Important Questions for Class 12 Physics Chapter 14 Semiconductor Electronics Materials Devices and Simple Circuits Class 12 Important Questions

December 6, 2019 by Sastry CBSE

Important Questions for Class 12 Physics Chapter 14 Semiconductor Electronics Materials Devices and Simple Circuits Class 12 Important Questions

Semiconductor Electronics Materials Devices and Simple Circuits Class 12 Important Questions Very Short Answer Type

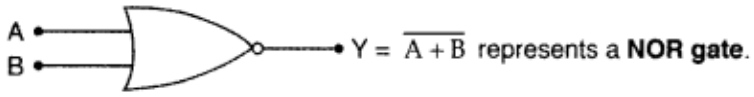
Question 1.

a reason, why GaAs is most commonly used in making of a solar cell. (All India 2008)

Question 3.

Give the logic symbol of NOR gate. (All India 2009)

Answer:



Question 4.

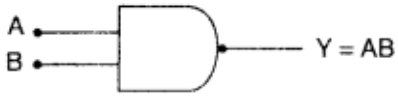
Give the logic symbol of NAND gate. (All India 2009)

Answer:

Question 5.

Give the logic symbol of AND gate. (All India 2009)

Answer:



Question 6.

In a transistor, doping level in base is increased slightly. How will it affect

(i) collector current and

(ii) base current? (Delhi 2011)

Answer:

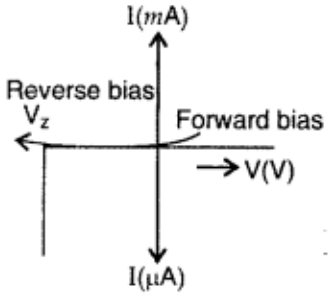
Increasing base doping level will decrease base resistance and hence increasing base current, which results in a decrease in collector current.

Answer:

n-type semiconductor	*p-type semiconductor*
The electron density (n_e) is much greater than the hole density (n_h), *i.e.*, $n_e >> n_h$.	The hole density (n_h) is much greater than the electron density (n_e), *i.e*, $n_h >> n_e$.

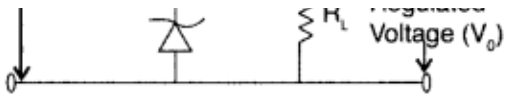
Question 9.

The figure shows the V-I characteristic of a semi conductor device. Identify this device. Explain briefly, using the necessary circuit diagram, how this device is used as a voltage regulator. (Comptt. Delhi 2011)



Answer:

(i) The semiconductor diode used is a Zener diode.



Zener diode as a DC voltage regulator

(iii) Zener diode as a voltage regulator

Principle : When a zener diode is operated in the reverse breakdown region, the voltage across it remains practically constant (equal to the breakdown voltage Vz) for a large change in the reverse current. If the input voltage increases, the current through R_S and zener diode also increases. This increases the voltage drop across R_S without any change in the voltage across the zener diode. This is because in the breakdown region, zener voltage remains constant even though the current through the zener diode changes. Similarly, if the input voltage decreases, the voltage across R_S decreases without any change in the voltage across the zener diode. Thus any increase/decrease of the input voltage results in increase/ decrease of the voltage drop across R_S without any change in voltage across zener diode. Hence the zener diode acts as a voltage regulator.

Question 10.

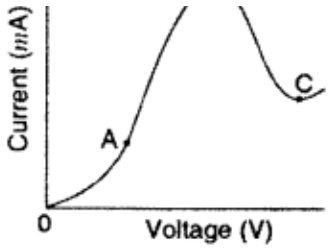
How does the depletion region of a p-n junction diode get affected under reverse bias? (Comptt. Delhi 2011)

Answer:

Depletion region widens under reverse bias.

Question 11.

How does the width of depletion region of a p-n junction diode change under forward bias?

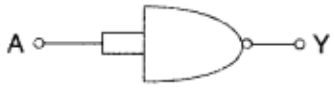


Answer:

Between the region B and C, the semiconductor has a negative resistance.

Question 13.

Write the truth table for a NAND gate as shown in the figure. (Comptt. All India 2013)



Answer:

Truth table for NAND gate

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

Answer:

Truth Table

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

This combination acts as AND gate.

Question 16.

Write the truth table of a two point input NAND gate. (Comptt. All India 2013)

Answer:

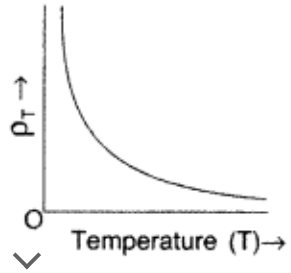
Truth Table:

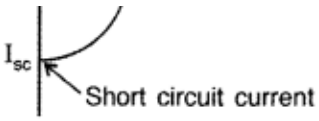
A	B	$Y = \overline{AB}$
0	0	1
0	1	1
1	0	1
1	1	0

Question 17.

Show variation of resistivity of Si with temperature in a graph. (Delhi 2014)

Answer:





Question 19.

Draw the logic symbol of NAND gate and give its Truth Table. (Comptt. All India 2015)

Answer:

Symbol of NAND Gate

Truth table

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

Question 20.

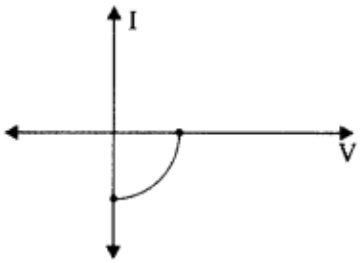
Identify the logic gate whose output equals 1 when both of its inputs are 0 each. (Comptt. Delhi 2015)

Answer:

NAND gate or NOR gate.

Question 21.

Name the junction diode whose I-V characteristics are drawn below: (Delhi 2015)



Answer:

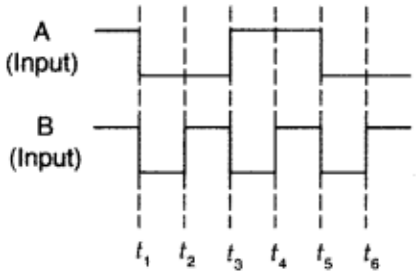
Solar cell

	semiconductor	*semiconductor*
1.	The pure semiconductors (Ge or Si) in which the electrical conductivity is totally governed by electrons thermally excited from the valence bond to the conduction bond are called intrinsic semiconductors.	A tetravent semiconductor of Si or Ge doped with trivalent impurity atoms of B, Al or In is called a *p*-type semiconductor.
2.	They have equal number of densities of free electrons and holes *i.e.* $n_e = n_h$.	It has more density of holes than density of free electrons *i.e.* $n_h >> n_e$.

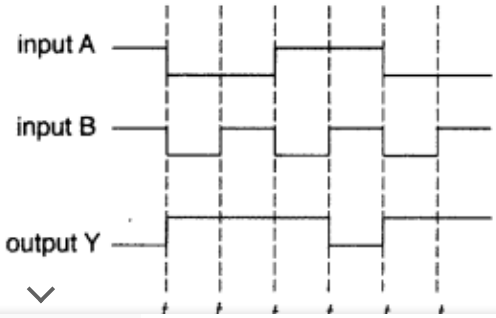
(ii) In a p-type semiconductor, the trivalent impurity atom shares its three valence electrons with the three tetravalent host atoms while the fourth bond remains unbounded. The impurity atom as a whole is electrical neutral. Hence the p-type semiconductor is also neutral.

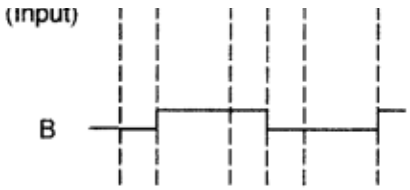
Question 23.

The given inputs A, B are fed to a 2-input NAND gate. Draw the output wave form of the gate.



Answer:

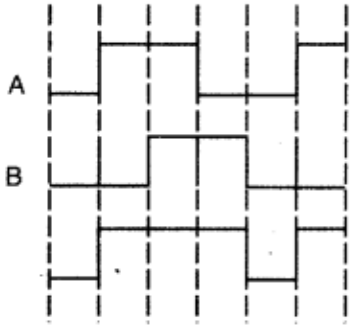




Answer:

A	B	$\overline{A.B} = Y_1$	$\overline{Y}_1 = X$
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

∴ The logic gate is *OR gate.*



Output Waveform

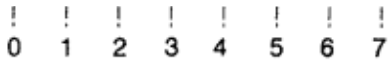
Question 25.

If the output of a 2 input NOR gate is fed as both inputs A and B to another NOR gate, write down a truth table to find the final output, for all combinations of A, B. (Delhi 2008)

Answer:

The truth table is:

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



Answer:

Truth table is :

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

Symbol

This truth table represents a *'NAND' gate.*

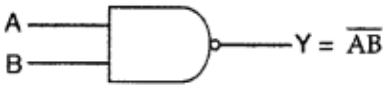
Question 27.

The output of a 2-input AND gate is fed to a NOT gate. Give the name of the combination and its logic symbol. Write down its truth table. (Delhi 2009)

Answer:

Name : NAND gate.

Its symbol is :

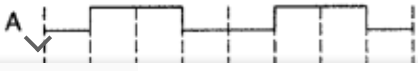


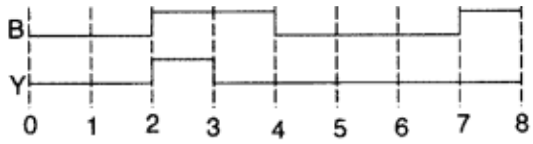
Truth table is :

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

Question 28.

(i) Sketch the output waveform from an AND gate for the inputs A and B shown in the figure.





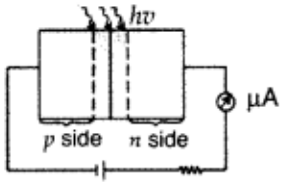
(ii) If this output of AND gate is fed to a NOT gate, the result will be a NAND gate.

Question 29.

Draw the circuit diagram of an illuminated photodiode in reverse bias. How is photodiode used to measure light intensity? (Delhi 2010)

Answer:

A measurement of the change in the reverse. saturation current on illumination can give the values of light intensity because photocurrent is pro-portional to incident light intensity.

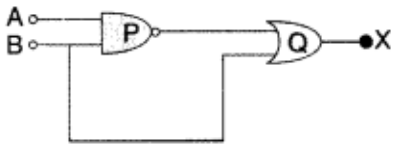


A reverse biased photodiode illuminated with light.

Question 30.

(i) Identify the logic gates marked P and Q in the given logic circuit.

(ii) Write down the output at X for the inputs A = 0, B = 0 and A = 1, B = 1. (All India 2010)



Answer:

(i) P is NAND gate and Q is OR gate.

(ii)

A	B	$\overline{AB} = \overline{A} + \overline{B}$	$(\overline{A} + \overline{B}) + B$
0	0	1	1
1	1	0	1

Answer:

(i) P is NOT gate

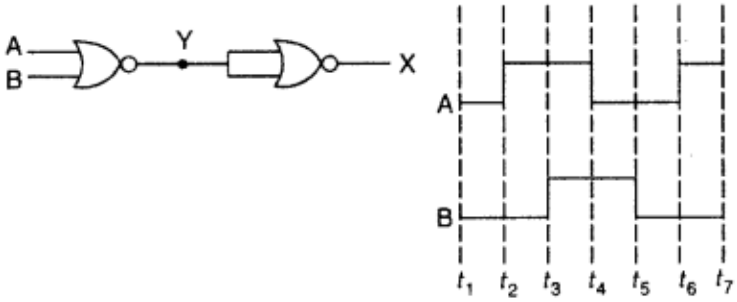
Q is OR gate

(ii)

Input		Output
A	B	$X = \overline{A} + B$
0	0	1
1	1	1

Question 32.

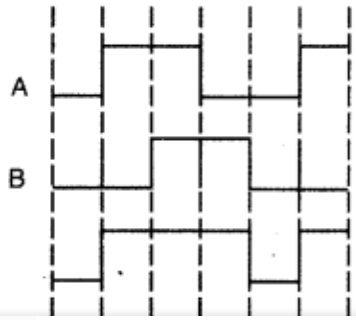
Draw the output wave form at X, using the given inputs A and B for the logic circuit shown below. Also, identify the logic operation performed by this circuit. (Delhi 2011)

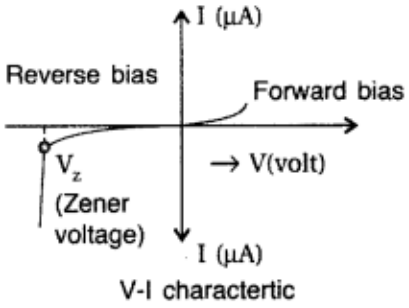


Answer:

A	B	$\overline{A.B} = Y_1$	$\overline{Y}_1 = X$
0	0	1	0
0	1	1	0
1	0	1	0
1	1	0	1

∴ The logic gate is *OR gate*.

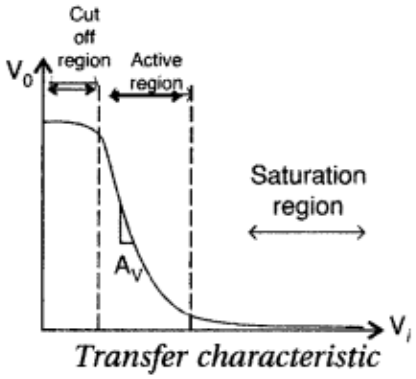




V-I charactertic

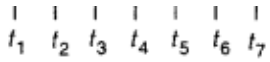
Working principle : When a zener diode is operated in the reverse break down region, the voltage across it remains practically constant (equal to the break down voltage V-I) for a large change in the reverse current.

Question 34.
Draw the transfer characteristic curve of a base biased transistor in CE configuration. Explain clearly how the active region of the VD versus V, curve in a transistor is used as an amplifier. (Delhi 2011)
Answer:
For using the transistor as an amplifier we will use the active region of the V0 vs. V, curve. The slope of the linear part of the curve represents the rate of change of the output with input. It is negative, that is why as input voltage of the CE amplifier increases its output voltage decreases and the output is said to be out of phase with input.



Transfer characteristic

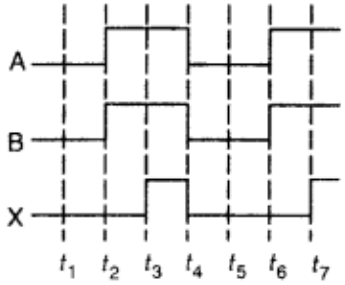
Question 35.
Draw the output waveform at X, using the given inputs A and B for the logic circuit shown below. Also, identify the logic operation performed by this circuit.



Answer:

Both are *NAND Gates.*
Truth table is :

Input		Output		
A	**B**	**Y = A.B**	**$\bar{Y}$**	**X**
0	0	0	1	0
0	1	0	1	0
1	0	0	1	0
1	1	1	0	1



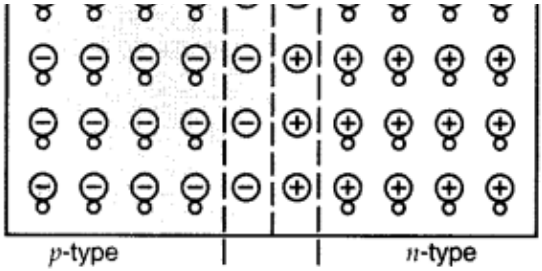
Question 36.
How is forward biasing different from reverse biasing in a pn junction diode? (Delhi 2011)
Answer:
Forward biasing : If the positive terminal of a battery is connected to a p-side and the negative terminal to the 72-side, then the p-n junction is said to be forward biased. Here the applied voltage V opposes the barrier voltage VB. As a result of this

- the effective resistance across the p-n junction decreases.
- the diffusion of electrons and holes into the depletion layer which decreases its width.

Reverse biasing : If the positive terminal of a battery is connected to the 72-side and negative terminal to the p-side, then the p-n junction is said to be reverse biased.
The applied voltage V and the barrier potential V_B are in the same direction. As a result of this

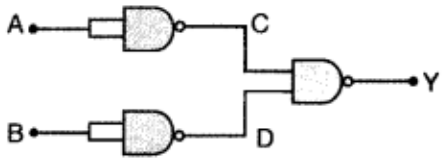
- the resistance of the p-n junction becomes very large.
- the majority charge carriers move away from the junction, increasing the width of the depletion layer.

Question 37.
Explain how a depletion region is formed in a junction diode. (Delhi 2011)
Answer:



The p-region near the junction is left with immobile -ve ions and n-region near the junction is left with +ve ions as shown in the figure. The small region in the vicinity of the junction which is depleted of free charge carriers and has only immobile ions is called the depletion layer. In the depletion region, a potential difference VB is created, called potential barrier as it creates an electric field which opposes the further diffusion of electrons and holes.
(i) In forward biased, the width of depletion region is decreased.
(ii) In reverse biased, the width of depletion region is increased.

Question 38.
Write the truth table for the logic circuit shown below and identify the logic operation performed by this circuit.



Answer:
Truth table :

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

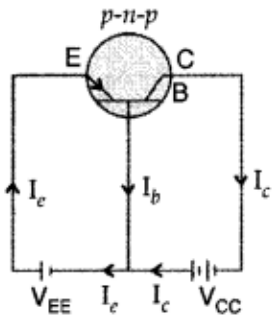
This combination acts as *OR gate.*

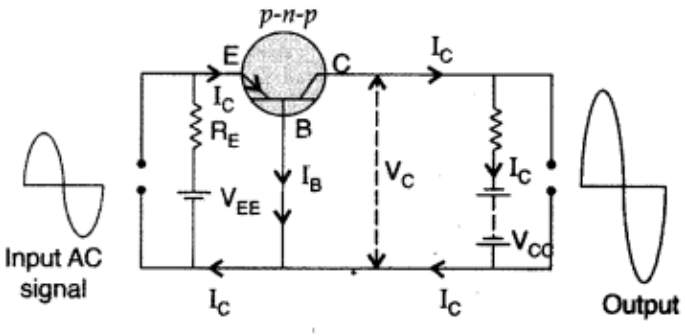
Question 39.
The current in the forward bias is known to be more (~mA) than the current in the reverse bias (~μA). What

regulated with emitter-base junction forward biased and base-collector junction reverse biased. (All India 2012)

Answer:

In a p-n-p transitor, the heavily doped emitter which is p-type has a majority charge carrier of holes. These holes when move towards 21-type base get neutralized by e^- in base. The majority carriers enter the base region in large numbers. As the base is thin and lightly doped, the majority carriers (holes) swamp the small number of electrons there and as the collector is reverse biased, these holes can easily cross the junction and enter the collector.





Question 41.

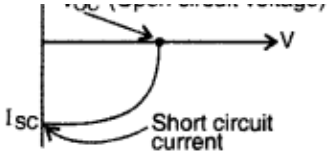
(a) Why are Si and GaAs preferred materials for fabrication in solar cells?

(b) Draw V-I characteristic of solar cell and mention its significance.(Comptt. All India 2012)

Answer:

(a) The important criteria for the fabrication of a material for solar cell fabrication are :

(*b*) It does not draw current but supplies the same to the load.

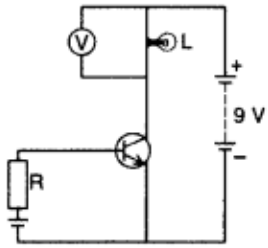


Question 42.

In the given circuit diagram, a voltmeter 'V' is connected across a lamp 'L'. How would

(i) the brightness of the lamp and

(ii) voltmeter reading 'V' be affected, if the value of resistance 'R' is decreased? Justify your answer. (Delhi 2012)



Answer:

When the value of R is decreased, forward biasing of emitter-base junction increases. As a result of this, the emitter current and hence the collector current increases. Therefore :

(i) The bulb glows more brightly.

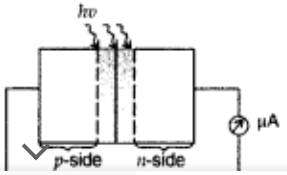
(ii) The reading of voltmeter is increased.

Question 43.

Explain, with the help of a circuit diagram, the working of a photo-diode. Write briefly how it is used to detect the optical signals. (Delhi 2013)

Answer:

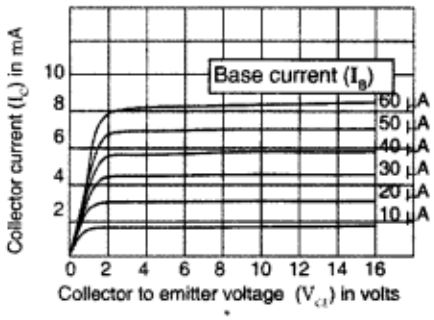
Working of a photo-diode: Its working is based on photo conduction from light. The conductivity of p-n junction photodiode increases with the increase in intensity of light falling in it.



incident on the p-n junction of photodiode. This current is called dark current. A photodiode can turn its current ON and OFF in nanoseconds. Hence it can be used to detect the optical signals.

Question 44.
Mention the important considerations required while fabricating a p-n junction diode to be used as a Light Emitting Diode (LED). What should be the order of band gap of an LED if it is required to emit light in the visible range? (Delhi 2013)
Answer:
The important considerations required while fabricating a p-n junction diode to be used as a Light Emitting Diode (LED) are :
(i) The Light Emitting efficiency is maximum.
(ii) The reverse breakdown voltage of LEDs are very low. Care should be taken that high reverse voltages do not appear across them.
(iii) The semiconductor used for fabrication of visible, LEDs must have a band gap of 1.8 eV (spectral range of visible light is from about 0.4 μm to 0.7 μm i.e. from about 3 eV to 1.8 eV).

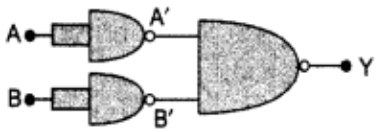
Question 45.
Draw typical output characteristics of an n-p-n transistor in CE configuration. Show how these characteristics can be used to determine output resistance. (All India 2013)
Answer:
Typical output characteristic curves :



$$\text{Output Resistance, } r_0 = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_B}$$

Question 46.

In the circuit shown in the figure, identify the equivalent gate of the circuit and make its truth table.(All India 2013)



Answer:

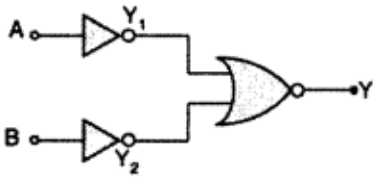
The equivalent gate is OR.

Truth table :

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

Question 47.

In the circuit shown in the figure, identify the equivalent gate of the circuit and make its truth table.
(All India 2013)



Answer:

AND Gate

Truth table:

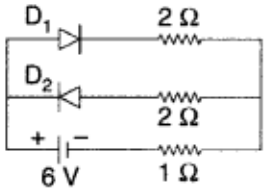
A	B	Y_1	Y_2	Y
0	1	1	0	0
1	0	0	1	0
0	0	1	1	0
1	1	0	0	1

Answer:

AND gate
Truth table :

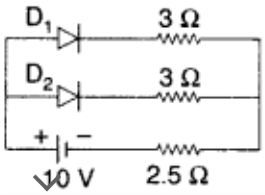
A	B	A'	B'	$Y' = A' + B'$	$Y = \overline{Y}$
0	1	1	0	1	0
1	0	0	1	1	0
0	0	1	1	1	0
1	1	0	0	0	1

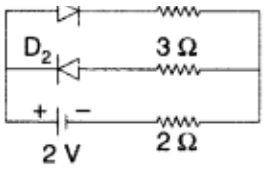
Question 49.
Assuming that the two diodes Dj and D2 used in the electric circuit shown in the figure are ideal, find out the value of the current flowing through 1Ω resistor. (Comptt. Delhi 2013)
Answer:
Since the diodes used are ideal, the diode Dj in forward bias will conduct the current in forward direction, while diode D_2 in reverse bias will not allow any current to flow.
As such, 2Ωwith D_1 and 1Ω are in series, the net resistance of the circuit will be



Hence the value of the current flowing through 1Ω resistor = 2A

Question 50.
Assuming that the two diodes D_1 and D_2 used in the electric circuit shown in the figure are ideal, find out the value of the current flowing through 2.5 Ω resistor. (Comptt. Delhi 2013)
Answer:

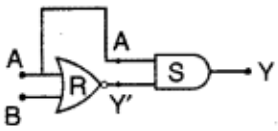




∴ Value of the current flowing through 2Ω resistor = 0.4A

Question 52.

Write the truth table for the combination of the gates shown. Name the gates used. (Delhi 2013)



Answer:

R gate = OR

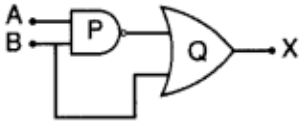
S gate = AND

Truth Table

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

Question 53.

Identify the logic gates marked 'P' and 'Q' in the A given circuit. Write the B truth table for the combination. (Delhi 2013)



Answer:

P gate = NAND

1 1	0 1	1 1

Question 54.

Explain, with the help of a circuit diagram, the working of a p-n junction diode as a half-wave rectifier. (All India 2013)

Answer:

Rectifier. A rectifier is a circuit which converts an alternating current into direct current.

p-n diode as a half wave rectifier. A half wave rectifier consists of a single diode as shown in the circuit diagram. The secondary of the transformer gives the desired a.c. voltage across A and B.

In the positive half cycle of a.c., the voltage at A is positive, the diode is forward biased and it conducts current.

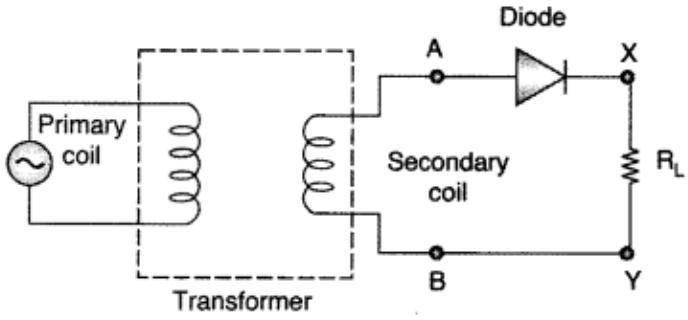


Fig. (a)

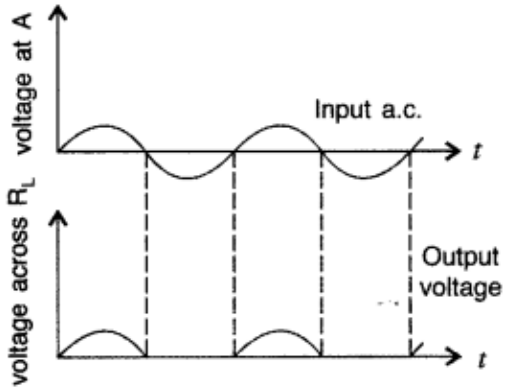
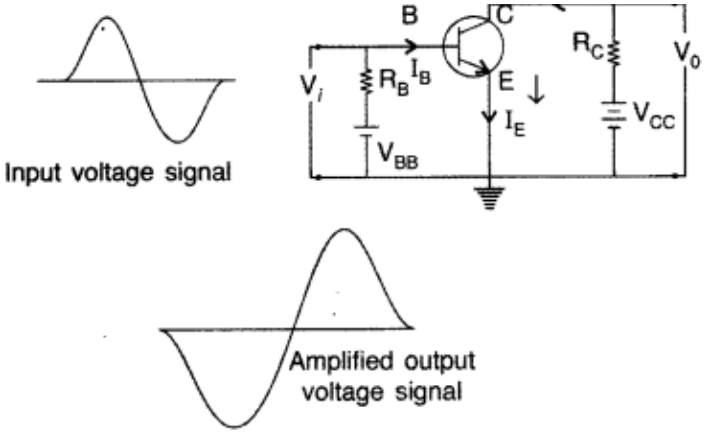


Fig. (b)

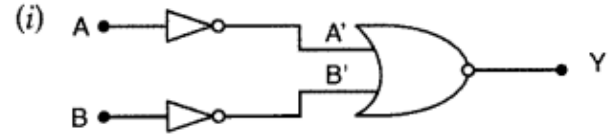


Condition: The linear portion of the active region of the transistor is used as an amplifier.

Question 56.

The outputs of two NOT gates are fed to a NOR gate. Draw the logic circuit of the combination of gates. Give its truth table. Identify the gate represented by this combination. (Comptt. Delhi 2014)

Answer:



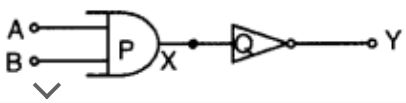
(ii) **Logic circuit**

Input				*Output*
A	*A'*	*B*	*B'*	*Y*
0	1	0	1	0
0	1	1	0	0
1	0	0	1	0
1	0	1	0	1

(iii) Identification : **AND Gate**

Question 57.

Name the gates 'P' and 'Q' shown in the figure of logic circuit of logic circuit given below. Write the truth table for the combination of the gates and identify the equivalent gate. (Comptt. Delhi)

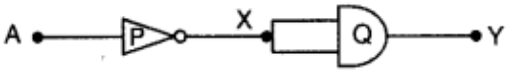


1	1	0

Truth table for combination of gates

Question 58.

Name the gates 'F and 'Q' in the logic circuit shown in the figure. Write the truth table for the combination of the gates and identify the equivalent gate.



Answer:

P gate : NOT

Q gate : AND

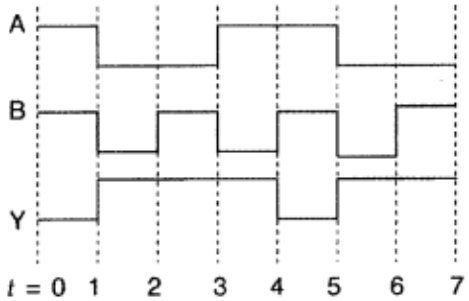
Identification of equivalent gate : NAND

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

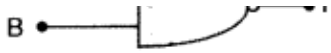
Truth table for combination of gates

Question 59.

The input waveforms 'A' and 'B' and the output waveform 'Y' of a gate are shown. Name the gate it represents, write its truth table and draw the logic symbol of this gate. (Comptt. All India 2014)

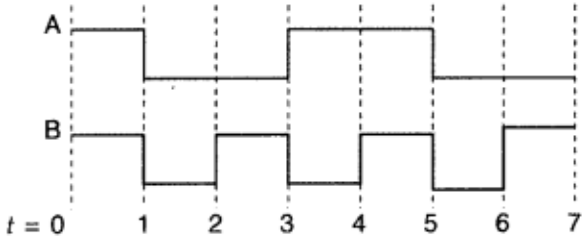


0	1	1
1	0	1
1	1	0



Question 60.

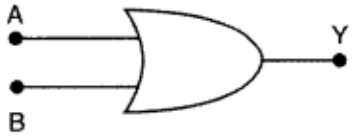
(a) Write the truth table for an OR gate and draw its logic symbol.



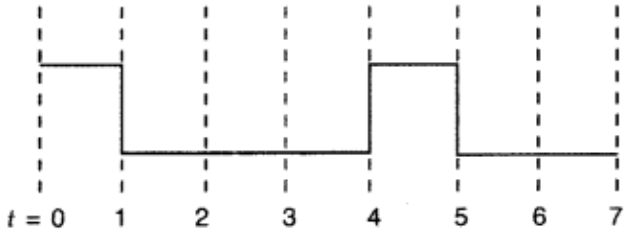
(b) The input waveforms A and B, shown here, are fed to an AND gate. Find the output waveform. (Comptt. All India 2014)

Answer:

Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

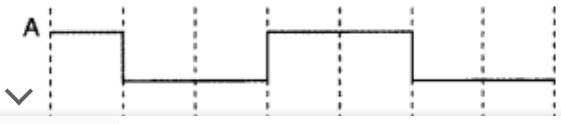


(b) Output waveform



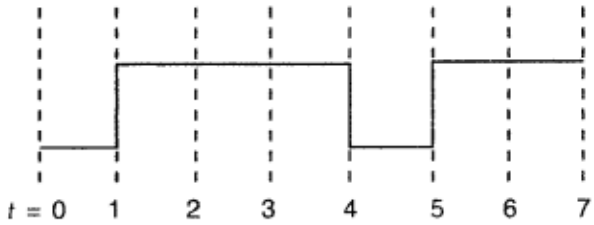
Question 61.

(i) Write the truth table for an AND gate and draw its logic symbol.



0	0	0
0	1	0
1	0	0
1	1	1

(*ii*) **Output waveform :**



Question 62.

Distinguish between 'intrinsic' and 'extrinsic' semiconductors. (Delhi 2015)

Answer:

Intrinsic Semiconductor	*Extrinsic Semiconductor*
1. Without any impurity atoms.	1. Doped with trivalent/pentavalent impurity atoms.
2. $n_e = n_h$.	2. $n_e \neq n_h$

Question 63.

The following data was obtained for a given transistor :

$V_{CE} \rightarrow$	10.0V	10.0 V
$V_{BE} \rightarrow$	0.82 V	0.72V
$I_B \rightarrow$	80 µA	30 µA

For this data, calculate the input resistance of the given transistor. (Comptt. Delhi 2015)

Calculation of input resistance of the given transistor

$$\text{Input Resistance } r_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)$$

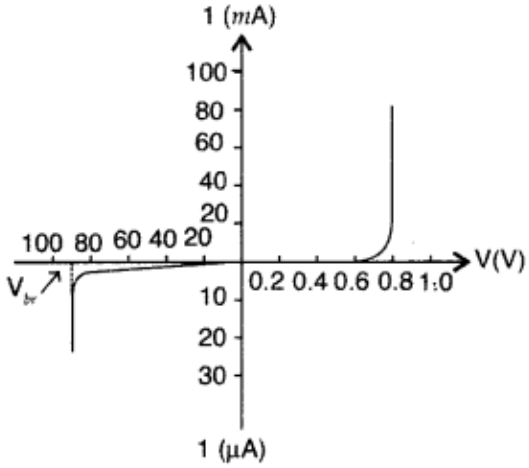
$$= \frac{(0.82 - 0.72)}{(80 \times 10^{-6} - 30 \times 10^{-6})}$$

$$= \frac{(0.82 - 0.72)\text{V}}{(80 - 30) \times 10^{-6}} = \frac{0.10}{50 \times 10^{-6}}$$

$$= \frac{100 \times 10^3}{50} = \mathbf{2000\Omega}$$

Question 64.

The figure given below shows the V-I characteristic of a semiconductor diode.



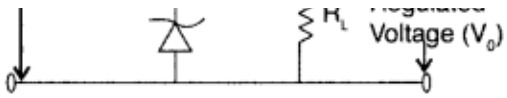
(i) Identify the semiconductor diode used.

(ii) Draw the circuit diagram to obtain the given characteristic of this device.

(iii) Briefly explain how this diode can be used as a voltage regulator. (Delhi 2015)

Answer:

(i) The semiconductor diode used is a Zener diode.



Zener diode as a DC voltage regulator

(iii) Zener diode as a voltage regulator

Principle : When a zener diode is operated in the reverse breakdown region, the voltage across it remains practically constant (equal to the breakdown voltage Vz) for a large change in the reverse current. If the input voltage increases, the current through R_S and zener diode also increases. This increases the voltage drop across R_S without any change in the voltage across the zener diode. This is because in the breakdown region, zener voltage remains constant even though the current through the zener diode changes. Similarly, if the input voltage decreases, the voltage across R_S decreases without any change in the voltage across the zener diode. Thus any increase/decrease of the input voltage results in increase/ decrease of the voltage drop across R_S without any change in voltage across zener diode. Hence the zener diode acts as a voltage regulator.

Question 65.

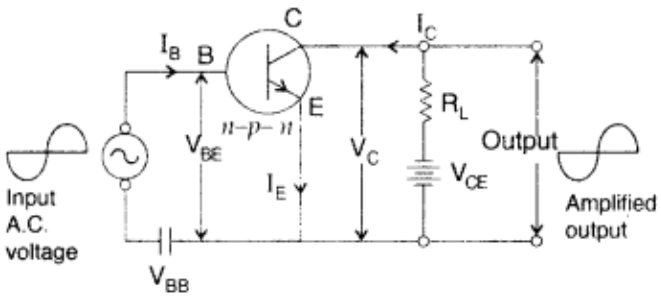
Draw the labelled circuit diagram of a common-emitter transistor amplifier. Explain clearly how the input and output signals are in opposite phase. (All India 2008)

Answer:

The diagram shows the circuit diagram of a n-p-n trasistor as a CE amplifier. In this diagram it is evident that the base-emitter junction is forward biased whereas collector emitter junction is set to be reverse biased for an ideal operation as an amplifier. In absence of any input a.c. signal the p.d. between collector and emitter is given by

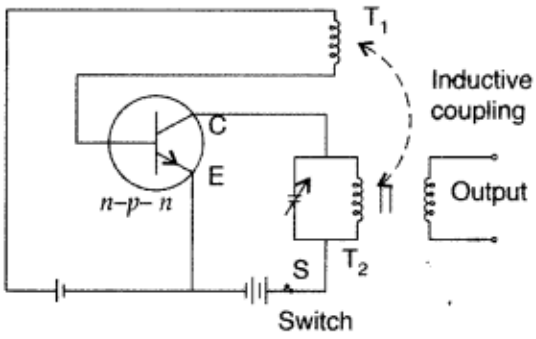
$$V_C = V_{CE} - I_C R_L$$

...where [V_{CE} is the voltage of battery V_{CE}] ...(*i*)



any external input signal by giving a positive feedback to the input circuit through inductive coupling or RC/LC network."

Oscillator action : In an ideal n-p-n biased transistor, when input base emitters junction and output base collector junction are forward and reverse biased respectively, a high collector current I_C flows through the circuit. If in circuit switch S is on, this current I_C will start flowing in the emitter circuit through the inductive coupling between coils T_1 and T_2, which provides the +ve feedback output to input and hence make I_E maximum. In the absence of +ve feedback the IE thus decreases making the circuit back to its original state. This process continues and ocillations are produced.



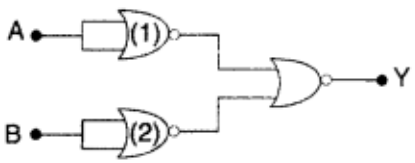
The f_R resonance frequency is thus given by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Question 67.

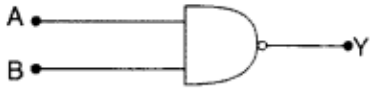
The inputs A and B are inverted by using two NOT gates and their outputs are fed to the NOR gate as shown:

Analyse the action of the gates (1) and (2) and identify the logic gate of the complete circuit so obtained. Give its symbol and the truth table. (All India 2008)



gate.

Symbol :



Truth table is

A	*B*	*Y = A . B*
0	0	0
0	1	0
1	0	0
1	1	1

Question 68.

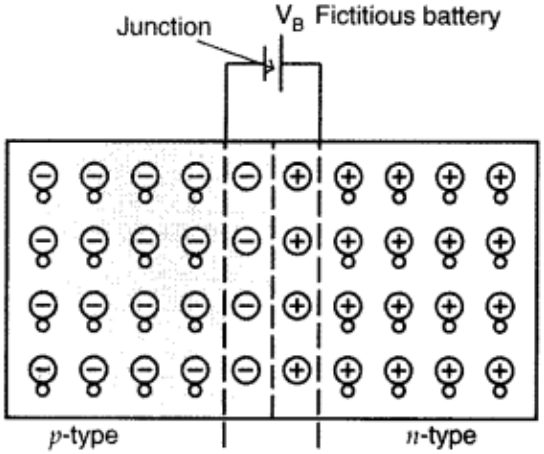
With the help of a suitable diagram, explain the formation of depletion region in a p-n junction. How does its width change when the junction is

(i) forward biased, and

(ii) reverse biased? (All India 2008)

Answer:

As soon as a p-n junction is formed, the majority charge carriers begin to diffuse from the regions of higher concentration to the regions of lower concentrations. Thus the electrons from the n-region diffuse into the p-region and where they combine with the holes and get neutralised. Similarly, the holes from the p-region diffuse into the n-region where they combine with the electrons and get neutralised. This process is called electron-hole recombination.

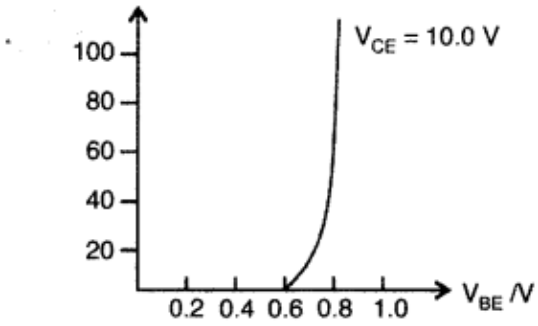


The p-region near the junction is left with immobile -ve ions and n-region near the junction is left with +ve

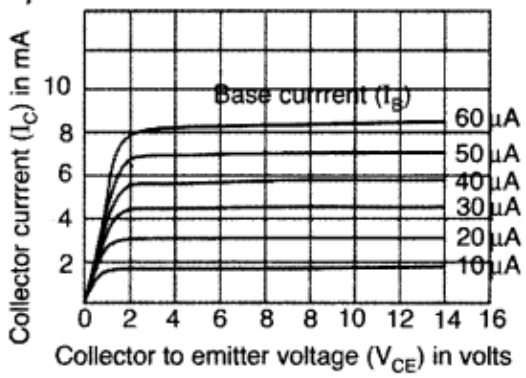
waveforms of the signal. Write the expression for its voltage gain. (All India 2009)

Answer:

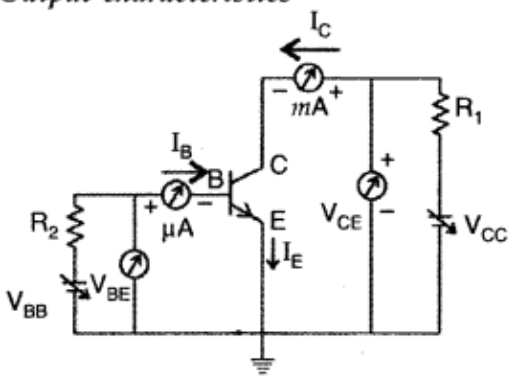
(i) (a) Common emitter configuration of n-p-n transistor



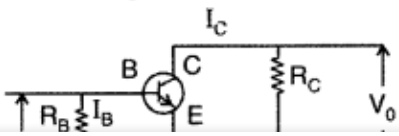
(b) Input characteristics



(c) Output characteristics



(ii) Transistor as an amplifier (C.E. configuration) : The circuit diagram of a common emitter amplifier using n-p-n transistor is given below :

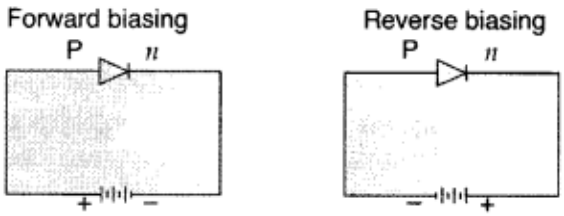


collector becomes less positive.

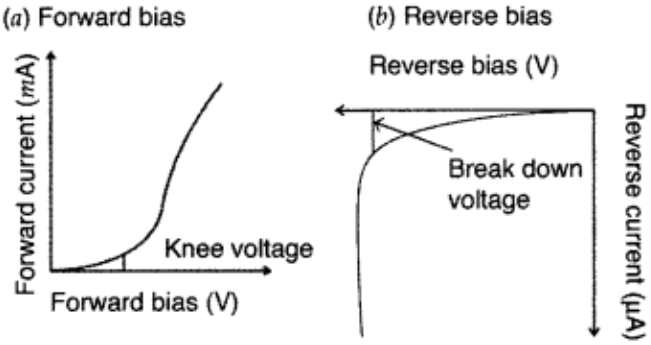
During the negative half cycle of the input, the forward bias is decreased resulting in decrease in I_E and hence I_C. Thus V_{CC} would increase making the collector more positive. Hence in a common-emitter amplifier, the output voltage is 180° out of phase with the input voltage.

$$A_V = \frac{V_0}{V_i} = \frac{I_C R_C}{I_B R_B} = \beta\left(\frac{R_C}{R_B}\right) \qquad \left[\because \beta = \frac{I_C}{I_B}\right.$$

Question 70.
(i) With the help of circuit diagrams, distinguish between forward biasing and reverse biasing of a p-n junction diode.
(ii) Draw V-I characteristics of a p-n junction diode in
(a) forward bias,
(b) reverse bias. (All India 2009)
Answer:
(i)

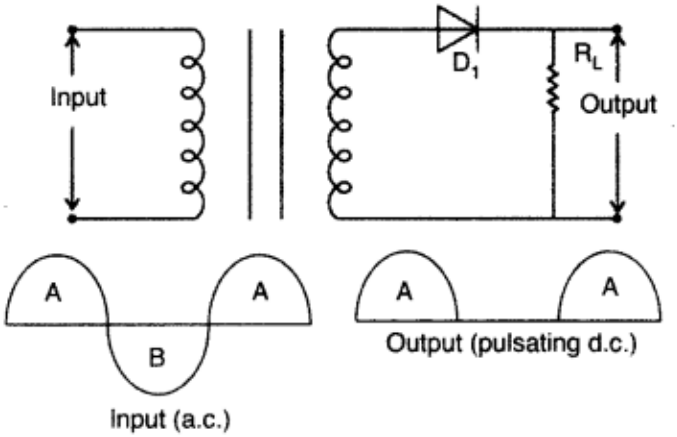


(ii) *V-I characteristics of a p-n junction diode*



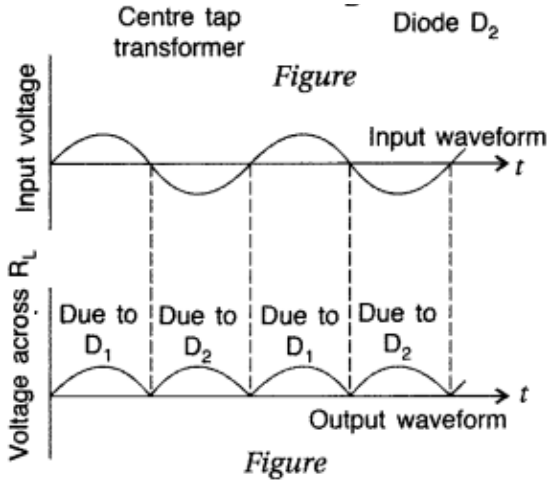
Question 71.

wide range. This property of the Zener diode is used for regulating voltages so that they are constant.
Semiconductor diode as a half wave Rectifier : The junction diode D, supplies rectified current to the band during one half of the alternating input voltage and is always in the same direction. During the first half cycles of the alternating input voltage, junction diodes D_1 will conduct each permitting current to flow during one half cycle whenever its p-terminal is positive with respect to the n-terminal.



The resulting output current is a series of unidirectional pulses with alternate gaps.

Question 72.
Draw a labelled diagram of a full wave rectifier circuit. State its working principle. Show the input-output waveforms. (All India 2009)
Answer:
p-n junction diode as full wave rectifier
A full wave rectifier consists of two diodes and special type of transformer known as centre tap transformer as shown in the circuit. The secondary of transformer gives the desired a.c. voltage across A and B.
During the positive half cycle of a.c. input, the diode D_1 is in forward bias and conducts current while D_2 is in reverse biased and does not conduct current. So we get an output voltage across the load resistor R_L.



Figure

Figure

During the negative half cycle of a.c. input, the diode D_1 is in reverse biased and does not conduct current while diode D_2 in forward biased and conducts current. So we get an output voltage across the load resistor R_L.

NOTE: This is a more efficient circuit for getting rectified voltage or current.

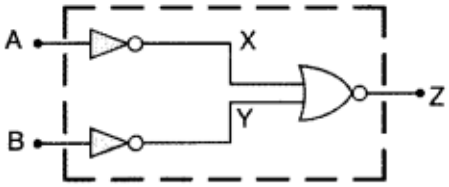
Let $I = I_0 \sin wt$ be the input current to be rectified

$\therefore$ The average current $= \frac{2I_0}{\pi}$

Hence output voltage $= \frac{2I_0}{\pi} R_L$

Question 73.

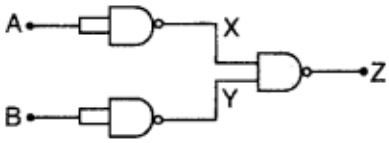
You are given a circuit below. Write its truth table. Hence, identify the logic operation carried out by this circuit. Draw the logic symbol of the gate it corresponds to.



A	B	Y = A.B
0	0	0
0	1	0
1	0	0
1	1	1

Question 74.

You are given a A circuit below. Write its truth table. Hence, identify the B logic operation carried out by this circuit. Draw the logic symbol of the gate it corresponds to. (All India 2011)



Answer:

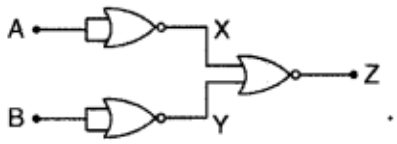
Truth table :

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

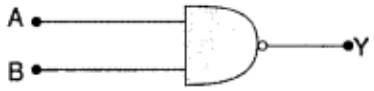
This combination acts as *OR gate.*

Question 75.

You are given a circuit below. Write its truth A table. Hence, identify the logic operation B carried out by this circuit. Draw the logic symbol of the gate it corresponds to. (All India 2011)



Symbol :



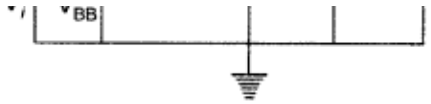
Truth table is

A	B	$Y = A . B$
0	0	0
0	1	0
1	0	0

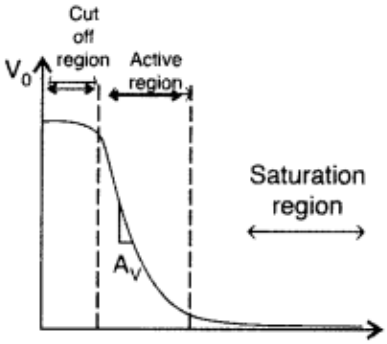
Question 76.
Draw the transfer characteristic of a base-biased transistor in CE configuration. Mark the regions where the transistor can be used as a switch. Explain briefly its working. (Comptt. Delhi 2011)
Answer:
Transistor as a switch. The circuit diagram of transistor as a switch is shown in Figure 1. Transfer characteristics. The graph between V_0 and V_i is called the transfer characteristics of the base-biased transistor, shown in Figure 2.

When the transistor is used in the cut off or saturation state, it acts as a switch.

As long as V_i is low and unable to forward bias the transistor, then V_0 is high. If V_i is high enough to drive the transistor into saturation, then V_0 is low. When the transistor is not conducting, it is said to be switched off and when it is driven into saturation, it is said to be switched on. This shows that a low input switches the

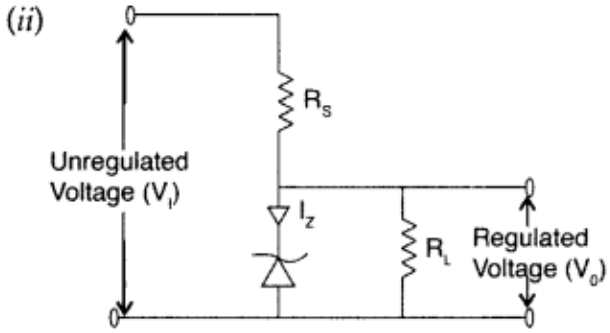


Base-biased transistor in CE configuration
Figure 1



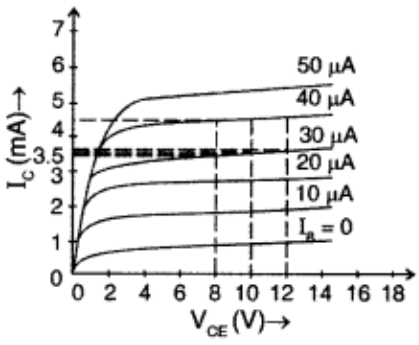
Transfer characteristics
Figure 2

Question 77.
The figure shows the V-I characteristics of a semiconductor device. Identify this device. Explain briefly, using the necessary circuit diagram, how this device is used as a voltage regulator. (Comptt. Delhi 2012)
Answer:
(i) The semiconductor diode used is a Zener diode.



Zener diode as a DC voltage regulator

(iii) Zener diode as a voltage regulator
Principle : When a zener diode is operated in the reverse breakdown region, the voltage across it remains practically constant (equal to the breakdown voltage Vz) for a large change in the reverse current. If the input voltage increases, the current through R_S and zener diode also increases. This increases the voltage



Determine

(i) dynamic output resistance

(ii) dc current gain and

(iii) ac current gain at an operating point

V_{CE} = 10 V, I_B = 30 μA (Delhi 2012)

Answer:

(*i*) Dynamic output resistance, $r_0 = \left(\frac{\Delta V_{CE}}{\Delta I_C}\right)_{I_b}$

From the graph, $\Delta V_{CE} = (12 - 8) = 4V$

$\Delta I_C = (3.7 - 3.5)$ mA

$= \mathbf{0.2\ mA}$

$\therefore$ Dynamic output resistance

$r_0 = \frac{4}{0.2 \times 10^{-3}} = \mathbf{20K\Omega}$

(*ii*) dc current gain, at 10 V, $I_C = 3.6$ mA

$\therefore \beta_{dc} = \frac{I_c}{I_b} = \frac{3.6 \times 10^{-3}}{30 \times 10^{-6}} = \mathbf{120}$

(*iii*) ac current gain, $\Delta I_b = 40\ \mu A - 30\ \mu A$

$= 10\ \mu A$

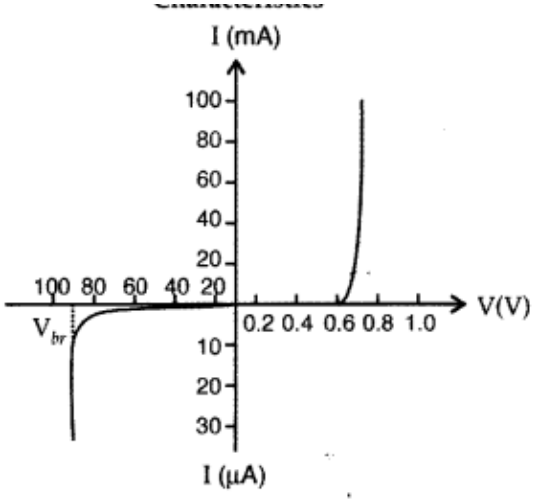
and $\Delta I_c = 4.7$ mA $- 3.6$ mA $= 1.1$ mA

$\therefore \beta_{ac} = \left(\frac{\Delta I_c}{\Delta I_b}\right) = \frac{1.1 \times 10^{-3}}{10 \times 10^{-6}} = \mathbf{110}$

Question 79.

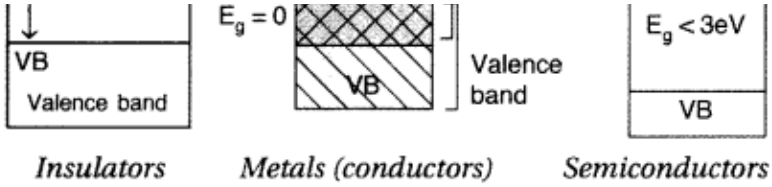
Draw V-I characteristics of a p-n junction diode.

Answer the following questions, giving reasons:



(ii) In reverse bias, reverse current through junction diode is due to minority charge carriers. As reverse bias voltage is increased, electric field at junction becomes significant. When reverse bias voltage becomes equal to zener voltage, electric field strength across junction becomes high. Electric field across junction is sufficient to pull valence electrons from the atom on p- side and accelerate them towards n-side. The movement of these electrons across the function account for high current which is observed at breakdown reverse voltage. Zener diode and photo diode operate under reverse bias.

Question 80.
Write any two distinguishing features between conductors, semiconductors and insulators on the basis of energy band diagrams. (All India 2012)
Answer:
Distinguishing features between conductors, semiconductors and insulators :
(i) Insulator. In insulator, the valence band is completely filled. The conduction band is empty and forbidden energy gap is quite large. So no electron is able to go from valence band to conduction band even if electric field is applied. Hence electrical conduction is impossible. The solid/ substance is an insulator.
(ii) Conductors (Metals). In metals, either the conduction band is partially filled or the conduction and valence band partly overlap each other. If small electric field is applied across the metal, the free electrons start moving in a direction opposite to the direction of electric field. Hence, metal behaves as a conductor.
(iii) Semiconductors. At absolute zero kelvin, the conduction band is empty and the valence band is filled. The material is insulator at low temperature. However the energy gap between valence band and conduction band is small. At room temperature, some valence electrons acquire thermal energy and jump



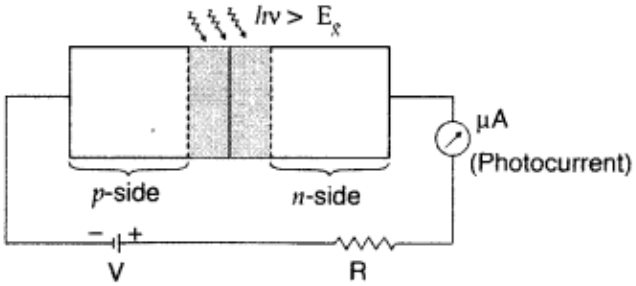
Question 81.
With what considerations in view, a photodiode is fabricated? State its working with the help of a suitable diagram.
Even though the current in the forward bias is known to be more than in the reverse bias, yet the photodiode works in reverse bias. What is the reason? (Delhi 2014)
Answer:
(a) Why is photodiode fabricated?

- It is fabricated with a transparent window to allow light to fall on diode.

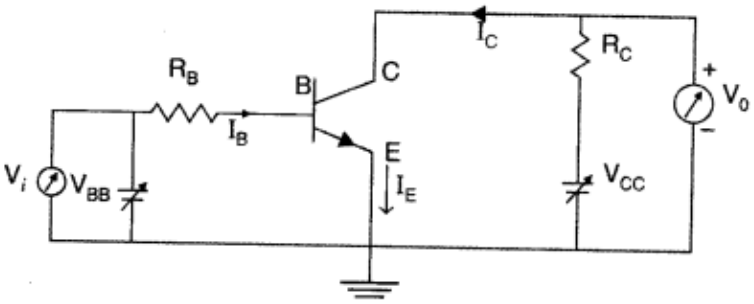
(b) Working of photodiode : When the
photodiode is illuminated with photons of energy ($hv > E_g$) greater than the energy gap

- of the semiconductor, electron-holes pairs are generated. These get separated due to the Junction electric field (before they recombine) which produces an emf.

(c) Diagram of photodiode



(d) Reason. It is easier to observe the change in the current, with change in light intensity, if a reverse bias is applied.



(*i*) **Input resistance** is defined as the ratio of base-emitter voltage to the change in base current at constant collector-emitter voltage :

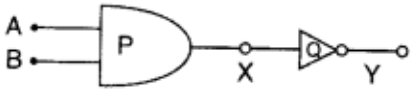
$$R_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$$

(*ii*) **Current amplification factor** is defined as the ratio of the change in collector current to the change in base current at a constant collector-emitter voltage when the transistor is in active state :

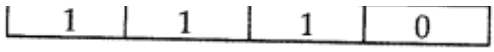
$$\beta_{ac} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$

The value of input resistance is determined from the slope of I_B versus V_{BE} plot at constant V_{CE}.
The value of current amplification factor is obtained from the slope of collector current I_C versus V_{CE} plot, using different values of I_B.

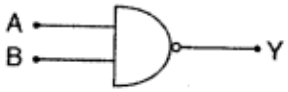
Question 83.
Identify the gates P and Q shown in A – the figure. Write B" the truth table for the combination of the gates shown.



Name the equivalent gate representing this circuit and write its logic symbol. (All India 2014)
Answer:
(i) R acts as AND gate; Q as NOT gate.



Equivalent gate is **'NAND'** and its logic symbol is :



Question 84.

Draw a circuit diagram of a C.E. transistor amplifier. Briefly explain its working and write the expression for

(i) current gain

(ii) voltage gain of the amplifier.

Answer:

n-p-n transistor as a common emitter amplifier :

Working: According to *Kirchoff's law,* emitter current I_t, base current (I_B) and collector current (I_C) are related as,

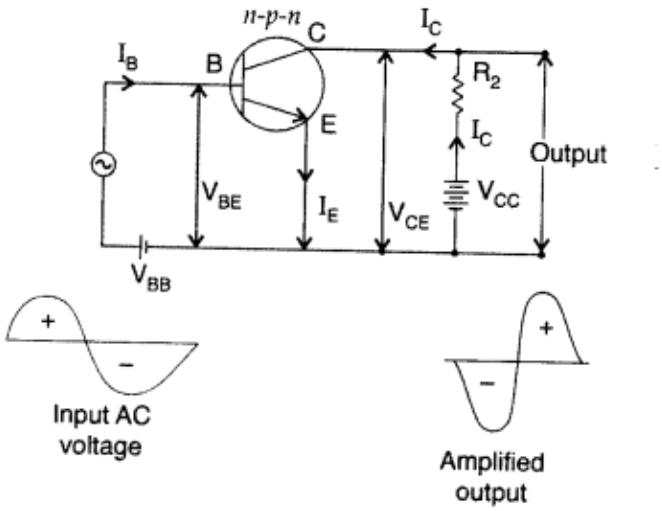
$$I_t = I_B + I_C \quad \ldots(i)$$

When current (I_C) flows through the load resistance (R_L),

Output or collector voltage (V_0)

= Applied voltage V_{CC} –Voltage drop across R_C

$$\Rightarrow \quad V_0 = V_{CC} - I_C R_L \quad \ldots(ii)$$



During the positive half cycle of input signal, the forward bias of emitter-base junction increases.

where [r_i is the resistance of the input or the emitter base circuit]

and $\Delta V_{CE} = R_L \cdot \Delta I_C$

where [R_L is the load resistance]

$$\therefore \quad A_V = \frac{\Delta I_C}{\Delta I_B} \cdot \frac{R_L}{r_i^0} = -\beta_{ac} \cdot \frac{R_L}{r_i}$$

(*i*) Current gain $(\beta_{ac}) = \frac{\Delta I_C}{\Delta I_B} = \frac{i_c}{i_b}$

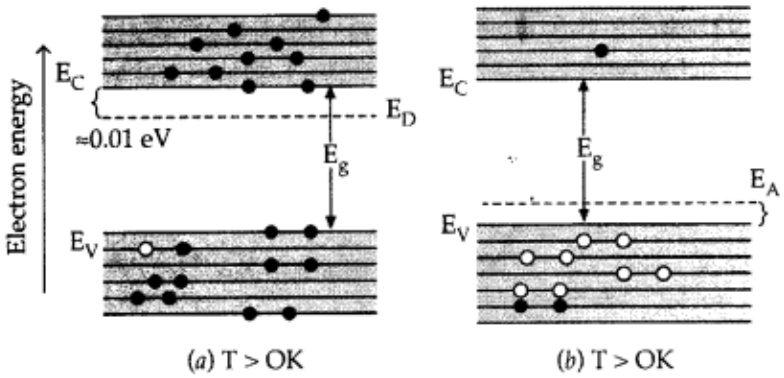
(*ii*) Voltage gain $(V_{Gain}) = \frac{\Delta V_0}{\Delta V_I}$

Question 85.

Distinguish between «-type and p-type semi-conductors on the basis of energy band diagrams. Compare their conductivities at absolute zero temperature and at room temperature. (Comptt. Delhi 2014)

Answer:

Distinction between n-type and p-type semiconductors on the basis of energy level diagram :



(*a*) T > OK (*b*) T > OK

One thermally generated electron-hole pair +9 electrons from donor atoms

(i) In n-type semi conductors an extra energy level (called donor energy level) is produced just below the bottom of the conduction band, while in the p-type semiconductor, this extra energy band (called acceptor energy level) is just above the top of the balanced band.

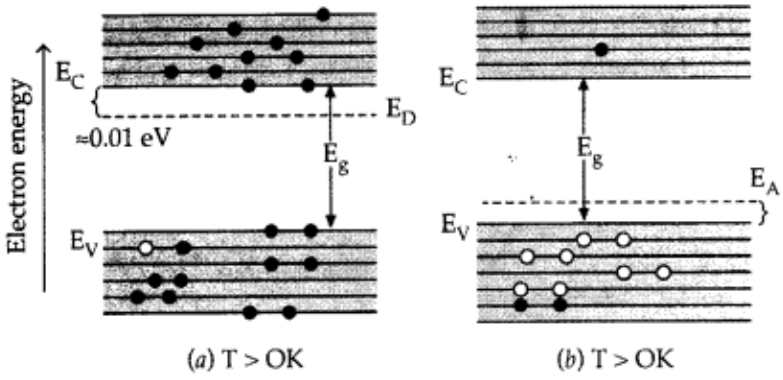
(ii) In n-type semiconductors, most of the electrons come from the donor impurity while in p-type semiconductor, the density of holes in the valence band is predominantly due to the impurity in the extrinsic semiconductors.

is slightly above the top of the valence band. Explain, what role do these energy levels play in conduction and valence bands. (Comptt. All India 2014)

Answer:

For energy level diagrams of n-type and p-type semiconductors:

Distinction between n-type and p-type semiconductors on the basis of energy level diagram :



One thermally generated electron-hole pair +9 electrons from donor atoms

(i) In n-type semi conductors an extra energy level (called donor energy level) is produced just below the bottom of the conduction band, while in the p-type semiconductor, this extra energy band (called acceptor energy level) is just above the top of the balanced band.

(ii) In n-type semiconductors, most of the electrons come from the donor impurity while in p-type semiconductor, the density of holes in the valence band is predominantly due to the impurity in the extrinsic semiconductors.

(iii) At absolute zero temperature conductivities of both types of semi-conductors will be zero.

(iv) For equal doping, an n-type semiconductor will have more conductivity than a p-type semiconductor, at room temperature.

Role of energy levels in conduction and valence bands : In the energy band diagram of n-type Si semiconductor, the donor energy level E_D is slightly below the bottom E_C of the conduction band and electrons from this level moves into conduction band with very small supply of energy. At room temperature, most of the donor atoms get ionised, but very few ($\sim 10^{-12}$) atoms of Si atom get ionised. So the conduction band will have most electrons coming from donor impurities, as shown in the figure.

For p-type semiconductor, the acceptance energy level E_A is slightly above the top E_V of the valence band.

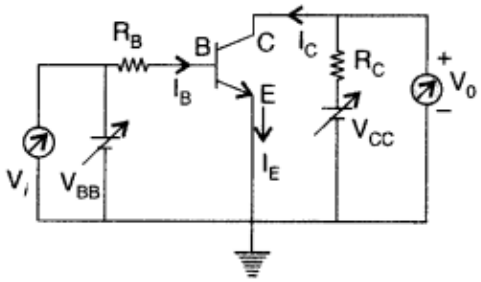
Answer:

(i)

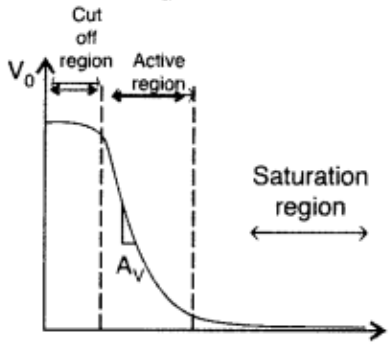
Transistor as a switch. The circuit diagram of transistor as a switch is shown in Figure 1. Transfer characteristics. The graph between V_0 and V_i is called the transfer characteristics of the base-biased transistor, shown in Figure 2.

When the transistor is used in the cut off or saturation state, it acts as a switch.

As long as V_i is low and unable to forward bias the transistor, then V_0 is high. If V_i is high enough to drive the transistor into saturation, then V_0 is low. When the transistor is not conducting, it is said to be switched off and when it is driven into saturation, it is said to be switched on. This shows that a low input switches the transistor off and a high input switches it on.



Base-biased transistor in CE configuration
Figure 1



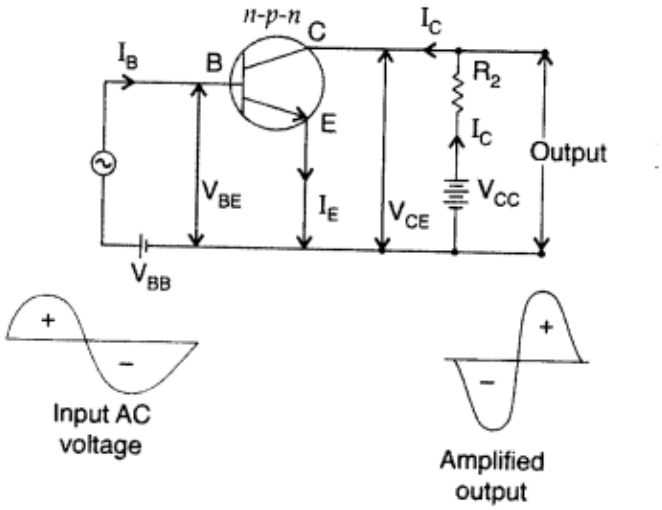
Transfer characteristics
Figure 2

resistance (R_L),

Output or collector voltage (V_0)

= Applied voltage V_{CC} –Voltage drop across R_C

$\Rightarrow \quad V_0 = V_{CC} - I_C R_L \qquad ...(ii)$



(ii)

During the positive half cycle of input signal, the forward bias of emitter-base junction increases.

Due to increased forward bias, emitter current (I_E) increases and hence according to equation (i) collector current (I_C) also increases. Therefore, the voltage drop across R_L (i.e. $I_C R_L$) increases. According to equation (ii), the collector voltage or output voltage (V_0) decreases. Thus collector is connected to the positive terminal of the battery (V_{CC})

so decrease in V_0 means that the collector voltage becomes 1 cm positive. In other words, amplified negative signal is obtained across the output.

Similarly, during negative hay cycle, an amplified positive signal is obtained across the output.

$$A_V = \frac{\Delta V_{CE}}{\Delta V_{BE}} \qquad \text{But } \Delta V_{BE} = r_i . \Delta I_B$$

where [r_i is the resistance of the input or the emitter base circuit]

and $\Delta V_{CE} = R_L \cdot \Delta I_C$

where [R_L is the load resistance]

$$\therefore \quad A_V = \frac{\Delta I_C}{\Delta I_B} \cdot \frac{R_L}{r_i^0} = -\beta_{ac} \cdot \frac{R_L}{r_i}$$

(i) Current gain $(\beta_{ac}) = \frac{\Delta I_C}{\Delta I_B} = \frac{i_c}{i_b}$

(i)

(a) All the three segments of a transistor have different thickness and their doping levels are also different. A brief description of the three segments of a transistor is given below :

- Emitter: This is the segment on one side of the transistor. It is of moderate size and heavily doped. It supplies a large number of majority carriers for the current flow through the transistor.
- Base : This is the central segment. It is very thin and lightly doped.
- Collector : This segment collects a major portion of the majority carriers supplied by the emitter. The collector side is moderately doped and larger in size as compared to the emitter.

(ii)

Common emitter (CE) transistor characteristics. The transistor is most widely used in the CE configuration. When a transistor is used in CE configuration, the input is between the base and emitter and the output is between the collector and emitter.

The input and the output characteristics of an n-p-n transistor in CE configuration can be studied by using the circuit as shown in Figure 1.

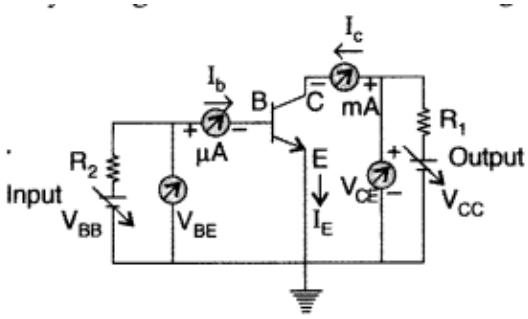


Figure 1

(i) Input characteristics. The variation of the base current IB with the base emitter voltage V_{BE} is called the input characteristic keeping V_{CE} fixed. A curve is plotted between the base current I_B

characteristics of a transistor is shown in Figure 2.

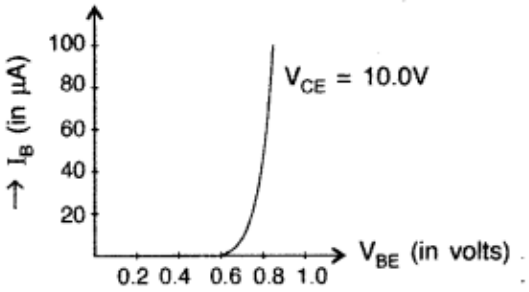


Figure 2

(ii) Output characteristics. The variation of the collector current I_C with the collector emitter voltage V_{CE}, keeping the base current IB constant is called output characteristics.

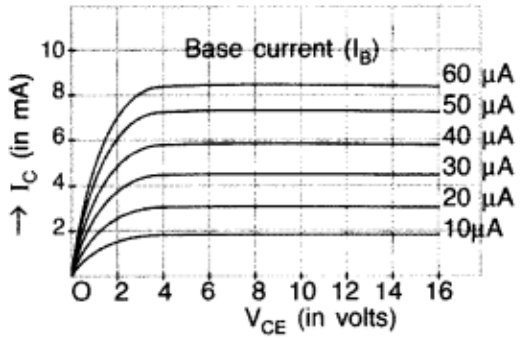


Figure 3

The plot of I_C versus V_{CE} for different fixed values of I_B gives one output characteristic. The different output characteristics for different values of I_B is shown in Figure 3.

$$\therefore \quad \beta_{AC} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CB}}.$$

Question 89.

(i) Explain with the help of a diagram the formation of depletion region and barrier potential in a pn junction.

(ii) Draw the circuit diagram of a half wave rectifier and explain its working. (All India 2016)

Answer:

(a) (i) Depletion layer. The layer containing unneutralized acceptor and donor ion across a p-n junction is called depletion layer. It is called depletion layer because it is depleted of mobile charge carriers.

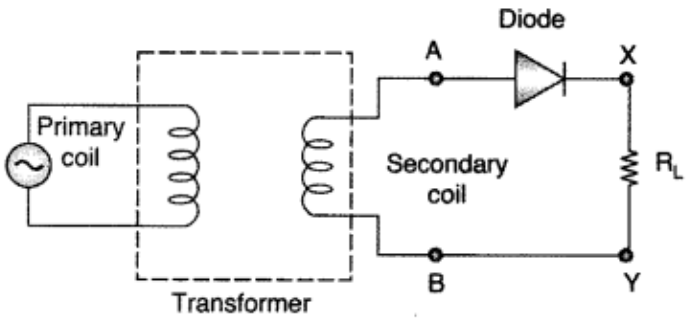


Fig. (a)

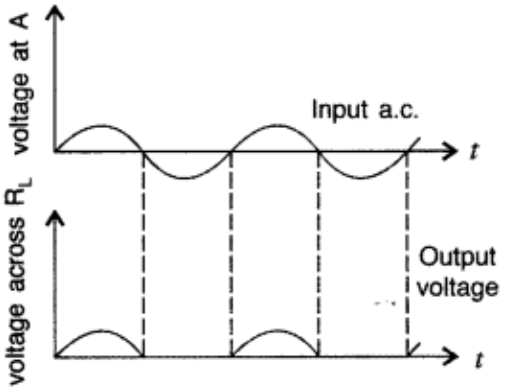


Fig. (b)

In the negative half cycle of a.c., the voltage at A is negative, the diode is reversed biased and it does not conduct current.

Thus, we get output across R_L during positive half cycles only. The output is unidirectional but varying.

Question 90.

For a CE-transistor amplifier, the audio signal voltage across the collector resistance of 2kΩ is 2 V. Suppose the current amplification factor of the transistor is 100, find the input signal voltage and base current, if the base resistance is 1 kΩ. (All India 2016)

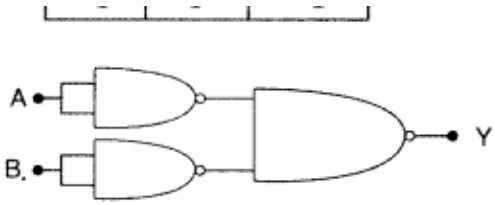
Answer:

Base Current $i_\beta = \frac{i_c}{\beta} = \frac{1.0\ mA}{100} = \mathbf{0.01\ mA}$

Input signal Voltage $= i_B R_B$
$= (0.01\ mA) \times (1\ k\Omega)$
$= (0.01 \times 10^{-3}\ A) \times (1 \times 10^3\ \Omega)$
$= 0.01\ V = \mathbf{10\ mV}$

Question 91.
Give reasons for the following :
(i) High reverse voltage do not appear across a LED.
(ii) Sunlight is not always required for the working of a solar cell.
(ill) The electric field, of the junction of a Zener diode, is very high even for a small reverse bias voltage of about 5V. (Comptt. Delhi 2016)
Answer:
(i) It is because reverse breakdown voltage of LED is very low, i.e., nearly 5V.
(ii) Solar cell can work with any light whose photon energy is more than the band gap energy.
(iii) The heavy doping of p and n sides of pn junction makes the depletion region very thin, hence for a small reverse bias voltage, electric field is very high.

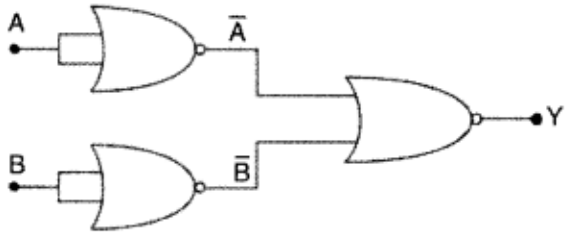
Question 92.
It is required to design a (two-input) logic gate, using an appropriate number, of :
(a) NAND gates that gives a 'low' output only when both the inputs are 'low'.
(b) NOR gates that gives a 'high' output only when both the inputs are 'high'.
Draw the logic circuits for these two cases and write the truth table, corresponding to each of the two designs. (Comptt. All India 2017)
Answer:
(a) The 'NAND' gate that gives a 'low' output only when both its inputs are low, is an 'OR' gate
The required design and the truth table are as follow :



(b) The 'NOR' gate that gives a high output only when both the inputs are high, is an 'AND' gate. The required

Truth Table

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

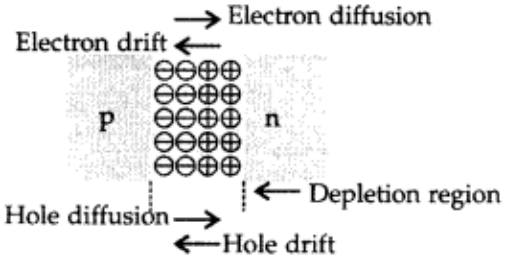


Question 93.

Write the two processes that take place in the formation of a p-n junction. Explain with the help of a diagram, the formation of depletion region and barrier potential in a p-n junction. (Delhi 2016)

Answer:

Diffusion and Drift are the two processes which take place in the formation of p-n junction.



current amplification factor of the transistor is 100, find the input signal voltage and base current, if the base resistance is 1 kΩ (Delhi 2017)

Answer:

Given : $R_C = 2k, \quad \Omega = 2 \times 10^3\ \Omega, \quad V_{CE} = 2V,$
$\beta = 100, \quad R_B = 1\ k\Omega = 1 \times 10^3\ \Omega, \quad V_i = ?$

$V_{CE} = I_C R_C$

$$I_C = \frac{V_{CE}}{R_C} = \frac{2}{(2 \times 10^3)^4} A = 10^{-3}\ A = 1\ mA$$

$$\text{Current gain } (\beta) = \frac{I_C}{I_B}$$

$$\therefore \quad 100 = \frac{10^{-3}}{I_B} \qquad \therefore \quad I_B = 10^{-5}\ A$$

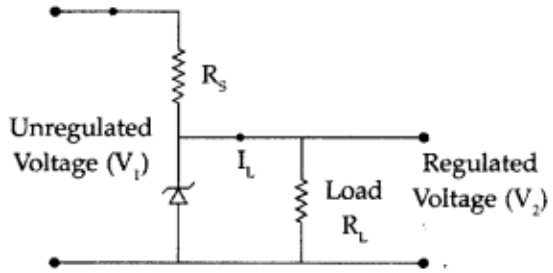
Input signal voltage (V_i)
$= I_B R_B = (1 \times 10^{-5}) \times (10^3)\ \Omega$
$= 10^{-2}\ V$

Question 95.

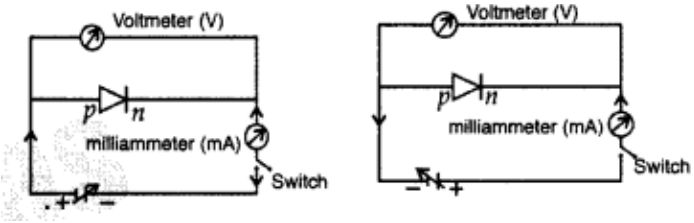
A zener diode is fabricated by heavily doping both p- and n-sides of the junction. Explain, why? Briefly explain the use of zener diode as a dc voltage regulator with the help of a circuit diagram. ‘ (Delhi 2017)

Answer:

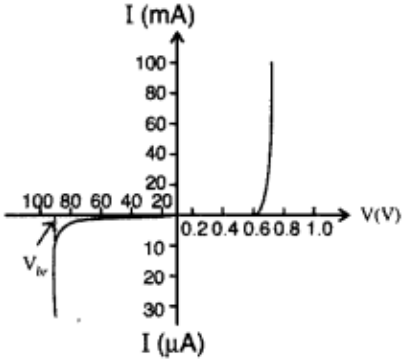
Zener Diode : By heavily doping both p and n sides of the junction, depletion region formed is very thin, i.e. < 10^{-6} m. Hence, electric field, across the junction is very high (~5×10^6 V/m) even for a small reverse bias voltage. This can lead to a ‘breakdown’ during reverse biasing.



If the input voltage increases/decreases, current through resistor R_S, and Zener diode, also increases/decreases. This increases/decreases the voltage drop across Rs without any change in voltage across the Zener diode.



The battery is connected to the silicon diode through a potentiometer (or rheostat), so that the applied voltage can be changed for different values of voltages, the corresponding values of current are noted.

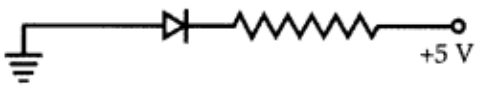


Using the circuit arrangements shown in fig. (i) and fig (ii), we study the variation of current with applied voltage to obtain the V-I characteristics.

From the V-I characteristics of a junction diode, it is clear that it allows the current to pass only when it is forward biased. So when an alternatively voltage is applied across the diode, current flows only during that part of the cycle when it is forward biased.

Question 97.

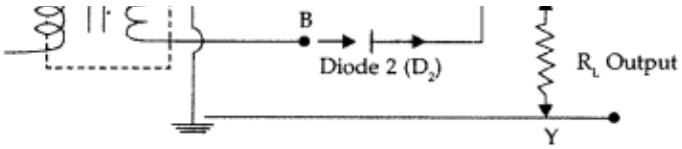
(a) In the given diagram, is the junction diode forward biased or reverse biased?



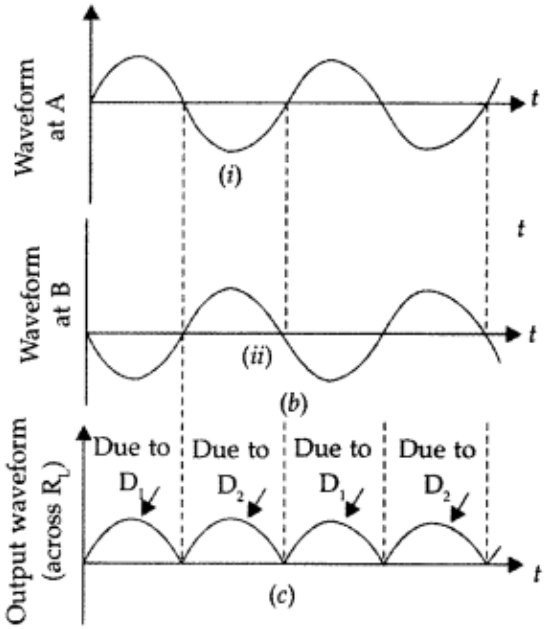
(b) Draw the circuit diagram of a full wave rectifier and state how it work. (All India 2017)

Answer:

(a) The junction diode is reverse biased in the given circuit diagram.



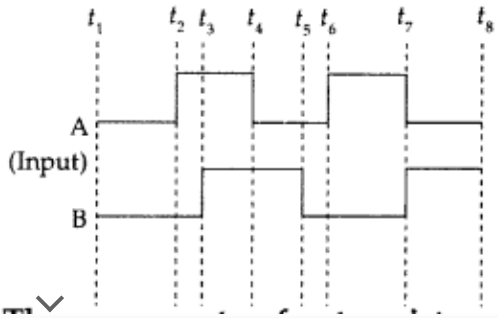
Working : The diode Dj is forward- biased during one half cycle and current flows through the resistor, but diode D_2 is reverse-biased and no current flows through it. During the other half cycles, current through the resistor flows in the same direction.

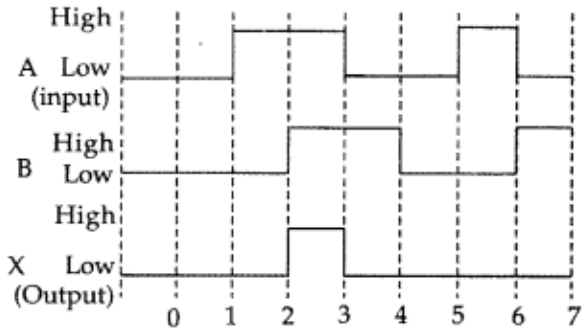


Question 98.

(a) Write the functions of the three segments of a transistor.

(b) The figure shows the input waveforms A and B for 'AND' gate. Draw the output waveform and write the truth table for this logic gate. (All India 2017)



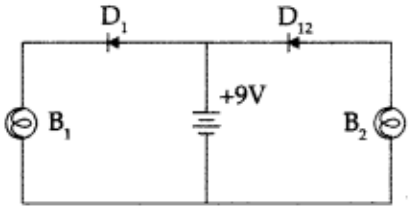


(*ii*) **Truth Table :**

Input		*Output*
A	*B*	*Y = AB*
0	0	0
0	1	0
1	0	0
1	1	1

Question 99.

(a) In the given diagram, which bulb out of B_1 and B_2 will glow and why ?



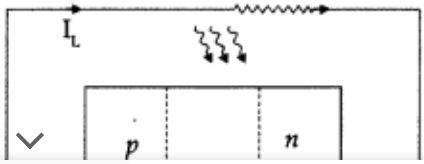
(b) Draw the circuit diagram of a full wave rectifier and state how it works.

(c) Explain briefly the three processes due to which generation of emf takes place in a solar cell. (All India 2017)

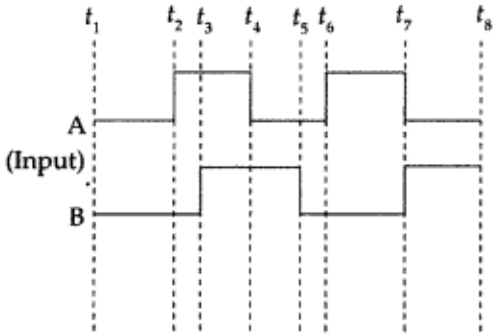
Answer:

(a) Bulb B_1 will glow, because Diode D_1 is forward biased.

(b) Diagram of Solar Cell :



(a) Draw the circuit diagram for studying the characteristics of a transistor in common emitter configuration. Explain briefly and show how input and output characteristics are drawn.



(b) The figure shows input waveforms A and B to a logic gate. Draw the output waveform for an OR gate. Write the truth table for this logic gate and draw its logic symbol. (All India 2017)

Answer:

(a) The base is made very thin so as to control current flowing between emitter and collector. The base is lightly doped to make a thin depletion layer between emitter and collector.

(b) Common emitter (CE) transistor characteristics. The transistor is most widely used in the CE configuration. When a transistor is used in CE configuration, the input is between the base and emitter and the output is between the collector and emitter.

The input and the output characteristics of an n-p-n transistor in CE configuration can be studied by using the circuit as shown in Figure 1.

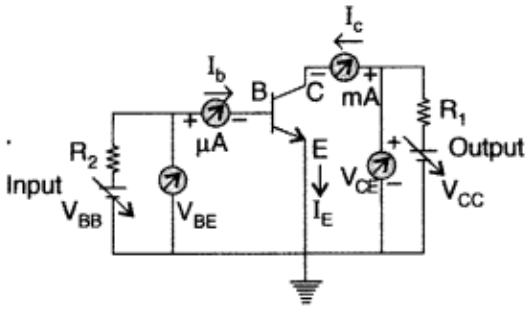


Figure 1

(i) Input characteristics. The variation of the base current IB with the base emitter voltage V_{BE} is called the input characteristic keeping V_{CE} fixed. A curve is plotted between the base current I_B

characteristics of a transistor is shown in Figure 2.

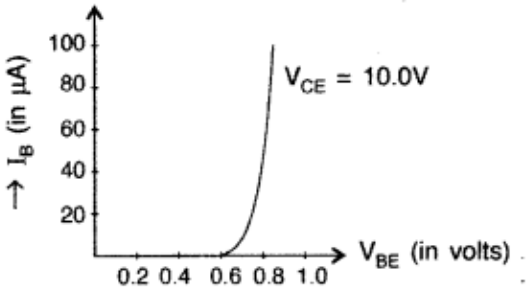


Figure 2

(ii) Output characteristics. The variation of the collector current I_C with the collector emitter voltage V_{CE}, keeping the base current IB constant is called output characteristics.

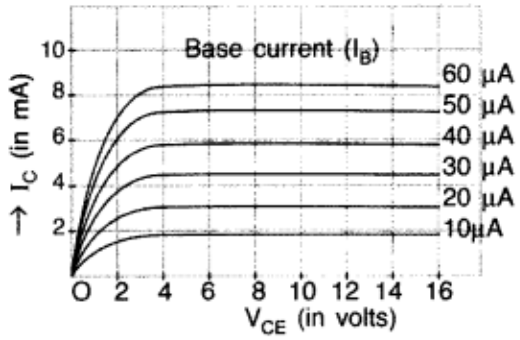


Figure 3

The plot of I_C versus V_{CE} for different fixed values of I_B gives one output characteristic. The different output characteristics for different values of I_B is shown in Figure 3.

$$\therefore \quad \beta_{AC} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CB}}.$$

Truth Table :

Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Logic symbol :

Question 101.

(a) Draw the circuit diagram of an n-p-n transistor amplifier in common emitter configuration.

(b) Derive an expression for voltage gain of the amplifier and hence show that the output voltage is in opposite phase with the input voltage. (All India 2017)

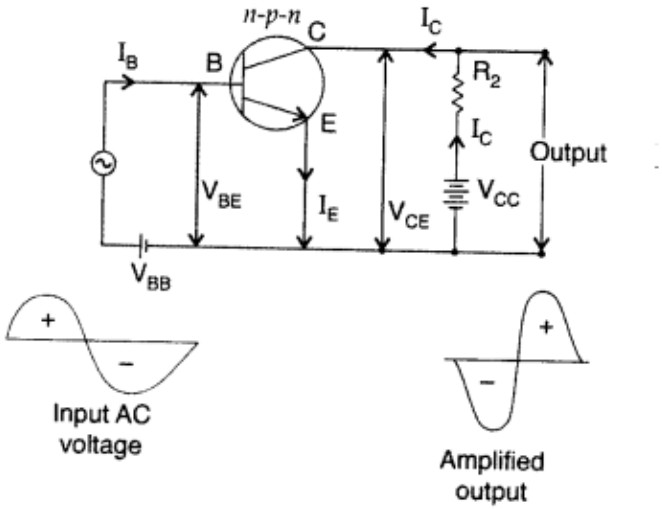
Answer:

resistance (R_L),

Output or collector voltage (V_0)

= Applied voltage V_{CC} –Voltage drop across R_C

$\Rightarrow \quad V_0 = V_{CC} - I_C R_L \qquad ...(ii)$



During the positive half cycle of input signal, the forward bias of emitter-base junction increases.

Due to increased forward bias, emitter current (I_E) increases and hence according to equation (i) collector current (I_C) also increases. Therefore, the voltage drop across R_L (i.e. $I_C R_L$) increases. According to equation (ii), the collector voltage or output voltage (V_0) decreases. Thus collector is connected to the positive terminal of the battery (V_{CC})

so decrease in V_0 means that the collector voltage becomes 1 cm positive. In other words, amplified negative signal is obtained across the output.

Similarly, during negative hay cycle, an amplified positive signal is obtained across the output.

$$A_V = \frac{\Delta V_{CE}}{\Delta V_{BE}} \qquad \text{But } \Delta V_{BE} = r_i . \Delta I_B$$

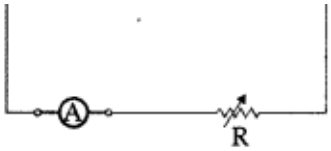
where [r_i is the resistance of the input or the emitter base circuit]

and $\Delta V_{CE} = R_L \, . \Delta I_C$

where [R_L is the load resistance]

$$\therefore \quad A_V = \frac{\Delta I_C}{\Delta I_B} . \frac{R_L}{r_i^0} = -\beta_{ac} . \frac{R_L}{r_i}$$

(*i*) Current gain $(\beta_{ac}) = \frac{\Delta I_C}{\Delta I_B} = \frac{i_c}{i_b}$



(b) The figure shows input waveforms A and B to a logic gate. Draw the output waveform for an OR gate. Write the truth table for this logic gate and draw its logic symbol. (All India 2017)
Answer:
(a) The value of 'R' would be increased since the resistance of 'S', a semi conductor decreases on heating.

(b) Photo diodes. Photo diode is a special type of photo-detector. Simplest photo-diode is a reverse biased as shown in Figure (i).

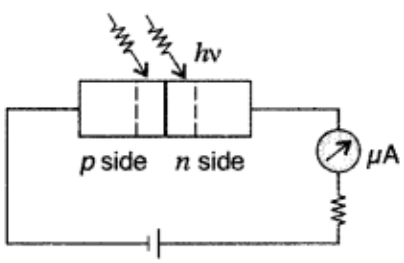


Fig. (i)

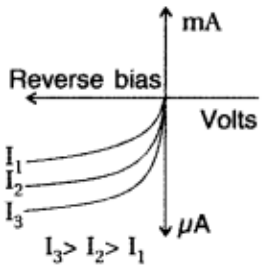
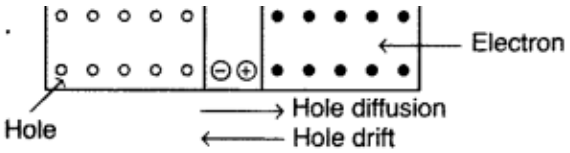


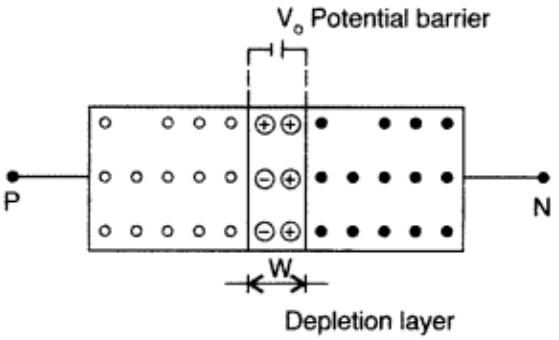
Fig. (ii)

When a p-n diode is illuminated with light photons having energy /xv > and intensities Iv I2, I3 etc. the electron and hole pairs generating in the depletion layer will be separated by the junction field and made to flow across the junction.
Graph showing variation in reverse bias currents for different intensities are shown in Figure (ii).

Question 103.
Explain the two processes involved in the formulation of a p-n junction diode. Hence define the term 'barrier potential'. (Comptt. Delhi 2017)
Answer:
(a) Two important processes that occur during the formation of a p-n junction are
(i) diffusion and
(ii) drift.
(i) Diffusion: In n-type semiconductor, the concentration of electrons is much greater as compared to concentration of holes; while in p-type semiconductor, the concentration of holes is much greater than the

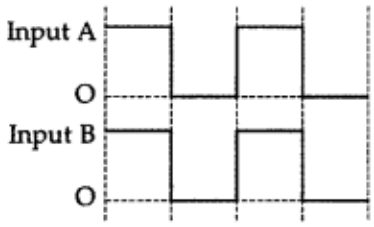


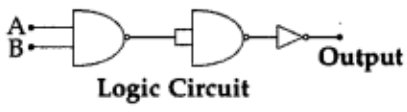
(ii) Drift: The drift of charge carriers occurs due to electric field. Due to built in potential barrier an electric field directed from n-region to p-region is developed across the junction. This field causes motion of electrons on p-side of the junction to n-side and motion of holes on n-side of junction to p-side. Thus a drift current starts. This current is opposite to the direction of diffusion current.



Question 104.

Using the wave forms of the input A and B, draw the output waveform of the given logic circuit. Identify the logic gate obtained. Write also the truth table. (Comptt. Delhi 2017)





(ii) NAND GATE

(iii) Truth Table

Input		Output
A	B	
1	1	0
0	0	1
1	1	1
0	0	1

Question 105.

State the reason, why the photodiode is always operated under reverse bias. Write the working principle of operation of a photodiode. The semiconducting material used to fabricate a photodiode, has an energy gap of 1.2 eV. Using calculations, show whether it can detect light of wavelength of 400 nm incident on it. (Comptt. All India 2017)

Answer:

(a) Why is photodiode fabricated?

- It is fabricated with a transparent window to allow light to fall on diode.

(b) Working of photodiode : When the

photodiode is illuminated with photons of energy ($hv > E_g$) greater than the energy gap

- of the semiconductor, electron-holes pairs are generated. These get separated due to the Junction electric field (before they recombine) which produces an emf.

(ii) NAND GATE

(iii) Truth Table

Input		Output
A	B	
1	1	0
0	0	1
1	1	1
0	0	1

(d) Reason. It is easier to observe the change in the current, with change in light intensity, if a reverse bias is applied.

Detection is possible if $E_p > E_g$

$$E_p = \frac{hc}{\lambda} \text{ J}$$

$$= \frac{hc}{e\lambda} \text{ eV}$$

$$= \frac{(6.63 \times 10^{-34}) \times (3 \times 10^8)}{(1.6 \times 10^{-19}) \times (400 \times 10^{-9})}$$

$$= 3.1 \text{ eV} > (E_g = 1.2 \text{ eV})$$

$\therefore$ It can detect this light.

Question 106.

Draw the circuit diagram of a common emitter transistor amplifier. Write the expression for its voltage gain. Explain, how the input and output signals differ in phase by 180°. (Comptt. All India 2017)

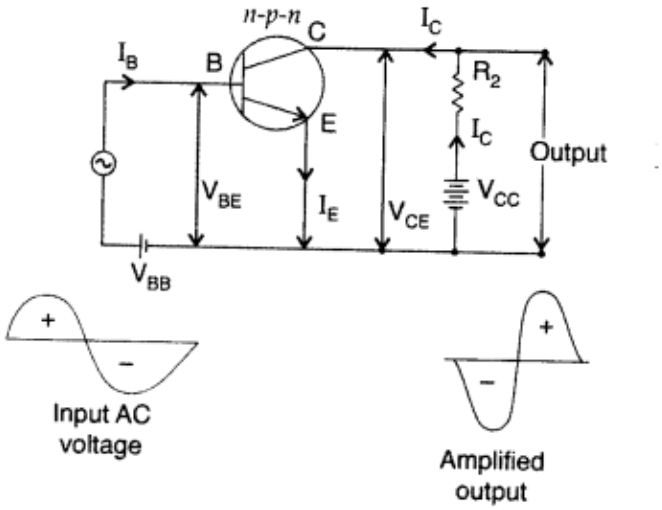
Answer:

resistance (R_L),

Output or collector voltage (V_0)

= Applied voltage V_{CC} –Voltage drop across R_C

$\Rightarrow \quad V_0 = V_{CC} - I_C R_L \qquad ...(ii)$



During the positive half cycle of input signal, the forward bias of emitter-base junction increases.

Due to increased forward bias, emitter current (I_E) increases and hence according to equation (i) collector current (I_C) also increases. Therefore, the voltage drop across R_L (i.e. $I_C R_L$) increases. According to equation (ii), the collector voltage or output voltage (V_0) decreases. Thus collector is connected to the positive terminal of the battery (V_{CC})

so decrease in V_0 means that the collector voltage becomes 1 cm positive. In other words, amplified negative signal is obtained across the output.

Similarly, during negative hay cycle, an amplified positive signal is obtained across the output.

$$A_V = \frac{\Delta V_{CE}}{\Delta V_{BE}} \qquad \text{But } \Delta V_{BE} = r_i . \Delta I_B$$

where [r_i is the resistance of the input or the emitter base circuit]

and $\Delta V_{CE} = R_L \, . \Delta I_C$

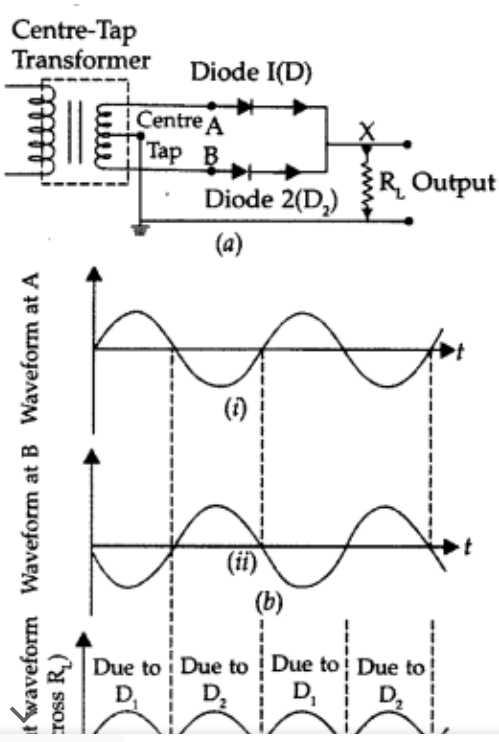
where [R_L is the load resistance]

$$\therefore \quad A_V = \frac{\Delta I_C}{\Delta I_B} . \frac{R_L}{r_i^0} = -\beta_{ac} . \frac{R_L}{r_i}$$

(*i*) Current gain $(\beta_{ac}) = \frac{\Delta I_C}{\Delta I_B} = \frac{i_c}{i_b}$

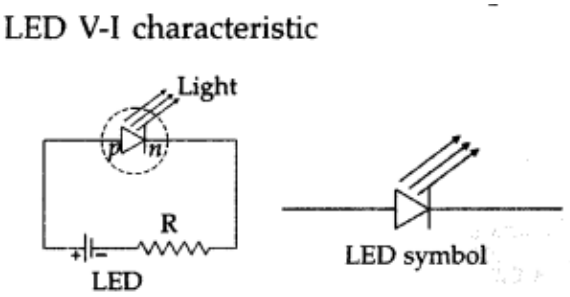
Hence, change in output is negative when the input signal is positive.
This shows that input and output signals differ in phase by 180°.

Question 107.
Draw the circuit diagram of a full wave rectifier. Explain its working principle. Draw the input and output waveforms. (Comptt. All India 2017)
Answer:
Working of a full wave rectifier :
1. A full wave rectifier uses two diodes and gives the rectified output voltage corresponding to both the positive and negative half-cycle of alternating current.
2. The p-side of the two diodes are connected to the ends of the secondary of the transformer and, the n-sides of the diodes are connected together.
3. Output is taken from between the common- point of the two diodes and secondary of the transformer. Hence, the secondary of the transformer is provided with center tapping and is also called the centre-tap transformer.
4. Let, the input voltage to A with respect to the centre be positive and, at the same instant, voltage at B being out-of-phase will be negative. Therefore, diode D_1 is forward biased and starts conducting whereas, D_2 being reverse biased does not conduct.

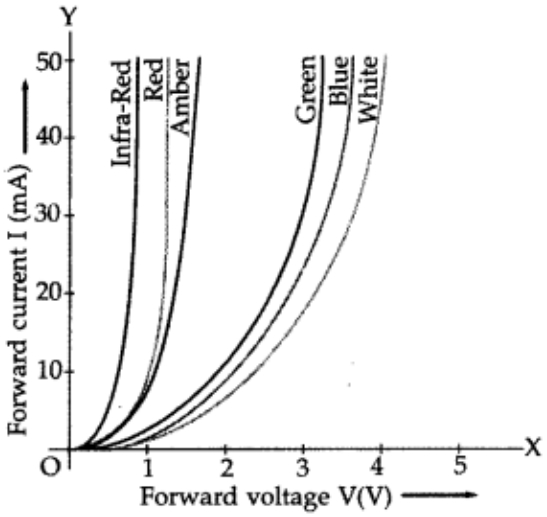


the shape of half sinusoids.

Question 108.
Draw the V-I characteristic of an LED. State two advantages of LED lamps over conventional incandescent lamps. Write the factor which controls
(a) wavelength of light emitted,
(b) intensity of light emitted by an LED. (Comptt. All India 2017)
Answer:



Light Emitting Diode (LED) : A light emitting diode is simply a forward biased p-n junction which emits spontaneous light radiation. When forward bias is applied, the electron and holes at the junction recombine and energy released is emitted in the form of light. V-I characteristics of LED are similar to that of Si junction diode but the threshold voltages are much higher and slightly different for each colour. No conduction or light emission occurs for reverse bias which, if it exceeds 5V, may damage the LED.



Semiconductor Electronics Materials Devices and Simple Circuits Class 12 Important Questions Long Answer Type

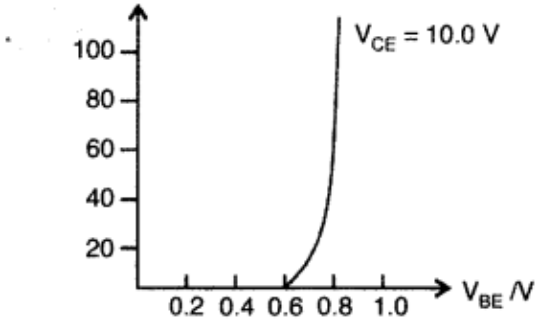
Question 109.

(i) Draw a circuit diagram to study the input and output characteristics of an n-p-n transistor in its common emitter configuration. Draw the typical input and output characteristics.

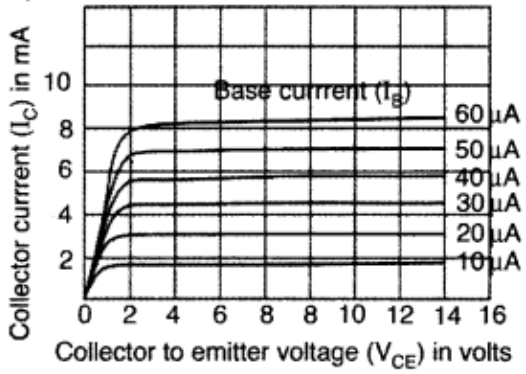
(ii) Explain, with the help of a circuit diagram, the working of n-p-n transistor as a common emitter amplifier. (Delhi 2017)

Answer.

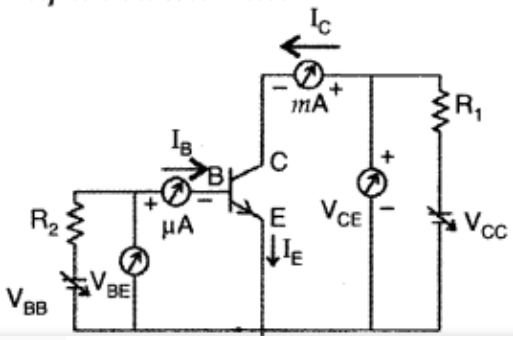
(i) (a) Common emitter configuration of n-p-n transistor



(b) Input characteristics



(c) Output characteristics



signal signal

The input (base-emitter) circuit is forward biased and the output circuit (collector- emitter) is reverse biased. When no a.c. signal is applied, the potential difference V_{CC} between the collector and emitter is given by

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

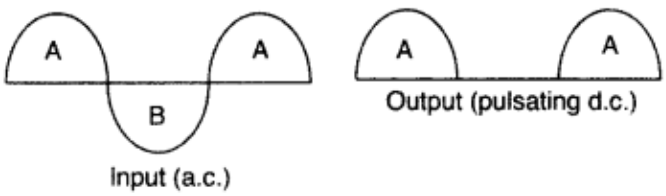
When an a.c. signal is fed to the input circuit, the forward bias increases during the positive half cycle of the input. This results in increase in I_C and decreases in V_{CC}. Thus during positive half cycle of the input, the collector becomes less positive.

During the negative half cycle of the input, the forward bias is decreased resulting in decrease in I_E and hence I_C. Thus V_{CC} would increase making the collector more positive. Hence in a common-emitter amplifier, the output voltage is 180° out of phase with the input voltage.

$$A_V = \frac{V_0}{V_i} = \frac{I_C R_C}{I_B R_B} = \beta\left(\frac{R_C}{R_B}\right) \qquad \left[\because \beta = \frac{I_C}{I_B}\right.$$

Question 110.
How is a zener diode fabricated so as to make it a special purpose diode? Draw I-V characteristics of zener diode and explain the significance of breakdown voltage.
Explain briefly, with the help of a circuit diagram, how a p-n junction diode works as a half wave rectifier.
Answer:
Zener diode is fabricated by heavily doping both p and n-sides. Due to this, depletion region formed is very thin (< 10^{-6} n and the electric field of the junction is extremely high (~5×10^6 V / m) even for a small reverse bias voltage of 5 volts. It is seen that when the applied reverse bias voltage (V) reaches the breakdown voltage (Vz) of the Zener diode, there is a large change in the current. After the breakdown voltage Vz, a large change in the current can be produced by almost insignificant change in the reverse bias voltage. In other words, Zener voltage remains constant even though current through the Zener diode varies over a wide range.

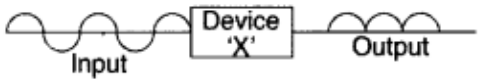
This property of the Zener diode is used for regulating voltages so that they are constant. Semiconductor diode as a half wave Rectifier : The junction diode D, supplies rectified current to the band during one half of the alternating input voltage and is always in the same direction. During the first half cycles of the



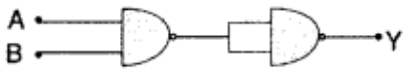
The resulting output current is a series of unidirectional pulses with alternate gaps.

Question 111.

(a) Explain the formation of depletion layer . and potential barrier in a p-n junction.



(b) In the figure given below the input waveform is converted into the output waveform by a device 'X'. Name the device and draw its circuit diagram.

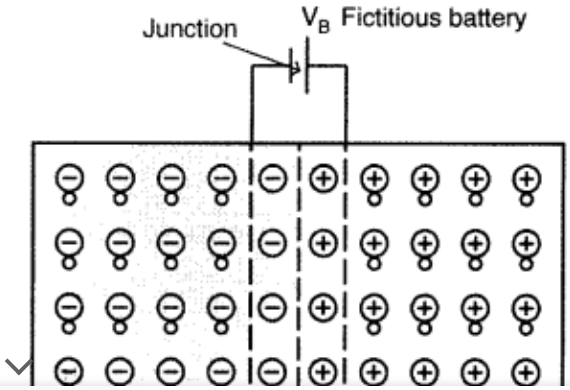


(c) Identify the logic gate represented by the circuit as shown and write its truth table. (Delhi 2017)

Answer:

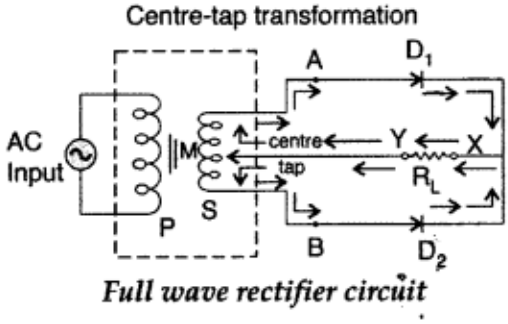
(a)

As soon as a p-n junction is formed, the majority charge carriers begin to diffuse from the regions of higher concentration to the regions of lower concentrations. Thus the electrons from the n-region diffuse into the p-region and where they combine with the holes and get neutralised. Similarly, the holes from the p-region diffuse into the n-region where they combine with the electrons and get neutralised. This process is called electron-hole recombination.



(b) Device 'X' given here represents the full wave rectifier.

Working of full wave rectifier : AC input to be rectified is applied to the primary (P) of a step up transformer. Two ends of the secondary of the transformer are connected to P end of two junction diodes. It is centre-trapped at M which is connected to an end through the load resistance R_L. Two crystals



Full wave rectifier circuit

are formed biased and reverse biased alternately. During half cycle of A.C. input, current flows through one crystal diode and during the next half cycle the current flows through the other crystal diode. However across the load R_L, current always flows in the same direction. Thus a continuous pulsating D.C. output voltage is obtained across the load resistance RL. This rectified signal is made smooth with the help of the fitter circuit.

(c) Logic gate is AND gate. Truth table of AND gate is

Input		*Output*
A	*B*	*Y = AB*
0	0	0
0	1	0
1	0	0
1	1	1

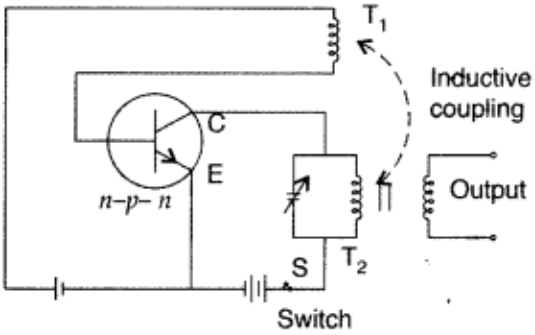
Question 112.

(a) With the help of the circuit diagram explain the working principle of a transistor amplifier as an oscillator.

(b) Distinguish between a conductor, a semiconductor and an insulator on the basis of energy band diagrams. (Delhi 2017)

Answer:

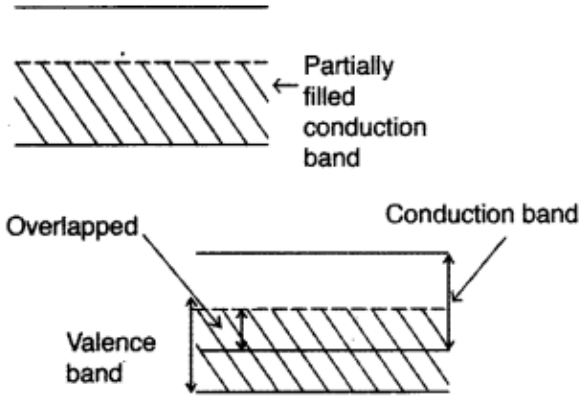
state. This process continues and ocillations are produced.



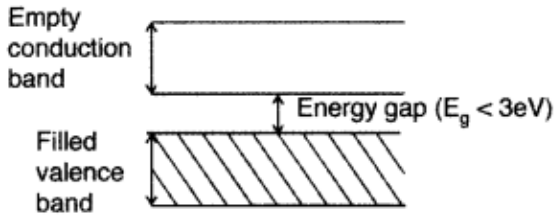
The f_R resonance frequency is thus given by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

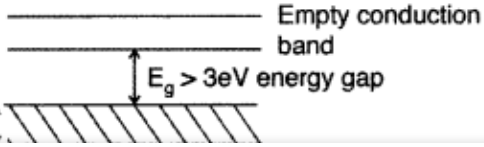
(b) Conductors :



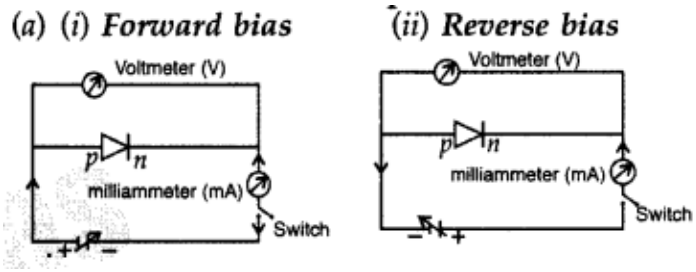
Semiconductor :



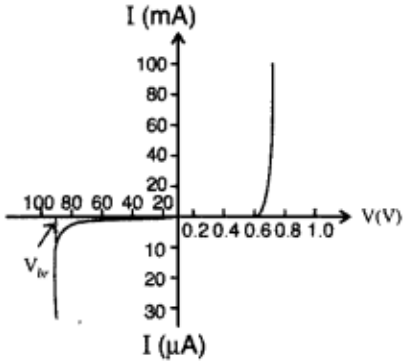
Insulator :



Answer:



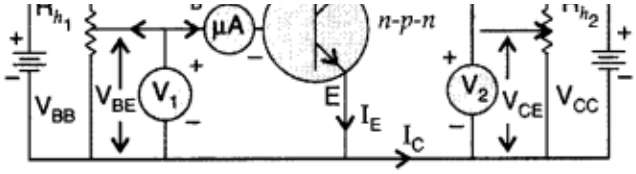
The battery is connected to the silicon diode through a potentiometer (or rheostat), so that the applied voltage can be changed for different values of voltages, the corresponding values of current are noted.



Using the circuit arrangements shown in fig. (i) and fig (ii), we study the variation of current with applied voltage to obtain the V-I characteristics.
From the V-I characteristics of a junction diode, it is clear that it allows the current to pass only when it is forward biased. So when an alternatively voltage is applied across the diode, current flows only during that part of the cycle when it is forward biased.

(b) Light emitting diode (LED) is a heavily doped p-n junction which under forward bias emits spontaneous radiations.
Two important advantages of LEDs:
(i) Low operational voltage and less power.
(ii) Fast on-off switching capacity.

Question 114.
(a) Draw the circuit arrangement for studying the input and output characteristics of an n- p-n transistor in



(i) Input resistance : The input resistance r, of the transistor in CE configuration is defined as the ratio of the small change in base-emitter voltage to the corresponding small change in the base current, when the collector-emitter voltage is kept fixed.

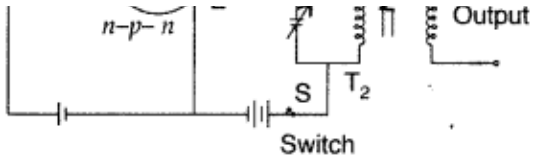
$$r_i = \left[\frac{\Delta V_{BE}}{\Delta I_B}\right]_{V_{CE}=\text{constant}}$$

(ii) Current amplification factor (β) : It is defined as the ratio of the change in collector current to the small change in base current at constant collector emitter voltage (V_{CE}) when the transistor is in the active state.

$$\beta_{ac} = \left[\frac{\Delta I_C}{\Delta I_B}\right]_{V_{CE}=\text{constant}}$$

(b)
Principle of transistor oscillator : "Sustained a.c. signals can he obtained from an amplifier circuit without any external input signal by giving a positive feedback to the input circuit through inductive coupling or RC/LC network."

Oscillator action : In an ideal n-p-n biased transistor, when input base emitters junction and output base collector junction are forward and reverse biased respectively, a high collector current I_C flows through the circuit. If in circuit switch S is on, this current I_C will start flowing in the emitter circuit through the inductive coupling between coils T_1 and T_2, which provides the +ve feedback output to input and hence make I_E maximum. In the absence of +ve feedback the IE thus decreases making the circuit back to its original



The f_R resonance frequency is thus given by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Question 115.

Draw a simple circuit of a CE transistor amplifier. Explain its working. Show that the voltage gain, Av, of the amplifier is given by $\mathbf{A_v} = -\frac{\beta_{ac} \mathbf{c_L}}{r_i}$, where β_{ac} is the current gain, R_L is the load resistance and r_i is the input resistance of the transistor. What is the significance of the negative sign in the expression for the voltage gain? (Delhi 2012)

Answer:

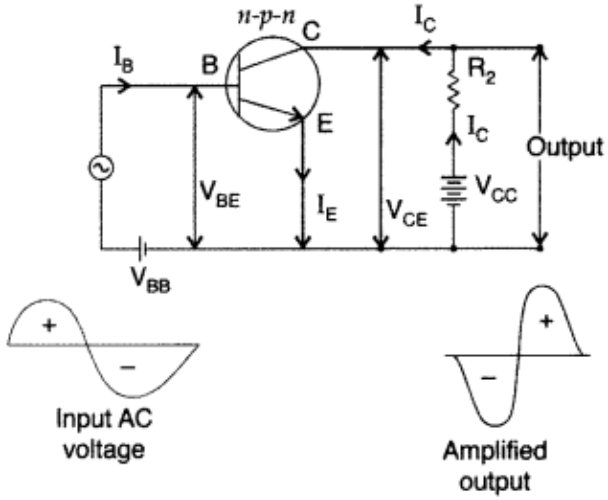
n-p-n transistor as a common emitter amplifier : Working: According to Kirchoff's law, emitter current I_t, base current (I_B) and collector current (I_C) are related as $I_t = I_B + I_C$ …(i)

When current (I_C) flows through the load resistance (R_L),

Output or collector voltage (V_0)

= applied voltage V_{CC} –Voltage drop across R_C

$\Rightarrow \quad V_0 = V_{CC} - I_C R_L \quad \ldots(ii)$



During the positive half cycle of input signal, the forward bias of emitter-base junction increases. Due to

$$\therefore \quad A_V = \frac{\Delta I_C}{\Delta I_B} \cdot \frac{R_L}{r_i^0} = -\beta_{ac} \cdot \frac{R_L}{r_i}$$

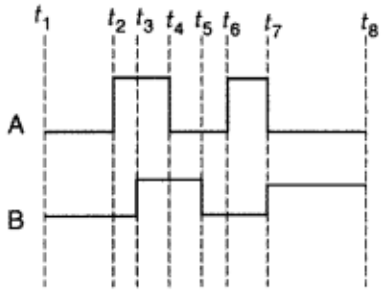
Question 116.

(a) Draw the circuit diagram of a full wave rectifier using p-n junction diode. Explain its working and show the output, input waveforms.

(b) Show the output waveforms (Y) for the following inputs A and B of

(i) OR gate

(ii) NAND gate. (Delhi 2012)

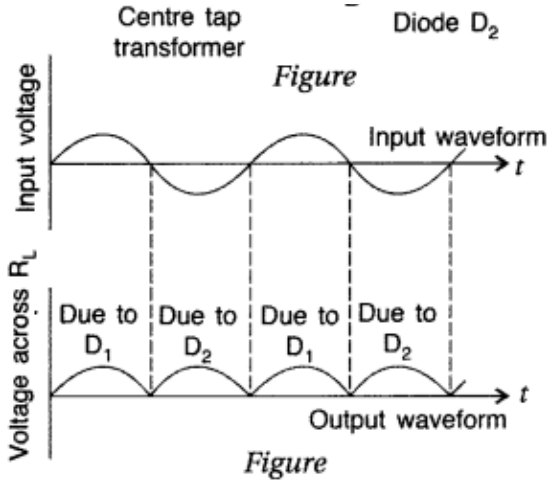


Answer:

p-n junction diode as full wave rectifier

A full wave rectifier consists of two diodes and special type of transformer known as centre tap transformer as shown in the circuit. The secondary of transformer gives the desired a.c. voltage across A and B.

During the positive half cycle of a.c. input, the diode D_1 is in forward bias and conducts current while D_2 is in reverse biased and does not conduct current. So we get an output voltage across the load resistor R_L.



Figure

Figure

During the negative half cycle of a.c. input, the diode D_1 is in reverse biased and does not conduct current while diode D_2 in forward biased and conducts current. So we get an output voltage across the load resistor R_L.

NOTE: This is a more efficient circuit for getting rectified voltage or current.

Let $I = I_0 \sin wt$ be the input current to be rectified

$\therefore$ The average current $= \frac{2I_0}{\pi}$

Hence output voltage $= \frac{2I_0}{\pi} R_L$

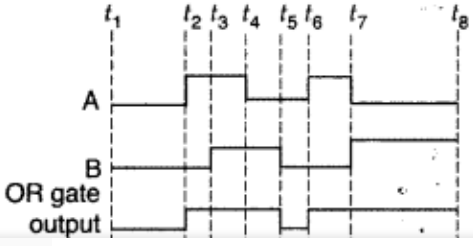
(b)

OR Gate

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

NAND Gate

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



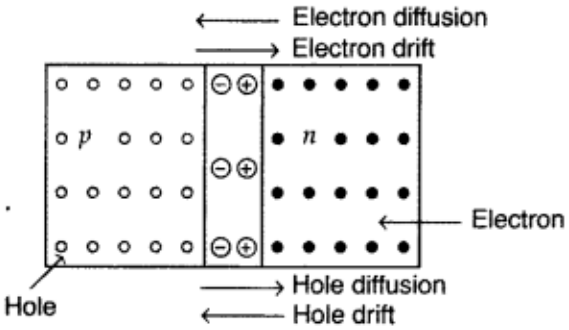
Answer:

(a) Two important processes that occur during the formation of a p-n junction are

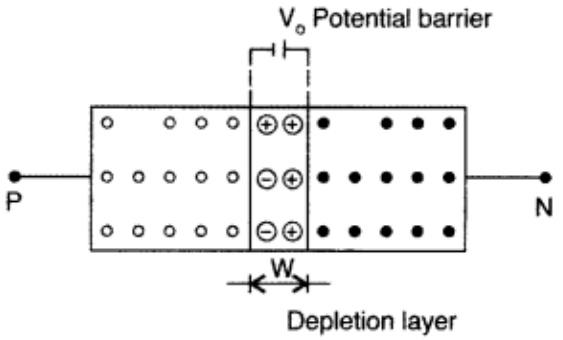
(i) diffusion and

(ii) drift.

(i) Diffusion: In n-type semiconductor, the concentration of electrons is much greater as compared to concentration of holes; while in p-type semiconductor, the concentration of holes is much greater than the concentration of electrons. When a p-n junction is formed, then due to concentration gradient, the holes diffuse from p side to n side (p → n) and electrons diffuse from n side to p-side (n → p). This motion of charge carriers gives rise to diffusion current across the junction.



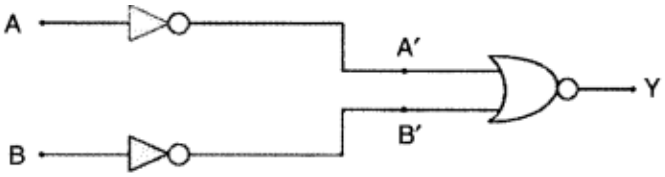
(ii) Drift: The drift of charge carriers occurs due to electric field. Due to built in potential barrier an electric field directed from n-region to p-region is developed across the junction. This field causes motion of electrons on p-side of the junction to n-side and motion of holes on n-side of junction to p-side. Thus a drift current starts. This current is opposite to the direction of diffusion current.



(b) Zener diode is used as voltage regulator.

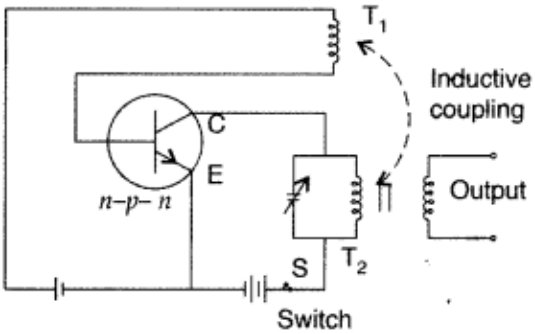
Any increase/decrease in the input voltage results in increase/decrease of the voltage drop across Rs without any change in voltage across the zener diode. Thus, the zener diode acts as a voltage regulator.

Question 118.
(a) Explain briefly the principle on which a transistor-amplifier works as an oscillator. Draw the necessary circuit diagram and explain its working.
(b) Identify the equivalent gate for the following circuit and write its truth table. (All India 2012)



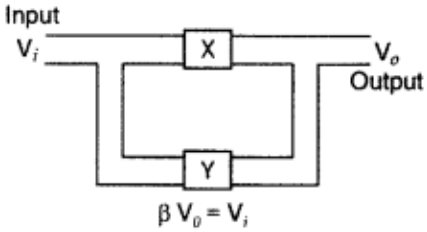
Answer:
(a)
Principle of transistor oscillator : "Sustained a.c. signals can he obtained from an amplifier circuit without any external input signal by giving a positive feedback to the input circuit through inductive coupling or RC/LC network."

Oscillator action : In an ideal n-p-n biased transistor, when input base emitters junction and output base collector junction are forward and reverse biased respectively, a high collector current I_C flows through the circuit. If in circuit switch S is on, this current I_C will start flowing in the emitter circuit through the inductive coupling between coils T_1 and T_2, which provides the +ve feedback output to input and hence make I_E maximum. In the absence of +ve feedback the IE thus decreases making the circuit back to its original state. This process continues and ocillations are produced.



Name of gate : AND Gate

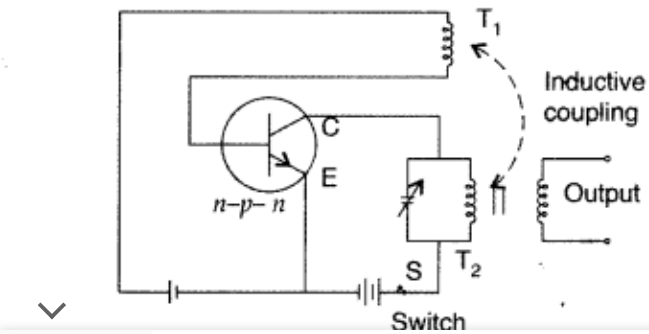
Question 119.
The set-up shown below can produce an a.c. output without any external input signal. Identify the components 'X' and 'Y' of this set-up. Draw the circuit diagram for this set-up. Describe briefly its working.



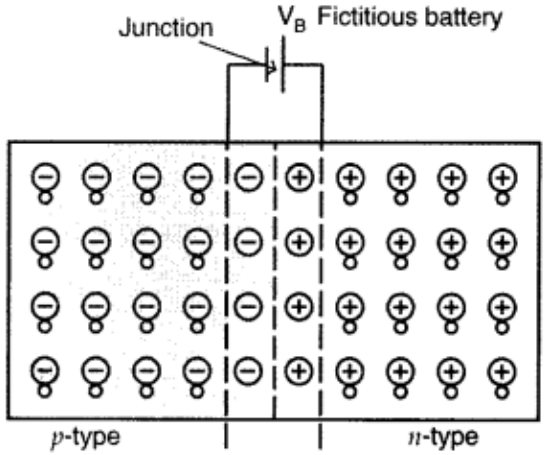
Answer:
The component X is Amplifier (Transistor Amplifier).
The component Y is (positive) Feedback Network. Circuit diagram and its working.

Principle of transistor oscillator : "Sustained a.c. signals can he obtained from an amplifier circuit without any external input signal by giving a positive feedback to the input circuit through inductive coupling or RC/LC network."

Oscillator action : In an ideal n-p-n biased transistor, when input base emitters junction and output base collector junction are forward and reverse biased respectively, a high collector current I_C flows through the circuit. If in circuit switch S is on, this current I_C will start flowing in the emitter circuit through the inductive coupling between coils T_1 and T_2, which provides the +ve feedback output to input and hence make I_E maximum. In the absence of +ve feedback the IE thus decreases making the circuit back to its original state. This process continues and ocillations are produced.



(b) Draw the circuit diagram of a full wave rectifier. Briefly explain its working. (Comptt. All India 2012)
Answer:
(a)
As soon as a p-n junction is formed, the majority charge carriers begin to diffuse from the regions of higher concentration to the regions of lower concentrations. Thus the electrons from the n-region diffuse into the p-region and where they combine with the holes and get neutralised. Similarly, the holes from the p-region diffuse into the n-region where they combine with the electrons and get neutralised. This process is called electron-hole recombination.



The p-region near the junction is left with immobile -ve ions and n-region near the junction is left with +ve ions as shown in the figure. The small region in the vicinity of the junction which is depleted of free charge carriers and has only immobile ions is called the depletion layer. In the depletion region, a potential difference VB is created, called potential barrier as it creates an electric field which opposes the further diffusion of electrons and holes.
(i) In forward biased, the width of depletion region is decreased.
(ii) In reverse biased, the width of depletion region is increased.

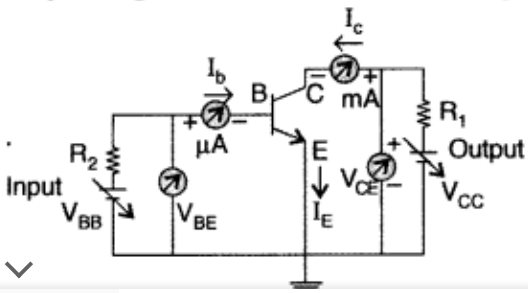
(b) Device 'X' given here represents the full wave rectifier.
Working of full wave rectifier : AC input to be rectified is applied to the primary (P) of a step up transformer. Two ends of the secondary of the transformer are connected to P end of two junction diodes. It is centre-trapped at M which is connected to an end through the load resistance R_L. Two crystals

Full wave rectifier circuit

are formed biased and reverse biased alternately. During half cycle of A.C. input, current flows through one crystal diode and during the next half cycle the current flows through the other crystal diode. However across the load R_L, current always flows in the same direction. Thus a continuous pulsating D.C. output voltage is obtained across the load resistance RL. This rectified signal is made smooth with the help of the fitter circuit.

Question 121.
(a) Why is the base region of a transistor thin and lightly doped?
(b) Draw the circuit diagram for studying the characteristics of an n-p-n transistor in com-mon emitter configuration.
Sketch the typical
(i) input and
(ii) output characteristics in this configuration.
(c) Describe briefly how the output characteristics can be used to obtain the current gain in the transistor.
(Comptt. Delhi 2012)
Answer:
(a) The base is made very thin so as to control current flowing between emitter and collector. The base is lightly doped to make a thin depletion layer between emitter and collector.

(b) Common emitter (CE) transistor characteristics. The transistor is most widely used in the CE configuration. When a transistor is used in CE configuration, the input is between the base and emitter and the output is between the collector and emitter.
The input and the output characteristics of an n-p-n transistor in CE configuration can be studied by using the circuit as shown in Figure 1.



characteristics of a transistor is shown in Figure 2.

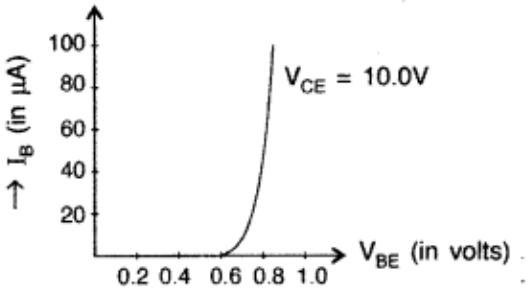


Figure 2

(ii) Output characteristics. The variation of the collector current I_C with the collector emitter voltage V_{CE}, keeping the base current IB constant is called output characteristics.

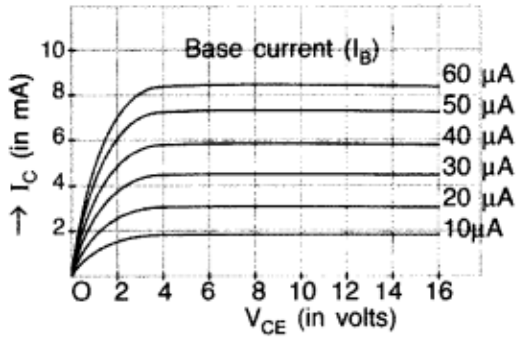


Figure 3

The plot of I_C versus V_{CE} for different fixed values of I_B gives one output characteristic. The different output characteristics for different values of I_B is shown in Figure 3.

$$\therefore \quad \beta_{AC} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CB}}.$$

Question 122.

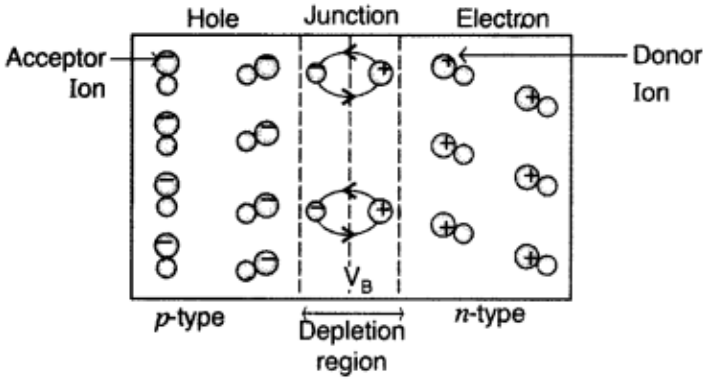
(a) How is a depletion region formed in p-n junction?

(b) With the help of a labelled circuit diagram, explain how a junction diode is used as a full wave rectifier. Draw its input, output wave-forms.

(c) How do you obtain steady d.c. output from the pulsating voltage? (Comptt. Delhi 2012)

Answer:

on p-side and electrons on n-side, the diffusion of holes towards n-side and electrons towards p-side takes place.



Hence, a region of unneutralized negative ions on p-side and positive ions on n-side is formed near the junction which is depleted of mobile charges. This region is called depletion region.

(b) p-n junction diode as full wave rectifier. A full wave rectifier consists of two diodes and special type of transformer known as centre tap transformer as shown in the circuit. The secondary of transformer gives the desired a.c. voltage across A and B.

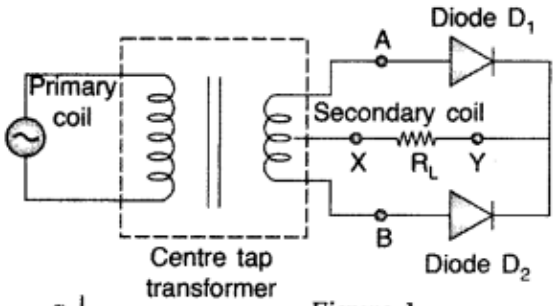


Figure 1

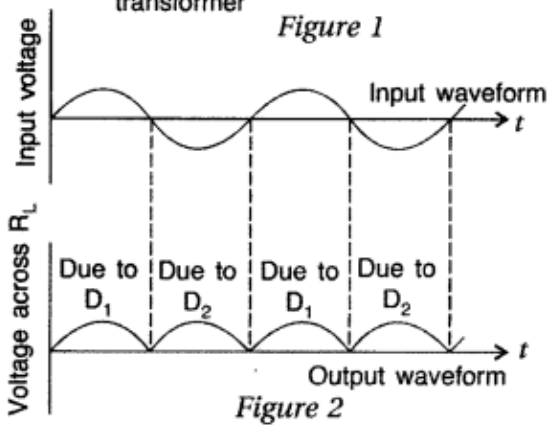


Figure 2

(ii) biasing across the junction, affect the width of the depletion layer?
(b) Draw the circuit diagram of a p-n diode used as a half-wave rectifier. Explain its working. (Comptt. All India 2012)
Answer:
(a) (i) Depletion layer. The layer containing unneutralized acceptor and donor ion across a p-n junction is called depletion layer. It is called depletion layer because it is depleted of mobile charge carriers.
(ii) Barrier potential. The electric field between the acceptor and donor ions is called the barrier. The difference of potential from one side of the barrier to the other side is called barrier potential.
(i) The increase of doping concentration will reduce width of depletion layer in semi conductor.
(ii) depletion layer widens under reverse bias and vice versa.

(b) Rectifier. A rectifier is a circuit which converts an alternating current into direct current.
p-n diode as a half wave rectifier. A half wave rectifier consists of a single diode as shown in the circuit diagram. The secondary of the transformer gives the desired a.c. voltage across A and B.
In the positive half cycle of a.c., the voltage at A is positive, the diode is forward biased and it conducts current.

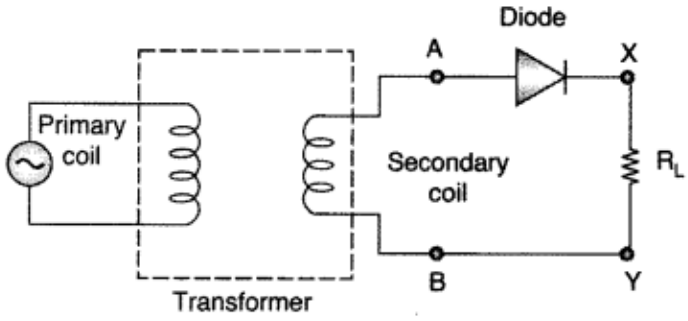
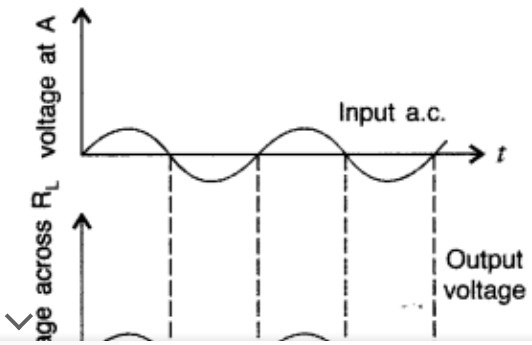


Fig. (a)



in CE configuration are obtained.

(b) Draw the transfer characteristics of a transistor in CE configuration. Explain how it is used in the working of the transistor as an amplifier and a switch. (Comptt. All India 2012)

Answer:

(a) Common emitter (CE) transistor characteristics. The transistor is most widely used in the CE configuration. When a transistor is used in CE configuration, the input is between the base and emitter and the output is between the collector and emitter.

The input and the output characteristics of an n-p-n transistor in CE configuration can be studied by using the circuit as shown in Figure 1.

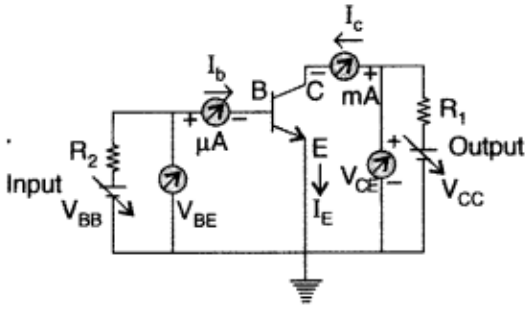
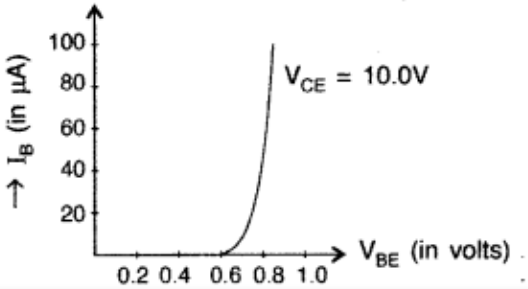


Figure 1

(i) Input characteristics. The variation of the base current IB with the base emitter voltage V_{BE} is called the input characteristic keeping V_{CE} fixed. A curve is plotted between the base current I_B against the base emitter voltage V_{BE}. The collector emitter voltage V_{CE} is kept fixed.

Since $V_{CE} = V_{CB} + V_{BE}$ and for Si transistor V_{BE} is 0.6 to 0.7 V, V_{CE} must be larger than 0.7 V. The input characteristics of a transistor is shown in Figure 2.



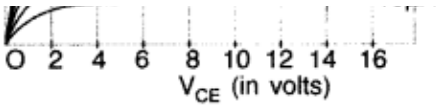
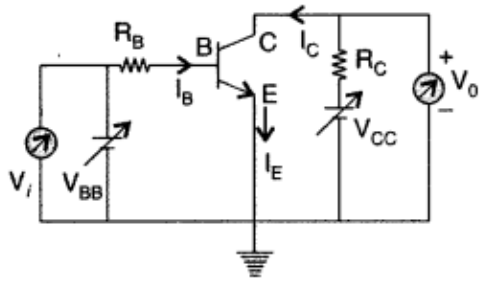


Figure 3

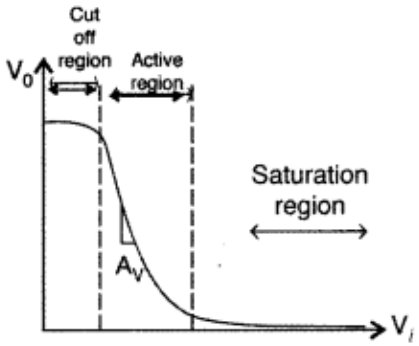
The plot of I_C versus V_{CE} for different fixed values of I_B gives one output characteristic. The different output characteristics for different values of I_B is shown in Figure 3.

$$\therefore \quad \beta_{AC} = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CB}}.$$

(b) Transistor as a switch. The circuit diagram of transistor as a switch is shown in Figure 1.
Transfer characteristics. The graph between V_0 and V_1 is called the. transfer characteristics of the base-biased transistor, shown in Figure 2.



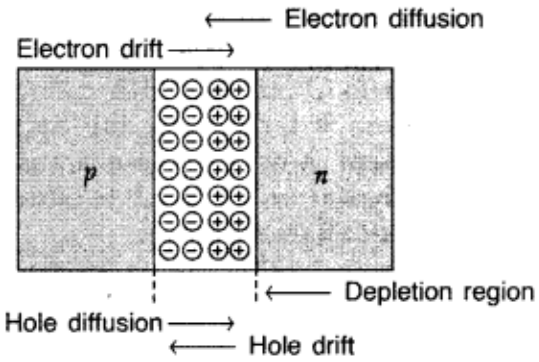
Base-biased transistor in CE configuration
Figure 1



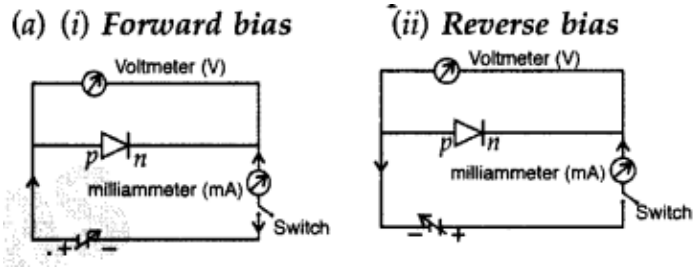
Transfer characteristics
Figure 2

When the transistor is used in the cut off or saturation state, it acts as a switch.
As long as V; is loio and unable to forward bias the transistor, then V0 is high. If V; is high enough to drive the transistor into saturation, then V0 is low. When the transistor is not conducting, it is said to be sivitched

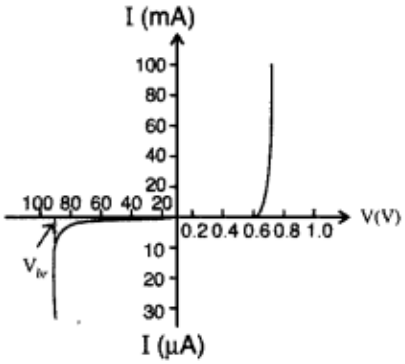
(a) p-n junction and depletion regions. Two processes involved during the formation of p-n junction are diffusion and drift. Due to the concentration gradient, across p and n sides of the junction, holes diffuse from p → n, and electrons from n → p. This movement of charge carriers leaves behind ionised acceptors on the p-side and donors on the n-side of the junction. This space charge region on either side of the junction, together, is known as depletion region.



(b)



The battery is connected to the silicon diode through a potentiometer (or rheostat), so that the applied voltage can be changed for different values of voltages, the corresponding values of current are noted.



Using the circuit arrangements shown in fig. (i) and fig (ii), we study the variation of current with applied

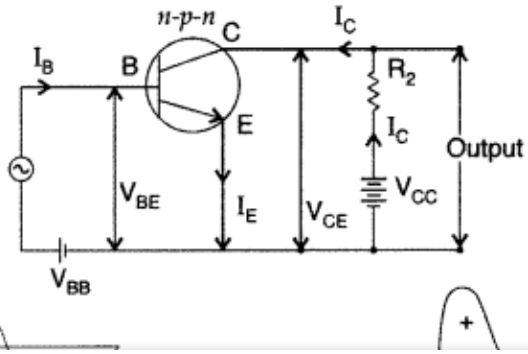
Question 126.
(a) Differentiate between three segments of a transistor on the basis of their size and level of doping.
(b) How is a transistor biased to be in active state?
(c) With the help of necessary circuit diagram, describe briefly how tt-p-n transistor in CE configuration amplifies a small sinusoidal input voltage. Write the expression for the ac current gain. (Delhi 2012)
Answer:
(a) All the three segments of a transistor have different thickness and their doping levels are also different. A brief description of the three segments of a transistor is given below :

- Emitter: This is the segment on one side of the transistor. It is of moderate size and heavily doped. It supplies a large number of majority carriers for the current flow through the transistor.
- Base : This is the central segment. It is very thin and lightly doped.
- Collector : This segment collects a major portion of the majority carriers supplied by the emitter. The collector side is moderately doped and larger in size as compared to the emitter.

(b) When the transistor works as an amplifier, with its emitter-base junction forward biased; and the base-collector junction reverse biased, is said to be in Active state.

(c) n-p-n transistor as amplifier.
n-p-n transistor as a common emitter amplifier : Working: According to Kirchoff's law, emitter current I_t, base current (I_B) and collector current (I_C) are related as $I_t = I_B + I_C$ ...(i)
When current (I_C) flows through the load resistance (R_L),
Output or collector voltage (V_0)

= applied voltage V_{CC} –Voltage drop across R_C
$\Rightarrow \quad V_0 = V_{CC} - I_C R_L$ ...(ii)



Similarly, during negative hay cycle, an amplified positive signal is obtained across the output.

$$A_V = \frac{\Delta V_{CE}}{\Delta V_{BE}} \qquad \text{But } \Delta V_{BE} = r_i.\Delta I_B$$

where [r_i is the resistance of the input or the emitter base circuit]

and $\Delta V_{CE} = R_L . \Delta I_C$ **where [R_L is the load resistance]**

$$\therefore \quad A_V = \frac{\Delta I_C}{\Delta I_B} . \frac{R_L}{r_i^0} = -\beta_{ac} . \frac{R_L}{r_i}$$

Question 127.

(a) Explain with the help of a diagram, how a depletion layer and barrier potential are formed in a junction diode.

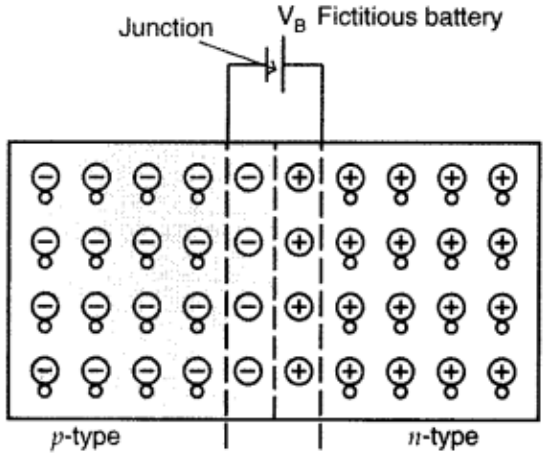
(b) Draw a circuit diagram of a full wave rectifier. Explain its working and draw input and output waveforms.

(Comptt. Delhi 2012)

Answer:

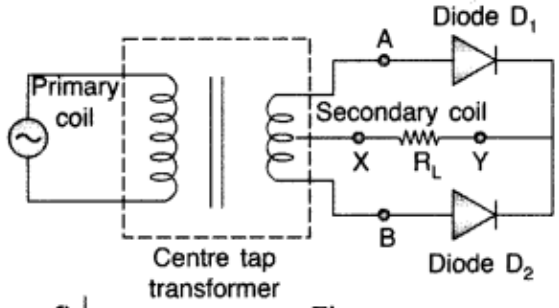
(a)

As soon as a p-n junction is formed, the majority charge carriers begin to diffuse from the regions of higher concentration to the regions of lower concentrations. Thus the electrons from the n-region diffuse into the p-region and where they combine with the holes and get neutralised. Similarly, the holes from the p-region diffuse into the n-region where they combine with the electrons and get neutralised. This process is called electron-hole recombination.

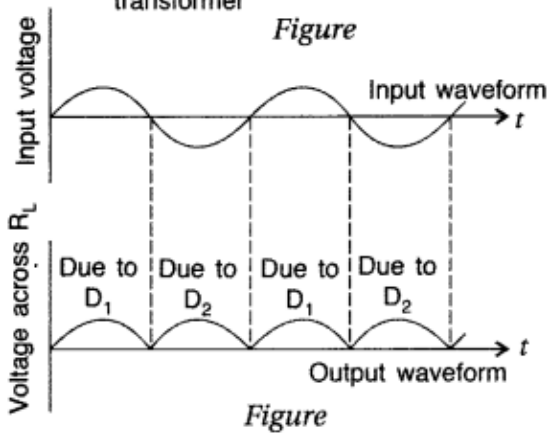


The p-region near the junction is left with immobile -ve ions and n-region near the junction is left with +ve

A full wave rectifier consists of two diodes and special type of transformer known as centre tap transformer as shown in the circuit. The secondary of transformer gives the desired a.c. voltage across A and B.
During the positive half cycle of a.c. input, the diode D_1 is in forward bias and conducts current while D_2 is in reverse biased and does not conduct current. So we get an output voltage across the load resistor R_L.



Figure



Figure

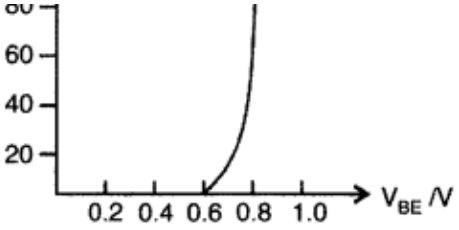
During the negative half cycle of a.c. input, the diode D_1 is in reverse biased and does not conduct current while diode D_2 in forward biased and conducts current. So we get an output voltage across the load resistor R_L.
NOTE: This is a more efficient circuit for getting rectified voltage or current.

Let $I = I_0 \sin wt$ be the input current to be rectified

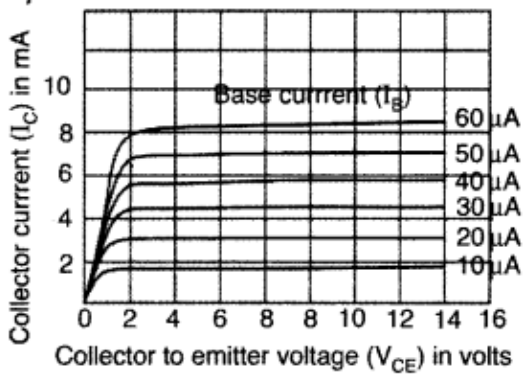
$\therefore$ The average current $= \frac{2I_0}{\pi}$

Hence output voltage $= \frac{2I_0}{\pi} R_L$

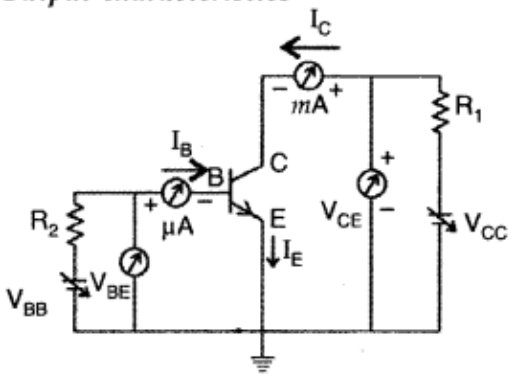
Question 128.
(a) Explain briefly, with the help of a circuit diagram how an n-p-n transistor in C.E. configuration is used to



(b) Input characteristics



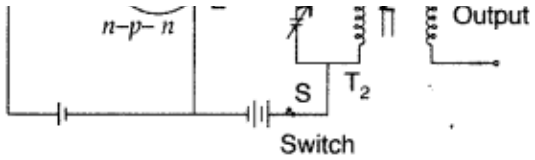
(c) Output characteristics



(b)

Principle of transistor oscillator : "Sustained a.c. signals can he obtained from an amplifier circuit without any external input signal by giving a positive feedback to the input circuit through inductive coupling or RC/LC network."

Oscillator action : In an ideal n-p-n biased transistor, when input base emitters junction and output base collector junction are forward and reverse biased respectively, a high collector current I_C flows through the circuit. If in circuit switch S is on, this current I_C will start flowing in the emitter circuit through the inductive coupling between coils T_1 and T_2, which provides the +ve feedback output to input and hence make I_E maximum. In the absence of +ve feedback the IE thus decreases making the circuit back to its original



The f_R resonance frequency is thus given by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Question 129.

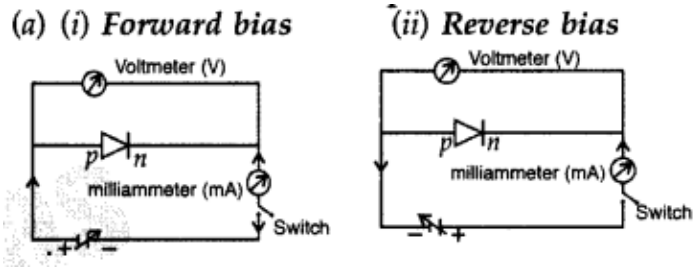
(a) Draw the circuit arrangement for studying . the V- I characteristics of a p-n junction diode in

(i) forward and

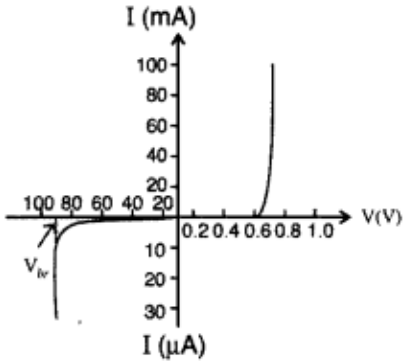
(ii) reverse bias. Briefly explain how the typical V-I characteristics of a diode are obtained and draw these characteristics.

(b) With the help of necessary circuit diagram explain the working of a photo diode used for detecting optical signals. (Comptt. All India 2012)

Answer:



The battery is connected to the silicon diode through a potentiometer (or rheostat), so that the applied voltage can be changed for different values of voltages, the corresponding values of current are noted.



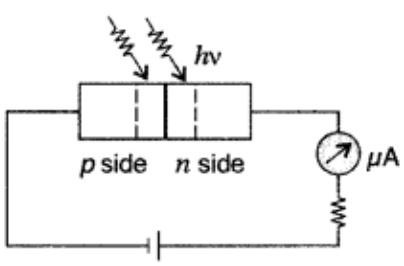


Fig. (i)

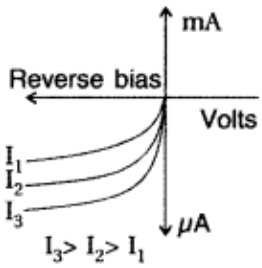


Fig. (ii)

When a p-n diode is illuminated with light photons having energy /xv > and intensities Iv I2, I3 etc. the electron and hole pairs generating in the depletion layer will be separated by the junction field and made to flow across the junction.

Graph showing variation in reverse bias currents for different intensities are shown in Figure (ii).

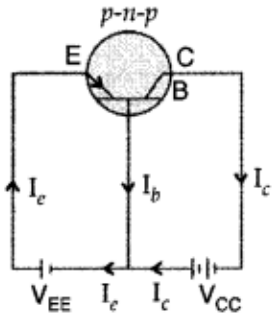
Question 130.

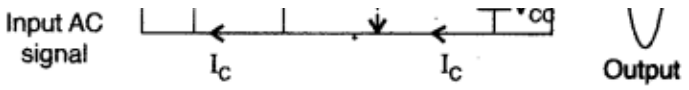
(a) Draw the circuit diagram of an n-p-n transistor with emitter-base junction forward biased and collector-base junction reverse biased. Describe briefly how the motion of charge carriers in the transistor constitutes the emitter current (I_E), the base current (I_B) and the collector current (I_C). Hence deduce the relation $I_E = I_B + I_C$.

(b) Explain with the help of circuit diagram how a transistor works as an amplifier. (Comptt. All India 2012)

Answer:

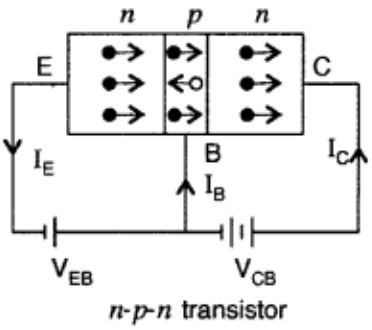
(a) In a p-n-p transitor, the heavily doped emitter which is p-type has a majority charge carrier of holes. These holes when move towards 21-type base get neutralized by e^- in base. The majority carriers enter the base region in large numbers. As the base is thin and lightly doped, the majority carriers (holes) swamp the small number of electrons there and as the collector is reverse biased, these holes can easily cross the junction and enter the collector.





Also read the following :

The function of emitter is to emit the majority carriers and collector is to collect the majority carriers. Base provides the proper interaction between the emitter and the collector.



Action of n-p-n transistor. The emitter-base junction of a transistor is forward biased while collector base junction is reverse biased as shown in adjoining Figure.

In case of n-p-n transistor, the negative terminal of V_{EB} repels the electrons of the emitter towards the base and constitute emitter current IE. About 5% of the electrons combine with the holes of the base to give small base current I_B.

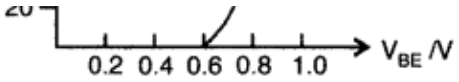
The remaining 95% of the electrons enter the collector region under the reverse bias and constitute collector current I_C.

According to Kirchhoff's law, the emitter current is the sum of collector current and base current.

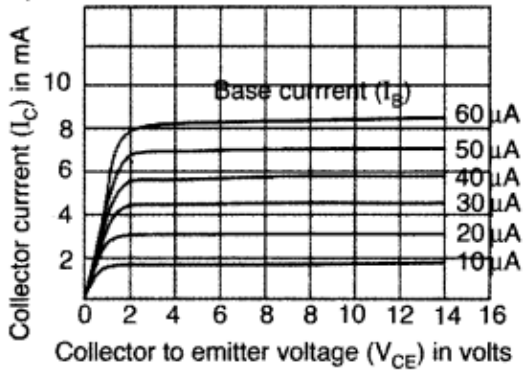
$I_E = I_C + I_B$

(b)

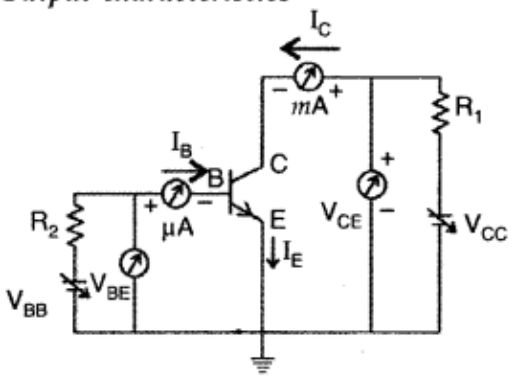
(i) Common emitter configuration of n-p-n transistor



(b) Input characteristics

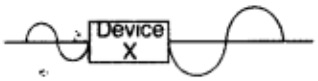


(c) Output characteristics



Question 131.

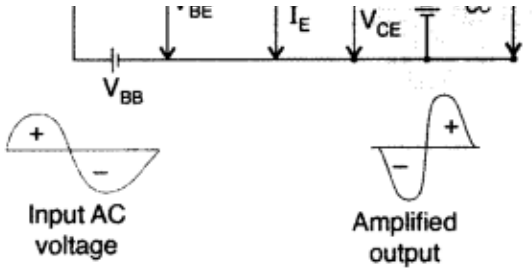
(a) Figure shows the input waveform which is converted by a device 'X' into an output waveform. Name the device and explain its working using the proper circuit Derive the expression for its voltage gain and power gain.



(b) Draw the transfer characteristic of a base biased transistor in CE configuration. Explain clearly which region of the curve is used in an amplifier. (Comptt. Delhi 2015)

Answer:

(a) (i) Name of device is common emitter amplifier.



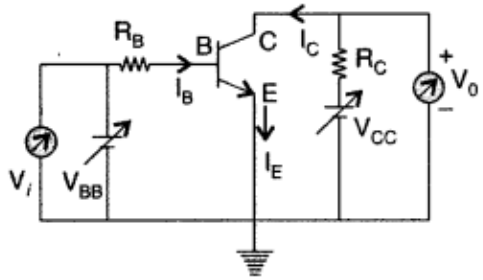
(iii) Expression for voltage gain and power gain

Power gain, A_p = Current gain × Voltage gain

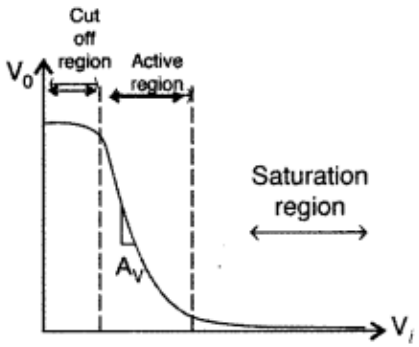
$$= (\beta_{ac})\ (A_v) = \beta_{ac}\left(\beta_{ac}\frac{R_L}{r}\right) = \beta_{ac}^2\frac{R_L}{r}$$

(b) Transistor as a switch. The circuit diagram of transistor as a switch is shown in Figure 1.

Transfer characteristics. The graph between V_0 and V_1 is called the. transfer characteristics of the base-biased transistor, shown in Figure 2.

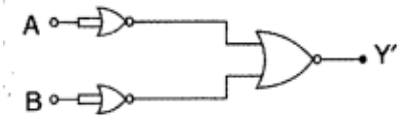


Base-biased transistor in CE configuration
Figure 1



Transfer characteristics
Figure 2

(b) Identify the logic gate equivalent to the circuit shown in the figure.



Draw the truth table for all possible values of inputs A and B. (Comptt. Delhi 2015)

Answer:

(a)

p-n junction diode as full wave rectifier. A full wave rectifier consists of two diodes and special type of transformer known as centre tap transformer as shown in the circuit. The secondary of transformer gives the desired a.c. voltage across A and B.

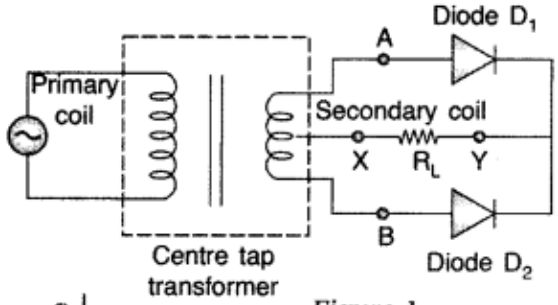


Figure 1

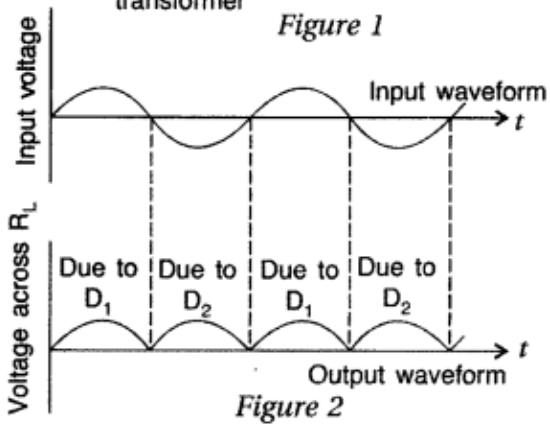


Figure 2

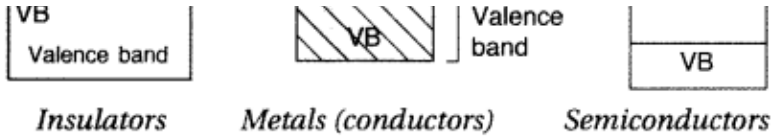
During the positive half cycle of a.c. input, the diode D_1 is in forward bias and conducts current while D_2 is in reverse biased and does not conduct current. So we get an output voltage across the load resistor R_L. During the negative half cycle of a.c. input, the diode D_1, is in reverse biased and does not conduct current while diode D_2 is in forward biased and conducts current. So we get an output voltage across the load

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

Question 133.
Draw the 'Energy bands', diagrams for a
(i) pure semiconductor
(ii) insulator.
How does the energy band, for a pure semiconductor, get affected when this semiconductor is doped with
(a) an acceptor impurity
(b) donor impurity? Hence discuss why the 'holes', and the 'electrons' respectively, become the 'majority charge carriers' in these two cases? Write the two processes involved in the formation of p-n junction.
(Comptt. All India 2015)
Answer:
'Energy Band' diagrams :
Distinguishing features between conductors, semiconductors and insulators :
(i) Insulator. In insulator, the valence band is completely filled. The conduction band is empty and forbidden energy gap is quite large. So no electron is able to go from valence band to conduction band even if electric field is applied. Hence electrical conduction is impossible. The solid/ substance is an insulator.

(ii) Conductors (Metals). In metals, either the conduction band is partially filled or the conduction and valence band partly overlap each other. If small electric field is applied across the metal, the free electrons start moving in a direction opposite to the direction of electric field. Hence, metal behaves as a conductor.

(iii) Semiconductors. At absolute zero kelvin, the conduction band is empty and the valence band is filled. The material is insulator at low temperature. However the energy gap between valence band and conduction band is small. At room temperature, some valence electrons acquire thermal energy and jump to conduction band where they can conduct electricity. The holes left behind in valence band act as a positive charge carrier.



Insulators *Metals (conductors)* *Semiconductors*

(a) When the semiconductor is doped with an acceptor impurity, thereby results in an additional energy level a little above the top of the valence band.
(b) The donor impurity results in an additional energy level a little below the bottom of the conduction band.

In the first case, electrons from the valence band, easily jump over to the acceptor lelvel, leaving 'holes' behind. Hence, 'holes' becomes the majority charge carriers.

In the second case, electrons from the donor level, easily 'jump over' to the conduction band. Hence, electrons become the majority charge carriers. The two processes involved in the formation of the p-n junction are :
(i) Diffusion
(ii) Drift

Question 134.
(a) Draw the diagram of the 'circuit arrangement used for studying the 'input' and 'output' characteristics of an n-p-n transistor in its CE configuration'. Briefly explain how these two types of characteristics are obtained and draw these characteristics.
(b) 'Define' the terms,
(i) Input resistance
(ii) Output resistance
(iii) Current amplification factor, for a given transistor. (Comptt. All India 2015)
Answer:
(a)
Common emitter (CE) transistor characteristics. The transistor is most widely used in the CE configuration. When a transistor is used in CE configuration, the input is between the base and emitter and the output is between the collector and emitter.
The input and the output characteristics of an n-p-n transistor in CE configuration can be studied by using the circuit as shown in Figure 1.

Figure 1

(i) Input characteristics. The variation of the base current IB with the base emitter voltage V_{BE} is called the input characteristic keeping V_{CE} fixed. A curve is plotted between the base current I_B

against the base emitter voltage V_{BE}. The collector emitter voltage V_{CE} is kept fixed.
Since $V_{CE} = V_{CB} + V_{BE}$ and for Si transistor V_{BE} is 0.6 to 0.7 V, V_{CE} must be larger than 0.7 V. The input characteristics of a transistor is shown in Figure 2.

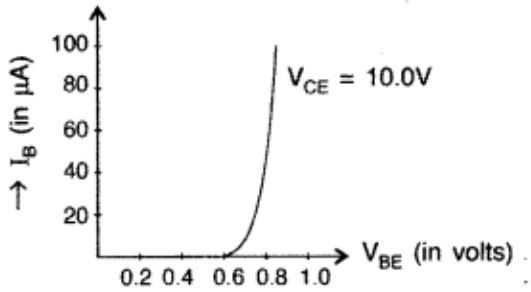


Figure 2

(ii) Output characteristics. The variation of the collector current I_C with the collector emitter voltage V_{CE}, keeping the base current IB constant is called output characteristics.

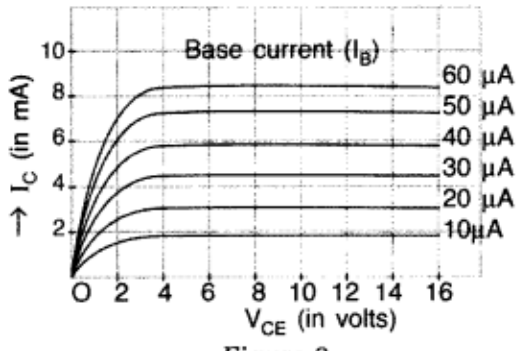


Figure 3

The plot of I_C versus V_{CE} for different fixed values of I_B gives one output characteristic. The different output characteristics for different values of I_B is shown in Figure 3.

$$\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$$

Important Questions for Class 12 Physics

Filed Under: CBSE

TOP Universities in India

TOP Engineering Colleges in India

TOP Pharmacy Colleges in India

Coding for Kids

Math Riddles for Kids with Answers

General Knowledge for Kids

General Knowledge

Scholarships for Students

NSP - National Scholarip Portal

Class 12 Maths NCERT Solutions

Class 11 Maths NCERT Solutions

NCERT Solutions for Class 10 Maths

NCERT Solutions for Class 9 Maths

NCERT Solutions for Class 8 Maths

NCERT Solutions for Class 7 Maths

NCERT Solutions for Class 6 Maths

NCERT Solutions for Class 6 Science

NCERT Solutions for Class 7 Science

NCERT Solutions for Class 8 Science

NCERT Solutions for Class 9 Science

NCERT Solutions for Class 10 Science

NCERT Solutions for Class 11 Physics

carbon and its compounds class 10

Periodic Classification of Elements Class 10

Life Process Class 10

NCERT Solutions for Class 10 Science Chapter 7

NCERT Solutions for Class 10 Science Chapter 8

NCERT Solutions for Class 10 Science Chapter 9

NCERT Solutions for Class 10 Science Chapter 10

NCERT Solutions for Class 10 Science Chapter 11

NCERT Solutions for Class 10 Science Chapter 12

NCERT Solutions for Class 10 Science Chapter 13

NCERT Solutions for Class 10 Science Chapter 14

NCERT Solutions for Class 10 Science Chapter 15

NCERT Solutions for Class 10 Science Chapter 16

FREE RESOURCES

RD Sharma Class 12 Solutions | RD Sharma Class 11

RD Sharma Class 10 | RD Sharma Class 9

RD Sharma Class 8 | RD Sharma Class 7

CBSE Previous Year | CBSE Previous Year

NCERT SOLUTIONS

NCERT Solutions for Class 10

NCERT Solutions for Class 9

NCERT Solutions for Class 8

NCERT Solutions for Class 7

NCERT Solutions for Class 6

QUICK RESOURCES

English Grammar	Hindi Grammar
Textbook Solutions	Maths NCERT Solutions
Science NCERT Solutions	Social Science NCERT Solutions
English Solutions	Hindi NCERT Solutions
NCERT Exemplar Problems	Engineering Entrance Exams
Like us on Facebook	Follow us on Twitter
Watch Youtube Videos	NCERT Solutions App