

$I_C = \frac{95}{100} \times I_E$

Rearranging for I_E, we get:

$I_E = \frac{100 \times I_C}{95}$

Substituting the known value of I_C:

$I_E = \frac{100 \times 10}{95} = 10.53\,\text{mA}$

Now, we use the relationship between emitter current, collector current, and base current:

$I_B = I_E - I_C$

Substitute the known values:

$I_B = 10.53 - 10$

Therefore, the base current is:

$I_B = 0.53\,\text{mA}$

Question26

The semiconductor used for fabrication of visible LEDS must at least have a band gap of

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Options:

A. 0.6 eV

B. 1.2 eV

C. 1.8 eV

D. 0.9 eV

Answer: C

Solution:

To emit visible light, an LED's semiconductor must have a band gap energy that falls within the range corresponding to visible photon energies. Here's why:

• The energy of the photon emitted when an electron recombines with a hole is approximately equal to the band gap energy, given by

$E = \frac{hc}{\lambda}$

where

- h is Planck's constant,
- c is the speed of light, and
- λ is the wavelength of the emitted light.

• Visible light covers roughly from 400 nm (violet) to 700 nm (red), which translates to energies approximately between 3.1 eV and 1.8 eV. A semiconductor with a band gap energy lower than 1.8 eV would emit light in the infrared region, not visible.

Given the options:

- Option A: 0.6 eV
- Option B: 1.2 eV
- Option C: 1.8 eV
- Option D: 0.9 eV

The minimum band gap for a visible LED is therefore about 1.8 eV.

Thus, the correct answer is: Option C.

Question27

In a common emitter amplifier, AC current gains 40 and input resistance is $2\text{k}\Omega$. The load resistance is given as $10\text{k}\Omega$. Then, the voltage gain is

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Options:

A. 52

B. 125

C. 178

D. 200

Answer: D

Solution:

To find the voltage gain of a common emitter amplifier, we have the following information:

AC current gain (β) = 40

Input resistance (R_i) = 2 kΩ

Load resistance (R_L) = 10 kΩ

The voltage gain (A_v) is calculated using the formula:

$A_v = \beta \cdot \frac{R_L}{R_i}$

Substituting the given values into the formula:

$$A_v = \frac{40 \times 10 \times 10^3}{2 \times 10^3}$$
$$A_v = 40 \times 5$$
$$A_v = 200$$

Thus, the voltage gain is 200.

Question28

The voltage gain and current gain of a transistor amplifier in common emitter configuration are respectively 150 and 50 . If the resistance in the base circuit is 850Ω, then the resistance in collector circuit is

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Options:

A. 1700Ω

B. 2250Ω

C. 2550Ω

D. 3000Ω

Answer: C

Solution:

Given:

Voltage gain, $A_V = 150$

Current gain, $A_i = 50$

Base resistance, $R_B = 850 \, \Omega$

To find the resistance in the collector circuit, use the relationship for voltage gain in a common emitter transistor configuration:

$A_V = A_i \cdot \frac{R_C}{R_B}$

Rearrange to solve for R_C:

$R_C = \frac{A_V}{A_i} \times R_B$

Substitute the given values:

$R_C = \frac{150}{50} \times 850$

$R_C = 3 \times 850$

$R_C = 2550 \, \Omega$

Thus, the resistance in the collector circuit is $2550 \, \Omega$.

Question29

If the energy gap of a substance is 5.4 eV , then the substance is

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Options:

A. insulator

B. conductor

C. p-type semiconductor

D. n-type semiconductor

Answer: A

Solution:

Let's analyze the energy gap (E_g) values typically associated with different materials:

Conductors (Metals):

Metals have overlapping conduction and valence bands, meaning they don't exhibit a significant band gap.

Semiconductors:

Semiconductors usually have a moderate energy gap, commonly less than about 3 eV. For example, silicon has an energy gap of around 1.1 eV.

Both n-type and p-type semiconductors are doped forms of intrinsic semiconductors and share similar energy gap values with the pure material.

Insulators:

Insulators typically have a large energy gap, often greater than 3 eV. A 5.4 eV energy gap is well within the range for insulators.

Since the given energy gap is 5.4 eV, the substance falls into the insulator category.

Thus, the correct answer is:

Option A: insulator.

Question30

A p-n junction diode is used as

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Options:

A. an amplifier

B. a rectifier

C. an oscillator

D. a modulator

Answer: B

Solution:

A p-n junction diode is utilized as a rectifier. This is because the diode allows current to flow in only one direction when it is forward-biased and prevents current flow when it is reverse-biased. This unidirectional conduction property makes the diode suitable for converting alternating current (AC) to direct current (DC), which is the primary function of a rectifier.

Question31

When a signal is applied to the input of a transistor, it was found that output signal is phase-shifted by 180°. The transistor configuration is

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Options:

A. CB - configuration

B. CE - configuration

C. CC - configuration

D. Both CB and CC - configuration

Answer: B

Solution:

The answer is Option B: CE - configuration.

Here's why:

In a common emitter (CE) amplifier, the output is taken from the collector while the input is applied to the base.

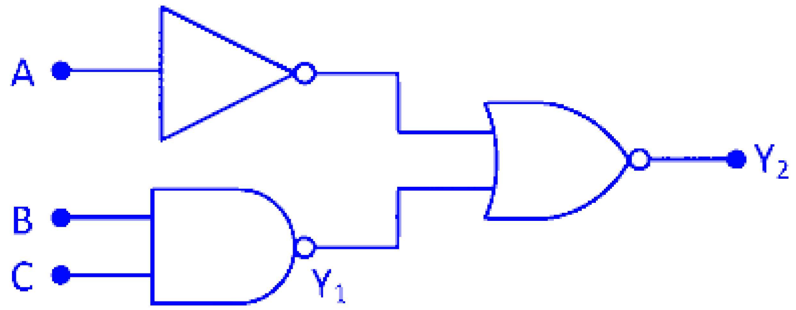
The CE configuration is known for inverting the input signal, which results in a phase shift of 180°.

Other configurations like common base (CB) and common collector (CC) do not exhibit this 180° phase inversion.

Thus, when you observe that the output signal is phase-shifted by 180°, it indicates that the transistor is set up in a common emitter configuration.

Question32

If n_r and n_h are concentrations of electron and holes in a semiconductor, then the intrinsic carrier concentration n_j in thermal equilibrium is



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Options:

A. $n = \sqrt{\frac{n_3}{n_n}}$

B. $n = \frac{n_n}{n_n}$

C. $n = \sqrt{7bn_n}$

D. $n_1 = n_0 + n_n$

Answer: C

Solution:

For an intrinsic (pure) semiconductor, where the number of electrons is equal to the number of holes ($n_e = n_h$), the intrinsic carrier concentration (n_i) in thermal equilibrium is given by,

$n_i^2 = n_e \times n_h \Rightarrow n_i = \sqrt{n_e \times n_h}$

Question33

In the given digital circuit, if the inputs are $A = 1B_x$ and $C = 1$, then the value of Y_1 and Y_2 are respectino

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Options:

A. 0,1

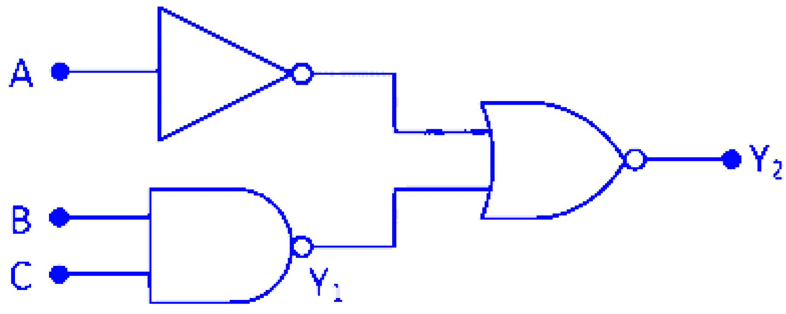
B. 0,0

C. 1,1

D. 1,0

Answer: A

Solution:



Given, input, $A = 1$

$B = 1$
$C = 1$

Here, B and C are inputs for NAND gate.

So, output

$Y_1 = \overline{B \cdot C}$
$Y_1 = \overline{1 \cdot 1} \Rightarrow Y_1 = 0$

Now, $\bar{A}$ and Y_1 are inputs for NOR gate.

So, output,

$Y_2 = \overline{\bar{A} + Y_1}$
$Y_2 = \overline{0 + 0} \Rightarrow Y_2 = 1$

Therefore, $Y_1 = 0, Y_2 = 1$

Question34

Consider the statementsIn a semiconductor

(A) There are no free electrons at 0 K.

(B) There are no free electrons at any temperature.

(C) The number of free electrons increases with temperature.

(D) The number of free electrons is less than that in a conductor.

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Options:

A. B, C, D are true but A is false.

B. A, B, C are true but D is false.

C. A, C, D are true but B is false.

D. A, B, C and D are all true.

Answer: C

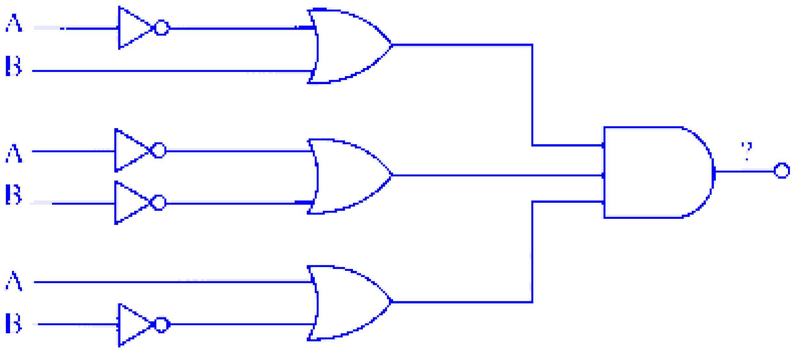
Solution:

At 0K , semiconductor behaves as an insulator, hence, there is no free electrons in the semiconductor at 0 K .

At room temperature or above room temperature, some covalent bonds are broken, hence some free electrons are found at these temperatures. On increasing temperature, more number of covalent bonds are broken, hence number of free electrons increases with increase of temperature of semiconductor.Conductivity of semiconductor is less than that in conductor, hence number of free electrons in semiconductor is less than that of conductor. Therefore, statements (A), (C), (D) are correct but (B) is false.

Question35

Output of following logic circuit is



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Options:

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

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

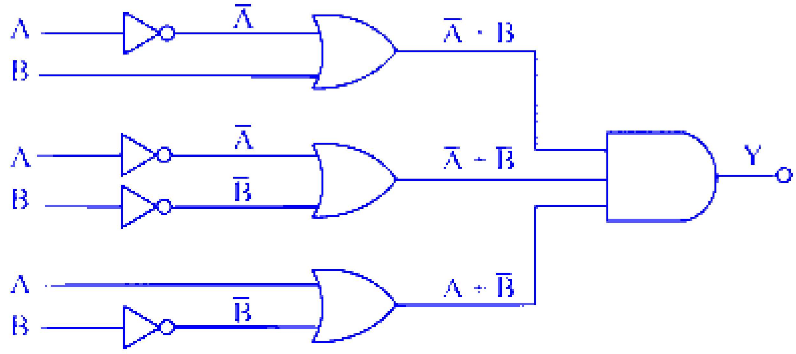
C. $(\bar{A}+B)\cdot(\bar{A}+\bar{C})\cdot(B+\bar{C})$

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

Answer: A

Solution:

The given logic circuit diagram is shown as:



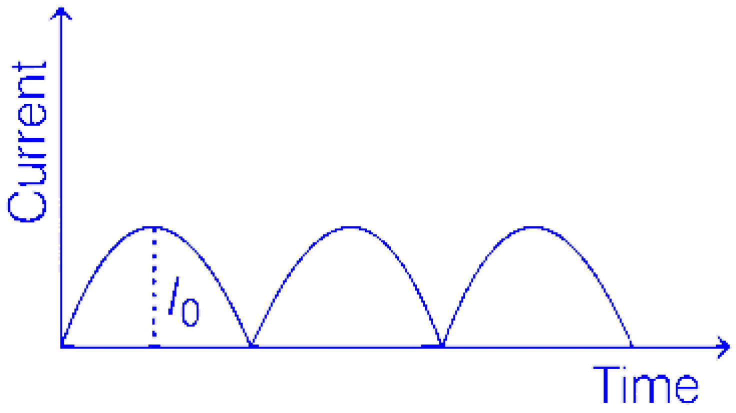
Output of the logic circuit is given as

$$
\begin{aligned}
Y &= (\bar{A}+B)(\bar{A}+\bar{B})(A+\bar{B}) \\
&= (\bar{A}\bar{A}+\bar{A}\bar{B}+B\bar{A}+B\bar{B})(A+\bar{B}) \quad (\because B\bar{B}=0) \\
&= (\bar{A}+\bar{A}\bar{B}+B\bar{A}+0)(A+\bar{B})
\end{aligned}
$$

$$
\begin{aligned}
&= [\bar{A}(1+\bar{B})+B\bar{A}](A+\bar{B}) \\
&= (\bar{A}+B\bar{A})(A+\bar{B}) \quad (\because 1+\bar{B}=1) \\
&= \bar{A}(1+B)(A+\bar{B}) \\
&= \bar{A}\cdot 1(A+\bar{B}) \quad (\because 1+B=1) \\
&= \bar{A}A+\bar{A}\bar{B} \\
&= 0+\bar{A}\bar{B} \\
&= \bar{A}\bar{B}
\end{aligned}
$$

Question36

The output current versus time curve of arectifier is shown in the figure. The averagevalue of output current in this case is ....



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Options:

A. 0

B. $\frac{I_0}{2}$

C. $\frac{2I_0}{\pi}$

D. I_0

Answer: C

Solution:

The current can be written as $I = I_0 \sin \omega t$, where I_0 is the highest value (peak current), and ω is the angular frequency.

To find the average value of the current (I_{av}), we need to find the average over half the cycle (because the current repeats every half cycle):

$I_{\text{av}} = \frac{1}{T/2} \int_0^{T/2} I\, dt$ where T is the time for one full cycle.

Plug in the current equation:

$I_{\text{av}} = \frac{2}{T} \int_0^{T/2} I_0 \sin \omega t\, dt$

Take out constants and solve the integral:

$I_{\text{av}} = \frac{2I_0}{T} \left[\frac{-\cos \omega t}{\omega}\right]_0^{T/2}$

Put in the values for $t = 0$ and $t = T/2$:

$I_{\text{av}} = \frac{2I_0}{T\omega} \left(-\cos(\omega \frac{T}{2}) + \cos(0)\right)$

Since $\omega = \frac{2\pi}{T}$, then $\omega \frac{T}{2} = \pi$:

$I_{\text{av}} = \frac{2I_0}{T\omega} [-\cos(\pi) + \cos(0)]$

We know $\cos(\pi) = -1$ and $\cos(0) = 1$:

$I_{\text{av}} = \frac{2I_0}{T\omega} [-(-1) + 1] = \frac{2I_0}{T\omega} [1 + 1] = \frac{2I_0}{T\omega} \times 2$

Now replace ω with $2\pi/T$:

$I_{\text{av}} = \frac{2I_0}{T \times \frac{2\pi}{T}} \times 2 = \frac{2I_0}{2\pi} \times 2 = \frac{2I_0}{\pi}$

So, the average current is: $I_{\text{av}} = \frac{2I_0}{\pi}$

Question37

A change of $0.04 \mathrm{~V}$ takes place between the base and the emitter when an input signal is connected to the common emitter transistor amplifier. As a result, $20 \mu \mathrm{A}$ change takes place in the base current and a change of $2 \mathrm{~mA}$ takes place in the collector current. The input resistance and AC current gain are

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Options:

A. $1 \mathrm{k} \Omega$ and 100

B. $2 \mathrm{k} \Omega$ and 100

C. $2 \mathrm{k} \Omega$ and 1000

D. $1 \mathrm{k} \Omega$ and 200

Answer: B

Solution:

Given, change in base emitter voltage,

$\Delta V_{BE}=0.04 \mathrm{~V}$

Change in base current, $\Delta I_B=20 \mu \mathrm{A}$

Change in collector current, $\Delta I_C=2 \mathrm{~mA}$

$\because$ Input resistance,

$$\begin{aligned} R_{\text{in}} & =\frac{\Delta V_{BE}}{\Delta I_B} \\ & =\frac{0.04}{20 \times 10^{-6}}=2 \times 10^3 \Omega \\ & =2 \mathrm{k} \Omega \end{aligned}$$

current gain, $$\begin{aligned} \beta & =\frac{\Delta I_C}{\Delta I_B} \\ & =\frac{2 \times 10^{-3}}{20 \times 10^{-6}}=10^2=100 \end{aligned}$$

Question38

The truth table given below corresponds to logic gate.

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

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Options:

A. NAND

B. OR

C. AND

D. XOR

Answer: B

Solution:

Given,

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

Here, $X = A + B$

$\therefore$ It is an output of OR gate.

Question39

A transistor is connected in common emitter configuration. The collector supply is 8 V and the voltage drop across a resistor of 800Ω in the collector circuit is 0.5 V. If the current gain factor α is 0.96, then the base current is

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Options:

A. $2.6 \times 10^{-5}\text{ A}$

B. $3.6 \times 10^{-5}\text{ A}$

C. $5.6 \times 10^{-5}\text{ A}$

D. $6.6 \times 10^{-5}\text{ A}$

Answer: A

Solution:

Given, collector voltage, $V_c = 8V$

Voltage drop across resistor, $R = 800\Omega$

and $V = 0.5\text{ V}$

Current gain, $\alpha = 0.96$

Let, collector, emitter and base current be I_C, I_E and I_B, respectively.

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

and $I_E = I_B + I_C$

$\because \alpha = \frac{I_C}{I_B+I_C} = \frac{1}{\frac{I_B}{I_C}+1}$

$\Rightarrow \frac{I_B}{I_C} = \frac{1}{\alpha} - 1$

$= \frac{100}{96} - 1 = \frac{4}{96} = 0.042$

$$\Rightarrow \quad I_B = 0.042 I_C = 0.042 \times \frac{0.5}{800}\left(\because I_C = \frac{V}{R}\right)$$

$$= \frac{42 \times 10^{-3} \times 5 \times 10^{-1}}{800}$$

$$= 2.625 \times 10^{-5} \text{ A}$$
