Chapter 2 – Diodes & their Applications

(Weightage – 16 Marks)

2 Marks Questions

1. **Write two applications of P-N junction diode.**
   Answer:
   1) in clamping circuits for DC restoration.
   2) in clipping circuits for wave shaping.
2. **State the need of filters. Define filter.**
   Answer:
   Need:
   1) In dc power supplies, the output of a rectifier contains dc component as well as ac component.
   2) The presence of the ac component is undesirable and must be removed so that pure dc can be obtained. Thus filters circuits are required.

   Filters (Definition): Filters are electronic circuits which remove or minimize unwanted ac component of the rectifier output and allows only the dc component to reach the load.
3. **Give two points of distinction between half wave & full wave rectifier.**
   Answer:

Sr. No.	half wave rectifier	full wave rectifier
1	ac wave is converted into dc	ac waveform is converted into the dc current
2	The rectification efficiency of a half-wave rectifier is 40.6 percent	Its efficiency is 81.2 percent
3	Its ripple factor is 1.21	Its ripple factor is 0.482
4	It provides voltage regulation of good quality	Its voltage regulation is better than the half-wave rectifier

4. **State need of regulated power supply.**
   Answer:
   1) A regulated power supply is used to ensure that the output remains constant even if the input changes.

2) But sometimes main supply voltage, load, and surrounding temperature keep changing and altering the component parameters and hence changing the output voltage.
3) Output voltage changes are undesirable.
4) Hence the regulated power supply is needed that will accept an AC input and give a constant DC output

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4 Marks Questions

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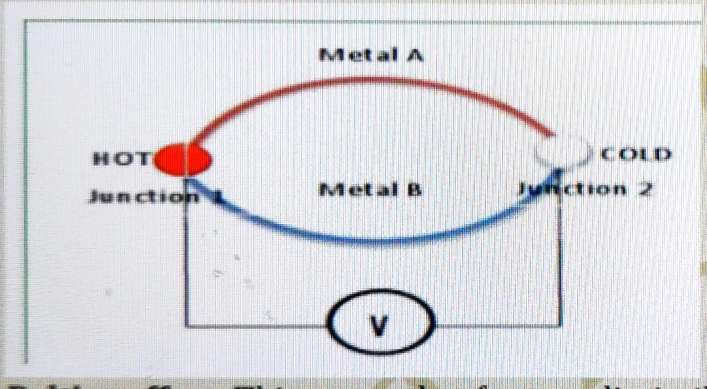
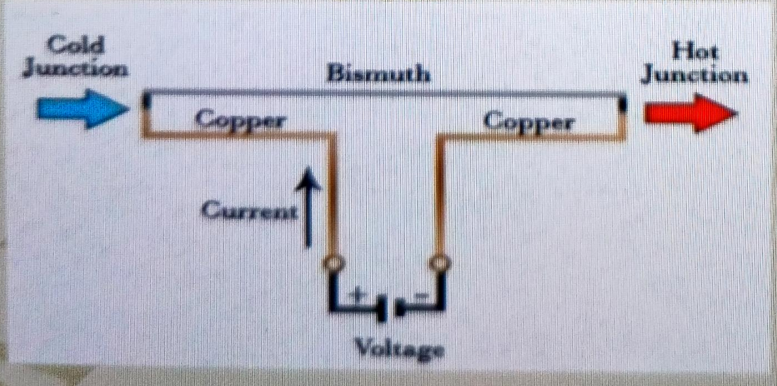
5. State Seebeck and Peltier effect.

Answer:

1) **Seebeck effect**: This states that whenever two dissimilar metals are connected together to form two junctions out of which, one junction is subjected to high temperature and another is subjected to low temperature then e.m.f is induced and it is proportional to the temperature difference between two junctions.



2) **Peltier effect**: This states that for two dissimilar metals in a closed loop, if current is forced to flow through, then one junction will be heated and other will become cool.



6. Define the following terms with respect to rectifier:
(i) Ripple factor
(ii) Rectification efficiency (η)
(iii) Transformer Utilization Factor (TUF)
(iv) Peak Inverse Voltage (PIV)
Answer:

1) **Ripple factor**: The factor which represents ac component present in the rectifier output, with respect to dc component is called Ripple Factor.
Mathematically, $\gamma = \frac{V_{rms}}{V_{dc}} = \frac{I_{rms}}{I_{dc}}$

2) **Rectification efficiency (η):** This is defined as the ratio of dc power delivered to the load to the ac input power from the secondary winding of the transformer.
Mathematically, $\gamma = \frac{P_{dc}}{P_{ac}}$

3) **Transformer Utilization Factor** (TUF): It is the ratio of dc power delivered to the load and the ac rating of the transformer secondary.
Mathematically, $\gamma = \frac{P_{dc}}{P_{ac}(rated)}$

4) **Peak Inverse Voltage (PIV):** The voltage occurring at the peak of the negative cycle of the input cycle is called Peak Inverse Voltage

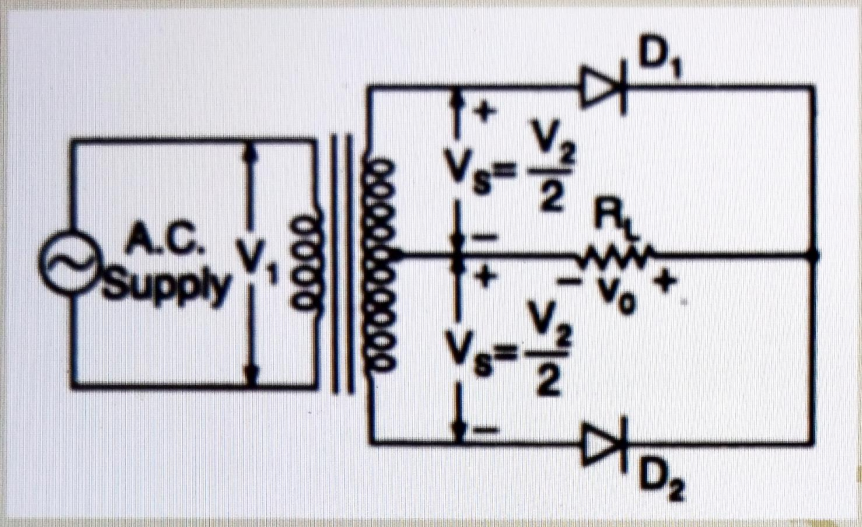
7. Differentiate between P-N junction diode and Zener diode.
Answer:

Sr. No.	P-N junction	Zener diode
1	It is not properly doped to control reverse breakdown.	It is properly doped to control reverse breakdown.
2	It conducts only in one direction	It conducts only in both direction
3	It is always operated in forward-bias condition	It is always operated in reverse-bias condition
4	It has no sharp reverse breakdown	It has quite sharp reverse breakdown

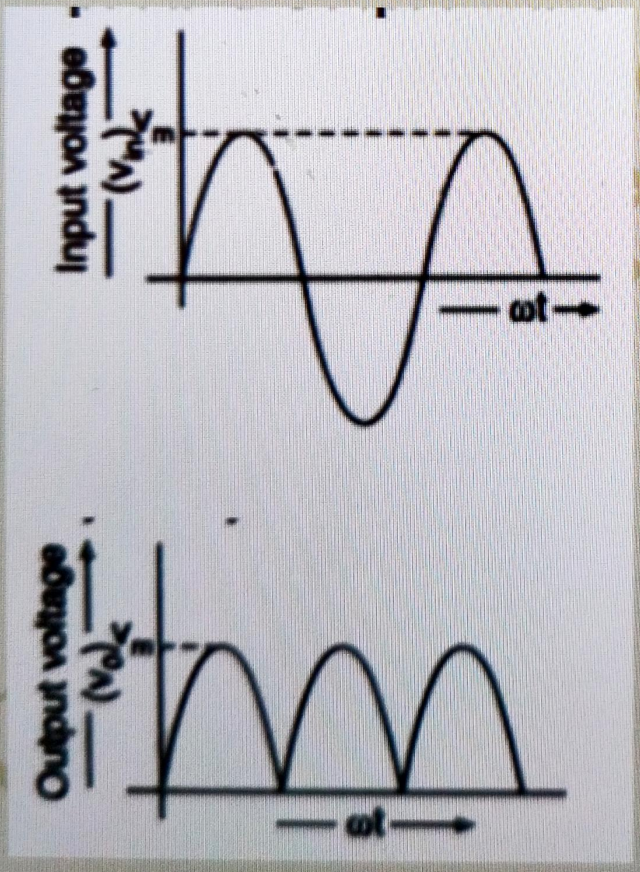
8. **Draw the neat sketch of center tap full wave rectifier. Draw i/p and o/p waveforms.**

Answer:

Circuit Diagram:



Input and Output Waveforms:

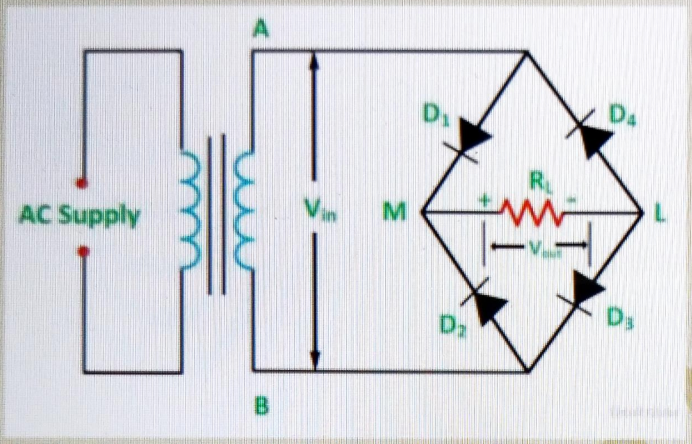


3) Ripple factor: The factor which represents ac component present in the rectifier output, with respect to dc component is called Ripple Factor.
4) Efficiency of rectifier: This is defined as the ratio of dc power delivered to the load to the ac input power from the secondary winding of the transformer.

11. Draw circuit diagram of bridge rectifier. Draw its input output waveforms and describe its operation.

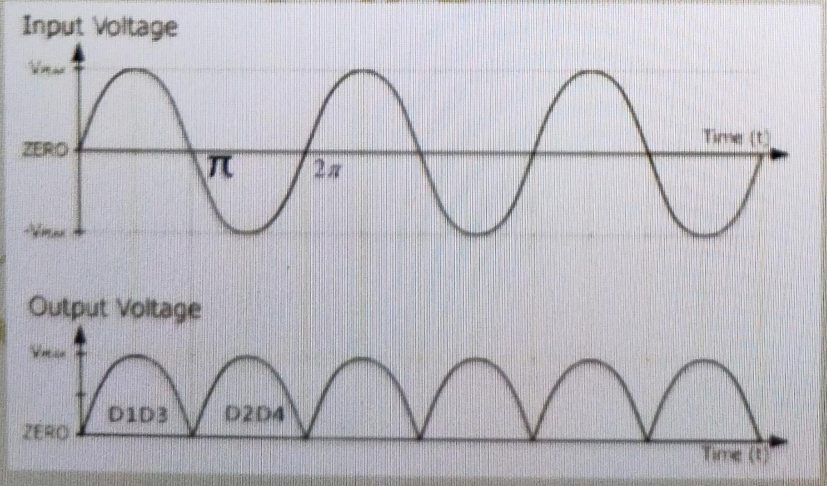
Answer:

Working:



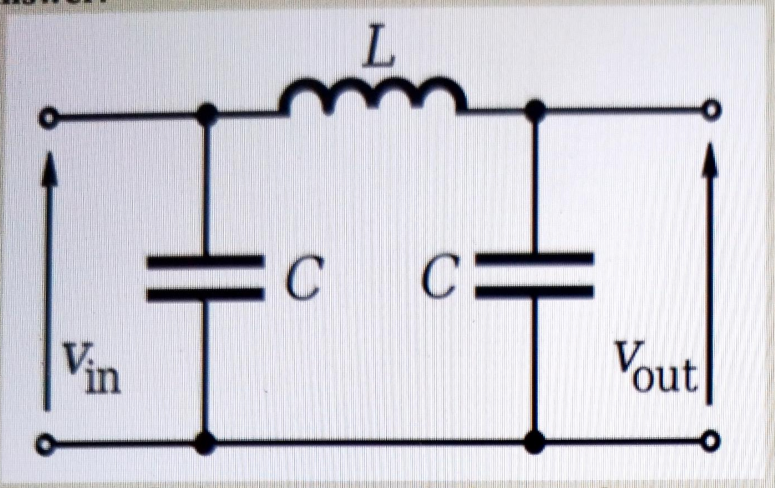
1) The four diodes labelled D1 to D4 are arranged in "series pairs" with only two diodes conducting current during each half cycle.
2) During the positive half cycle of the supply: diodes D1 and D3 conduct in series while diodes D2 and D4 are reverse biased and the current flows through the load for the period o to π.
3) During the negative half cycle of the supply: diodes D2 and D4 conduct in series, but diodes D1 and D3 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before for the period π to 2π.

Waveform:



12. Draw the circuit diagram of π filter and state its working.

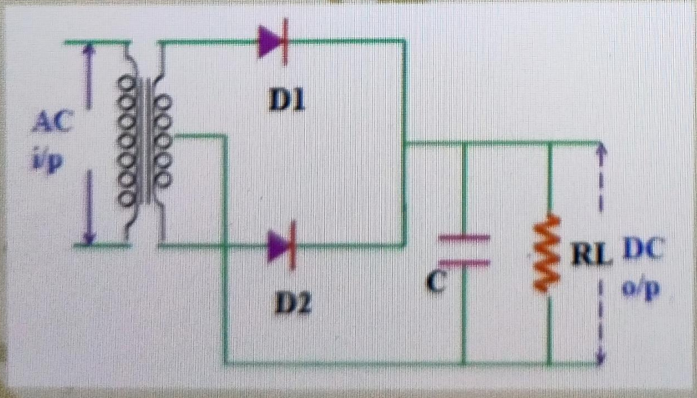
Answer:



1) The rectifier's output is applied across the input terminals of the filter like. The filtering act of these three components in the filter circuit is discussed below.
2) The first filter capacitor (C1): provides small reactance toward a.c. component of rectifier o/p output as it gives unlimited reactance toward the d.c. component. So, capacitor C1 avoids a considerable amount of a.c. component whereas the d.c. component maintains its journey toward the choke 'L'
3) The choke (L): provides approximately zero reactance to the d.c. component and high reactance to the a.c. component. Therefore, it permits the d.c. component to supply through it, whereas the unbiased a.c. component can be blocked.
4) The second filter capacitor (C2): avoids the a.c. the component which the choke has unsuccessful to block. Thus, simply d.c. component shows across the load.

13. With suitable diagram, explain the working of capacitor filter with full wave rectifier. Draw i/p & o/p waveforms.

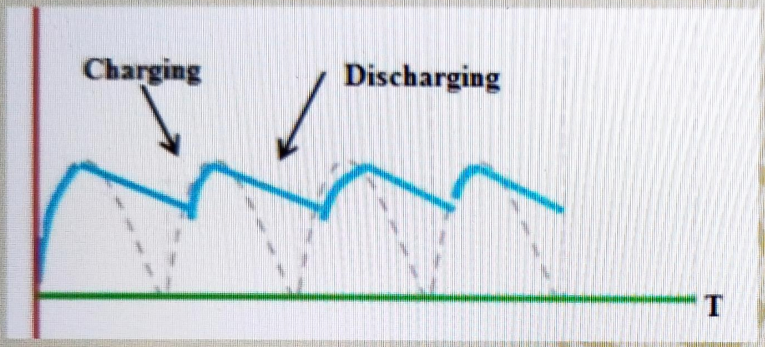
Answer:



1) The main function of full wave rectifier is to convert an AC into DC. As the name implies, this rectifier rectifies both the half cycles of the i/p AC signal, but the DC signal acquired at the o/p still have some waves.
2) To decrease these waves at the o/p this filter is used.
3) In the full wave rectifier circuit using a capacitor filter, the capacitor C is located across the RL load resistor.
4) The working of this rectifier is almost the same as a half wave rectifier.

5) The only dissimilarity is half wave rectifier has just one-half cycles (positive or negative) whereas in full wave rectifier has two cycles (positive and negative)
6) Once the i/p AC voltage is applied throughout the positive half cycle, then the D1 diode gets forward biased and permits flow of current while the D2 diode gets reverse biased & blocks the flow of current.
7) Throughout the above half cycle, the current in the D1 diode gets the filter and energizes the capacitor.
8) But, the capacitor charging will occur just when the voltage which is applied is superior to the capacitor voltage.
9) Firstly, the capacitor will not charge, as no voltage will stay among the capacitor plates.
10) So when the voltage is switched on, then the capacitor will get charged immediately.

Waveform:

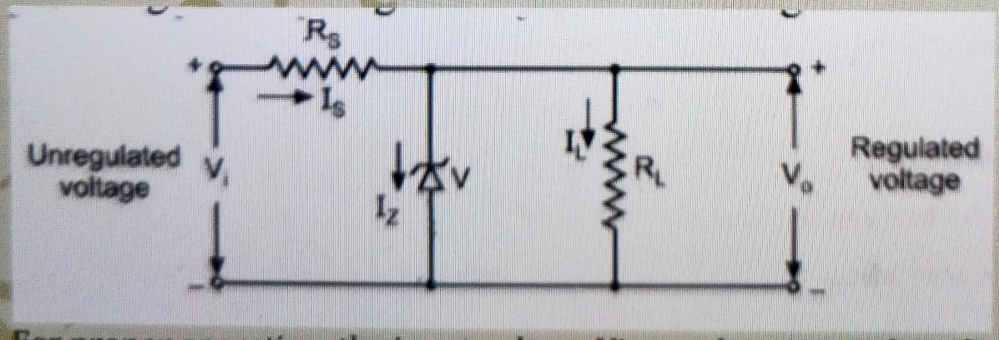


14. Draw and explain Zener diode as a voltage regulator.

Answer:

Zener diode as voltage regulator:

a) A reverse biased Zener diode is used to provide a constant voltage across the load resister R_L.
b) The voltage regulator circuit diagram showing the Zener diode is as given below



c) For proper operation, the input voltage Vi must be greater than the Zener voltage Vz.
d) This ensures that the Zener diode operates in the reverse breakdown condition. The unregulated input voltage Vi is applied to the Zener diode.

Regulation with varying input voltage: (Line Regulation)

1) As the input voltage increases, the input current (I_S) increases. This increases the current through Zener Diode, without affecting the load current (I_L).

2) The increase in input current will also increase the voltage drop across RS and keeps V_L as constant.
3) If the input voltage is deceased, the input current also decreases. As a result, the current through zener will also decrease. Hence voltage drop across series resistance will be reduced.

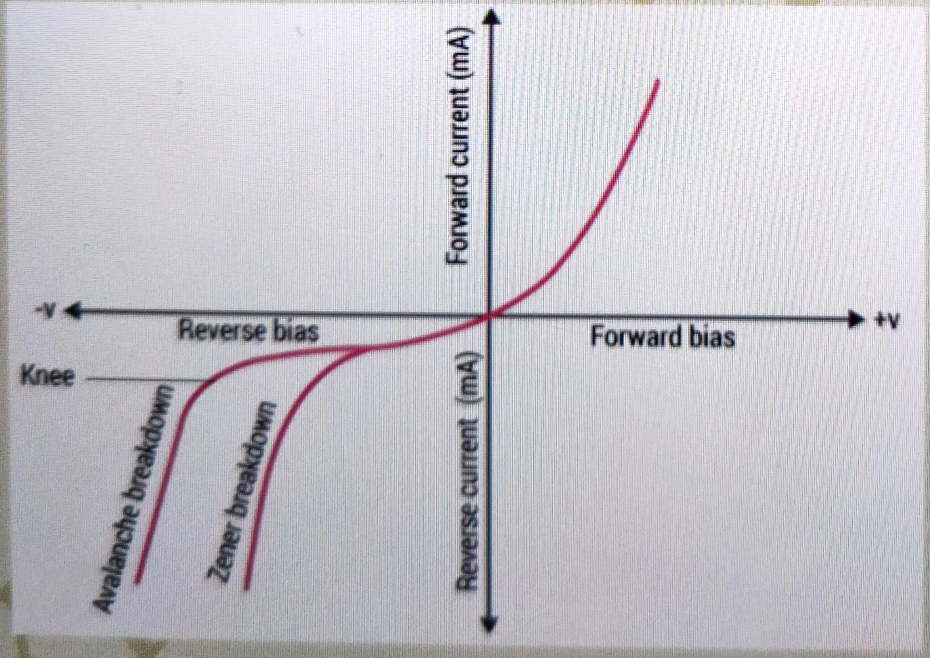
Thus V_L and I_L remains constant. Regulation with varying load resistance: (Load Regulation)

1) The variation in the load resistance R_L changes I_L, thereby changing V_L. When load resistance decreases, the load current increases.
2) This causes zener current to decrease. As a result, the input current and voltage drop across R_S remains constant.
3) Thus, the load voltage V_L is also kept constant. On the other hand, when load resistance increases, the load current decreases.
4) This causes zener current to increase. This again keeps the input current and voltage drop across R_S constant.
5) Thus, the load voltage V_L is also kept constant. Thus, a Zener diode acts as a voltage regulator and the fixed voltage is maintained across the load resistor RL

15. Draw and explain reverse biased V-I characteristics of Zener diode.

Answer:

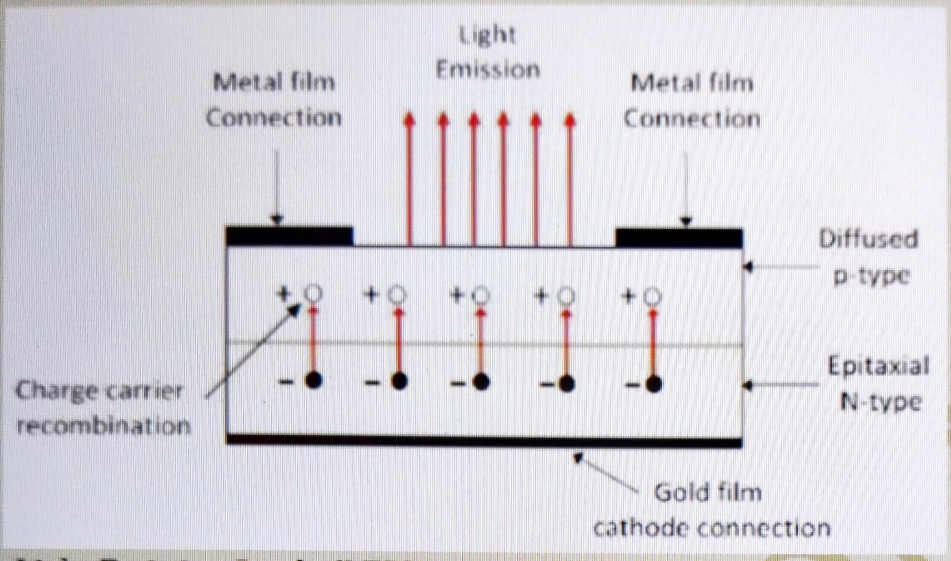
Reverse Characteristics of Zener Diode:



1) When a reverse voltage is applied to a Zener voltage, a small reverse saturation current Io flows across the diode.
2) This current is due to thermally generated minority carriers.
3) As the reverse voltage increases, at a certain value of reverse voltage, the reverse current increases drastically and sharply.
4) This is an indication that the breakdown has occurred. We call this voltage breakdown voltage or Zener voltage, and Vz denotes it.

16. Sketch the constructional diagram of LED and describe its working.

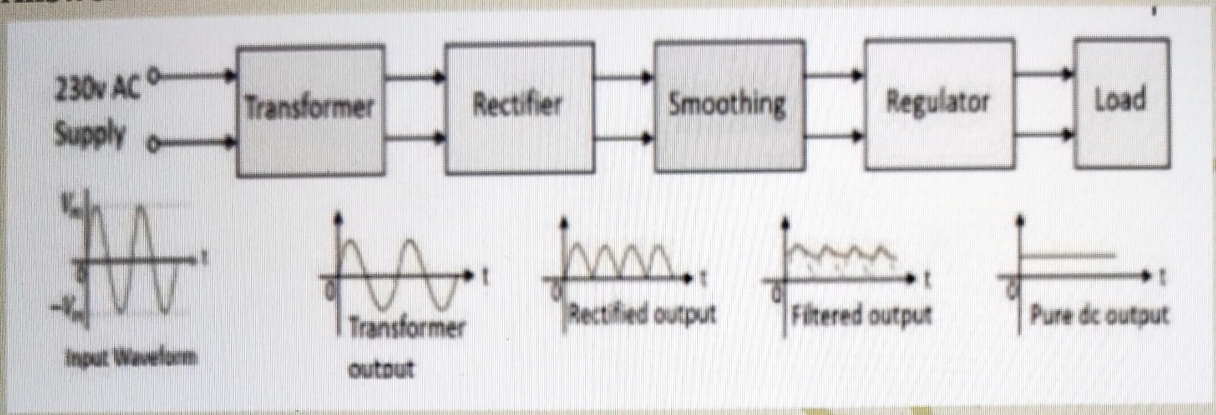
Answer:



1) Light Emitting Diode (LED) works only in forward bias condition.
2) When Light Emitting Diode (LED) is forward biased, the free electrons from n-side and the holes from p-side are pushed towards the junction.
3) When free electrons reach the junction, some of the free electrons recombine with the holes in the positive ions. In the similar way, holes from p-side recombine with electrons in the depletion region.
4) Some free electrons from n-type semiconductor cross the p-n junction and recombines with holes in p-type semiconductor.
5) In the similar way, holes from ptype semiconductor cross the p-n junction and recombines with free electrons in the n-type semiconductor.
6) Thus, recombination takes place in depletion region as well as in p-type and n-type semiconductor.
7) The free electrons in the conduction band releases energy in the form of light before they recombine with holes in the valence band.
8) In silicon and germanium diodes, most of the energy is released in the form of heat and emitted light is too small.
9) However, in materials like gallium arsenide and gallium phosphide the emitted photons have sufficient energy to produce intense visible light.

17. Draw the block diagram of regulated power supply, explain function of each block and draw waveforms of each stage.

Answer:



A typical Regulated Power supply unit consists of the following.

1) Transformer – Step Up or Step Down input transformer for the stepping up or down AC power supply.
2) Rectifier – A Rectifier circuit to convert the AC signal into pulsating DC components.
3) Smoothing – A filtering circuit to smoothen the variations present in the rectified output.
4) Regulator – A voltage regulator circuit is used to control the voltage to a desired output level against line and load variations.
5) Load – The load which uses the pure dc output from the regulated output.

18. Identify the circuit shown in Fig. 2 and explain working with input-output waveforms for a sinusoidal input.

Answer:

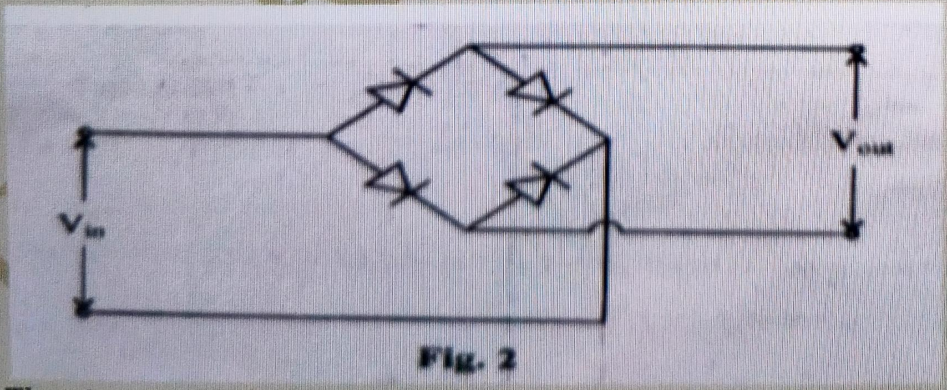


Fig. 2

The given circuit is Bridge rectifier– (with diodes numbered)

Working:

1) The four diodes labelled D1 to D4 are arranged in "series pairs" with only two diodes conducting current during each half cycle.

2) During the positive half cycle of the supply: diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load for the period o to π
3) During the negative half cycle of the supply: diodes D3 and D4 conduct in series, but diodes D1 and D2 switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before for the period π to 2π.

Waveforms: