Analog Circuits:-

(*) Electronics :- is a branch deals with flow of charge carriers in Diodes, BJT's FET's which are made of semi conductors

(*) in Electrical :- deals with flow of charge carriers in metals

Example of semiconductor is "silicon" consists of P-type & N-type

(*) type of circuits in Electronics

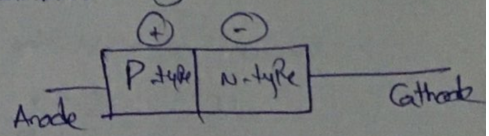
→ Analog circuits → BJT/FET/OP-Amp
→ Digital circuits → Gates/mux/counters/Registers/MP's
→ mixed signal circuits → ADC/DAC
i/p may be Analog/Digital & o/p may be Analog/Digital

1) Diode circuits:-

(a) Small signal Equivalent of Diode:-

→ Diode is a semiconductor device which is made of 2-type of materials (P-type & N-type).

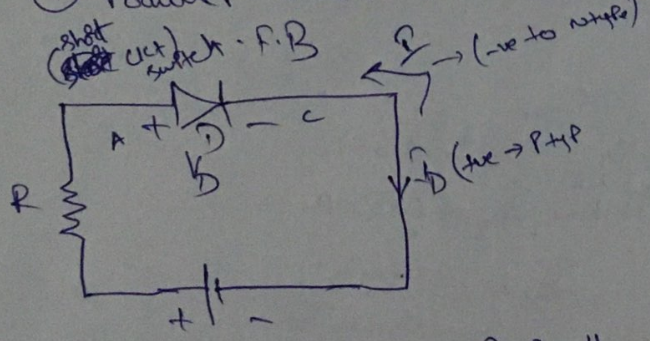
P-type has excess of holes (+)
N-type has " " Electrons (−)
} Combination form a diode



→ It is operated in 2-ways which depends on polarity of direction.

(1) forward Bias

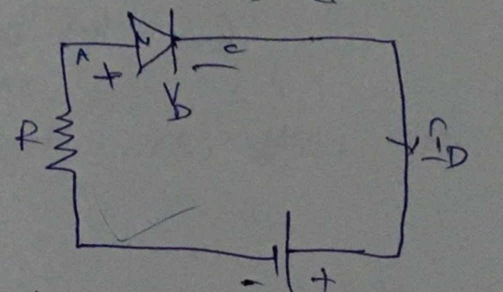
(short ckt) switch · F.B



+ve polarity of Battery connected to P-type all the holes are repeld by +ve polarity of Diode and −ve polarity is connected to N-side all the electrons are repeld in N-side of Diode i.e current direction is in Reverse

(2) Reverse Bias

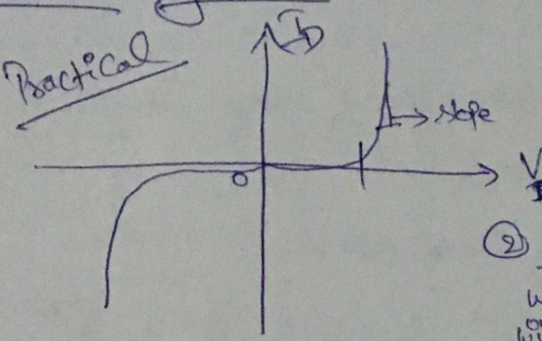
R.B (open ckt)



P-side to −ve polarity & N-side to +ve polarity i.e all the holes of P-side attracted by −ve polarity & all the electrons are attracted by +ve polarity so that charge carriers are different direction no current direction so $I_D = 0$ for practical application I_D is (nA)

Characteristic of Diode :-

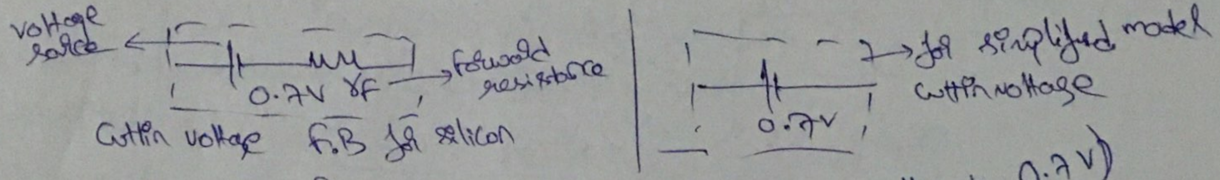
Practical



① → when we apply 0 volts there is no current flow as we reach cuttin voltage (0.7V) then conduction starts and after cuttin voltage conduction will be huge so F.B acts like short circuit

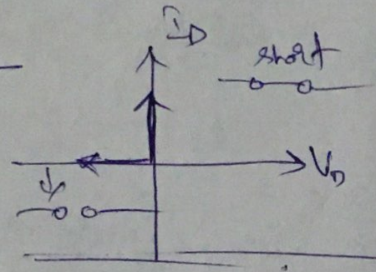
② R.B :- when we apply less than 0 volts when we increase R.B voltage at some point diode will break down. (open circuit)

→ To use this diode for calculation purpose we chose cuttin voltage above in to a linear peace wise model as slope. ~~cuttin voltage~~



(cuttin voltage is 0.7V)

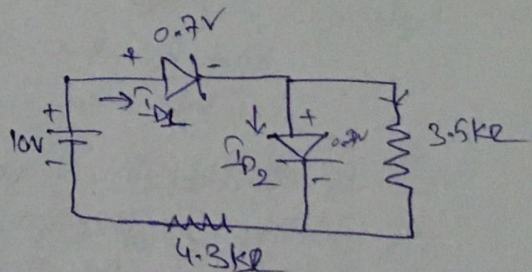
Ideal



Problems :-

($I = \frac{V}{R}$) → cuttin voltage

Q) Consider practical diodes, find I_{D_1}, I_{D_2} ?



Sol:- current across the resistor is

$$I = \frac{0.7V}{3.5k\Omega} = 0.2mA.$$

$$I_{D_1} = I_{4.3k\Omega} = ?$$

$$10V - 0.7V - 0.7V - 4.3k\Omega \times I_{D_1} = 0$$

$$8.6 - 4.3 I_{D_1} = 0$$

$$I_{D_1} = 2mA$$

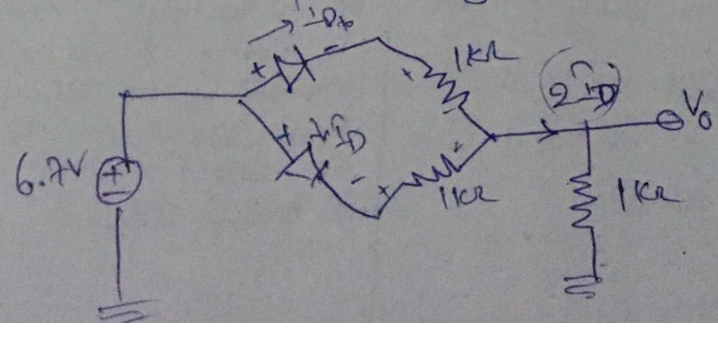
from kirchhoff current law :- $I_{D_1} = I_{D_2} + I_{3.5k\Omega}$

$$2mA = I_{D_2} + 0.2mA$$

$$I_{D_2} = 2 - 0.2$$

$$= 1.8mA$$

Eg:-2 Consider practical diodes, find out values of V_0 & I_0



$V = IR$

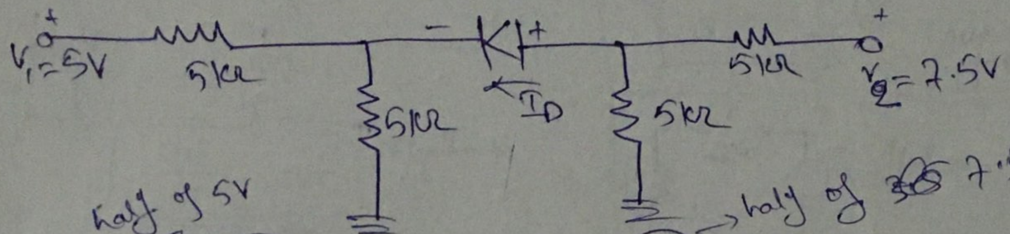
from KCL

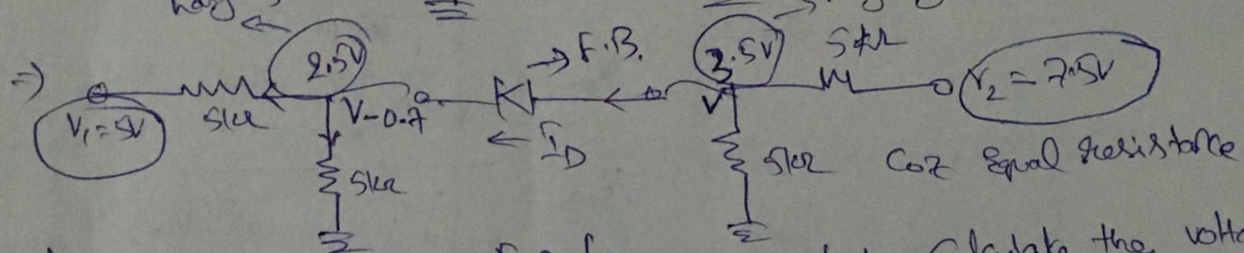
$$V_0 = 1 \times 2 I_D$$

$$V_0 = 2 I_D$$

$$6.7V - 0.7V - 1I_D - V_o = 0$$
$$6V - I_D - V_o = 0 \quad (\because V_o = 2I_D)$$
$$6V - I_D - 2I_D = 0$$
$$I_D = \frac{6}{3} = 2mA.$$
$$\therefore V_o = 2 \times I_D = 2 \times 2 = 4V.//$$

Eg:-3 Consider a Practical diode, find the value of current I_D.





To find out Diode is F.B / R.B we need to calculate the voltage at nodes.

If Diode voltage is $V_D > 0.7$ it is F.B

$V_D < 0.7$ it is R.B.

from KCL

F.B

$$\frac{7.5 - V}{5} = \frac{V}{5} + I_D$$
$$7.5 - V = V + 5I_D$$
$$2V + 5I_D = 7.5V \rightarrow (a)$$

R.B

$$I_D = \frac{V - 0.7}{5} + \frac{V - 0.7 - 5}{5}$$
$$5I_D = 2V - 6.4V \rightarrow (b)$$

from Eq (a)

$$2V + 2V - 6.4 = 7.5$$
$$4V = 13.9$$
$$V = \frac{13.9}{4} = 3.4.//$$

$$\therefore I_D = \frac{2 \times 3.4 - 6.4V}{5} = 0.08mA.//$$

Applications of Diode circuits:-

(1) Rectifiers:- → Half wave; → Full wave → Centertapped, → Bridge

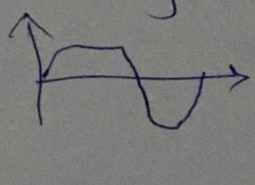
↓ Converts Ac to DC.

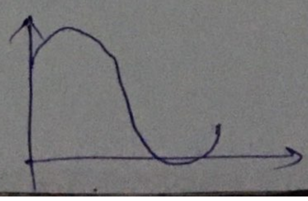
(2) clippers:- (to clipp. away voltage) → +ve; → -ve; → Both side

(3) Clampers:- → +ve; → -ve

(4) voltage multipliers

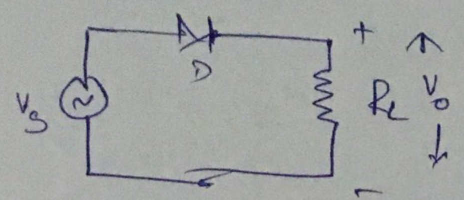
give Peak voltage as a multiplier of voltage no:-

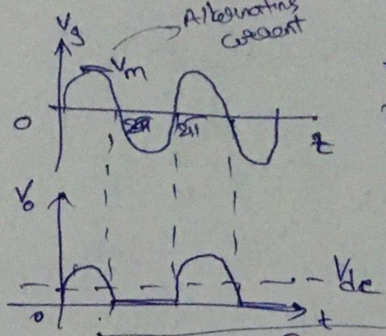




2) Rectifiers :-

Half wave Rectifier :-





Ac voltmeter gives V_{rms} value

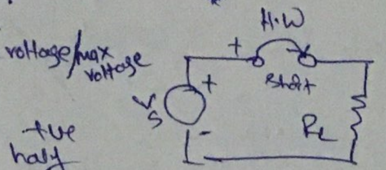
Dc " " " V_{dc} value

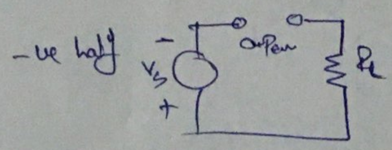
$V_s = V_m \sin \omega t$

↓

Peak voltage/max voltage

H.W





$$\boxed{V_{dc} = \frac{1}{2\pi}\int_0^{2\pi} V_o \cdot dt = \frac{1}{2}\int_0^{2\pi} V_m \sin \omega t \cdot d(\omega t)}$$

$$\Rightarrow \boxed{V_{dc} = \frac{V_m}{\pi}}.$$

Similly :- $\boxed{I_{dc} = \frac{I_m}{\pi}}$.

$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} V_o^2 \cdot d(\omega t)} =$$

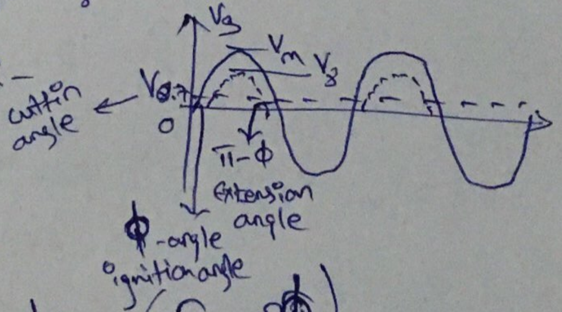
$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{\pi} (V_m \sin \omega t)^2 \cdot d(\omega t)}$$

$$\boxed{V_{rms} = \frac{V_m}{2}}$$

similly $\boxed{I_{rms} = \frac{I_m}{2}}$

when cuttin voltage 'V_γ' << V_m.

In Practical Case :-



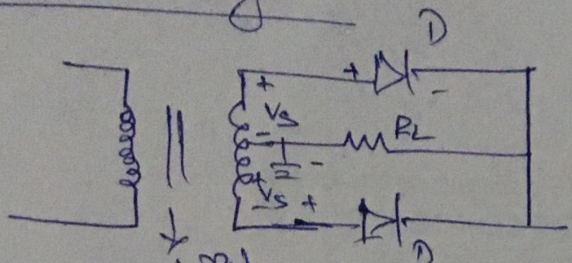
$$\Rightarrow \boxed{\text{Ignition angle } \phi = \sin^{-1}\left(\frac{V_\gamma}{V_m}\right)}.$$

Conducting angle $= (\pi - 2\phi)$

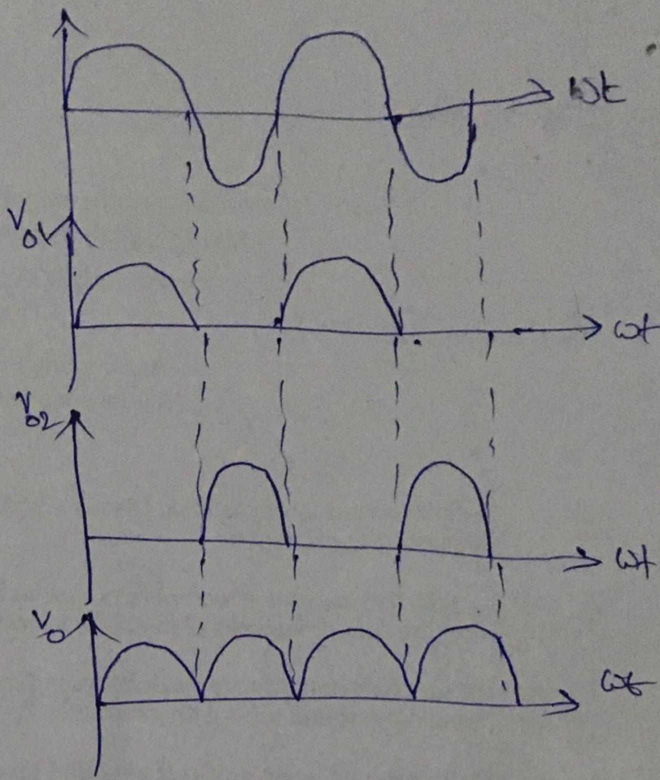
Use of Rectifiers :- is to drive Dc Power from an AC supply (AC to DC Converter)

Rectifier is an Electrical device that Converts alternate Current, which periodically reverse direction to direct Current, which follow only one direction..

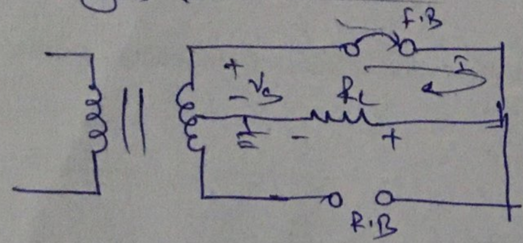
full wave Rectifier:-



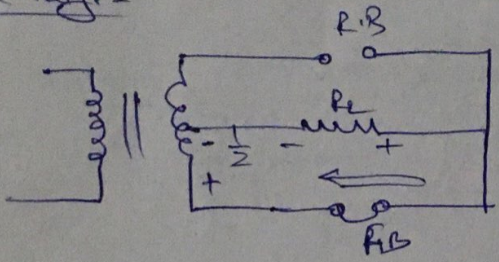
center tapped transformer.



+ve half (Equivalent ckt)



-ve half:-



Dc voltage in f.w. Rectifier is

$V_{dc} = \frac{2V_m}{\pi}$; $I_{dc} = \frac{2I_m}{\pi}$

$V_{rms} = \frac{V_m}{\sqrt{2}}$; $I_{rms} = \frac{I_m}{\sqrt{2}}$

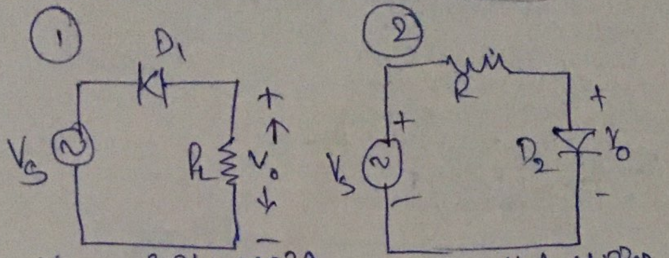
3) **Clippers:-** is a wave shapping ckt remove the wave (or) clipper away (or) remove portion of wave form.

~~Atc to~~

Types:-

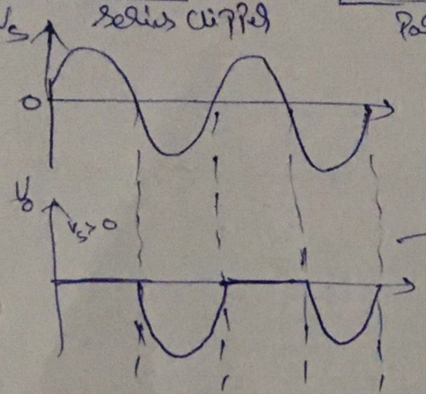
+ve clippers	Parallel clippers	Biased clippers (voltage source present)
-ve "	series "	unbiased " (no voltage source)
Combination clippers	↓	↓
	when load is Connected in parallel to diode ckt series,	with load & diode ckt & voltage source are connected mean it is Biased clippers.
		2) with load & diode ckt no voltage source.

Un biased Positive clippers:-



Series clipper   Parallel clipper.

when $V_s > 0$ the D_1 - off
$V_s < 0$ the D_1 - ON

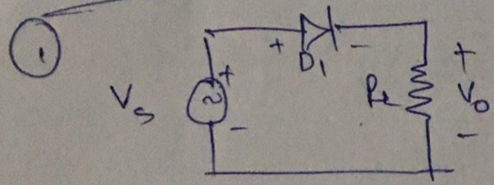


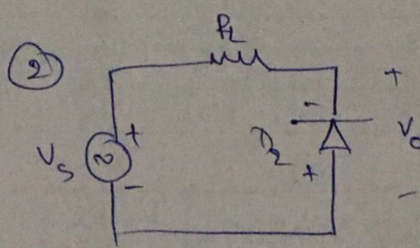
→ +ve side is clipped it is +ve clipper.

In ckt (2).

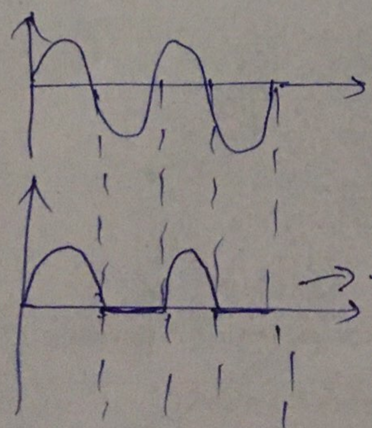
$V_s^+ \to V_o^+$ when D_2 is Conducting $V_o = 0$
D_2 is open ckt ($V_o \doteq V_s$)

Un biased -ve clippers:-





($V_s < 0$)



$V_s > 0 \Rightarrow D_1$ - ON
($V_o \doteq V_s$)
$V_s < 0 \to D_1$ - off

→ -ve side is clipped it is -ve clipper

In ckt (2) Voltage across diode

$V_s^+ \to V_o^-$ the D_2 - conducting
$V_o = 0$

∴ D_2 is open ckt ($V_o = V_s$)

→ series clipper means o/p is taken ~~across the~~ in series with the diode

→ Parallel " " o/p is taken across the diode.