Power Supplies

By

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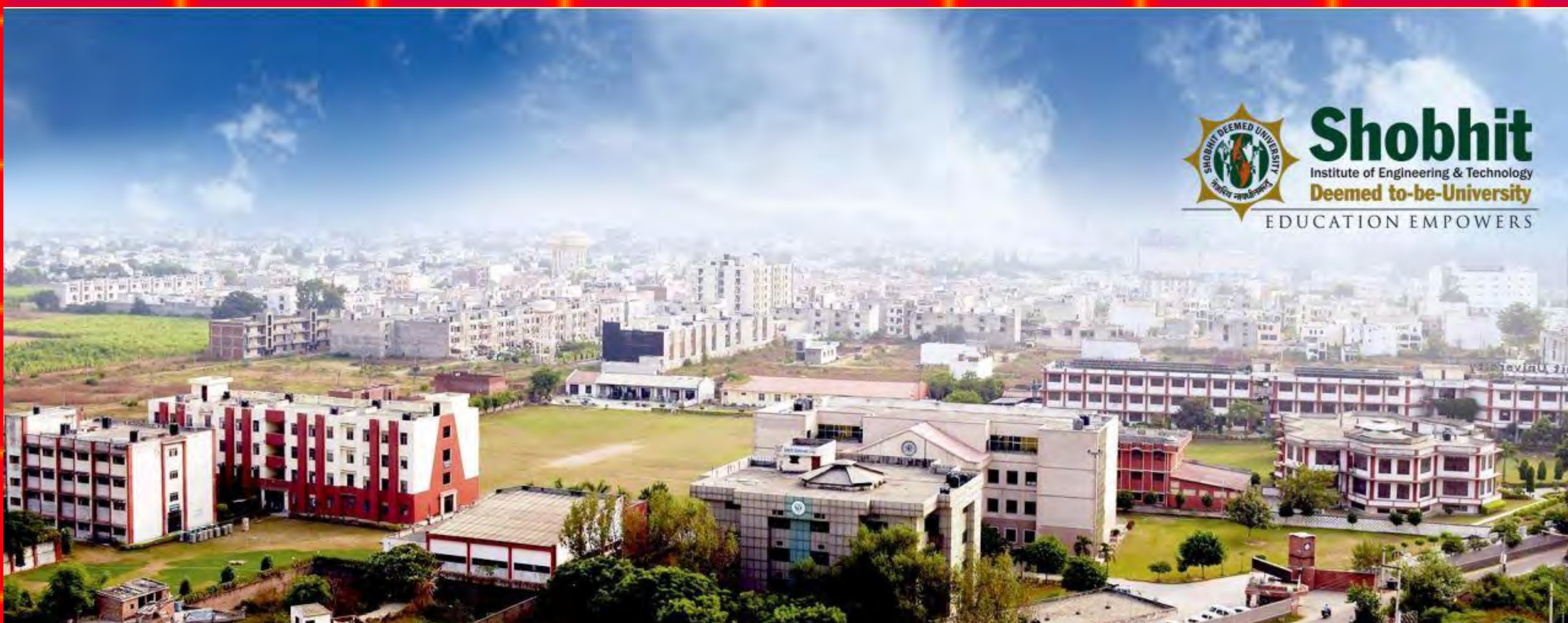


Chapter-8
Power Supplies

The Half- Wave Rectifier
The half wave rectifier has a diode in series with a load resistance. The load voltage is a half- wave output. The average or dc voltage out of a half-wave rectifier equals 31.8 percentage of the peak voltage.

The Transformer
The input transformer is usually a step-down transformer in which the voltage steps down and the current step up. The secondary voltage equals the primary voltage divided by the turn ratio.

Filters
Filters are circuits which perform signal processing functions, specifically to remove unwanted frequency components from the signal, to enhance wanted ones, or both.

Passive Filters
Filters that are based on combinations of resistors (R), inductors (L) and capacitors (C), known as *passive filters*, these filters do not depend upon an external power supply and/or they do not contain active components such as transistors.

Active Filters
Active filters are implemented using a combination of passive and active (amplifying) components, and require an outside power source. Operational amplifiers are frequently used in active filter designs.

Filter Responses
There are five basic types of responses : low-pass, bandpass, bandstop and all-pass. The first four have a pass-band and a stop-band. Ideally, the attenuation band zero in the pass-band and infinite in the stop-band.

Approximate Responses
The pass-band is identified by its low attenuation and its edge frequency. The stop-band is identified by its high attenuation and edge frequency. The order of the filter is the number of reactive components. With active filters, it is usually the number of capacitors .

First-Order Stages
First-order stages have a single capacitor and one or more resistor. All first –order stages produce a butterworth response because peaking is possible only in second-order stages.

Higher-Order Filters
Higher-order filters are usually made by cascading first order filter . When filters are cascaded , we add the decibel gain.

Supply Characteristics
Load regulation indicates how much the output voltage changes when the load current changes. Line regulation indicates how much the load voltage changes when the line voltage changes. The output resistance of load determines the load regulation.

Shunt Regulators
The zener regulator is the simplest example of a shunt regulator. By adding transistors and an op-amp, we can build a shunt regulator that has excellent line & load regulation. The main disadvantage of shunt regulator is its low efficiency, caused by power losses in the series resistor and shunt transistor.

Series Regulators
By using a pass transistor instead of a series resistor, we can build series regulator with higher efficiency then shunt regulator. The zener follower is the simplest example of a series regulator. By adding transistors and op amp, we can build series regulators with excellent line and load regulation, plus current limiting.

Power supply
The combination of a transformer ,a rectifier and a filter constitutes an ordinary dc power supply also known as unregulated power supply.

Regulated power supply

A regulated power supply is an electronic circuit designed to provide constant dc voltage of predefined value across load terminals, which is independent of variations in load current, ac mains voltage & temperature.

Voltage regulator

A Voltage regulator is a circuit that supplies a constant voltage regardless of variations in load current and in ac mains voltage.

Switching Regulators

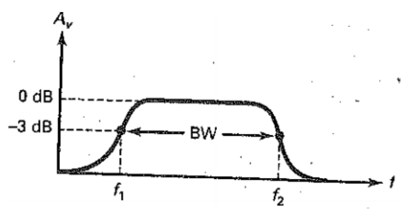
A switching regulator is a dc-to-dc converter that uses pulse-width modulation to regulate the output voltage.

Uninterruptable power supplies (UPS)

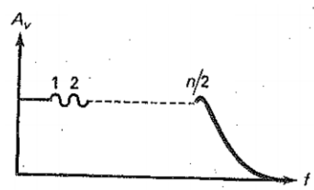
An UPS is just an alternative source that consists of a rectifier, battery charger , a battery bank and inverter circuit which converts the commercial ac input into dc suitable for input to the battery bank and the inverter.

Definitions

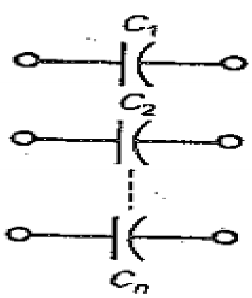
Bandwidth



Number of ripples :



#Ripples = n/2



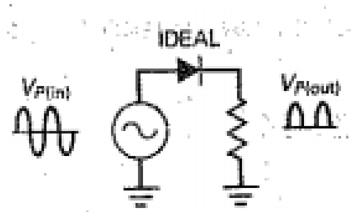
n= # capacitors

Efficiency

Efficiency= $P_{out} / P_{in} \times 100$ %

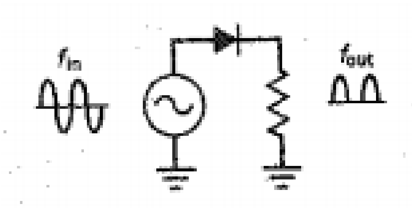
Derivations

Ideal half- wave

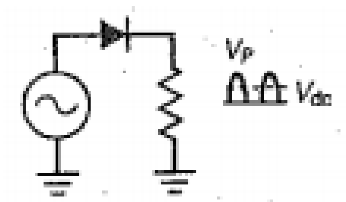


$V_{P(out)} = V_{p(in)}$

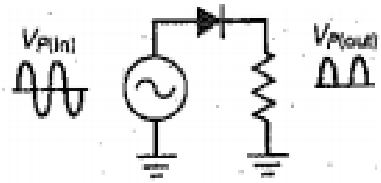
Half-wave



$V_{dc} = V_p / \pi$



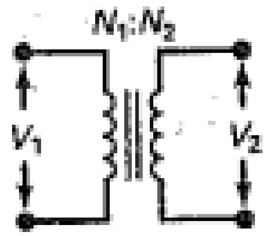
$f_{out}=f_{in}$



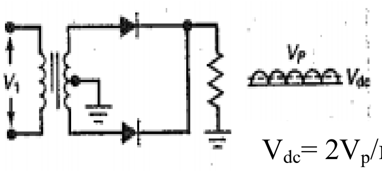
$V_{p(out)}= V_{P(in)}- 0.7V$

Ideal Transformer

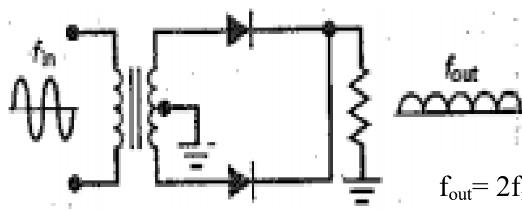
$V_2= V_1/[N_1/ N_2]$



Full Wave



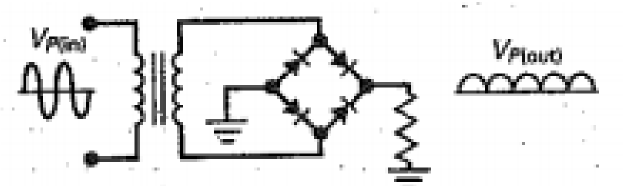
$V_{dc}= 2V_p/\pi$



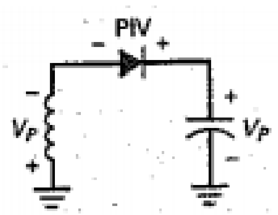
$f_{out}= 2f_{in}$

Bridge rectifier

$V_{p(out)}= V_{p(in)}$ -1.4V

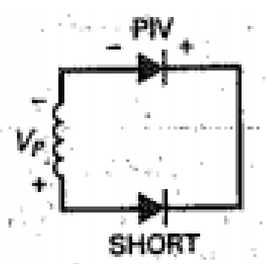


Half wave PIV



PIV= $2V_P$

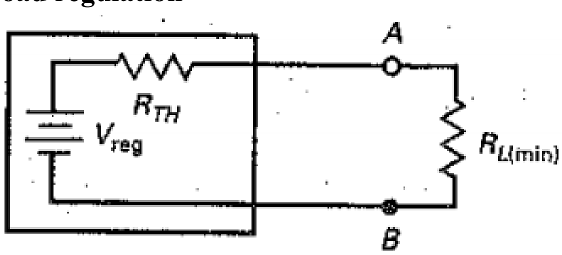
Full wave PIV



PIV= V_P

Bridge PIV

Load regulation

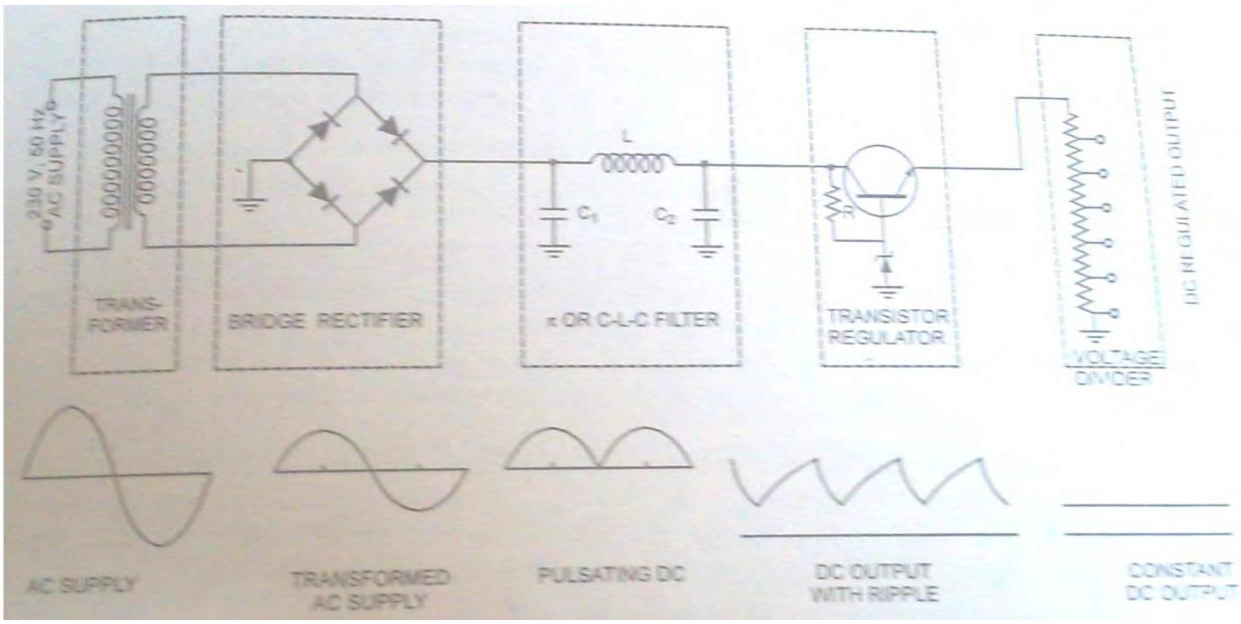


Load regulation = $\frac{R_{TH}}{R_{L(min)}}$ **x 100** %

Long & Short Questions

Q.1. What is power supply ? Explain its working .

The combination of a transformer ,a rectifier and a filter constitutes an ordinary dc power supply also known as unregulated power supply.
A regulated power supply is an electronic circuit that is designed to provide a constant dc voltage of predefined value across load terminals irrespective of ac mains fluctuations or load variations. Fig. shows the complete circuit of a regulated power supply with a transistor series regulator as a regulating device .



- The ac voltage , typically $230V_{rms}$ is connected to a transformer which transforms that ac voltage to the level for desired dc output .
- A bridge rectifier then provides a fullwave rectified voltage that is initially filtered by a pi filter or C-L-C filter to produce a dc voltage. The resulting dc voltage usually has some ripple or ac voltage variation.
- A regulating circuit use this dc input to provide a ripple free dc voltage . The regulated power supply is available across a voltage divider.
- Often more than one dc voltage is required for the operation of electronic circuits. A single power supply can provide as many as voltages as are required by using a voltage divider as shown in the figure.
  A potential divider is a single tapped resistor connected across the output terminals of the supply.

Power Supply Characteristics

The quality of power supply depends on different factors such its load voltage, load current, voltage regulation, source regulation, output impedance, ripple rejection etc. Some of the characteristics of regulated power are discussed below.

1. **Load Regulation:** The load regulation , abbreviated as LR (also called the load effect), is the change in regulated output voltage when the load current changes from minimum to maximum value i.e.

$$LR = V_{NL} - V_{FL}$$

Where V_{NL} is load voltage at no load and V_{FL} is the load voltage at full load.

2. **Minimum Load Resistance:** The load resistance at which a power supply delivers its full-load rated current at rated voltage is referred to a minimum load resistance, $R_{L(min)}$.

i.e. $R_{L(min)} = V_{FL}/ I_{FL}$

3. **Source or line Regulation :** Defined as the change in regulated output voltage for a specified range of line voltage, typically 230V± 10 % .

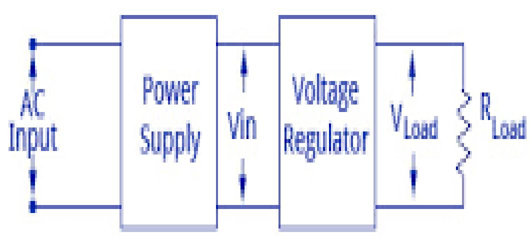
$$\%SR = \frac{(V_{NL} - V_{FL})}{Normalized\ \ load\ \ voltage} X\ 100$$

3. **Output Impedance :** A regulated power supply is a very stiff dc voltage source. This means that the output resistance is very small (in milliohms). Even though the external load resistance is varied , almost no change is seen in the load voltage. An ideal voltage source has an output impedance of zero.
4. **Ripple rejection :** Voltage regulators stabilize the output voltage against variations in input voltage . Ripple is equivalent to a periodic variation in the input voltage. Thus a voltage regulator attenuates the ripple that comes in with the unregulated input voltage.

Q.2. What do you mean by regulated power supply

Related Short Answer Questions
(i) Write short notes on electronically regulated power supply.

A **regulated power supply** is an embedded circuit; it converts unregulated AC into a constant DC. With the help of a rectifier it converts AC supply into DC.
Its function is to supply a stable voltage (or less often current), to a circuit or device that must be operated within certain power supply limits. The output from the regulated power supply may be alternating or unidirectional, but is nearly always DC.



Applications

- Mobile Phone power adaptors
- Regulated power supplies in appliances
- Various amplifiers and oscillators
- D.C. variable bench supply (a **bench power supply** usually refers to a power supply capable of supplying a variety of output voltages useful for bench testing electronic circuits, possibly with

continuous variation of the output voltage, or just some preset voltages; a laboratory (lab) power supply normally implies an accurate bench power supply, while a balanced or tracking power supply refers to twin supplies for use when a circuit requires both positive and negative supply rails).

Q.3. Explain the working of a voltage regulated power supply by drawing its circuit diagram .

Refer to Q.1

Q.4. Why unregulated power supply is not good enough for many applications in electronics ?

Since the output voltage available from an unregulated power supply varies with the variations in load current, ac mains voltage ,temperature etc , these variations in dc output voltage may cause inaccurate or malfunctioning of many electronic circuits. Unregulated power supply is not considered suitable for many of the applications in electronics.

Q.5. Why are electronic generators in great demand ?

There is acute storage of power in the country and during summer, power cuts of 1 to 4 hours duration are common in cities & villages. Every home dreams of buying a generator during that time and in comparison to kerosene operated generators , the electronic generators, commonly known as inverters, are attractive due to their low cost and enhanced electronic features. If each home in India buys one inverter, one can imagine what the demand for electronic generators would come to.

Q.6. Differentiate between On-line UPS , off line UPS & Electronic Generators

S. No.	On-line UPS	Off- line UPS	Electronic Generator
1.	Inverter is ON all the time and supplies output power switching time ≈ 0ms	Inverter is ON when mains is OFF. switching time <5ms	Inverter is ON only when mains is OFF switching time =30-100ms
2.	Used for mainframe or work-station computers or in applications where an uninterrupted supply is a must.	Used with PCs or computers or other appliances where a power interruption for 5ms or less does not matter, when the mains supply fails.	Used in houses & offices to run fans, lights, TV , VCR, medical equipment, PC where switching time of 100ms does not matter.
3.	Generally sine-wave inverters used	Sine-wave inverters / Square wave inverters with CVT used.	Generally square-wave inverters without CVT used
4.	Cost is highest	Cost is medium	Cost is lowest
5.	High quality sealed maintenance-free batteries used	Sealed maintenance-free batteries or other batteries used	Generally automobile lead-acid batteries used
6.	Running time of the inverters is generally less(10min to 30min)	Running time of the inverters is generally less(10min to 30min)	Running time of the inverters is high (1 to 4 hours)

Q.7. Give the concept of load line.

The load line is defined as a line that contains every possible operating point for the circuit. To understand the concept of dc load line consider the common emitter configuration & the output circuit as shown in fig (a) & fig. (b) resp.

Procedure to obtain the DC load line :

- Refer to the collector circuit of the CE configuration & apply KVL to this circuit, we have $V_{CC} - V_{CE} - I_C R_C = 0$
- Rearranging the equation , We have
  $I_C = V_{CE}(-1/R_E) + V_{CC} / R_C$

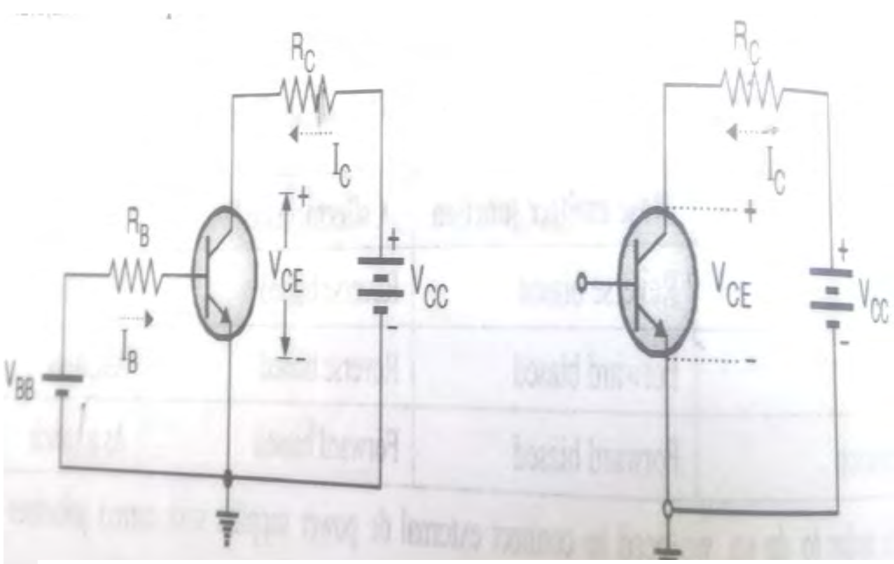


Fig. (a) Fig. (b)

- The above equation is the equation of a straight line ($y = mx + c$) with slope $-1/R_E$ & intercept V_{CC} / R_C.
- This straight line equivalency is known as dc load line.
- DC indicates that this line is drawn under dc operating conditions without ac signal at input

Q.8. What is rectification ? Explain half wave rectifier with diagram.

Or

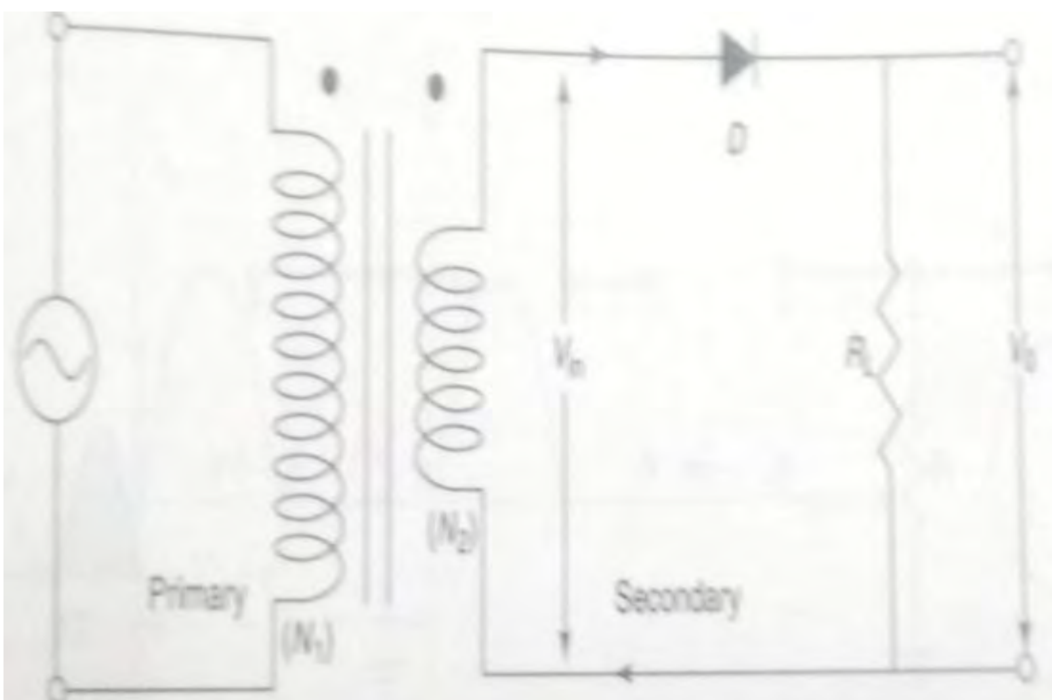
What is rectification ? Draw and explain the diagram of half wave rectifier and explain its working ? How full wave rectifier is better than half wave rectifier ?

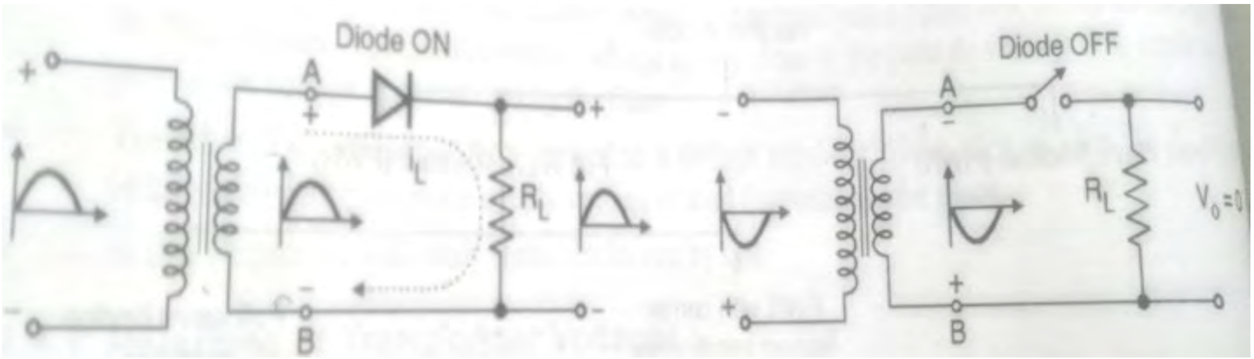
The rectification is a process of converting the alternating waveform to the corresponding direct waveforms. Rectifiers in general, be classified into two categories.

(i) Half- Wave Rectifier
(ii) Full- Wave Rectifier
  a. Centre-tapped transformer full-wave rectifier
  b. Bridge type full-wave rectifier

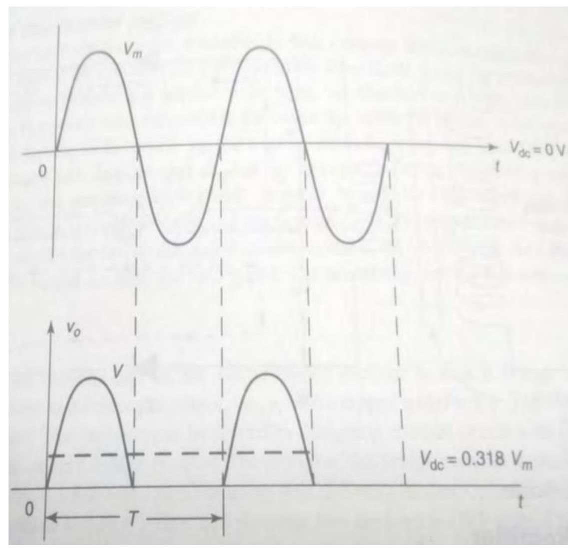
Half –Wave Rectifier

This circuit shown is called as half wave rectifier because it delivers power to the load during only one half cycle of the ac supply voltage.
Hear primary of a transformer is connected to the single phase ac supply , with positive half cycle extends from 0 to T/2 second & the negative half cycle extends from T/2 to T sec.





(a) (b)



In a half-wave rectifier , the output waveform occurs after every alternate half cycle of the input sinusoidal signal.

Between the time interval t = 0 to T/2 , the polarity of the applied voltage v_i is such that makes the diode forward baised (fig. a), as a result output voltage v_0 is obtained between interval t = 0 to T/2.

For the period t = T/2 to T , the polarity of the input voltage is reversed creates reverse baised (fig. b) condition across diode i.e. open circuit state therefore output voltage v_0 is zero for the interval.

The average value of output signal v_0 is 0.318 v_m or v_m/π

The R.M.S. value of output signal is $v_m/2$.

Ripple Factor

The ripple factor indicates how close the rectified output is to the pure ideal dc voltage waveform.

It is denoted by r

$$\text{Ripple factor} = \frac{RMS\ value\ of\ the\ AC\ component\ of\ output}{Dc\ or\ average\ value\ of\ the\ output}$$

$$\mathbf{r} = \sqrt{\frac{V_{rms}^2}{V_{average}^2} - 1}$$

For half wave r= 1.21

Full wave rectifier is better

(i) In the half- wave rectifier, a single diode exists and the load current flows through it for only the +ve half cycle. On the other hand, in a full- wave rectifier, the current flows throughout the cycles of the input signals.

(ii) Full- Wave rectifiers require a centre-tapped transformer. For a half- wave rectifier, only a simple transformer is required.

(iii) The PIV in a half-wave rectifier is the maximum voltage across the transformer secondary. Whereas, in case of a full wave rectifier, the PIV for each diode is two times the maximum voltage between the centre tap and at the either end of the transformer secondary.

(iv) In a half –wave rectifier, the frequency of the load current is the same as that that of the input signal and it is twice the frequency of the input supply for the full- wave rectifier.

(v) The dc load current and the conversion efficiency for a full- wave rectifier is twice that of a half wave rectifier. Also, the ripple factor of the full-wave rectifier is less than that of the half-wave circuit. This indicates that the performance of the full- wave rectifier is better than the half wave rectifier.

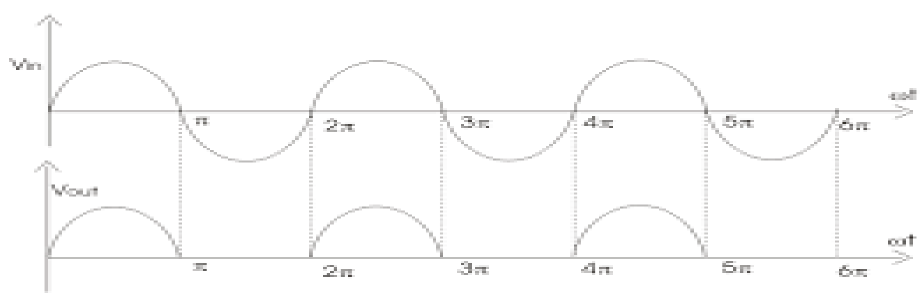
(vi) In a full- wave rectifier, two diode currents flows through the two halves of the centre – tapped transformer secondary in opposite directions, so that there is no magnetization of the core. The transformer losses being smaller, a smaller transformer can be used for a full-wave rectifier.

Q.9. Explain the working of half wave rectifier on the basis of energy bands . Derive expressions for average and rms values of output current power efficiency and ripple factor.

For working of half wave rectifier refer to Q.8.

Expression for average value

As the load is purely resistive, the average load voltage of a half wave rectifier is



$V_{average} = I_{average} \times R_L$

Average load current (I_{dc})

As load current is available for 0 to π secs & is unavailable for π to 2 π secs with in a complete cycle

Therefore $I_{dc} = \frac{1}{2\pi}\int_0^{\pi} I_m \, sinwt \, dwt = -\frac{I_m}{2\pi}[coswt]_0^{\pi}$,

$I_{dc}= -\frac{I_m}{2\pi}[cos\pi - cos0] = -\frac{I_m}{2\pi}[-1-1] = \frac{I_m}{\pi}$

where I_m = Peak amplitude of the load current with $V_m = peak\ amplitude\ of\ load\ voltage$

Expression for R.M.S. value

Ref. to the waveform in above fig.

$I_{rms}= [\frac{1}{2\pi}\int_0^{\pi} I^2{}_m\ sin^2wt\ dwt]^{1/2} = [\frac{I^2{}_m}{2\pi}\int_0^{\pi} \frac{1-cos2wt}{2}\ dwt]^{1/2} = \frac{I_m}{2}[\frac{1}{\pi}(\pi - \frac{1}{2}\ sin2\pi)]^{1/2}$,

but $sin2\pi = 0$

Therefore $I_{rms}= \frac{I_m}{2}$

Where, $I_m = Peak\ amplitude\ of\ the\ load\ current\ with$

$V_m = peak\ amplitude\ of\ load\ voltage$

Q.10. Explain the working of full wave rectifier drawing its circuit diagram. Derive expression for (i) average and r.m.s. output current (ii) efficiency of rectification (iii) ripple factor of full wave rectifier.

or

Draw circuit diagram of bridge type full wave rectifier and explain its working.

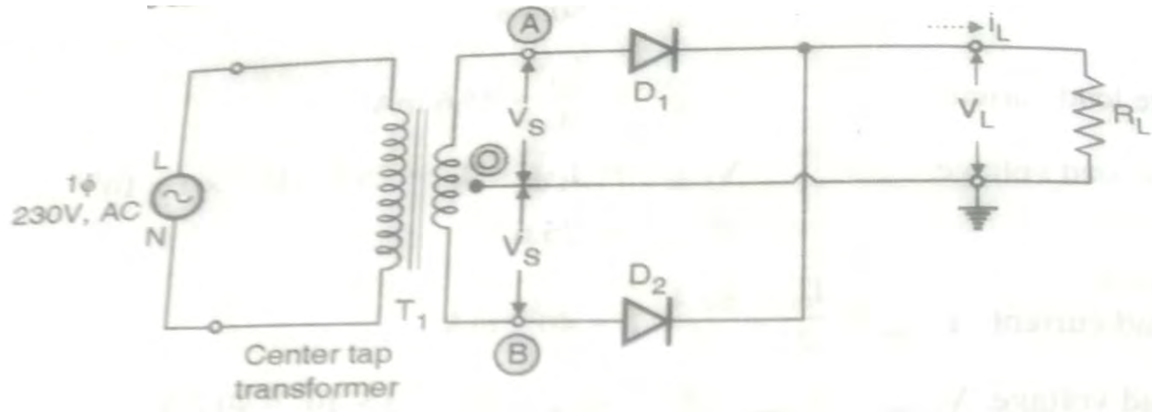
Or

Explain giving circuit diagram the working of a double way rectifier. Why is it widely used ? Obtain expressions for its average and rms values of current and efficiency. What is its main disadvantages.

Full wave rectifier

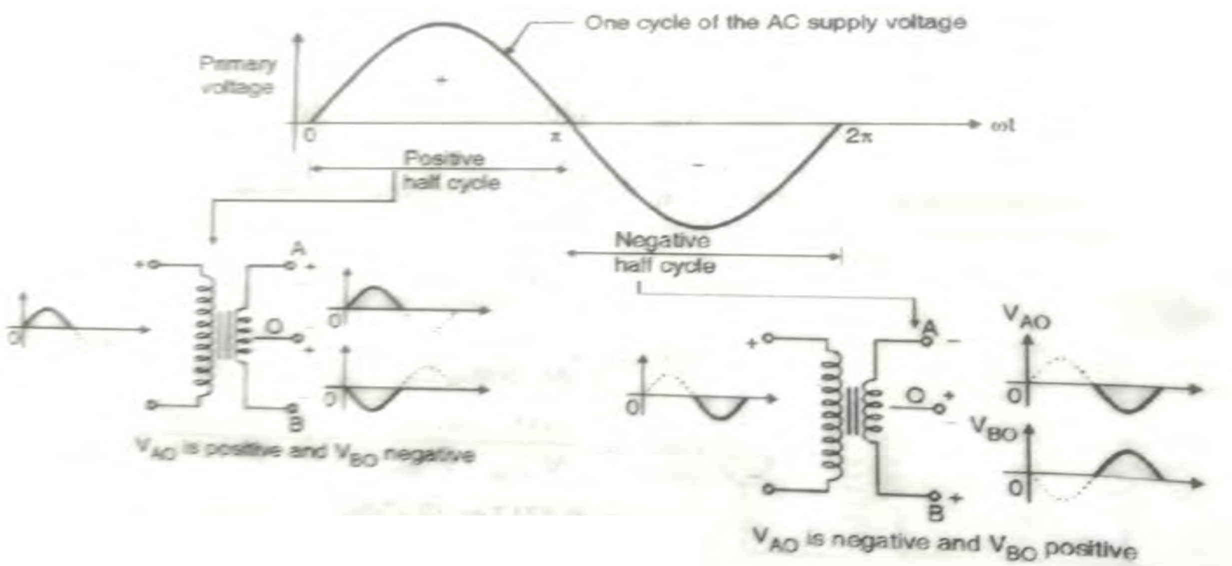
Full wave rectifier configuration is shown in fig. , consists of a step down center taped transformer T_1 , two diodes and a purely resistive load R_L .

In half wave rectifier (HWR) , the load current flows in only one half cycle of the supply but in the full wave rectifier it flows in the both the half cycles of ac supply.



Centre tapped transformer

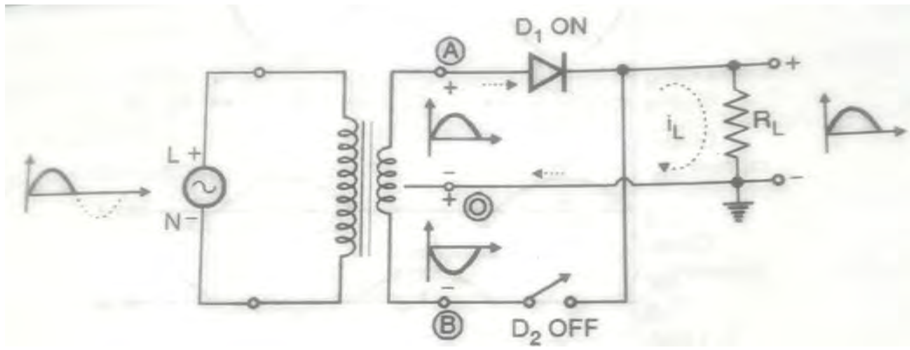
Here, the transformer is of step down type with secondary side centre tapped. The induced voltage in the halves of the secondary winding is always 180^0 out of phase with respect to each other.



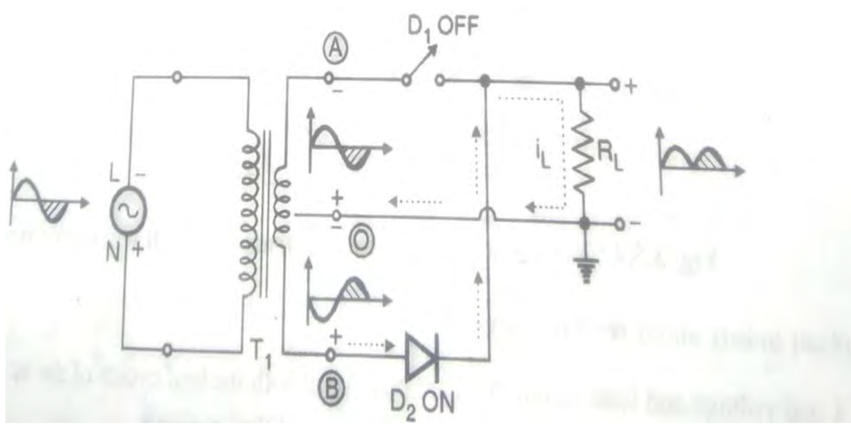
In the **+ve half cycle** of ac supply, the polarities of the secondary induced voltages are as shown in fig. It shows that V_{AO} is positive & V_{BO} is negative.

- Due to the centre tapped secondary, V_{AO} and V_{BO} are always equal & opposite to each other.
- Hence diode D_1 is forward bias & D_2 is reversed biased . The load current starts flowing from A, through D_1, load resistance R_L back to point O as shown in figure.

- The instantaneous load voltage is +ve and approximately equal to V_{AO} . As the load is purely resistive , the load current i_L has the same shape as the load voltage.



In the -ve half cycle of ac supply, the polarities of the secondary induced voltages are as shown in fig. It shows that V_{BO} is positive & V_{AO} is negative.

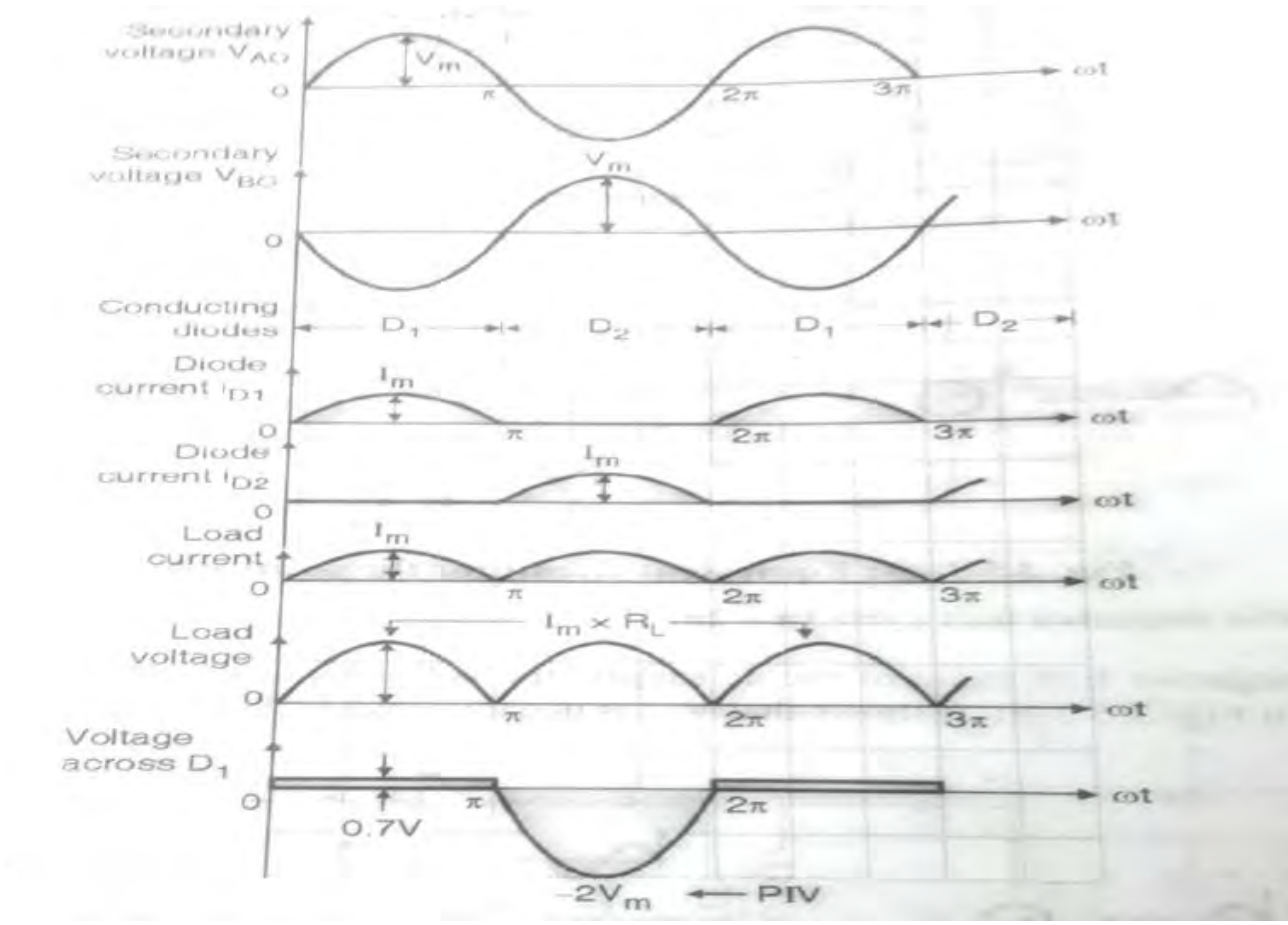


- Due to the centre tapped secondary, V_{AO} and V_{BO} are always equal & opposite to each other.
- Hence diode D_2 is forward bias & D_1 is reversed biased . The load current starts flowing from B, through D_2, load resistance R_L back to point O as shown in figure.
- The direction of load current i_L is same as that in the positive half cycle. It means even in negative half cycle the load current continues to be positive.

Waveforms

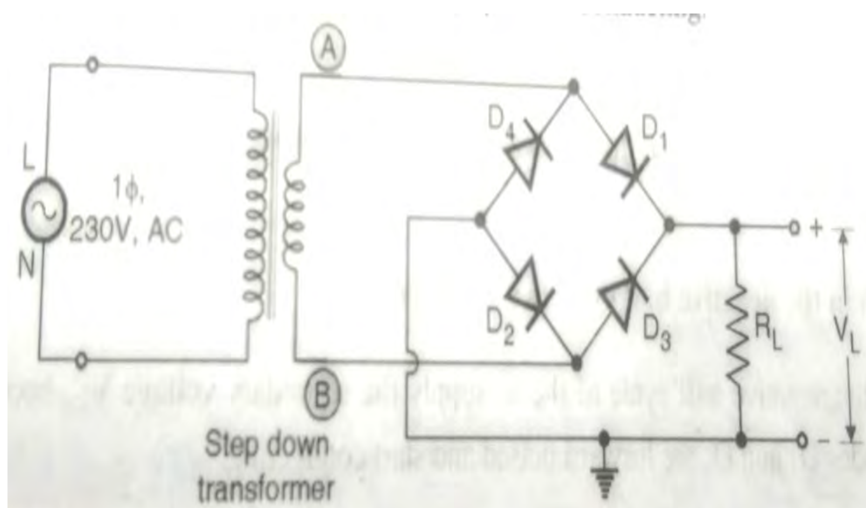
As shown in the fig. we have

1. Load voltage & load current both are positive in both the half cycles of the ac supply.
2. Output voltage is available in both the half cycles of the ac supply.
3. The full wave rectifier circuit consists of two half wave rectifier, which work independently feed the common load.



Bridge Rectifier

The disadvantages of the full wave rectifier such as high PIV and compulsory use of centre tapped transformer are overcome in bridge rectifier.



The circuit configuration is shown in fig. , having four diode connected to form a bridge.

The Centre tapped input transformer is not required. The input transformer T_1 shown in fig. is step down transformer.

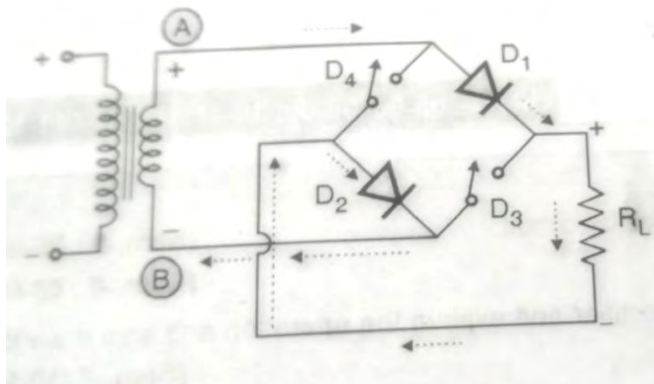
Bridge rectifier offers full wave rectification . The diodes conduct in pairs i.e. at any given instant of time , one pair of diode either D_1, D_2 or D_3 , D_4 will be conducting.

Operation of the Bridge Rectifier

Operation of bridge rectifier can be explained in two half cycles of the AC Supply Voltage as follow :

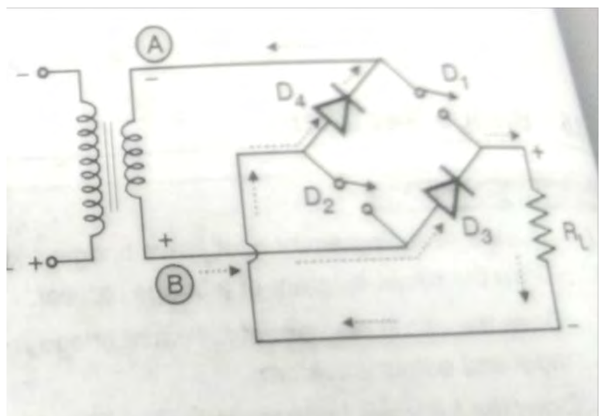
Operation in Positive Half Cycle

- In the +ve half cycle of the ac supply the secondary voltage V_{AB} is positive. Therefore diodes D_1 & D_2 are forward biased whereas D_3 & D_4 are reversed biased
- The equivalent circuit is shown in fig. The reverse biased diodes D_3 & D_4 act as open switches.
- The Load voltage & current both are positive.

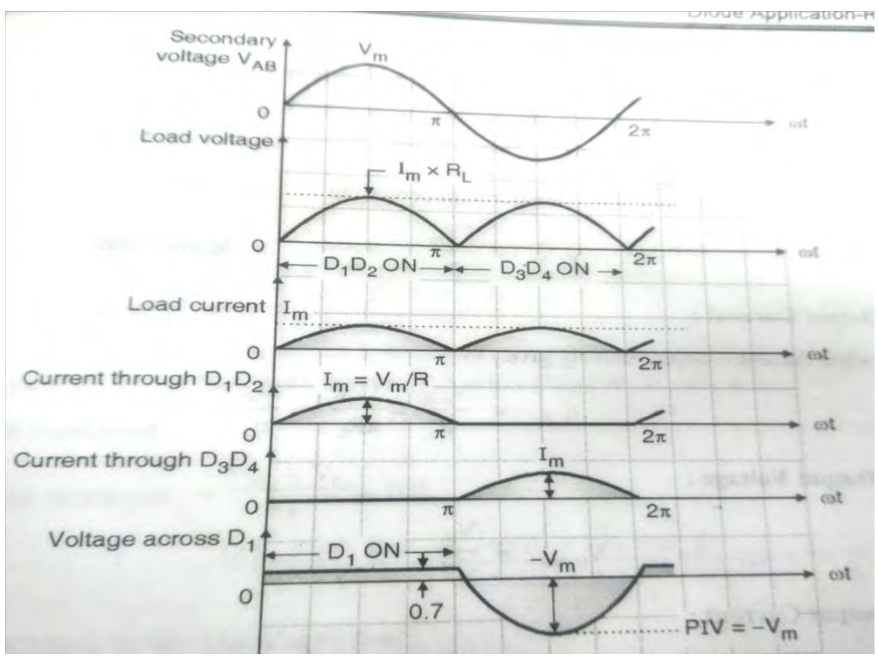


Operation in Negative Half Cycle

- In the -ve half cycle of the ac supply the secondary voltage V_{AB} is negative. Therefore diodes D_3 & D_4 are forward biased whereas D_1 & D_2 are reversed biased
- The equivalent circuit is shown in fig. The reverse biased diodes D_1 & D_2 act as open switches.
- The Load voltage & current both are positive.



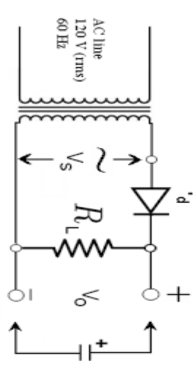
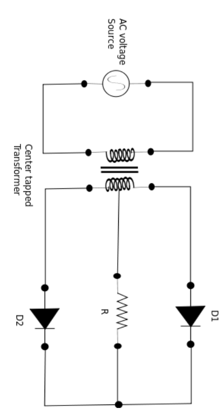
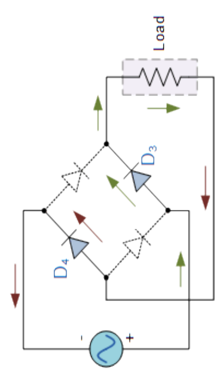
Waveforms



Q.11. How full wave rectifier is better than half wave rectifier ?

Or

Differentiate between half-wave and full-wave rectification.

S.No.	Parameters	HWR	FWR	Bridge Rectifier
1.	**DC or average load current(I_{dc})**	$\frac{I_m}{\pi}$	$\frac{2I_m}{\pi}$	$\frac{2I_m}{\pi}$
2.	**Max^m average load voltage (V_{dc})**	$\frac{V_m}{\pi}$	$\frac{2V_m}{\pi}$	$\frac{2V_m}{\pi}$
3.	**RMS load current I_{rms}**	$\frac{I_m}{2}$	$\frac{I_m}{\sqrt{2}}$	$\frac{I_m}{\sqrt{2}}$
3.	**RMS load voltage V_{rms}**	$\frac{V_m}{2}$	$\frac{V_m}{\sqrt{2}}$	$\frac{V_m}{\sqrt{2}}$
4	**DC load power**	$\frac{I_m^2}{\pi^2} R_L$	$\frac{4I_m^2}{\pi^2} R_L$	$\frac{4I_m^2}{\pi^2} R_L$
6	**Maximum rectification efficiency (η)**	40%	81.2 %	81.2%
7	**Ripple frequency**	121 %	48%	48%
8	**No. of diodes used**	One	Two	Four
9	**Centre tap transformer**	Not Required	Very much required	Not Required
10	**PIV**	V_m	2 V_m	V_m
11	**Circuit diagram**			

Q.12. Describe the working of a full wave rectifier and discuss the use of filters to avoid ripples. Give the diagram to illustrate your answer.

Related Short Answer Questions	
(i)	What is filter circuit
(ii)	What is the necessity of having filter in a power supply ?

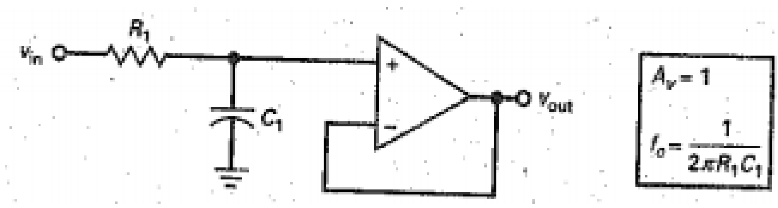
For full wave ref to Q.7.

Filter

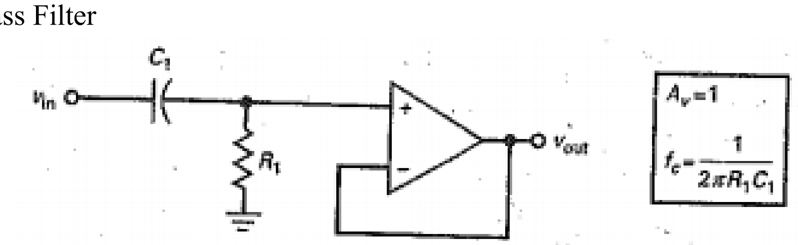
A filter is a circuit that passes one band of frequencies while rejecting another. Filters can separate desired signals from undesired signals, block interfering signals, enhance speech and video, and alter signals in other ways. A filter can either passive or active. Passive filters are built with resistors, capacitors and inductors. They are generally used above 1MHz. have no power gain, and are relatively difficult to tune. Active filters are built with resistors , capacitors and op amps. They are useful below 1 MHz, have power gain, and are relatively easy to tune.

There are five types of filter

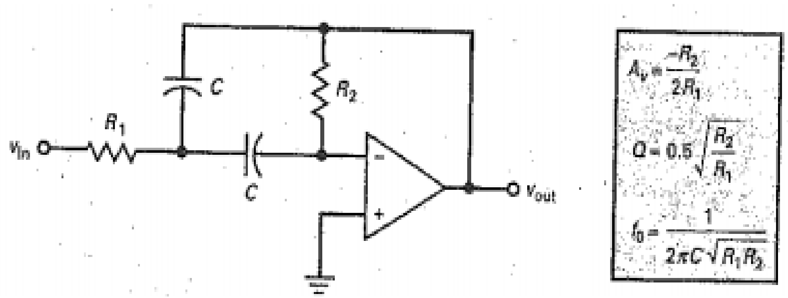
(i) Low Pass Filter



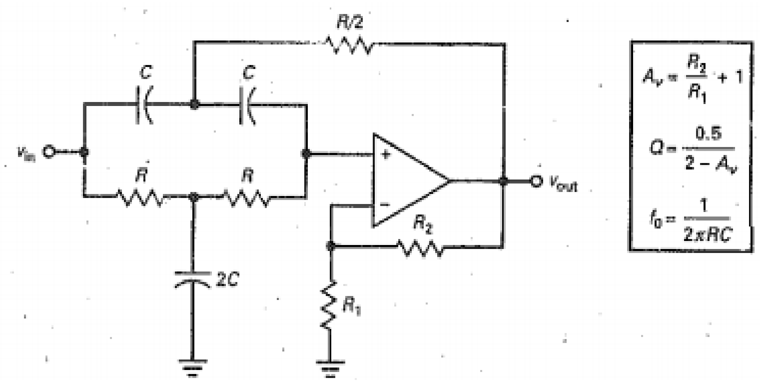
(ii) High Pass Filter



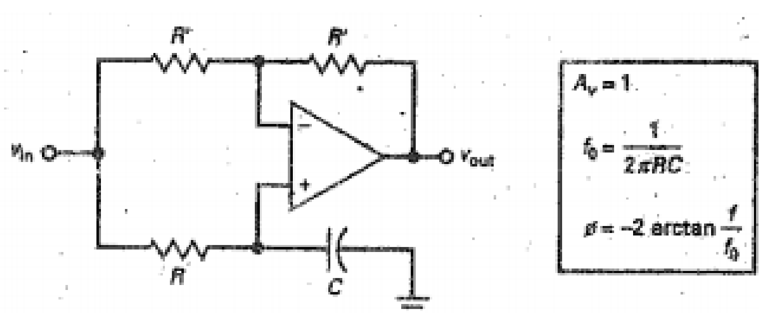
(iii) Band Pass Filter



(iv) Band Reject Filter



(v) All Pass Filter



Numerical

Q.1. **A full wave rectifier uses two crystal diodes each having 10Ω internal resistance . The maximum a.c. voltage across each diode is 70.7 volts. Find the d.c. output voltage across the load resistance through which rms value of load current is 50mA.**

Exp: The full wave rectifier uses two diode i.e. type is centre taped

Diode Resistance(R_d) = 10Ω

If V_m is the peak voltage of input , then maximum voltage across diode is $2V_m$

i.e. $2V_m$= 70.7

∴ V_m= 70.7/2 = 35.35 volts

∵ rms current across the load with diode resistance (R_D) & load resistance(R_L) is

$$I_{rms} = I_m/\sqrt{2} = \frac{V_m}{\sqrt{2}\,(R_F+R_L)} = 50\text{mA} \qquad (1)$$

$$\Rightarrow \quad \frac{35.35}{\sqrt{2}\,(R_F+R_L)} = 50\text{mA} \qquad \{\text{From eq. (1)}\}$$

$$\therefore R_d + R_L = 500\,\Omega$$

$$\Rightarrow 10\Omega + R_L = 500\,\Omega$$

$$\therefore\ R_L = 490\,\Omega$$

$$\Rightarrow \quad I_m/\sqrt{2} = 50\text{mA} \qquad \{\text{From eq. (1)}\}$$

$$\therefore I_m = 50\sqrt{2}\ \text{mA}$$

DC output voltage across load $V_{dc} = \frac{2I_m R_L}{\pi}$

$$\Rightarrow \quad V_{dc} = \frac{2\ x\ 50\sqrt{2}\ \text{x}\ 490\ \Omega}{\pi} = \frac{1.414\ x\ 49}{\pi}\ volt$$

$$\therefore V_{dc} = 22.06\ volt\ \ \text{Ans}$$

Q.2. **Calculate the current through 48 Ω resistor in the circuit shown in figure below. Each diode is made of silicon and the forward resistance of each diode is equal to 1Ω .**

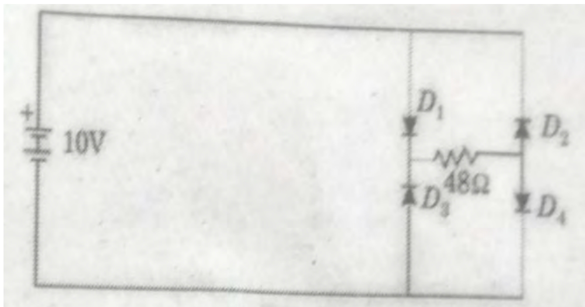
Exp: In the given circuit D_1 & D_4 are forward bias

for the given bias .

∴ $R_{resultant}$ = 1 +48+1 = 50Ω

∴ Current through 48 Ω = 10V / 50 Ω

= 1/5= 0.2Amp Ans



Q.3. **A full wave rectifier uses two diodes. The internal resistance of each diode may be assumed constant at 20 Ω. The transformer R.M.S. secondary voltage from centre tap to each end of secondary is 50 volt and load resistance is 980 Ω.**

Calculate:

(i) The mean load current (or d.c. load current)
(ii) The R.M.S. value of load current.

Exp: The full wave rectifier uses two diode i.e. type is centre taped
Diode Resistance(R_d) = 20Ω
Load resistance (R_L) = 980 Ω

Max^m load current (I_m) = $\frac{V_m}{(R_F+R_L)} = \frac{70.7V}{(20\Omega+980\ \Omega)} = 70.7\text{mA}$

RMS load current (I_{rms}) = $\frac{I_m}{\sqrt{2}} = \frac{70.7\text{mA}}{\sqrt{2}} = 50\text{mA}$

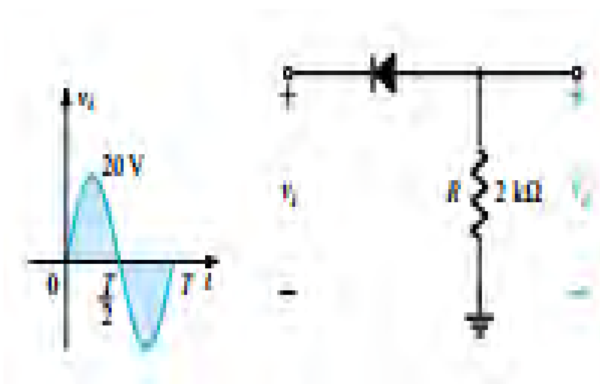
Mean load current (I_{dc})= $\frac{2I_m}{\pi} = \frac{70.7\text{mA}}{\pi} = 45\text{mA}$

Q.4. **(a) Sketch the output v_o and determine the dc level of the output for the network of Fig.**

(b) Repeat part (a) if the ideal diode is replaced by a silicon diode.

Exp: The diode will conduct during the -ve part of

the input as shown in fig.



(a) For the full period , the dc level is

V_{dc}= -0.318V_m

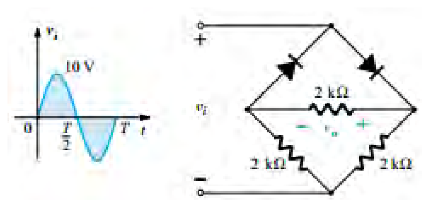
= -0.318 x 20V

= -6.36V Ans

The negative sign indicates that the polarity of the output is opposite to the defined polarity

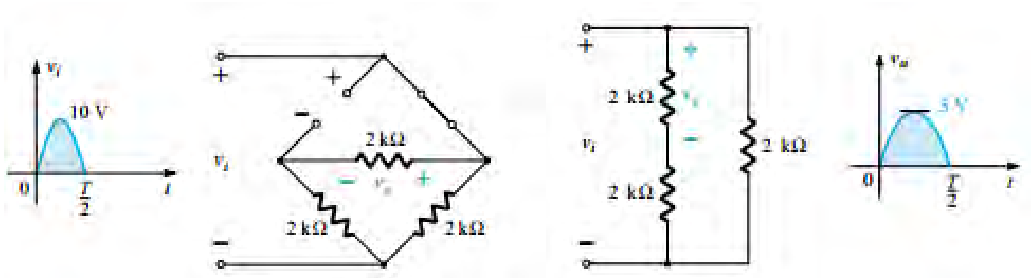
(b) If the general diode replaces ideal diode
∴ $V_{dc} \approx$ -0.318 (V_m – 0.7V)
≈ -0.318 (20 – 0.7V)
≈ -0.318 x 19.3
≈ -6.14V Ans

Q. 5. **Determine the output waveform for the network of fig. and calculate the output dc level and the required PIV of each diode.**



Exp: The network shown in the question , for the positive region of the input voltage will appear as in

fig(a)



(a) (b) (c)

Redrawing the network as in fig. (b) , We have

$v_O = 0.5\ v_i$

$v_{O(max)} = 0.5 \times 10 = 5$ Volt

v_O will appear as shown in fig.(c) .

Since the circuit is not a centre taped , and acting as a full wave rectifier

∴ Output DC level = 0.636 (5V)= 3.18 V

∴ PIV of each diode = 5Volt Ans

Q.6. Determine I, V_1, V_2 and V_0 for the series dc configuration shown in figure

Exp: Applying KVL for the given circuit , we have

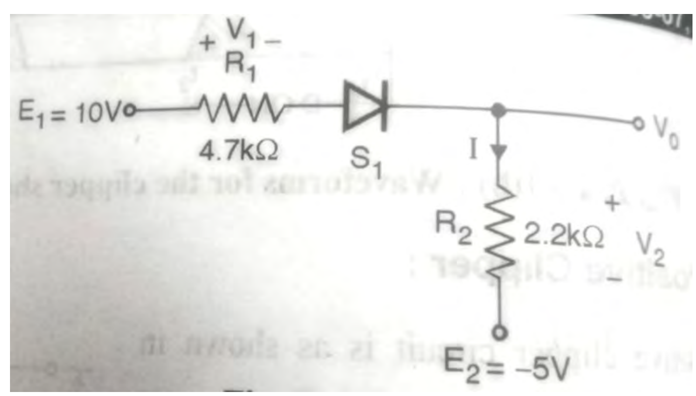
$-10 + IR_1 + 0.7 + IR_2 - 5 = 0$

$I (R_1 + R_2) = 15-0.7$

$I (4.7k\Omega + 2.2k\Omega) = 14.3$

$I = 14.3 / 6.9\ k\Omega$

$= 2.0724$ mA Ans



$V_1 = 4.7k\Omega \times 2.0724$ mA
$= 9.740$ V Ans
$V_2 = 2.2k\Omega \times 2.0724$ mA $= 4.56$ V Ans
$\because V_0 = V_2 - 5$ V
$\therefore V_0 = 4.56$ V -5V $= -0.4$V Ans