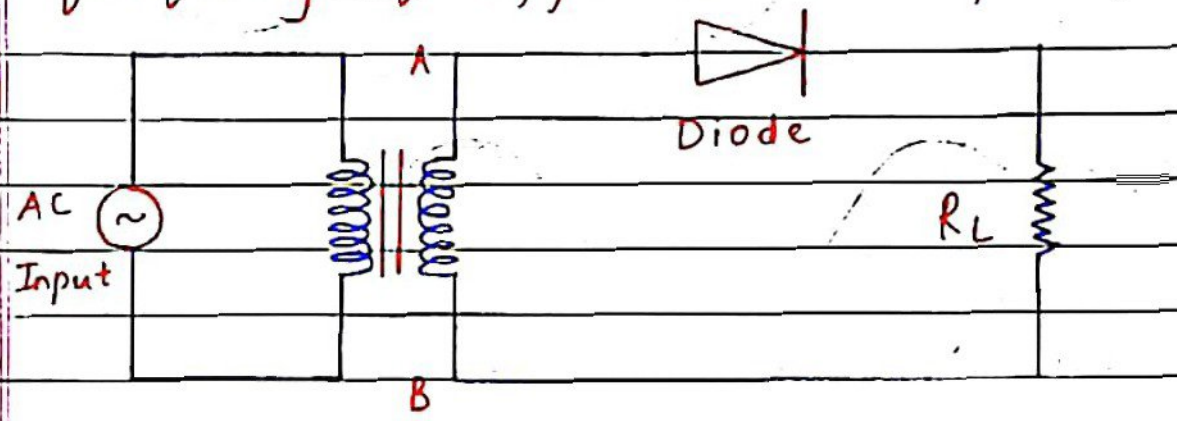
03) Draw the circuit diagram of a half wave rectifier. Explain its working. what is the frequency of ripple in its output.?



i) Figure shows circuit diagram for half wave rectifier. The secondary coil AB of a transformer is connected in series with a diode and load resistance R_L.

ii) The secondary coil AB changes its polarities after every half cycle.

iii) When positive half cycle begins, point A is at higher potential w.r.t. point B.

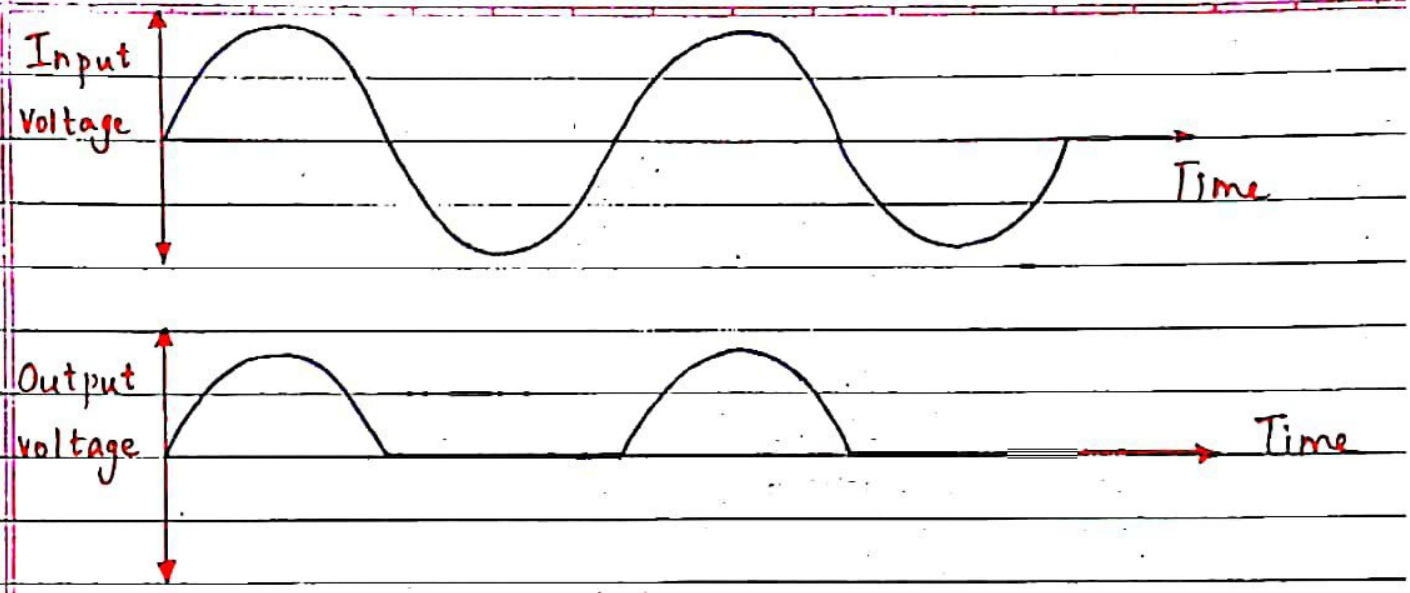
iv) Therefore diode is forward biased. It conducts and current flows through R_L.

v) When negative half cycle begins, point A is at lower potential w.r.t. point B.

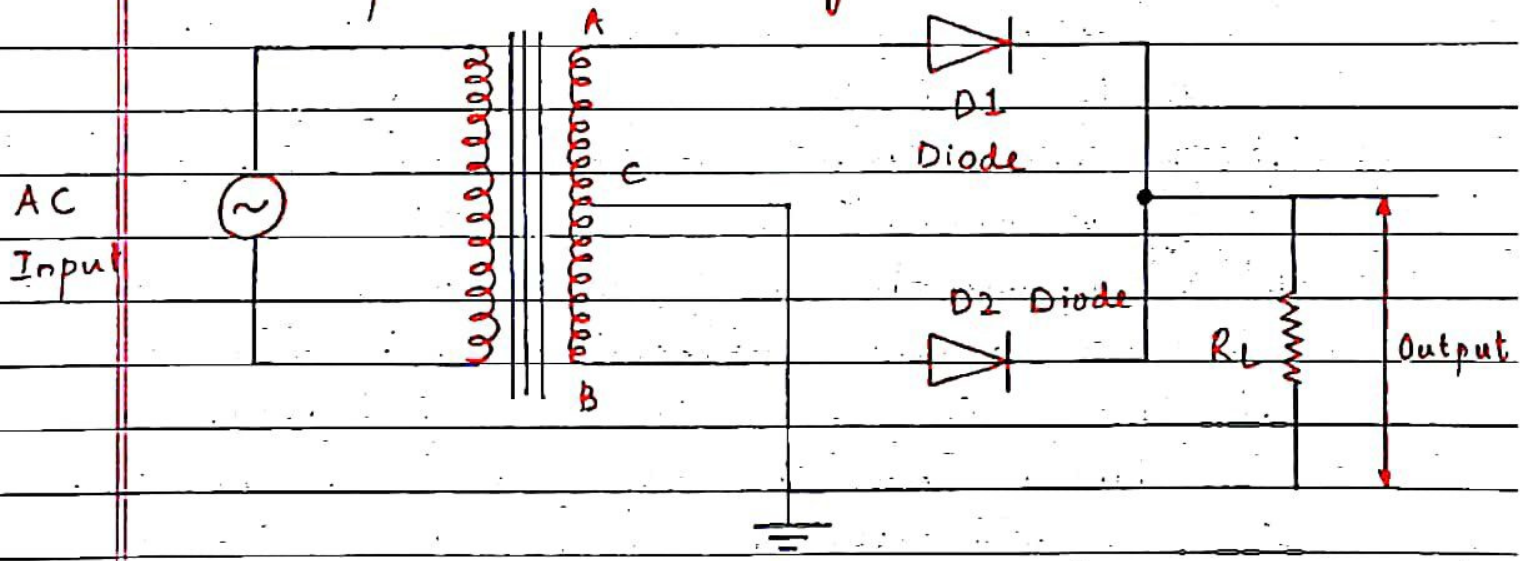
vi) Therefore diode is reverse biased. It does not conduct and no current passes through R_L

vii) Since current flows through R_L in the same direction for alternate positive half cycle, it is called half wave rectifier.

viii) The frequency of the ripple in output is same as that of the frequency of input for half wave rectifier



05) Draw a neat diagram of a full wave rectifier and explain its working.



i) Figure shows circuit diagram for full wave rectifier consisting of a centre tapped transformer and diodes (D_1 & D_2) as well as load resistance R_L

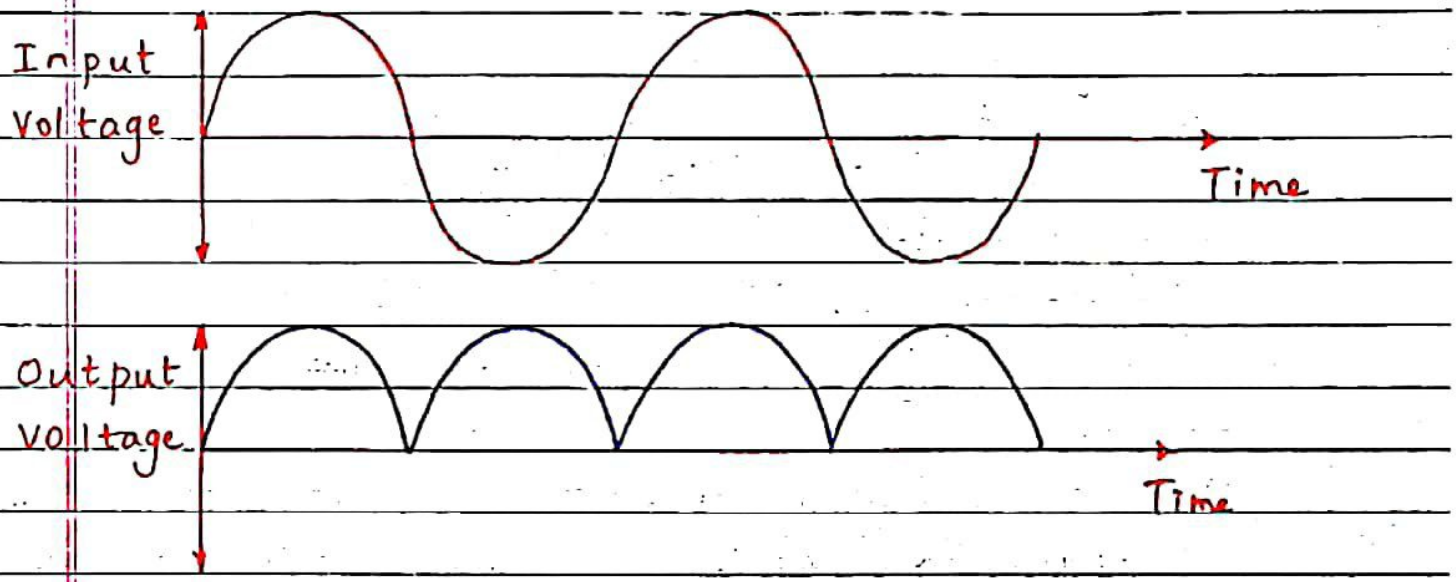
ii) When positive half cycle begins, point A is at higher potential w.r.t. point B

iii) Diode D_1 is forward biased and D_2 is reversed biased. Diode D1 conducts and current flows through R_L.

iv) When negative half cycle begins, point A is at lower potential w.r.t. point B.

v) Therefore, Diode D1 is reverse biased and Diode D2 is forward biased. Diode D2 conducts and current flows through R_L in same direction.

vi) Since current flows through R_L in the same direction for both the cycles, hence it is called full wave rectifier.



Q4) Why do we need filters in a power supply ?

Ans i) For any rectifier, the output is unidirectional but the output does not have a steady value.

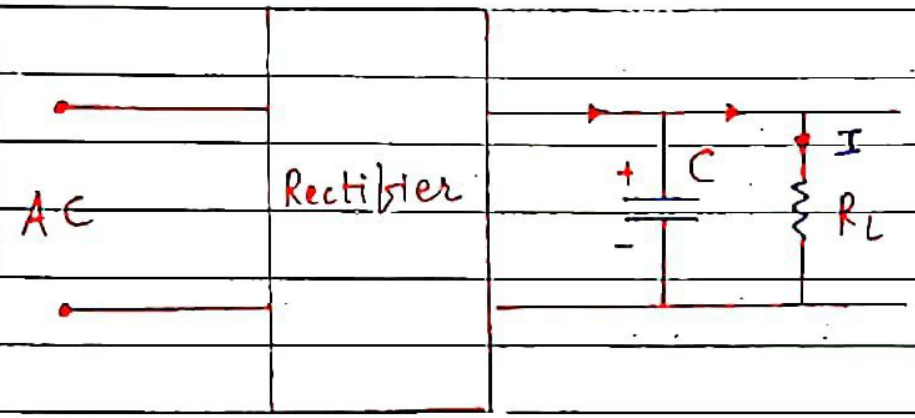
ii) It keeps fluctuating due to the ripple component present in it.

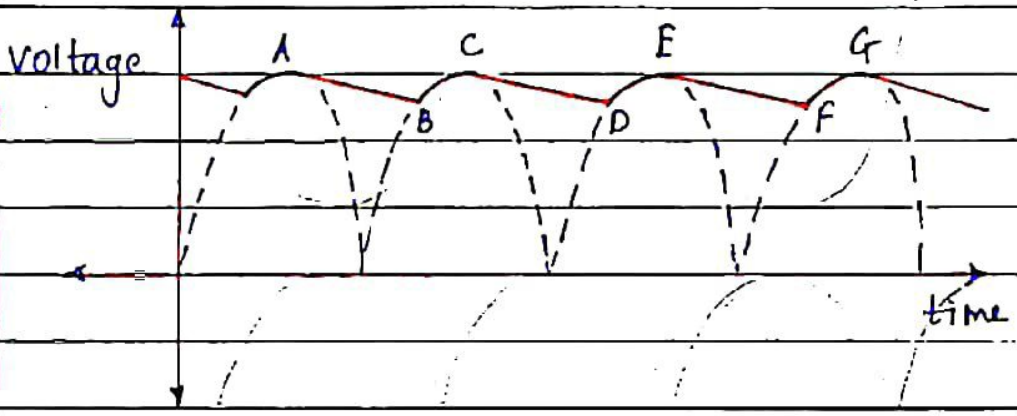
iii) A filter circuit is used to remove the ripple from the output of a rectifier.

Hence, to get a steady output from a power supply, we need filters.

* Explain the working of filter circuit with Capacitor

Ans A filter circuit is a circuit which removes the AC component (or ripple) from a rectifier output and allows only the DC component.





i) From rectifier, the DC output voltage which contains (ripple) ie. AC component is applied across Capacitor.

ii) Therefore Capacitor gets charged upto point A and it supplies current to the load resistance.

iii) Now, after point A, rectifier voltage begins to decrease. So capacitor now gets discharged through load resistance

iv) Voltage across load decreases only slightly upto point B because next voltage rise recharges the capacitor immediately.

v) This process is repeated again and again and the output waveform takes the shape ABCDEFG.. as shown in figure.

* What is Ripple factor ?

Ans The output of a rectifier consists of a small fraction of an AC component along with DC is called the ripple

$$\text{Ripple factor} = \frac{\text{r.m.s. value of AC Component}}{\text{value of DC component}}$$

Q2 ii) How is Zener diode different than an ordinary diode ?

Ans i) Zener diode is heavily doped as compared to ordinary diode.

ii) The depletion region is narrow in Zener diode when compared to ordinary diode.

iii) Zener diode does not get damaged when reverse voltage is increased, whereas ordinary diode gets damaged when reverse voltage increases after certain limit.

iv) Zener diode is used for voltage regulation whereas ordinary diode is used for rectification.

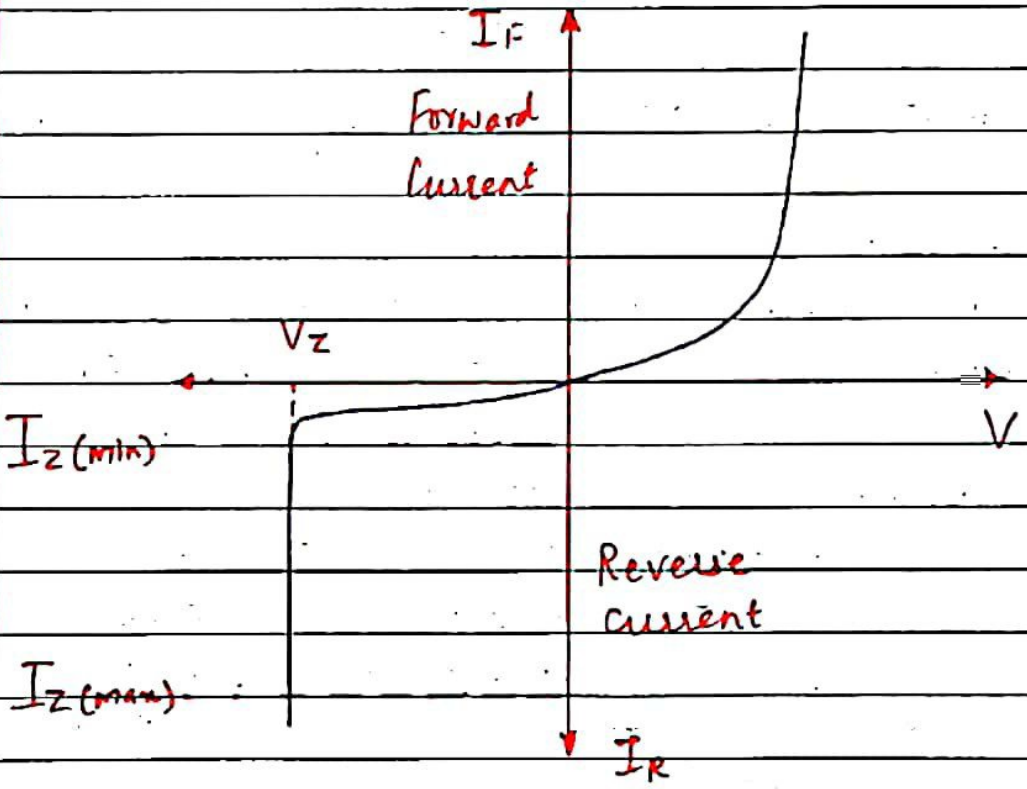
Q7) Explain the forward and reverse characteristics of a Zener diode.

Ans Forward characteristic : Zener diode behaves like a normal diode when forward biased.

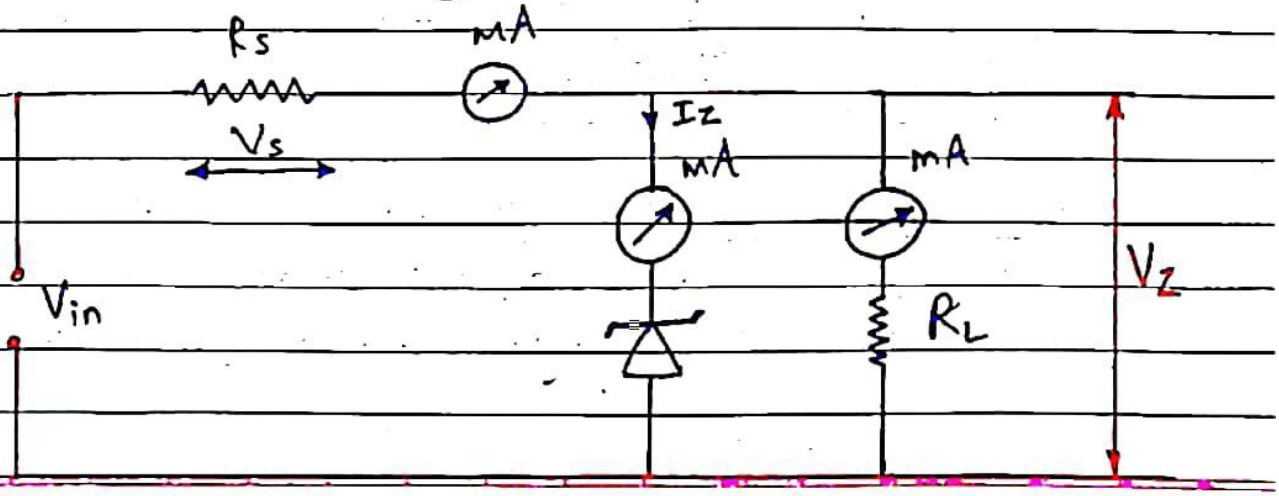
Reverse characteristic : When Zener diode is reverse biased, it shows a breakdown at reverse voltage called as Zener voltage.

The current suddenly increases if the applied voltage is increased beyond the Zener voltage (V_Z).

It is interesting to note that voltage remains constant at V_Z even if the current increases. This property of Zener diode is used in a voltage regulator.



06) Explain how a Zener diode maintains constant voltage across a load.



The circuit diagram for using zener diode as a voltage regulator is shown:

i) The Resistor R_s is connected in series with the Zener diode.
ii) The load resistance R_L is connected in parallel with Zener diode.

Working : i) If the input voltage (V_i) increases, then the voltage across the series resistance R_s also increases. But the voltage across Zener diode does not change.
ii) Since, load resistance is connected in parallel to Zener diode, so same voltage is maintained across load resistance like Zener
iii) So, the series resistance R_s absorbs the increase in input voltage (V_i) and helps in maintaining constant voltage across Zener diode and load resistance

iv) If, similarly the input voltage (V_i) decreases then the voltage across series resistance R_s also decreases.
v) But the voltage across Zener diode and hence load resistance R_L does not change.

$$V_{in} = V_s + V_z$$

But $V_s = I_z \times R_s$

$$\therefore V_{in} = (I_z R_s) + V_z$$

Lower value of input voltage $V_{in(low)} = I_{z(min)} R_s + V_z$

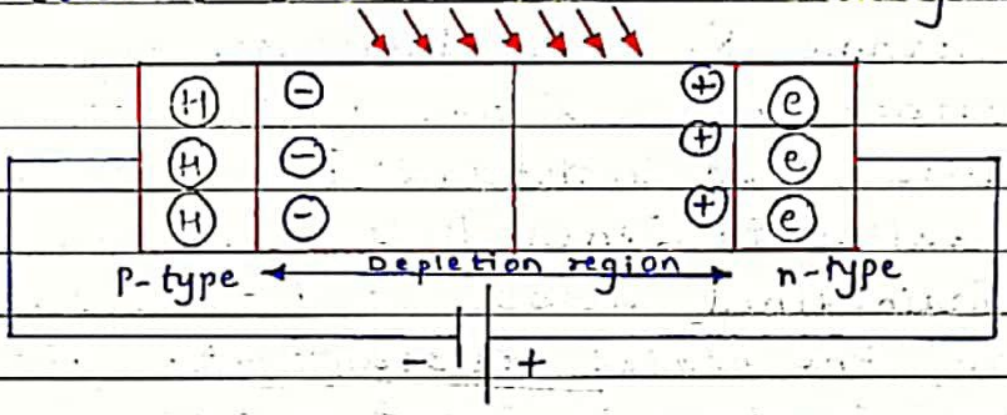
Higher value of input voltage $V_{in(high)} = I_{z(max)} R_s + V_z$

Q10) Explain the principle of operation of a photodiode.

Ans i) A photodiode is a special type of p-n junction diode which converts light energy into electrical energy.

ii) When p-n junction is reverse biased, then a reverse saturation current flows through the junction

iii) This reverse current is called dark current and is due to minority carriers.



iv) When P-n junction diode is exposed to light, electron - hole pairs are generated in the depletion region.

v) The electric field present in the depletion region separates electrons & holes.

vi) The electrons are attracted towards the anode and holes are attracted towards the cathode.

vii) These flow of electrons and holes causes reverse current to increase.

viii) The total current in photodiode is sum of photocurrent and the dark current

Q2 iv) why should a photodiode be operated in reverse biased mode?

Ans i) In case of reverse biased p-n junction, the width of depletion layer increases.
ii) Thus, more number of electrons are available for reverse current; i.e. conduction.
iii) On the other hand, when P-n junction diode is forward biased, the width of depletion region decreases.
iv) Only a small portion of electrons are available for reverse current i.e. conduction.
Therefore, efficiency of photodiode increases if it is operated in reverse biased mode.

* What is saturation current of photodiode? Define dark resistance of a photodiode.

Ans Reverse current increases initially with increase in the intensity of light and then reaches a constant value after certain fixed voltage. This constant value of current is called Saturation current.

Dark resistance is the ratio of maximum reverse voltage and its dark current.

* State Advantages, Disadvantages & Applications of photodiode

Ans Advantages: i) Quick response when exposed to light.
ii) Light weight and compact size.
iii) Relatively low cost.
iv) High speed of Operations.

Disadvantages : i) properties of photodiode are temperature dependent.
ii) Low reverse current produced for low intensity of light.

Applications : i) Counters & Switches
ii) Burglar alarm systems.
iii) Detection of visible and invisible radiations
iv) Safety electronics like fire & smoke detectors
v) Used as sensors / detectors for accurate measurement of light intensity.

Q2 v) State the principle and uses of a solar cell.

Ans Solar cell principle → It is a device which converts solar energy into electrical energy.

Uses : i) Used for charging batteries during day time so that batteries can supply power during night.
ii) Supplying power to electronic equipments like calculators, satellites, space stations and traffic signals.
iii) Used in lux meter to measure intensity of light.

Q9) Explain the construction and working of solar cell.

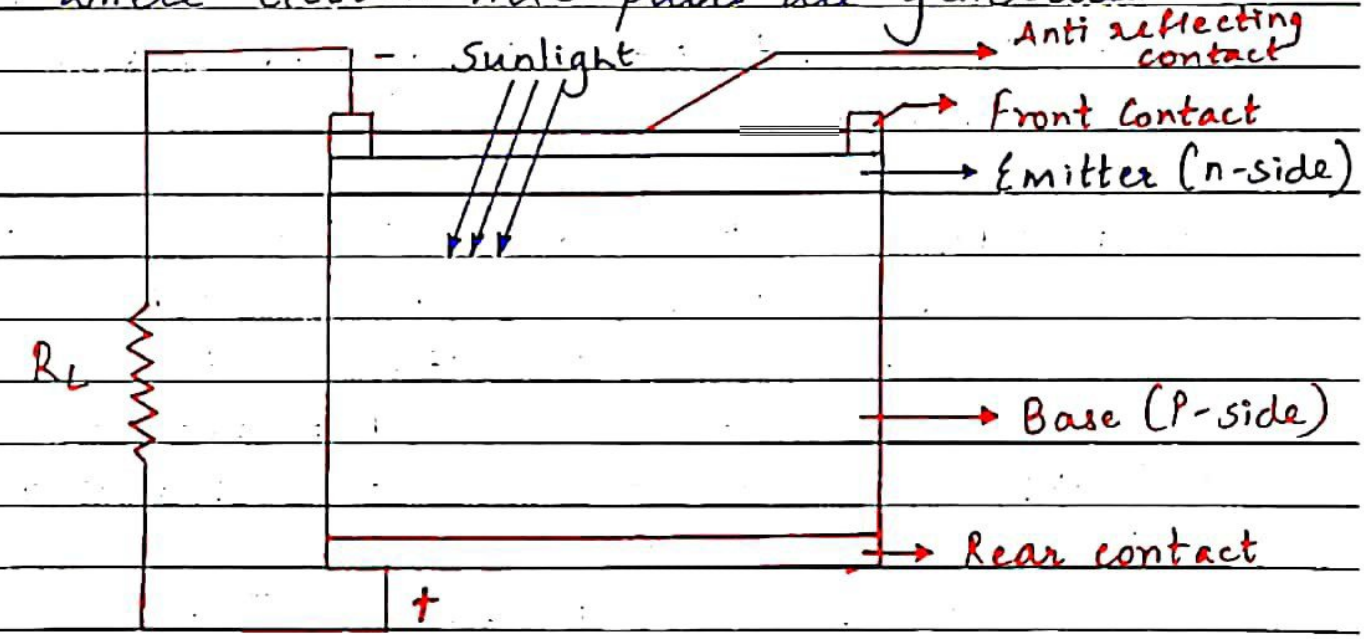
Ans Construction :- i) Solar cell consists of p-n junction. The n-side faces the solar radiation and p-side is at the back of the solar cell.

ii) Both p-side and n-side are coated with conducting material.

iii) The n-side is coated with antireflection coating which allows light to pass through it.

iv) The main function of this coating is to reflect the IR radiations and protect the solar cell.

v) The p-side is relatively thick. The n-side of a solar cell is thin so that light is incident on it reaches the depletion region where electron-hole pairs are generated.



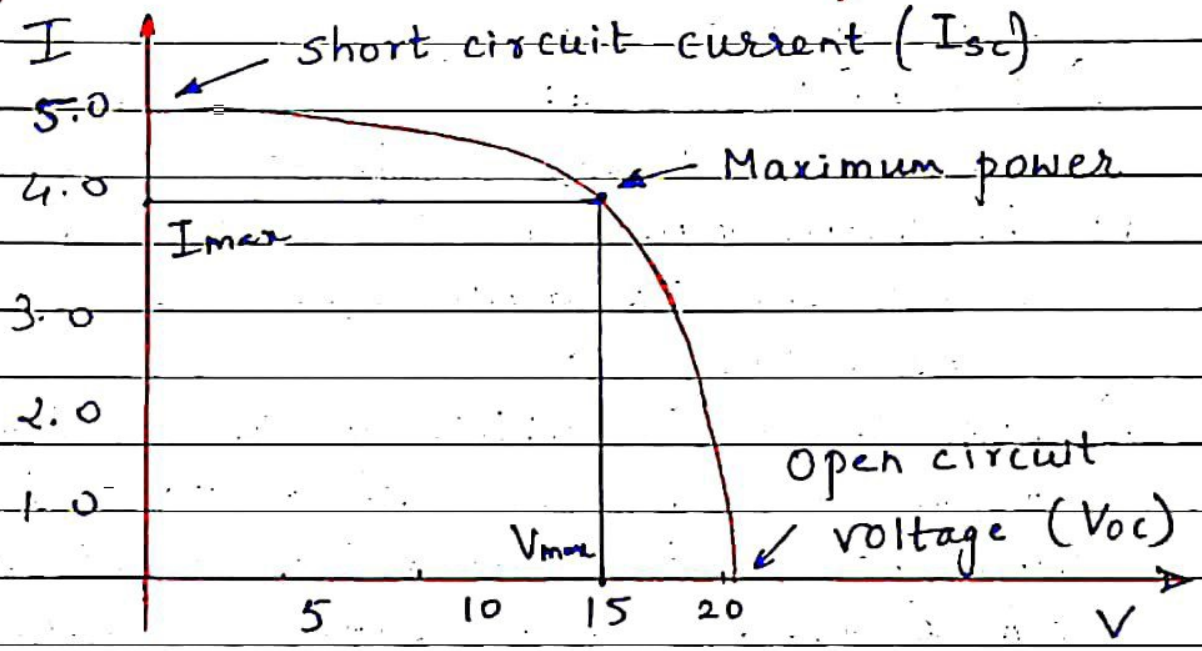
Working :- i) When light is incident on a solar cell, then incident photons are absorbed and electron-hole pairs are generated.

ii) The electrons and holes are separated. Electrons are collected at cathode and holes are collected at anode.

iii) So, carriers are accumulated and it generates a voltage across the solar cell.

iv) Thus, power is produced and utilised at the load connected in the circuit.

* Explain V-I characteristics of solar cell



V-I characteristics is drawn in fourth quadrant.

We know, $P = V \times I$

when the load is short circuited, $V = 0$
and short circuit current is I_{sc}.
$\therefore$ Power delivered = Zero.
This is intersection of curve with I-axis.

when the load is open, $I = 0$
and open circuit voltage is V_{oc}
$\therefore$ power delivered = Zero
This is intersection of curve with Y-axis.

There is a point on the curve where power delivered is maximum.

$P = V_{max} \cdot I_{max}$

* Explain construction of LED (Light Emitting Diode)

Ans i) LED (Light Emitting diode) is a diode which emits light when large forward current passes through it.

ii) The construction of LED is different from that of a normal diode.

iii) The n-region is heavily doped than the p-region of p-n junction.

iv) LED p-n junction is encased in a dome-shaped transparent case. It helps in uniform emission of light in all directions as well as internal reflections are minimized.

v) Metal electrodes (Anode and cathode) are attached. The Larger leg of LED is the positive electrode or anode.

vi) Epoxy resin body of LED is constructed. Due to such body, the emitted light appears to be brightest at the top of LED.

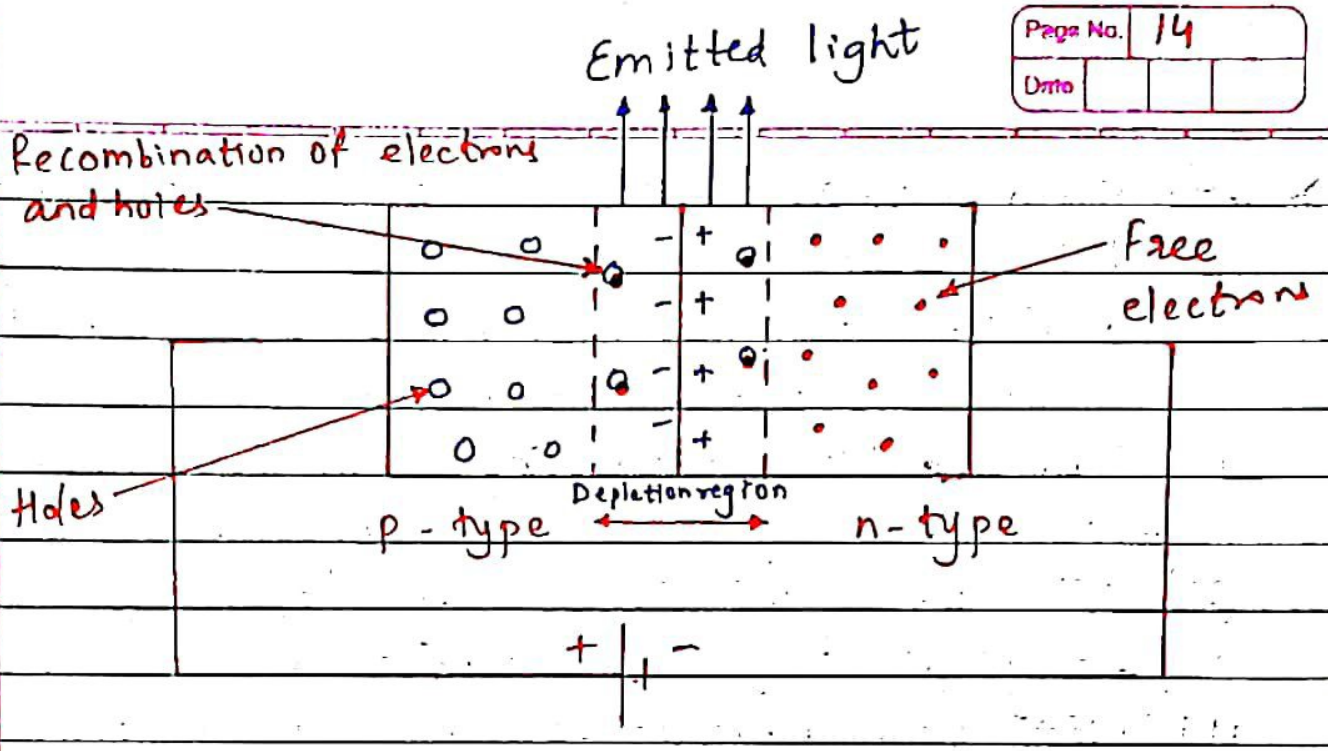
Q8) Explain the working of a LED.

Ans i) In LED, emission of light occurs when electron-hole pair combines.

ii) When the diode is forward biased, electrons from conduction band recombine with holes from valence band.

iii) This recombination releases sufficient energy to produce photons and emit coloured light.

iv) Higher the forward current, higher is the light output.



Q2 iii) On which factors does the wavelength of light emitted by a LED depend?

Ans By varying the proportions of elements like gallium, phosphorus and arsenic in the semiconducting materials, it is possible to produce light of different wavelengths.

* How does an LED emits different colours?

Ans i) when LED is manufactured using aluminium gallium arsenide (Al GaAs), it emits infrared radiations.

ii) when LED is made using gallium arsenic phosphide (GaAsP), it produces either red or yellow light.

iii) when LED is made using aluminium gallium phosphide (AlGaP), it emits red or green light.

iv) when LED is made using Zinc Selenide, it produces blue light.

* State Advantages & Uses of LED.

Ans Advantages :-

i) LEDs are energy efficient. They produce more light output for lesser electrical power.
ii) LEDs have long lifetime of 50,000 hours or more
iii) LEDs start instantly and emits light in nanoseconds.
iv) LEDs do not contain mercury or other hazardous substances.
v) Brightness and colour of light emitted by LEDs can be controlled.

Uses : (Applications) :

LEDs are used in variety of ways such as burglar alarm system, counters, display screen of cell phone handset, LED television, vehicle head lamps, street lighting.

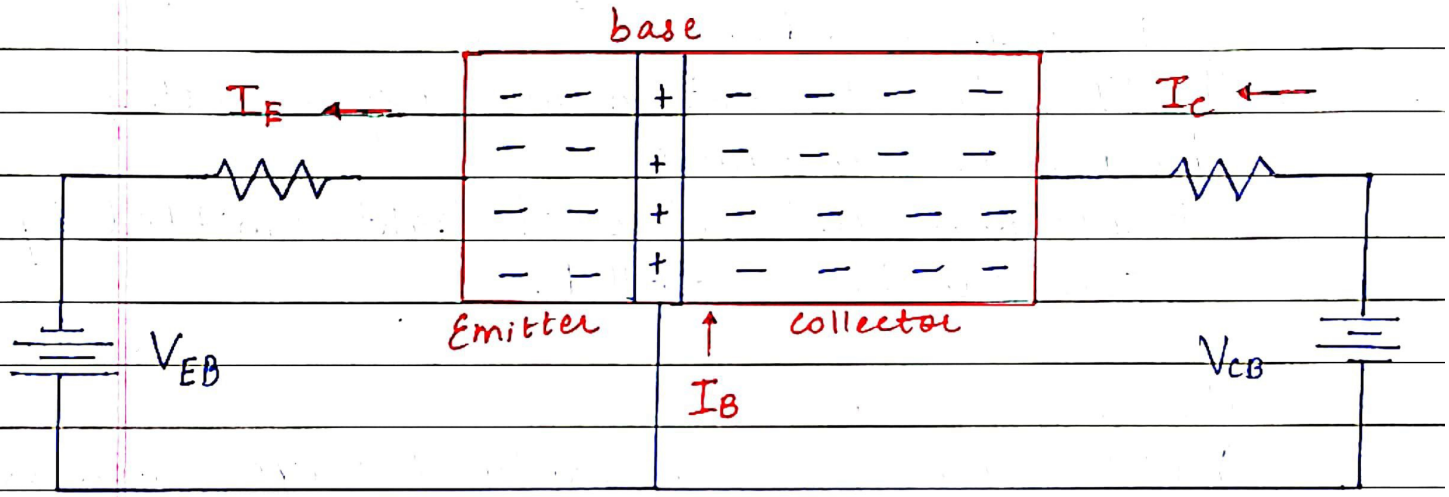
* Explain the construction of a transistor

Ans i) A transistor is a semiconductor device having two junctions and three doped regions.
ii) The three doped regions are emitter, base and collector.
iii) Emitter :- It is thick heavily doped layer. This layer supplies a large number of majority carriers for the current flow through the transistor.

iv) Base :- It is thin, lightly doped central layer.
v) Collector :- It is also thick and moderately doped layer. Its area is larger than that

of emitter and the base.

vi) There are two types of transistors :
   i) n-p-n transistor
   ii) p-n-p transistor



* Explain the working of n-p-n transistor.

Ans i) When E-B junction is forward biased, large number of electrons enter the base region from emitter called emitter current (I_E)

ii) These electrons can now flow in two directions

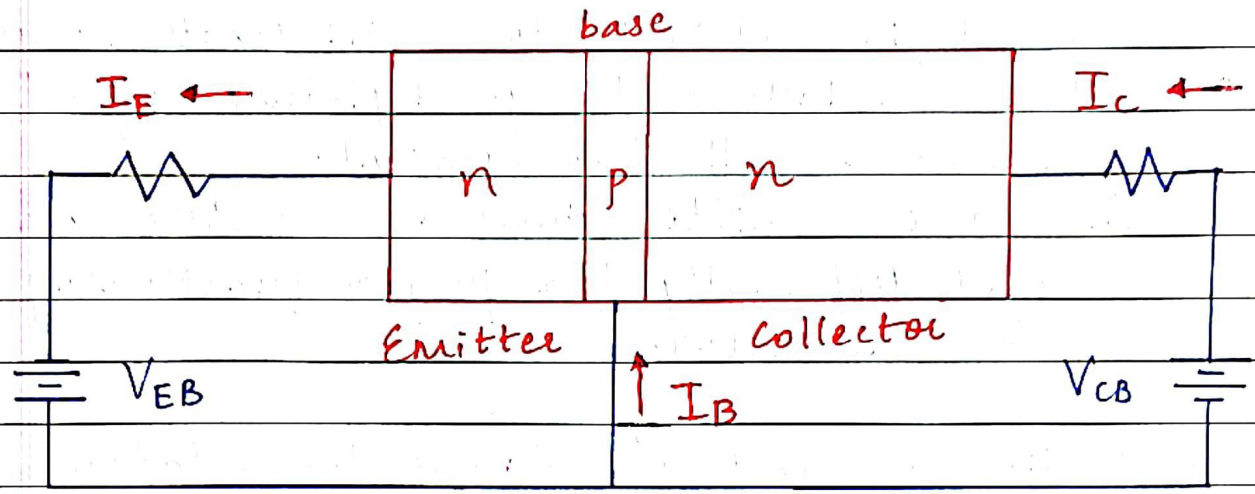
iii) They can flow through base circuit and constitute base current (I_B)

iv) They can also flow through collector circuit and contribute towards the collector current (I_c)

v) Since base is thin and lightly doped, the base current (I_B) is small. It is only 5% of I_E

vi) The collector current (I_c) is about 95% of I_E.

$\therefore I_E = I_B + I_C$



Q2 i) Why is the base of a transistor made thin and is lightly doped ?

Ans i) Thin base region of transistor helps electrons from emitter to diffuse into collector region instead of going into base.

ii) Base is lightly doped because electrons from emitter should not combine to a larger extent with holes in base.

iii) This results in most electrons entering collector and produces collector current upto 95%.

Q15) Why is the emitter, the base and the collector of BJT doped differently ?

Ans i) Emitter is heavily doped so that it supplies a large number of majority carriers for the current flow through the transistor.

ii) Base is lightly doped so that only few electrons from emitter recombine with the holes.

iii) Thus, base current is minimum and large number of electrons are pushed into collector region.

iv) Collector is also heavily doped because low doping of collector will create large depletion layer. Large depletion layer decreases collector current.

Therefore, emitter, base & collector are doped differently for proper functioning of transistor

Q17) Define α and β. Derive the relation between them.

Ans DC current gain (α) is the ratio of collector current and the emitter current.

$$\alpha_{DC} = \frac{I_C}{I_E} \quad \text{— (1)}$$

Current gain or current amplification factor (β) is the ratio of collector current to base current.

$$\beta_{DC} = \frac{I_C}{I_B} \quad \text{— (2)}$$

We know, $I_E = I_B + I_C$

Dividing whole equation by I_C

$$\therefore \frac{I_E}{I_C} = \frac{I_B}{I_C} + \frac{I_C}{I_C}$$

From eqn (1) & (2)

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

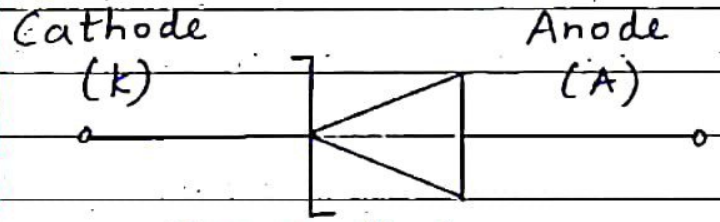
$$\therefore \frac{1}{\alpha} = \frac{1+\beta}{\beta}$$

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

Q16) Which method of biasing is used for operating transistor as an amplifier.

Ans For transistor operating as an amplifier, the emitter base junction is forward biased while collector base junction is reverse biased.

* Draw the circuit symbol of following
i) Zener diode ii) photo diode iii) LED
iv) P-n-p transistor v) n-p-n transistor



Zener diode

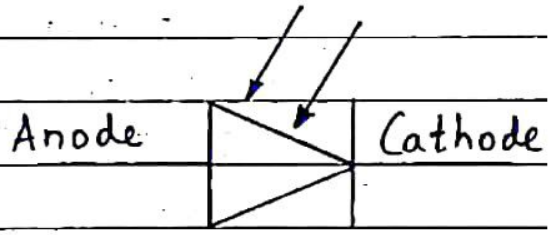
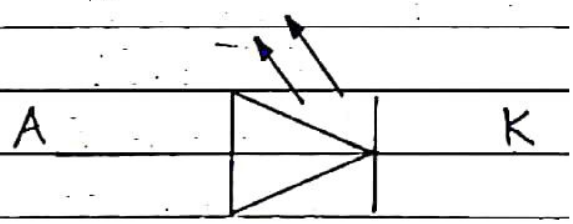
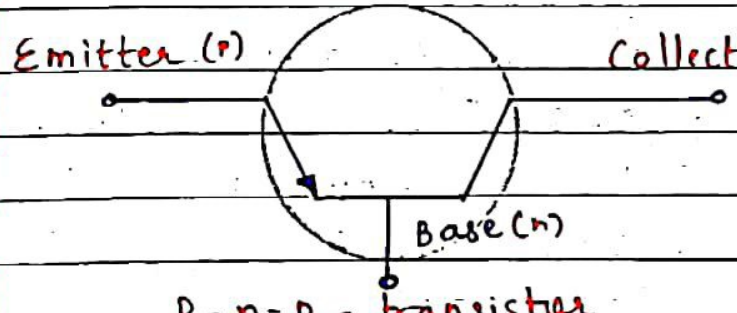


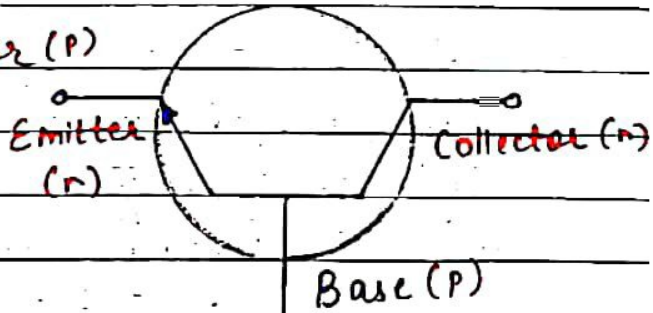
photo diode



LED



p-n-p - transistor



n-p-n transistor

Q11) What do you mean by a logic gate, a truth table and a Boolean expression?

Ans Logic gate : A digital circuit with one or more input signals but only one output signal is called a logic gate

Truth table : It shows all possible combinations of the input and corresponding outputs

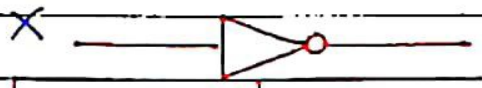
Boolean expression : The mathematical statement that provides the relationship between the input and output of a logic gate is called Boolean expression.

Q13) What are the uses of logic gates? Why is a NOT gate known as an inverter.

Ans Uses : i) NAND and NOR gates are universal building blocks to construct digital circuits used in digital clocks, computers etc.
ii) Gates are used in boolean algebra.
iii) The binary arithmetic operations such as addition, multiplication etc can be realised through logic gates.

i) NOT gate has one input and one output
ii) It produces output '1' if the input is '0'.
iii) When input is '1', the output is '0'.
iv) It always produces a negated version of input at its output.
Hence, it is also known as an inverter.

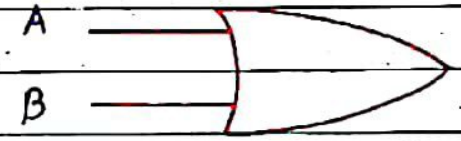
* Draw the schematic symbol for NOT gate. Write its Boolean expression and truth table



Input	Output
X	Y
0	1
1	0

Boolean expression :- $Y = \bar{X}$

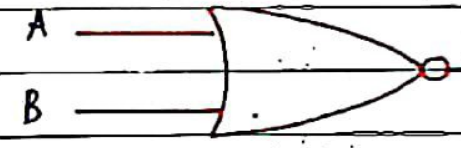
* Draw the schematic symbol for OR Gate Write its Boolean expression and truth table



Boolean expression :- $Y = A + B$

Input A	Input B	output
0	0	0
0	1	1
1	0	1
1	1	1

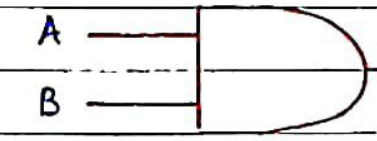
* Draw the schematic symbol for NOR Gate Write its Boolean expression & truth table



Boolean expression : $Y = \overline{A + B}$

Input A	Input B	output Y
0	0	1
0	1	0
1	0	0
1	1	0

Q12) * Draw the schematic symbol for AND Gate Write its Boolean expression & its truth table



Boolean expression :. $Y = A \cdot B$

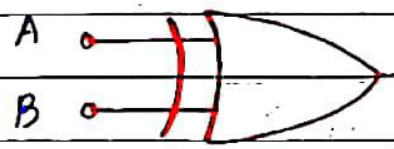
Input A	Input B	Output Y
0	0	0
0	1	0
1	0	0
1	1	1

* Draw the schematic Symbol for NAND Gate Write its Boolean expression & its truth table

Boolean expression : $Y = \overline{A \cdot B}$

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

* Draw the schematic Symbol for XOR Gate. Write its Boolean expression & its truth table



Boolean expression : $Y = A \oplus B$

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