Chapter 2

- Basic Components, Devices and applications

Basic Electronics (**18EECF101)**

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Topic Learning Outcomes

- **At the end of the topic the student should be able to:**

1.Discuss the characteristics of semiconductor Diode.
2.Realize simple applications such as rectifier, voltage regulator, gates using diodes.
3.Analyze and compare various configurations of rectifier circuits with respect to their performance parameters.

CO2.Describe the characteristics of semiconductor devices and their applications in rectifiers, switches, regulators, gates.

CONTENTS

1) P-N Junction diode
2) Diode characteristics
3) Diode approximations
4) Half wave rectifier
5) Full wave rectifier with two diodes
6) Bridge rectifier with four diodes
7) All three rectifiers with filter.
8) Zener diode as voltage regulator
9) Realization of logic gates using diodes.

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SEMICONDUCTOR DEVICES

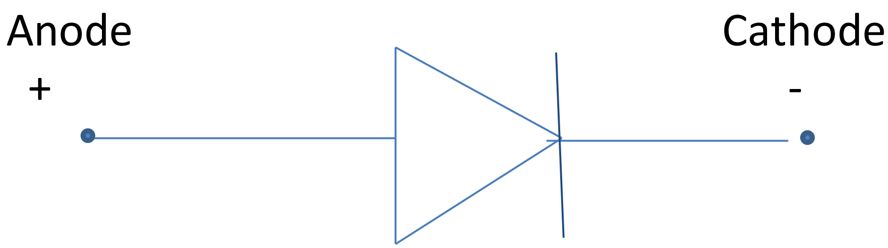
- P-N Junction diode
- Bipolar Junction Transistor- BJT
- Field Effect Transistor - FET
- Uni Junction Transistor- UJT
- MetalOxide Semiconductor FET - MOSFET

P-N Junction Diode

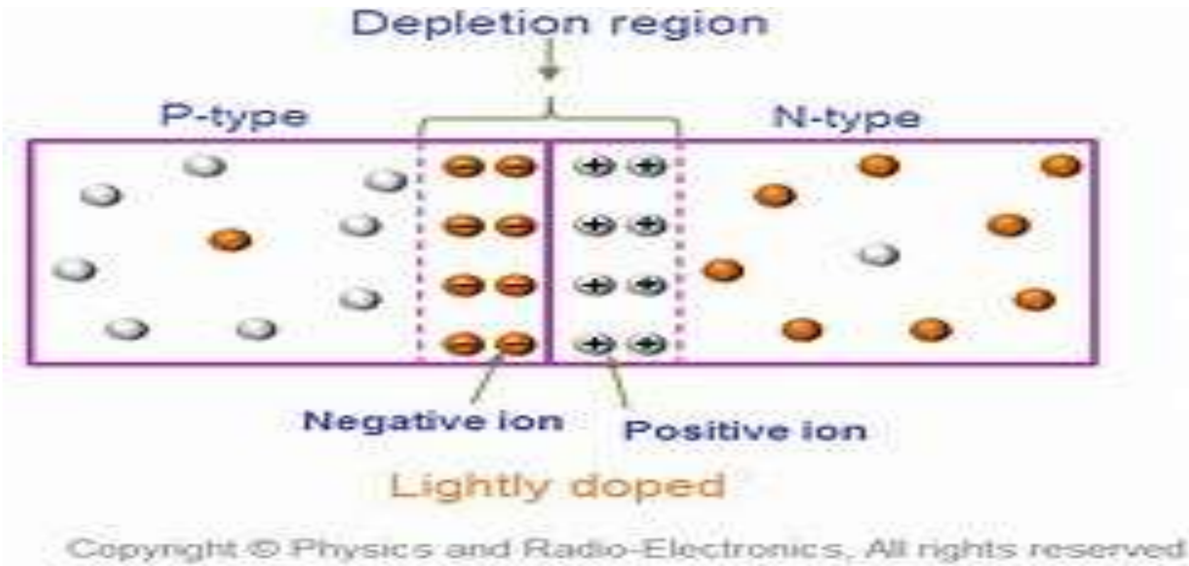
- P-N Junction diode is a two terminal device formed by joining P type and N type semiconductor materials and it allows current flow in one direction only.

P-N Junction diode

- Symbol



P-N JUNCTION DIODE

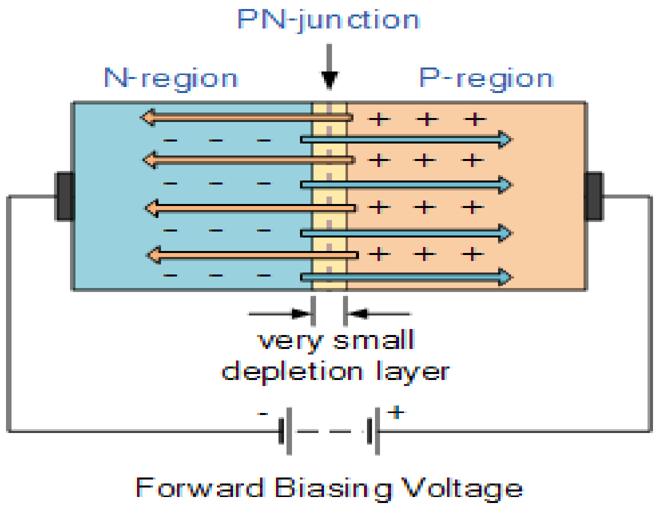


	P-Type	N-Type
Majority carriers	Holes	Electrons
Minority carriers	Electrons	Holes

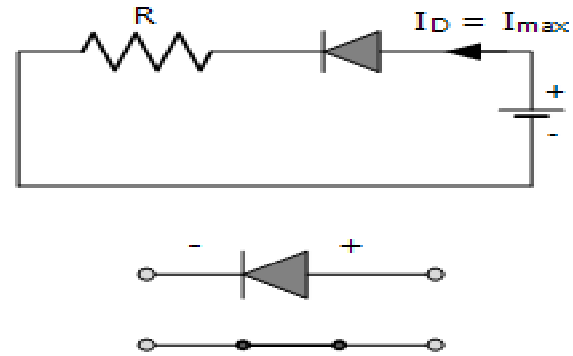
What is a Depletion region ?

- Depletion region or depletion layer is a region in a P-N junction diode where no mobile charge carriers are present. Depletion layer acts like a barrier that opposes the flow of electrons from n-side and holes from p-side

Forward Bias

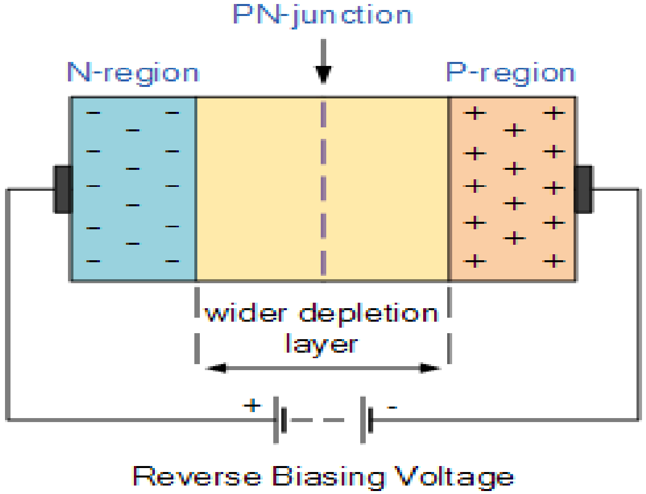


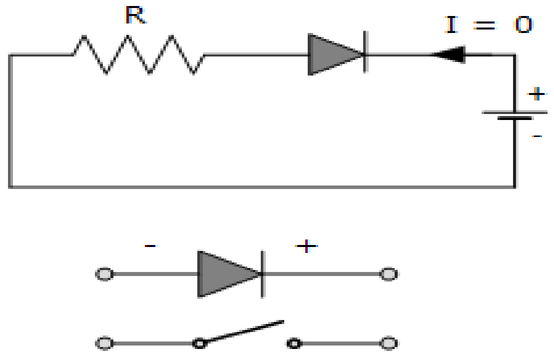
https://circuitglobe.com



Forward bias means , the **positive terminal** of the battery is connected to the **p-type semiconductor** material and the **negative terminal** is connected to the **n-type semiconductor** material. Electrons in N type material gets repelling force and they start moving towards the junction& current starts flowing.

Reverse Bias

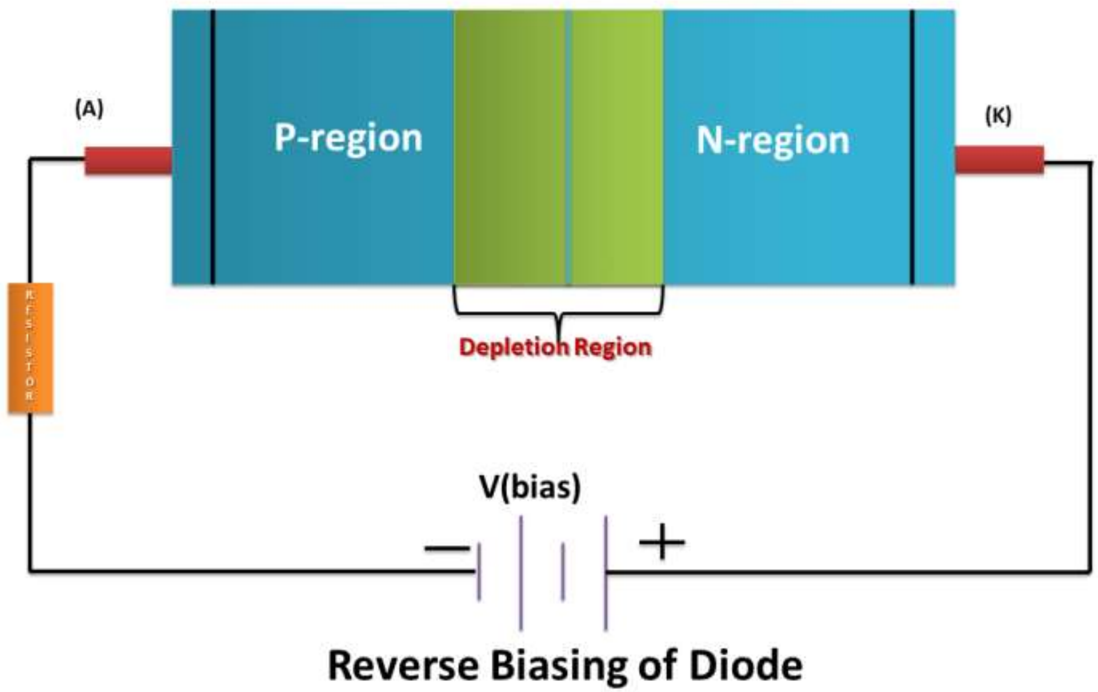




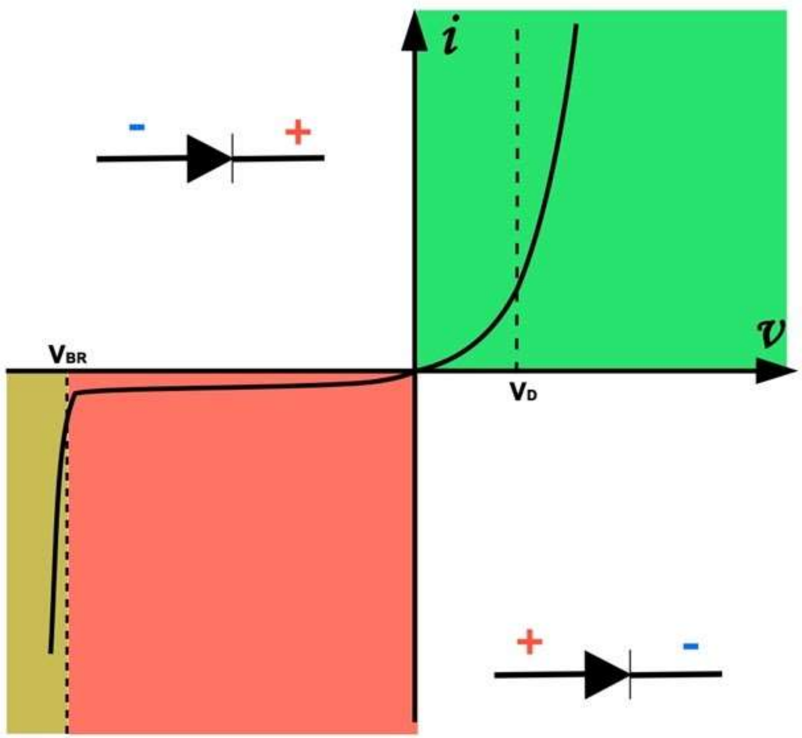
https://circuitglobe.com

Reverse bias means the **n-type material** is connected to the **positive terminal** of the battery and the **p-type material** is connected to the **negative terminal** .Electrons from N type,move away from junction due to which depletion region widens and current cannot flow.

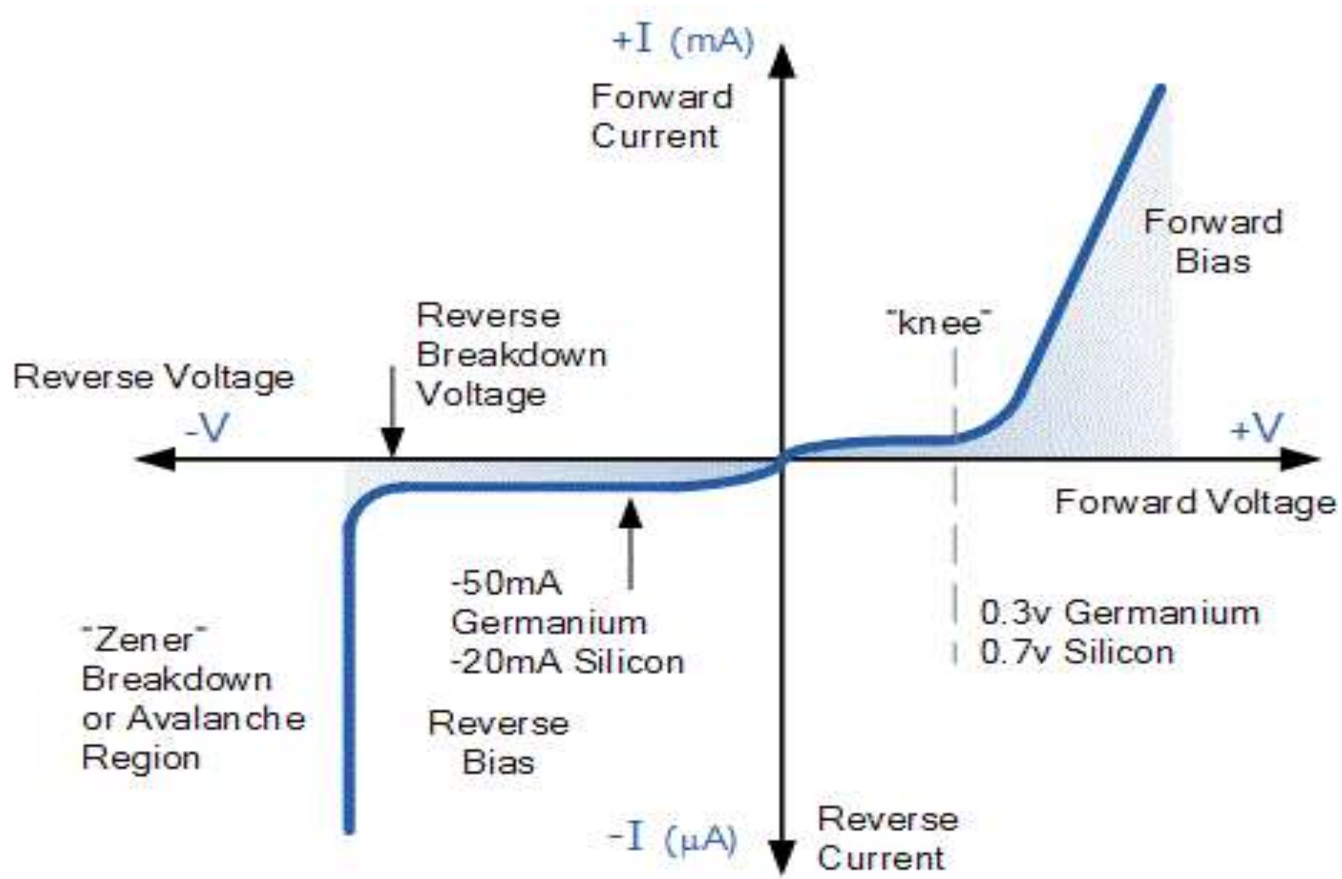
Reverse Bias



V-I characteristics of pn junction diode



V-I Characteristics of diode



Parameters of diode

- **Forward Voltage drop-VF**

The diode forward voltage is the drop in electrical voltage that occurs when electrical current is conducted through a diode. Diodes are two-lead semiconductor devices that conduct an electrical signal in one direction but not the other.

- **Maximum Forward current-**

It is the maximum current that can flow in a diode when it is forward biased.

- **Reverse saturation current-**

This is the current flowing through the diode during reverse bias due to the flow of minority charge carriers.

- **Reverse breakdown voltage-**

When the diode reverse voltage (VR) is sufficiently increased,the device goes to reverse breakdown & it can destroy a diode unless the current is limited by a resistor.

- Static resistance- Resistance offered by the diode at particular voltage level.

  Forward static resistance= RF=$\frac{VF}{IF}$

  Reverse static resistance= Rr=$\frac{VR}{IR}$

- Dynamic resistance- rd=$\frac{\delta Vf}{\delta If}$

  is the resistance offered by the diode to changing levels of forward voltage.

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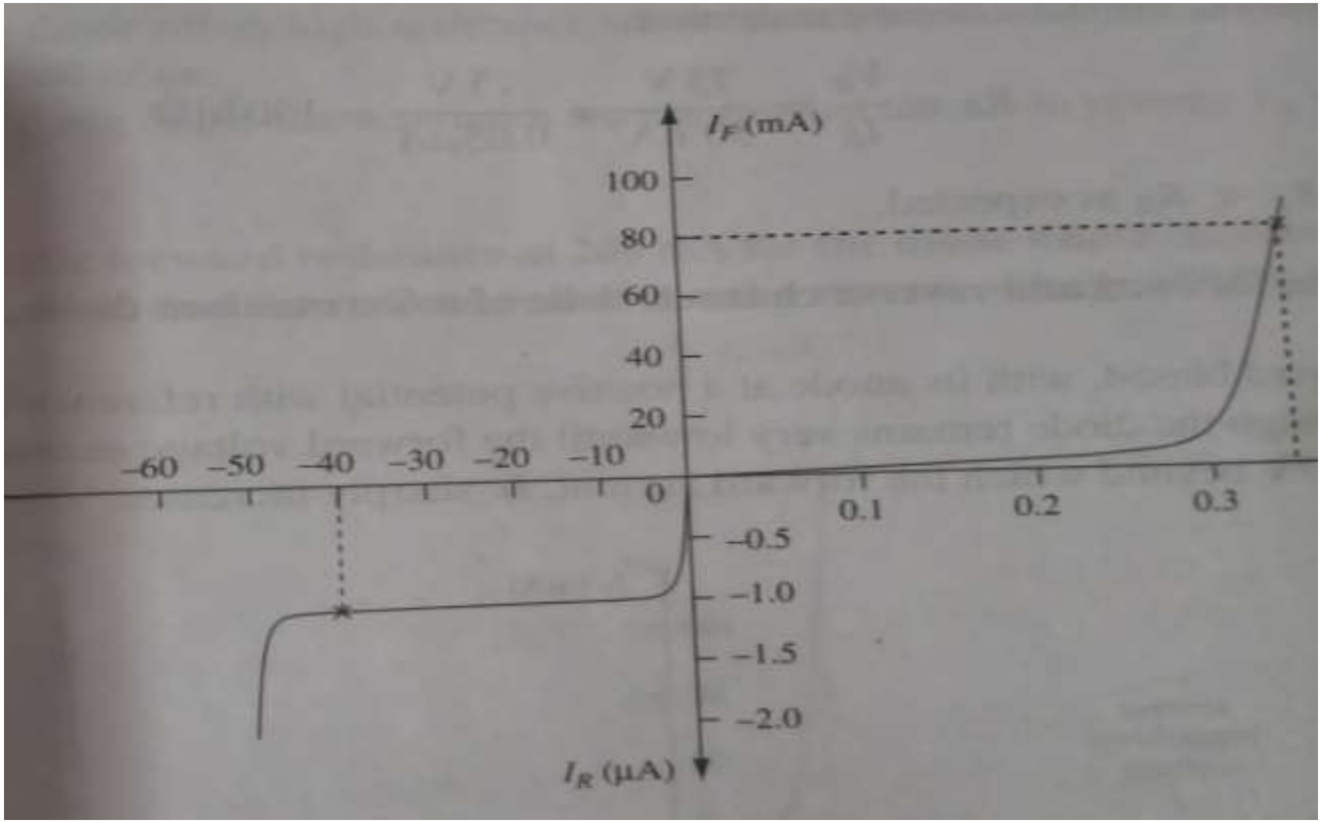
Problem1: Find the static resistance of the diode whose characteristics is shown in Fig.when the forward current is 80mA & reverse voltage is 40V.Cut-in-voltage is 0.35V



Solution

- Given I_F=80mA, V_F=0.35V

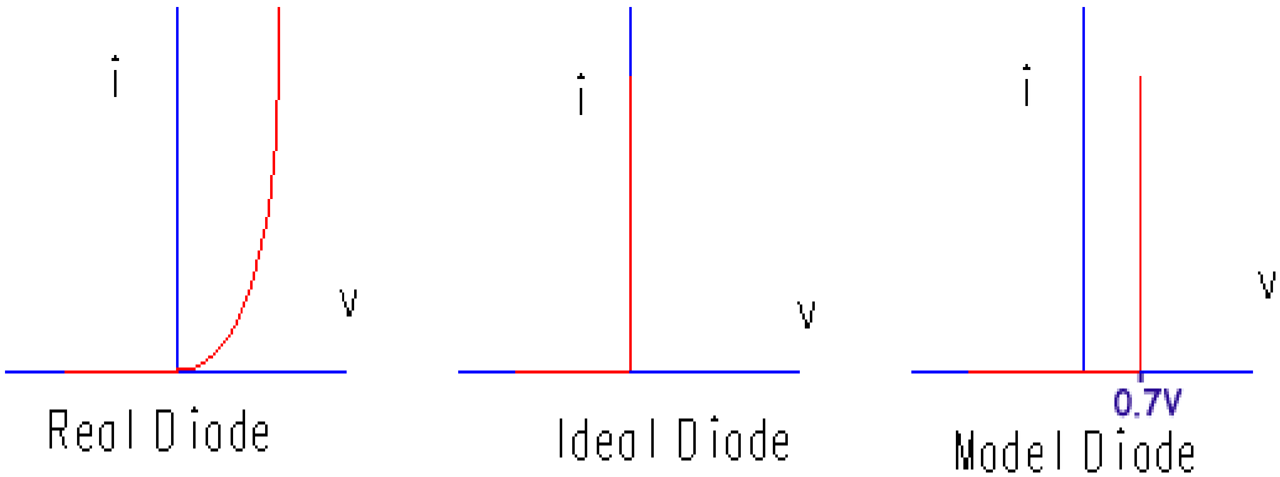
- Static forward resistance=R_F=$\frac{VF}{IF}$

  R_F=$\frac{0.35v}{80mA}$=4.375 ohms

- Reverse resistance=R_R=$\frac{VR}{IR}$
- $From\ Fig.\ I_R = 1\mu A$

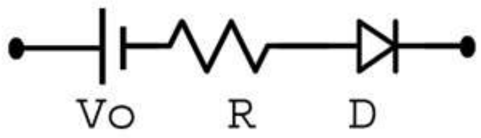
  R_R= $\frac{40V}{1\mu A}$=40Mohms

Diode Approximations

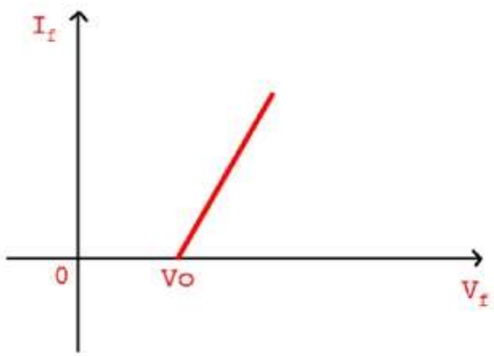


Piecewise linear model

Piecewise linear diode model



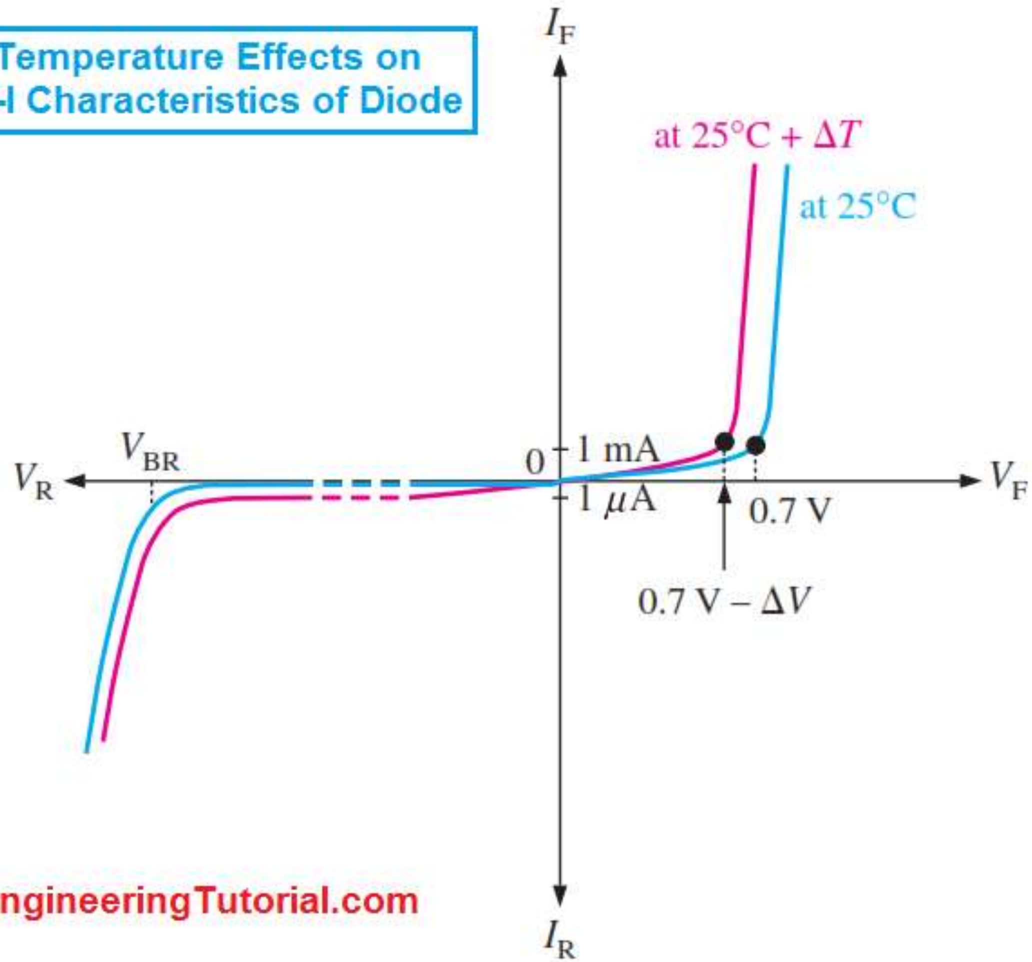
Characterisics



Temperature effects on diode

- An increased temperature will result in a large number of **broken covalent bonds** increasing the large number of majority and minority carriers. This amounts to a diode current larger than its previous diode current. The above phenomenon applies both to forward and reverse current.
- The effect of increased temperature on the characteristics curve of a PN junction diode is as shown in figure. It may be noted that the forward characteristics shifts upwards with increase in temperature. On the other hand, the reverse characteristics shifts downwards with the increase in temperature.

Temperature Effects on V-I Characteristics of Diode



Courtesy: **EngineeringTutorial.com**

Effect on power dissipation

- Maximum power dissipation is one of the rating, which when exceeded will destroy the diode. and this is given at 25^{o}C.In case the diode is operated at higher temperatures, it must be derated. This derating is done in accordance with the power-Temperature curve or a specified derating factor. The slope of the curve defines the derating factor, D
- $D = \frac{\delta P}{\delta T}$
- If power dissipation PT1 at temperature T1 & derating factor is given, then we can find the power dissipation at temperature T2 as
- PT2=PT1-(T2-T1) D

Problem2: Find the maximum forward current at $25^{o}c$ & $65^{o}c$ of a diode with 600mW max.power dissipation at $25^{o}c$& a derating factor of $5mw/^{o}c$. Assume that the forward voltage drop remains constant at 0.6v

Solution

Given $T1=25^{o}c$,$PT1=600mW$, $T2=65^{o}c$ $D=5mw/^{o}c$

- PT1=VT1 X IT1 (power dissipation at T1)
- IT1=PT1/VT1=600mW/0.6v= 1A
- PT2=PT1-(T2-T1) D
- =600mW-(65-25)5=400mW
- Hence current IT2=PT2/VT2=400mW/0.6v=667mA

Applications of diode

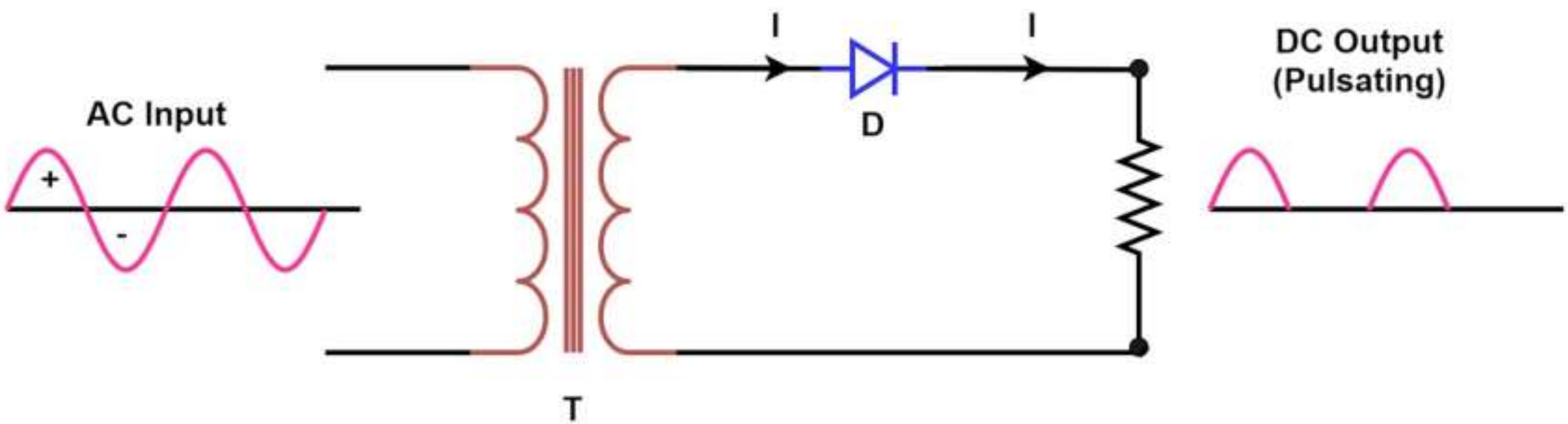
- RECTIFIERS:

➢A rectifier is an electronic device that converts AC voltage into DC voltage. In other words, it converts alternating current to direct current.

➢A rectifier is used in almost all electronic devices. Mostly it is used to convert the mains voltage into DC voltage in the power supply section.

➢Rectifiers are classified into two categories: Half Wave Rectifier and Full Wave Rectifier

Half wave Rectifier



Half Wave Rectifier

Half wave Rectifier working

- A step down transformer is used to convert high voltage A.C. to low voltage A.C. and Voltage will be reduced as per the turns ratio of primary & secondary of transformer.
- During the positive half cycle, the diode is under forward bias condition and it conducts current through RL (Load resistance). A voltage is developed across the load, which is the same as the input AC signal of the positive half cycle.
- Alternatively, during the negative half cycle, the diode is under reverse bias condition and there is no current flow through the diode and RL.
- Hence the output voltage is pulsating DC voltage as shown in Fig.

WAVEFORMS

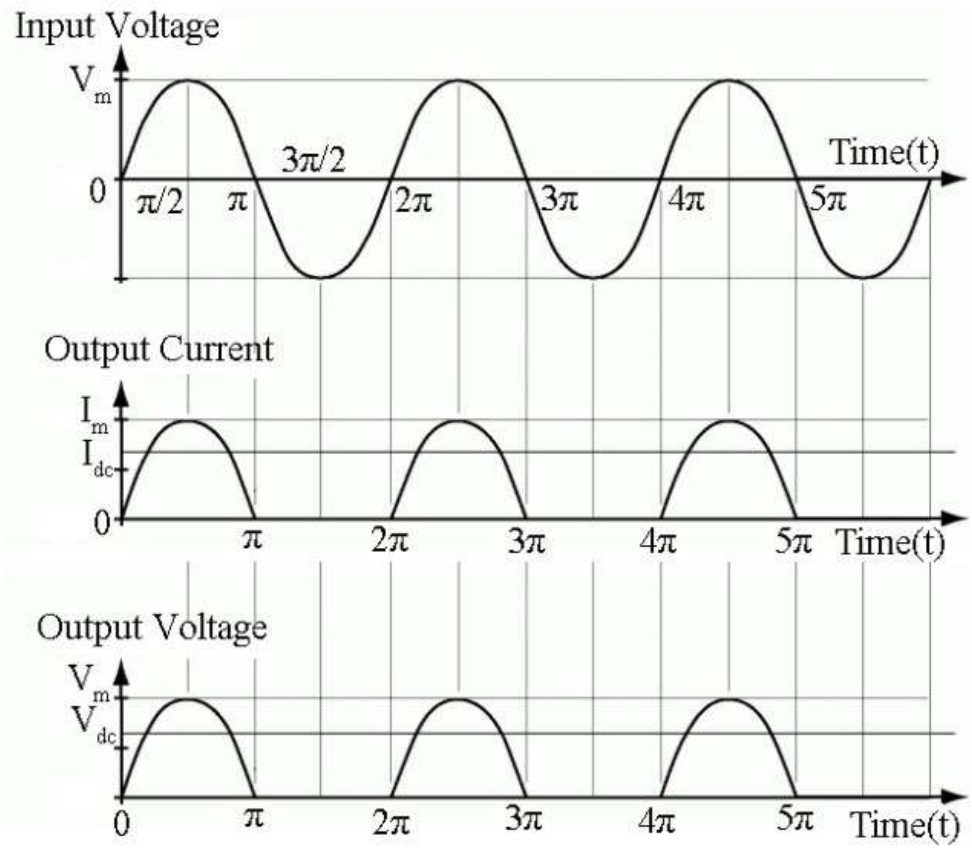


Figure 2: Waveform of Half Wave Rectifier

Derivations

- $v_1 = V_m Sinwt$[Input primary voltage]
- $v_2 = \frac{N2}{N1}$ v1 [voltage at secondary of transformer]

$v_2 = \frac{N2}{N1} V_m Sinwt = V_m Sinwt$[if N2/N1=1]

$$i_o = \begin{cases} I_m Sinwt & 0 <= wt < \pi \\ 0 & \pi <= wt < 2\pi \end{cases}$$ [secondary current]

Derivation of average current Idc

- Im=$\frac{Vm}{Rf+RL}$
- Idc= $\frac{\text{Area under one cycle of io}}{\text{Period of io}}$

$=\int_0^{2\pi} \frac{io}{2\pi}$ dwt

$=\frac{1}{2\pi}\int_0^{\pi} Im\ sinwt$ dwt+$\int_{\pi}^{2\pi} 0\ dwt$ [substituting for io]

$= \frac{Im}{2\pi}$ -Coswt] = $-\frac{Im}{2\pi}$ [Cos π-Cos 0]

$= \frac{Im}{\pi}$

Derivation of effective/rms current Irms

- Irms= $\sqrt{\dfrac{Area\ under\ one\ cycle\ of\ io^2}{period\ of\ io}}$

- $= \sqrt{\dfrac{\int_0^{2\pi} io2\ dwt}{2\pi}}$

- $= \sqrt{\dfrac{\int_0^{\pi} Im2sin2dwt+\int_0^{2\pi} 0dwt}{2\pi}}$

Contd..

-
- $=\text{Im}\sqrt{\frac{\int_0^{\pi}\frac{1-cos2wt}{2}dwt}{2\pi}}$
- $=\text{Im}\sqrt{\frac{\int_0^{\pi}dwt-\int_0^{\pi}cos2wt\ dwt}{4\pi}}$
- $=\frac{Im}{2}\sqrt{\frac{wt]-\frac{sin2wt}{2}]\ (limits\ 0-\pi)}{\pi}}$ Type equation here.
- $=\frac{Im}{2}\sqrt{\frac{(\pi-0)-(sin2\pi-sin0)}{\pi}}$
- $=\frac{Im}{2}$

Average/DC load voltage

Vdc= Idc x RL

$$= \frac{Im}{\pi} \text{ X RL}$$

$$= \frac{Vm \;\; X \; RL}{\pi \quad (Rf+RL)} \quad [\text{ Im}= \frac{Vm}{Rf+RL}]$$

$$= \frac{Vm/\pi}{1+(Rf+RL)}$$

RMS Load voltage

- Vrms=Irms X RL

$$=[\frac{Im}{2}]RL \qquad Im=\frac{Vm}{Rf+RL}$$

$$=\frac{1}{2}\quad\frac{Vm\ X\ RL}{Rf+RL}$$

$$=\frac{Vm/2}{1+Rf/RL}$$

Ripple Factor

- Ripple factor is the ratio of RMS value of ac component present in the rectified output to the dc component of the rectified output.
- It is denoted by ϒ
- $\Upsilon = \frac{Vac}{Vdc}$ where, Vac =RMS value of ac component present in the rectified output

  Vdc=dc component of rectifier

- Total output power is the sum of powers of dc and ac components, we can use the equation
- $(Vrms)^2 = Vdc^2 + Vac^2$
- Dividing throughout by Vdc^2
- $[Vrms/Vdc]^2 = 1 + [Vac/Vdc]^2$
- But $\Upsilon = \frac{Vac}{Vdc}$
- $[Vrms/Vdc]^2 = 1 + \Upsilon^2$

- $\Upsilon = \sqrt{\left[\frac{Vrms}{Vdc}\right]^2 - 1}$

Vdc= $\frac{Vm/\pi}{1+(Rf+RL)}$

Vrms= $\frac{Vm/2}{1+Rf/RL}$

substituting Vdc & Vrms in above equation,

$\Upsilon = \sqrt{\left[\frac{\pi}{2}\right]^2 - 1}$

= 1.21

Rectification Efficiency

- Rectification efficiency is defined as the ratio of dc output power to the ac input power supplied to the rectifier. It is denoted by η.
- $\eta = \frac{Pdc}{Pac}$ --(1)

Derivation:

- $Pdc = Idc^2$ X RL

$=[\frac{Im}{\pi}]^2$ X RL ---(2)

- $Pac = Irms^2 \times [Rf+RL]$

  But $Irms = Im/2$

- $Pac = \frac{Im^2}{4}[Rf+RL]$ —(3)

  Substituting Eq(2)& Eq(3) in Eq(1)

  $$\eta = \frac{40.6}{1+Rf/RL}$$

Problem 3: A diode whose internal resistance is 20Ω,is used to supply power to a 1000 Ω load in a H.W.Rectifier ckt. From a 110V(rms)source of supply. Calculate

a)Peak load current
b)DC load current
c)AC load current
d)DC load voltage
e)Rms load voltage

Solution

- Given Rf=20 Ω and RL=1000 Ω

- Assuming N2/N1=1

  $\frac{V1}{V2}=\frac{N1}{N2}=1$ hence, V2=V1=110V

- Vm=$\sqrt{2}$ Vrms(V2)= $\sqrt{2}$ X 110V

  Vm=155.56V

- a)Im=Vm/Rf+RL= 155.56/(20+1000)

  Im=152.5mA

b)DC load current=Idc=Im/π = 152.5mA/ π

Idc=48.54mA

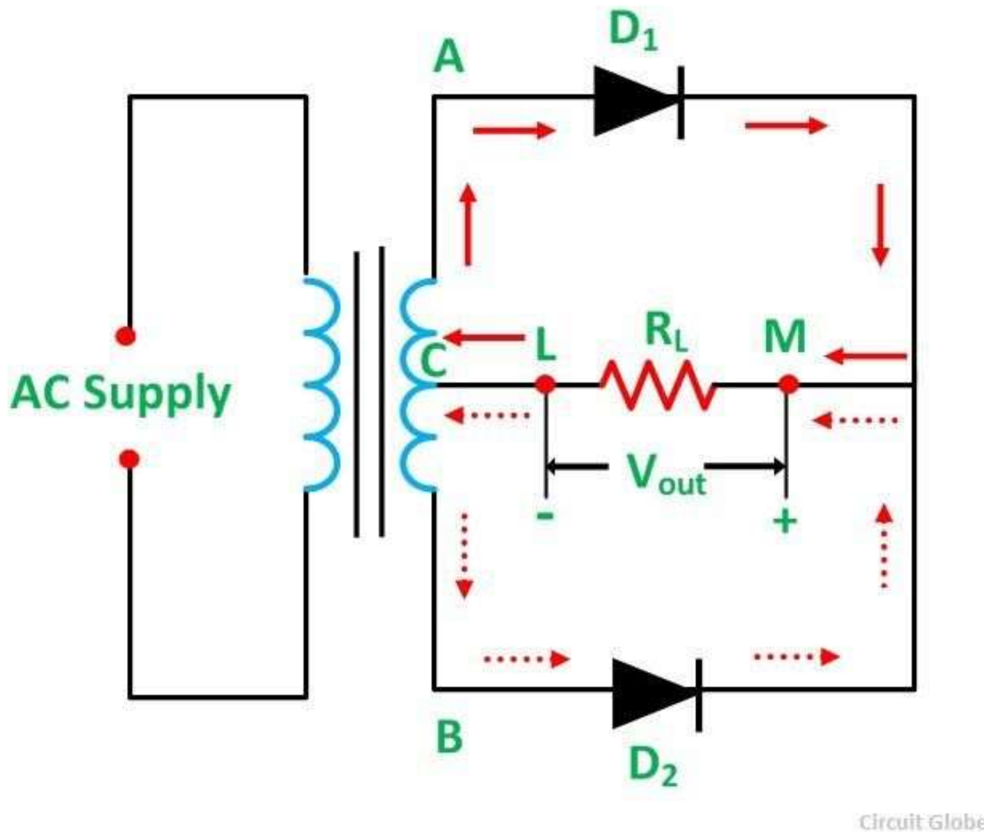
c) Irms=Im/2=152.5mA/2=76.25mA

d)DC load voltage=Vdc=$\frac{Vm}{\pi(1+\frac{Rf}{RL})}$

$$Vdc=\frac{155.56}{\pi(1+\frac{20}{1000})}=51.5V$$

e)Vrms=$\frac{Vm/2}{1+Rf/RL}$=76.25V

Center-tapped Full wave Rectifier using two diodes



Full wave Rectifier working

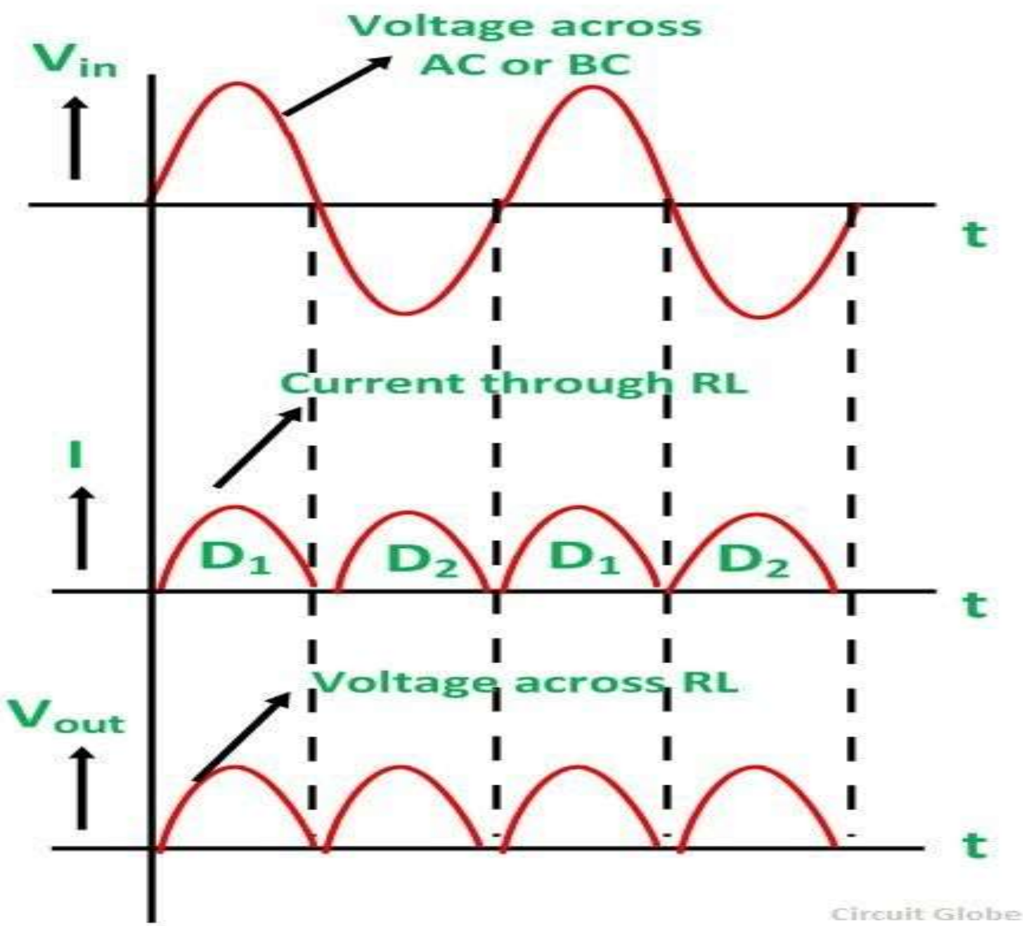
- The input AC supplied to the full wave rectifier is very high. The step-down transformer in the rectifier circuit converts the high voltage AC into low voltage AC.

- The anode of the centre tapped diodes is connected to the transformer's secondary winding and connected to the load resistor. During the positive half cycle of the alternating current, the top half of the secondary winding becomes positive while the second half of the secondary winding becomes negative.

- During the positive half cycle, diode D_1 is forward biased as it is connected to the top of the secondary winding while diode D_2 is reverse biased as it is connected to the bottom of the secondary winding. Due to this, diode D_1 will conduct acting as a short circuit and D_2 will not conduct acting as an open circuit

- During the negative half cycle, the diode D_1 is reverse biased and the diode D_2 is forward biased because the top half of the secondary circuit becomes negative and the bottom half of the circuit becomes positive. Thus in a full wave rectifiers, DC voltage is obtained for both positive and negative half cycle.

Waveforms



Voltage across
AC or BC
V_{in}
t
Current through RL
I
D_1
D_2
D_1
D_2
t
Voltage across RL
V_{out}
t
Circuit Globe

Derivations

- $v_1 = V_m Sinwt$[Input primary voltage]
- $v_2 = \frac{N2}{N1}$ v1 [voltage at secondary of transformer]

$v_2 = \frac{N2}{N1} V_m Sinwt = V_m Sinwt[N2/N1=1]$

$$io = \begin{cases} I_m Sinwt & 0 <= wt < \pi \\ & \end{cases}$$ [secondary current]

- $Im = \frac{Vm}{Rf+RL}$
- Idc= $\frac{\text{Area under one cycle of io}}{\text{Period of io}}$

$= \int_0^{\pi} \frac{io}{\pi}$ dwt

$= \frac{1}{\pi} \int_0^{\pi} Im\, sinwt$ dwt [substituting for io]

$= \frac{Im}{\pi}$ -Coswt] = $- \frac{Im}{\pi}$ [Cos π-Cos 0]

$= \frac{2Im}{\pi}$

- Irms= $\sqrt{\frac{Area\ under\ one\ cycle\ of\ io^2}{period\ of\ io}}$
- $= \sqrt{\frac{\int_0^{\pi} io^2\, dwt}{\pi}}$
- $= \sqrt{\frac{\int_0^{\pi} Im^2 sin^2 dwt}{\pi}}$

-
- $=Im\sqrt{\frac{\int_0^{\pi}\frac{1-cos2wt}{2}dwt}{\pi}}$
- $=Im\sqrt{\frac{\int_0^{\pi}dwt-\int_0^{\pi}cos2wt\ dwt}{2\pi}}$
- $=\frac{Im}{\sqrt{2}}\sqrt{\frac{wt]-\frac{sin2wt}{2}]}{\pi}}$
- $=\frac{Im}{\sqrt{2}}\sqrt{\frac{(\pi-0)-(sin2\pi-sin0)}{\pi}}$
- $=\frac{Im}{\sqrt{2}}$

Average/DC load voltage

- Vdc= Idc x RL

$$= \frac{2Im}{\pi} \text{ X RL}$$

$$= \frac{2\,Vm \;\; X\,RL}{\pi \;\; (Rf+RL)} \quad [\,\text{Im}= \frac{Vm}{Rf+RL}]$$

Dividing by RL both numerator & Denominator

$$= \frac{2Vm/\pi}{1+(Rf/RL)}$$

RMS Load voltage

- Vrms=Irms X RL

$$=\left[\frac{Im}{\sqrt{2}}\right]RL \qquad Im=\frac{Vm}{Rf+RL}$$

$$=\frac{1}{\sqrt{2}} \quad \frac{Vm\ X\ RL}{Rf+RL}$$

$$=\frac{Vm/\sqrt{2}}{1+Rf/RL}$$

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Ripple Factor

- Ripple factor is the ratio of RMS value of ac component present in the rectified output to the dc component of the rectified output.
- It is denoted by Υ
- $\Upsilon = \frac{Vac}{Vdc}$ where, Vac =RMS value of ac component present in the rectified output

  Vdc=dc component of rectifier

- Total output power is the sum of powers of dc and ac components, we can use the equation
- $(Vrms)^2 = Vdc^2 + Vac^2$
- Dividing throughout by Vdc^2
- $[Vrms/Vdc]^2 = 1 + [Vac/Vdc]^2$
- But $\Upsilon = \frac{Vac}{Vdc}$
- $[Vrms/Vdc]^2 = 1 + \Upsilon^2$

- $\Upsilon = \sqrt{\left[\frac{Vrms}{Vdc}\right]^2 - 1}$

$$Vdc = \frac{2Vm/\pi}{1+(Rf+RL)}$$

$$Vrms = \frac{Vm/\sqrt{2}}{1+Rf/RL}$$

substituting Vdc & Vrms in above equation,

$$\Upsilon = \sqrt{\left[\frac{\pi^2}{8}\right] - 1}$$

$$= 0.483$$

Rectification Efficiency

- Rectification efficiency is defined as the ratio of dc output power to the ac input power supplied to the rectifier. It is denoted by η.
- $\eta = \frac{Pdc}{Pac}$ --(1)

Derivation:

- Pdc= Idc^2 X RL

$$=[\frac{2Im}{\pi}]^2 \text{ X RL} \quad \text{---(2)}$$

- Pac=$Irms^2$ X [Rf+RL]
- But Irms=Im/$\sqrt{2}$
- Pac=$\frac{Im^2}{2}$[Rf+RL]—(3)
- Substituting Eq(2)& Eq(3) in Eq(1)
- η=$\frac{81.2}{1+Rf/RL}$

Problem4:A Full wave Rectifier with two diodes having internal resistance of 500 & load resistance of 2000.the secondary voltage wrt center tap is 280V/calculate

a)Peak load current
b)DC load current
c)AC load current
d)DC load voltage
e)Rms load voltage

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Solution

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Given Rf=500 Ω and RL=2000 Ω

- Vm=$\sqrt{2}$ Vrms(V2)= $\sqrt{2}$ X 280V

  Vm=395.98V

  a)Im=Vm/Rf+RL= 395.98/(500 Ω +2000 Ω)

  Im=158.39mA

b)DC load current=Idc=2Im/π $= 2X158.39mA/\pi$

Idc=100.83mA

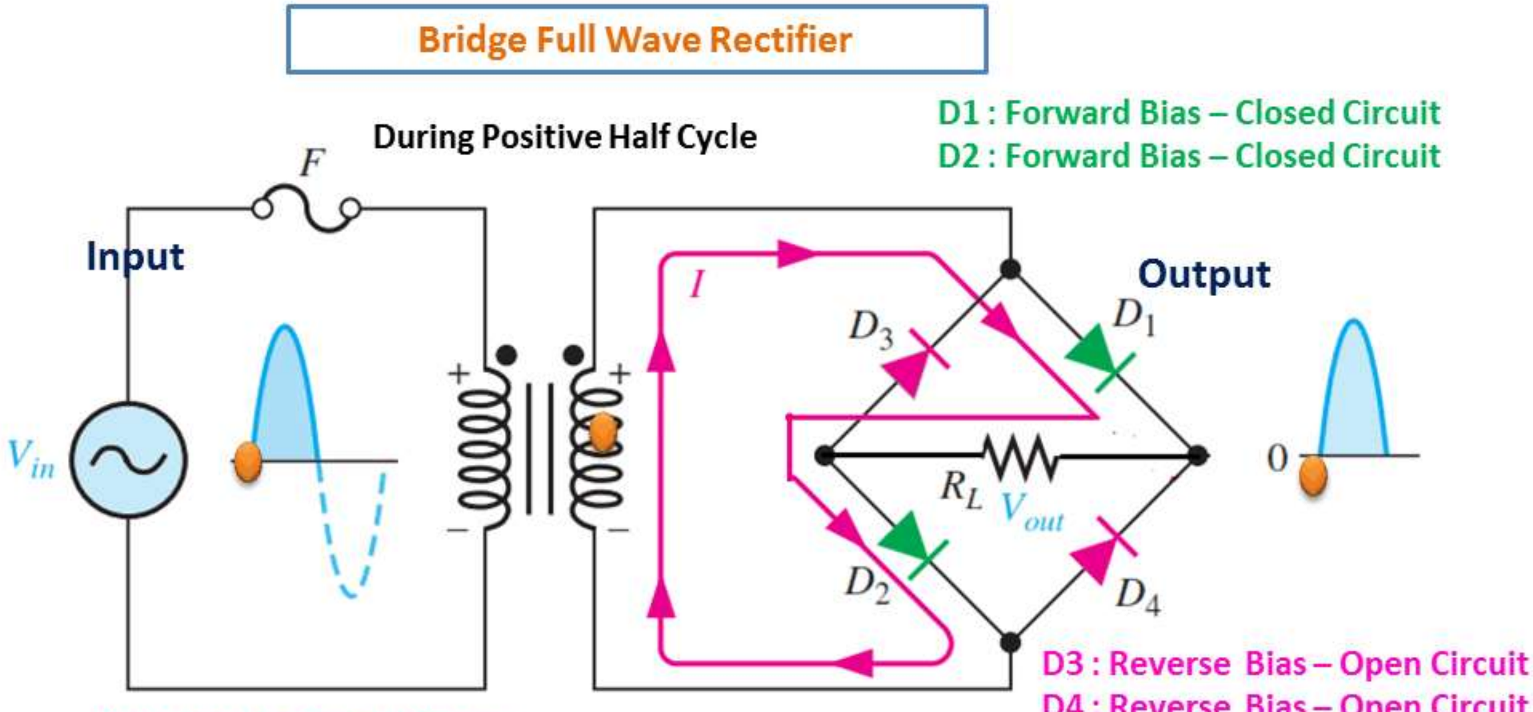
c) Irms=Im/$\sqrt{2}$=158.39mA/$\sqrt{2}$=112mA

d)DC load voltage=Vdc=$\frac{2XVm}{\pi(1+\frac{Rf}{RL})}$

Vdc=$\frac{2X395.98}{\pi(1+\frac{500}{2000})} = 201.66$V

e)Vrms=$\frac{395.98/\sqrt{2}}{1+Rf/RL}$=226.27V

Bridge Rectifier

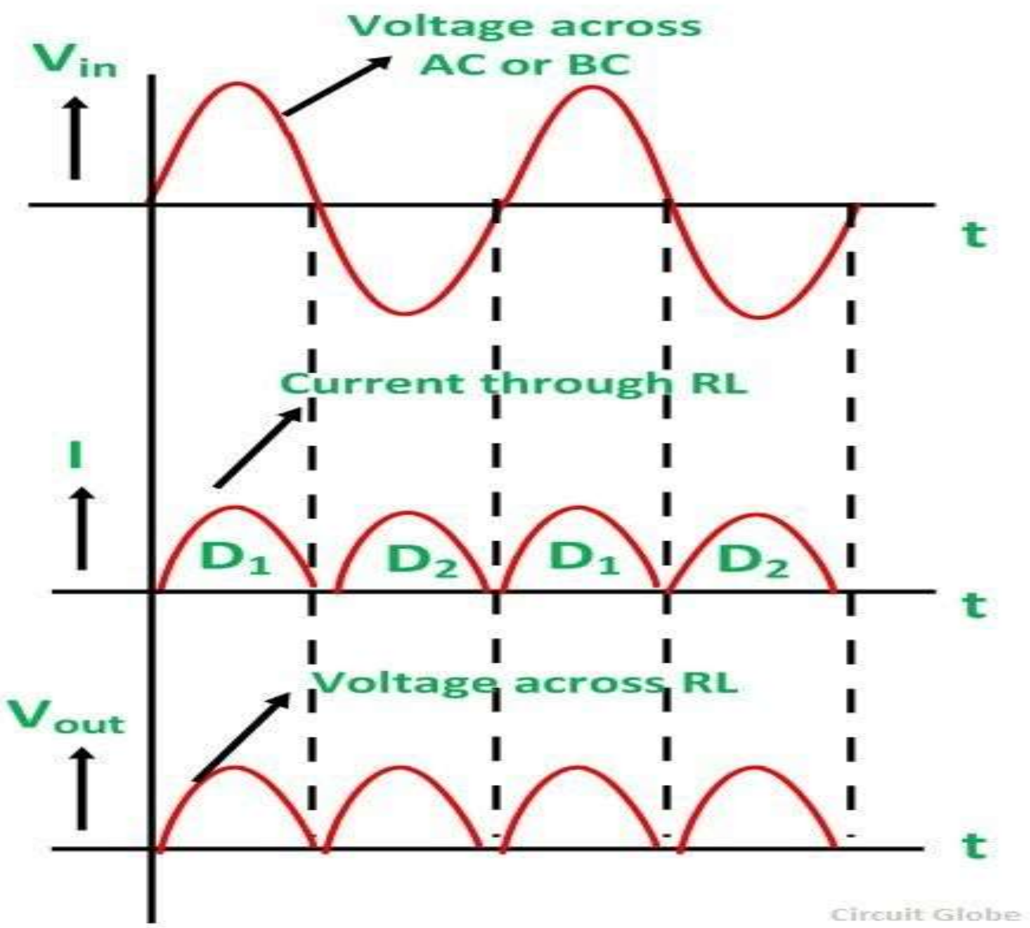


Courtesy: EngineeringTutorial.com

Bridge Rectifier Working

- When an AC signal is applied across the bridge rectifier, during the positive half cycle, terminal A becomes positive while terminal B becomes negative. This results in diodes D_1 and D_2 to become forward biased while D_3 and D_4 become reverse biased.
- The current flow during the positive half-cycle is shown in the figure .
- During the negative half-cycle, terminal B becomes positive while the terminal A becomes negative. This causes diodes D_3 and D_4 to become forward biased and diode D_1 and D_2 to be reverse biased.
- The current flow during the negative half cycle is shown in the figure .
- Hence there is a current flow in both half cycles through the load and hence we call it as full wave rectifier.

Waveforms



Voltage across
AC or BC
V_{in}
t
Current through RL
I
D_1
D_2
D_1
D_2
t
Voltage across RL
V_{out}
t
Circuit Globe

Bridge Rectifier parameters

- Idc= $2Im/\pi$
- Irms= $Im/\sqrt{2}$
- Vdc= $\dfrac{2Vm/\pi}{1+(\frac{2Rf}{RL})}$
- Vrms=$\dfrac{Vm/\sqrt{2}}{1+(\frac{2Rf}{RL})}$
- Ripple factor=0.483
- Efficiency=$\dfrac{81.2}{1+(\frac{2Rf}{RL})}$

- **Problem5**:a Full wave bridge rectifier,with load resistance 100 is driven by source voltage of 100V,50HzNeglecting diode resistances,calculate

a)average output voltage

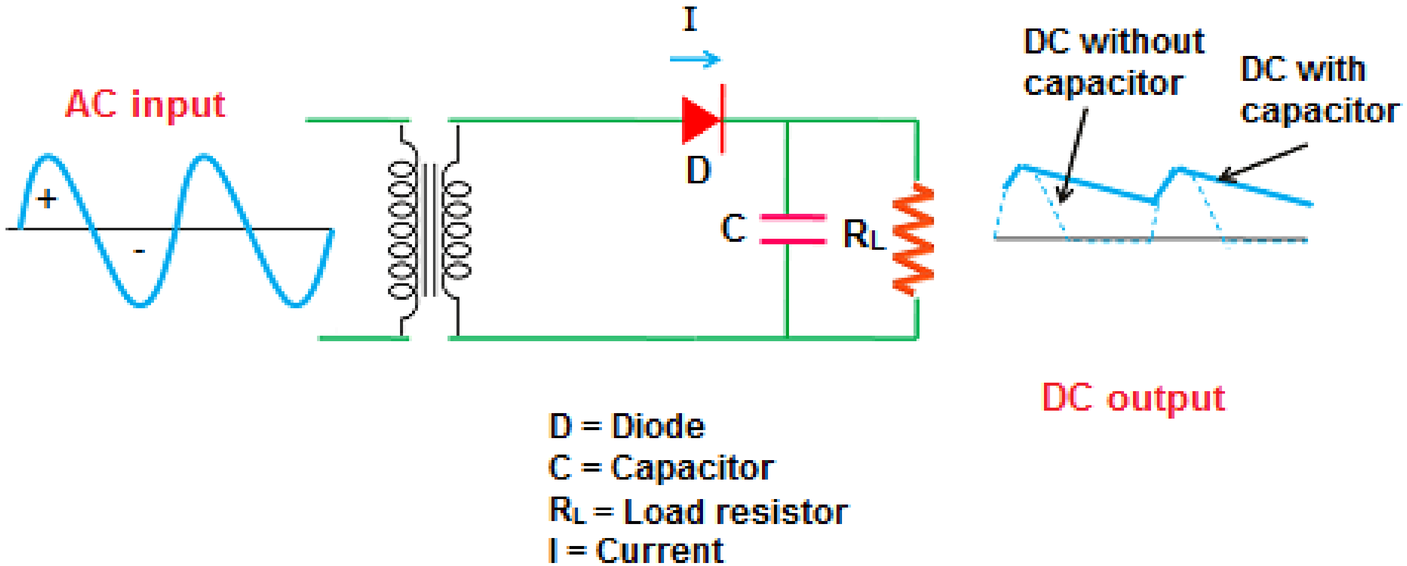
b)average load current

c)frequency of output wavefoem

d)dc power output

- Given,V2=100V
- Vm=$\sqrt{2}$ X V2=141.42V
- a)Vdc =$\frac{2\ X\ Vm}{\pi(1+\frac{2Rf}{RL})}$= 90.03V
- b)Idc= Vdc/RL=90.03/100=0.9A
- C)Frequency of O/p=2X Frequency of input
- 2X50=100Hz
- D)Pdc=$(Idc)^2$XRL= 81W

Half-Wave Rectifier with Filter

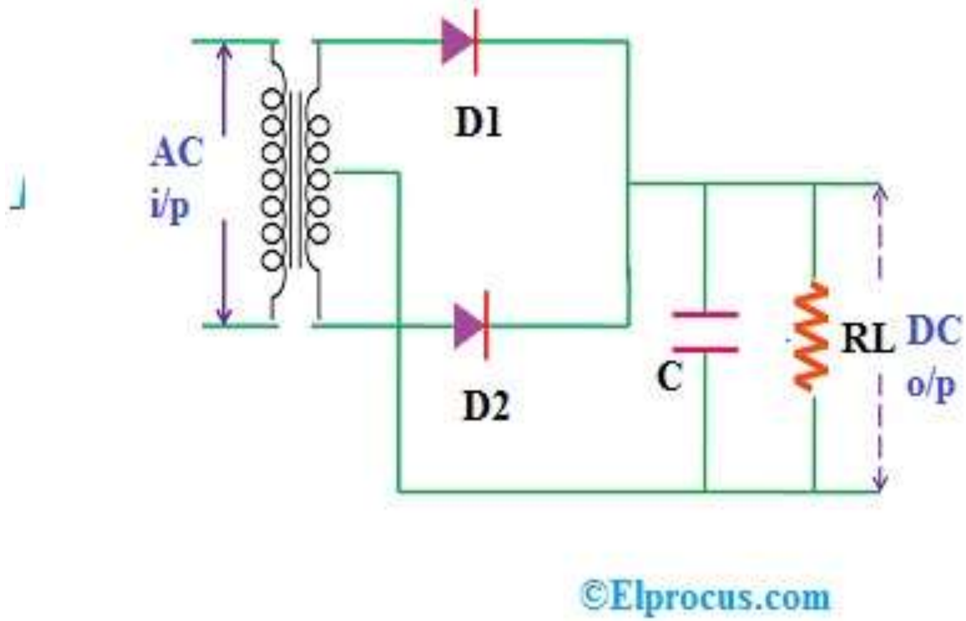


Half wave rectifier with capacitor filter

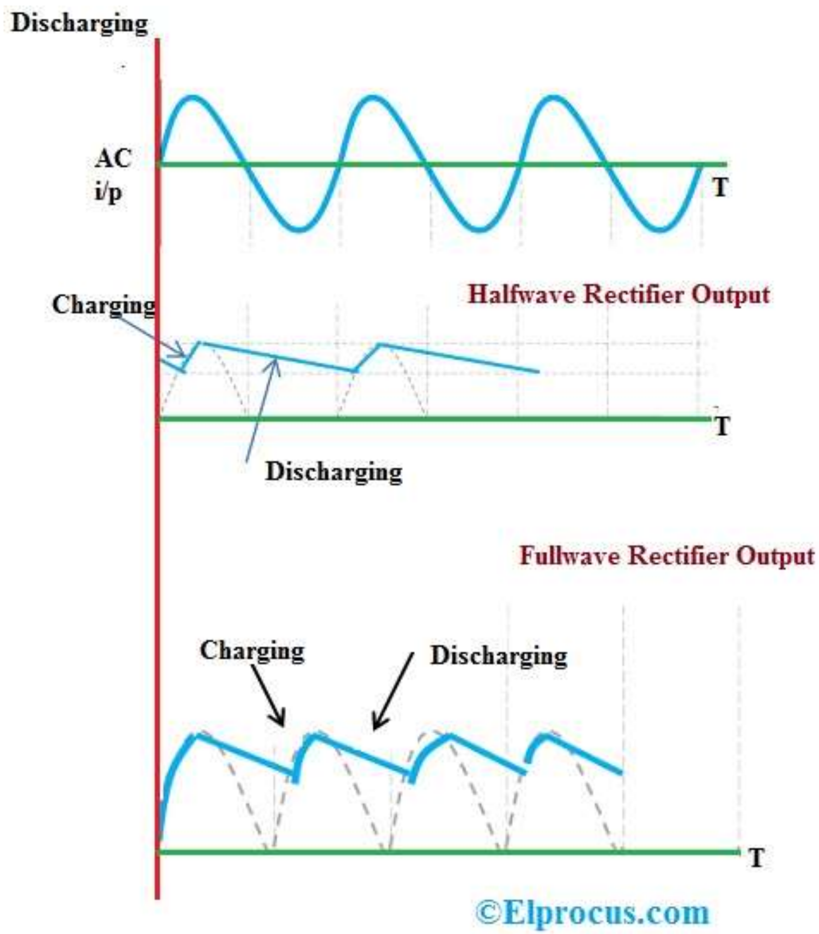
Problem6:A H.W.Rectifier with capacitor filter is supplying a resistive load of 500Ω.If the load ripple content should not exceed 10%,find the value of capacitance required,The supplyFrequency is 50 Hz

- Given, f=50Hz,RL=500Ω
- %ϒ=10,
- ϒ=10/100=0.1
- $\Upsilon=\frac{1}{2\sqrt{3fRLC}}$
- C=115.47μF

Full Wave Rectifier with Filter



Rectifier with filter waveforms

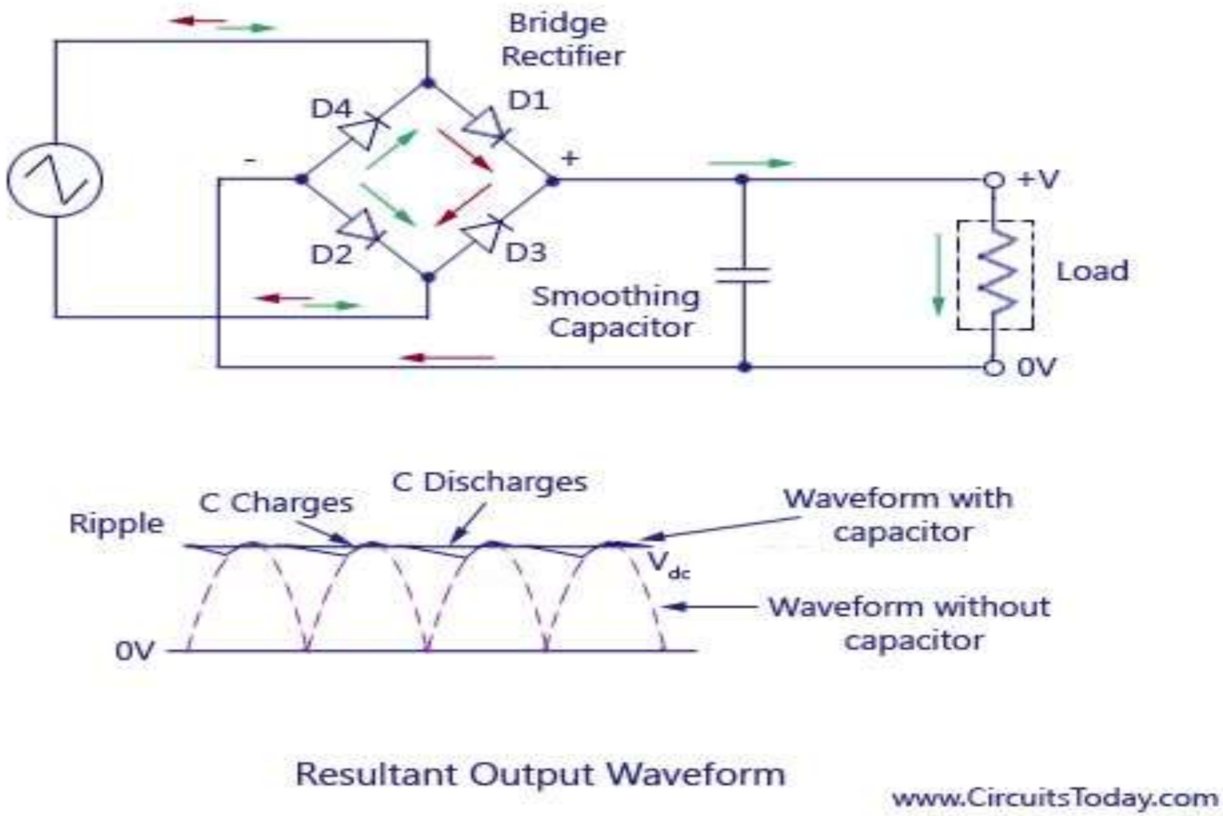


Problem7:In a Full wave rectifier with filter,the load current from the circuit operating from 230V,50 Hz supply is 10mA,Estimate the value of capacitance required to keep the ripple factor below 1%

- Given, V2=230V
- Vm=$\sqrt{2}$ XV2=325.27V
- F=50Hz
- Idc=10mA
- % ϒ<1 or <0.01
- $\Upsilon=\frac{1}{4\sqrt{3fR_LC}}<0.01$

- Taking reciprocal on both sides
- $4\sqrt{3}\ fR_LC>100$
- RL=Vdc/Idc
- Taking Vdc=Vm
- RL=Vm/Idc=325.27v/10mA
- =32.53kohm
- $C > 8.87\mu F$

Bridge Rectifier with Filter

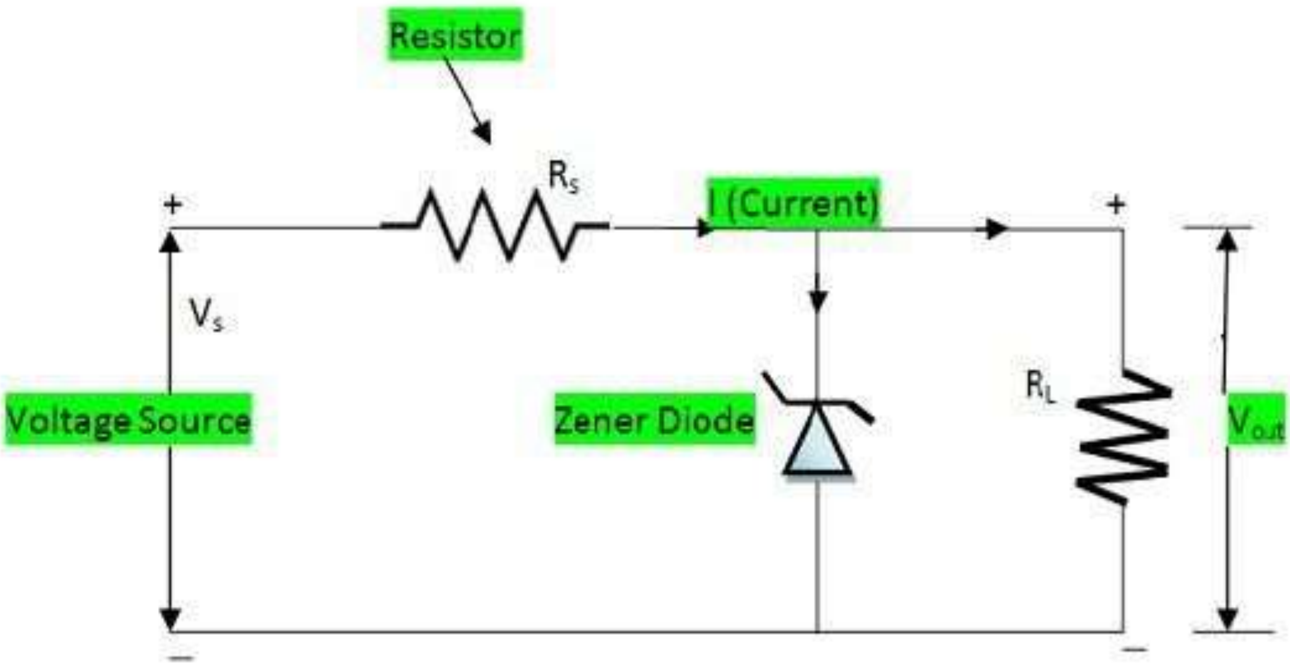


Problem8:A bridge rectifier with filter,supplies a load of 400Ω in parallel with a capacitor of 500μF.If the ac supply voltage is 230sin314tV,find the
a)Ripple factor and
b)DC load current

- Vm=230V
- W=2πf $= 314$ r/s
- F=314/2 π=50Hz
- RL=400ohms.
- C=500μF

- Ripple factor= ϒ=$\frac{1}{4\sqrt{3}fRLC}$
- =0.0144 or 1.44%
- B)DC load current=Idc
- Using Vdc=$\frac{Vm}{1+\frac{1}{4fCRl}}$=$\frac{230}{1+\frac{1}{4X50X500\mu FX400}}$
- =224.39V
- Idc=Vdc/RL=224.39/400=0.56V

Zener diode as Voltage Regulator



Zener Diode as Voltage Regulator

working

- Zener diode is a silicon semiconductor with a p-n junction that is specifically designed to work in the reverse biased condition. When forward biased, it behaves like a normal signal diode, but when the reverse voltage is applied to it, the voltage remains constant for a wide range of currents.
- Due to this feature, it is used as a voltage regulator in d.c. circuit. The primary objective of the Zener diode as a voltage regulator is to maintain a constant output voltage in spite of any fluctuations at input side voltage. Let us say if Zener voltage of 5 V is used then, the voltage becomes constant at 5 V, and it does not change.

- For the zener diode to operate in the breakdown region,the regulated dc input voltage Vi must be greater than the zener breakdown voltage Vz.

Since RL & zenerdiode are in parallel,

Voltage across RL=Voltage across Zener diode

Vo=Vz

It is seen that,

I=Iz+IL where,Iz=Zener current

IL=Load current

Iz=I-IL

But I=(Vi-Vo)/R

$$Iz=\left[\frac{Vi-Vo}{R}\right]-IL$$

- Assume that Vi varies between Vimin & Vimax & IL varies from ILmin to Ilmax, From eq,we find that min,zener current flows when Vi=Vimin & IL=ILmax,The current through zener must be > than Izmin and <Izmax for safe operation.
- $\left[\frac{Vimin-Vo}{R}\right]$- ILmax > Izmin
- $\left[\frac{Vimax-Vo}{R}\right]$-ILmin < Izmax
- Izmax= P_D/Vz where, P_D is max.Power dissipation in the zener

Problem9:Design a zener diode voltage regulator to meet the following specifications

dc input voltage Vi=20V-30V

dc output voltageVo=10V

Load current IL=0-25mA

Izmin=2mA

Izmax=100mA

Solution:

- Here, Vimin=20V, Vimax=30V
- ILmax=25mA, ILmin=0
- V0=10V

- 1)[$\frac{Vimin-Vo}{R}$]-ILmax > Izmin
- $\frac{20-10}{R} - 25\text{mA} > 2\text{mA}$
- $\frac{10}{R}$ >27mA; R< $\frac{10v}{27mA}$; R< 370Ω—(1)

Similarly,

2)[$\frac{Vimax-Vo}{R}$]-ILmin < Izmax

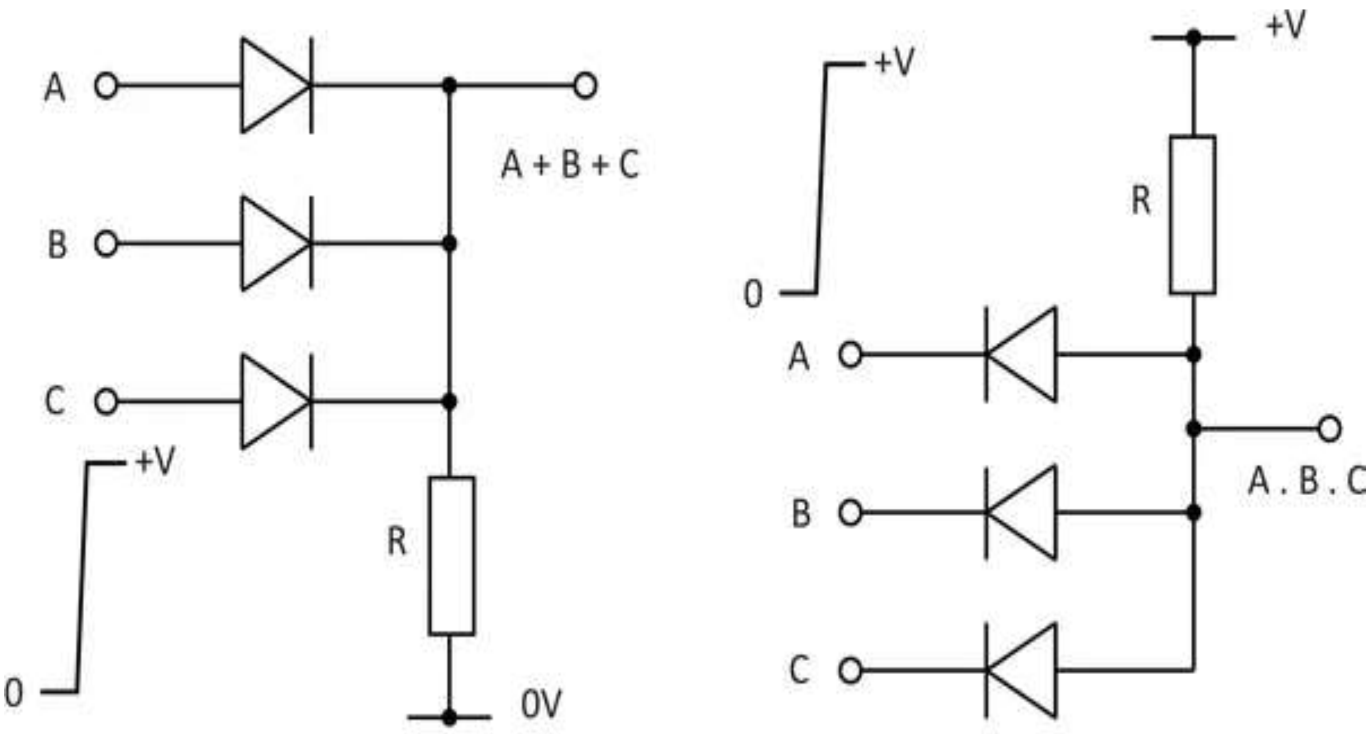
$\frac{30-10}{R} - 0 < 100\text{ mA}$

R> 200Ω—(2)

By taking average of Eq.1 & Eq.2

R= (370Ω+200Ω)/2=285Ω

Realization of Logic gates using Diodes



(a): Diode Logic OR Gate

(b): Diode Logic AND Gate

AND gate truth table

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

Fig,C

OR gate truth table

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

Fig.d

OR Gate Working:

- Refer Fig a.Fig d(Truth Table)
- When either of the inputs A,B,C is logic ‘1’(5V),current flows through the diode & the resistor R. hence there is a voltage drop across R, Vo=I x R=5v
- If all inputs are at logic ‘0’, no current flows through the diodes and ‘R’,hence voltage drop across ‘R’ is 0.

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AND Gate Working

- ReferFig. b,c
- Output is taken at anode of diode.
- When either of the inputs A,B,C is logic ‘1’(5V),current flows through the diode & the resistor R. hence there is a voltage drop across R, and voltage at anode is at ‘0’ level
- If all inputs are at logic ‘1’, no current flows through the diodes and ‘R’,hence voltage drop across ‘R’ is 0.and voltage at anode is at logic’1’


THANK
YOU