6/1/25

Unit 1

1] Introduction to Electronics [10] mark

2] Transistors [10] marks

3] Operational Ampliphers [10] marks

4] Sensors. [10] marks

5] Number system and logic gates. [20] marks.

Co [Course outcome].

1] CO I → To understand the basics of semiconductors and Components like diode, transistors and diode.

2] To intriduce the fundamental of electronic instruments and measurements

To implement logical operations on variables

Introduction to Electronics.

i] Introduction to electronics

A] Evolution of electronics.

B] Active and passive components.

A] Evolution of electronics.

→ i] E.of.E have three key components, vaccum tube, transistor and IC's [Intregrated circuits]

2] In 1883 → Thomous alua adition → Conductivity

3) 1904 – vaccum tube → fleming.

4) 1906 – W Lee-forest → delvop vaccum triode.

5) 1927 → Macronic - invented radio

6] 1947 → John Barden → Transister.

7) 1958 → First IC.

8] 1900 → Vaccum tube [1st gen]

9) 1947 → 2nd gen

10) 1958, → 3rd gen

11) 1960 → SSI [Small Scale Integration]

12) 1966 → MSI
13) 1969 → LSI
14) 1975 → VLSI
15] 1995 → VSI

Active and passive Components.

Q] Active and passive components

1] Active componets can supply power in a electric circuit

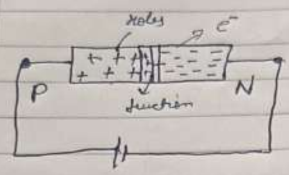
Eg generator, Transistor, Diode, Battary,

] Passive Component → A passive component cannot deliver power it can only absorb power in their circuit

Eg RLC [Resistance, Capacitance, inductor]

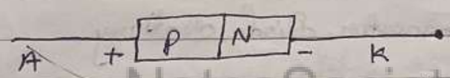
Active	Passive
Required external source for operation	1] Does not required external source.
...ntrol flow of current	2] Cannot control flow of current.
...ergy donner	3] Energy acceptor.
...able of provide power gain	4] Not able to provide Power gain.
...stor diode, Battary, ... linear graph	Eg Inductor, Resistor Capactor. linear graph.

A] PN-junction Diode.

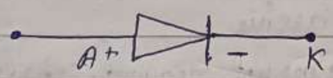
→ 

1] PN-junction diode it has two electrode it is a semi conduct Device having two terminals naming anode and cathode.

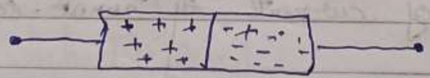
2] It allows currents to flow in one direction from its anode to cathode.



Symbol of diode.



Zero Bias



The is No connection of Battery.
NO - Bias
It does not have any

7/1/25

a] Forward bias

→ 1] Positive terminal of Battary is connected with positive terminal of the diode.

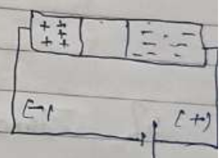
2] Negative terminal of battary is connected with negative terminal of diode.

3] When current ~~from~~ in the diode the ~~holes~~ ~~and~~ ~~deplication~~ deplication region become smaller.

4] It show current moving in forward bias

b] Reverse Biase.

1] Positive terminal of Battery is connected with negative terminal of the diode.

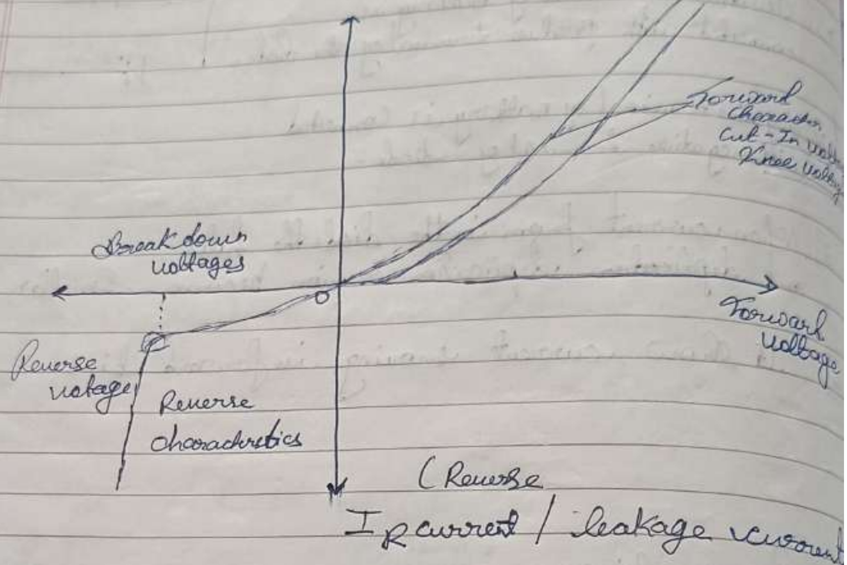


2] Negative terminal of battary is connected with positive terminal of the diode.

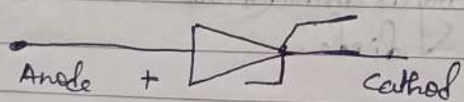
When current flow then the deplication region become larger.

It show current moving in reverse biase

2] V-I characterg PN-junction.

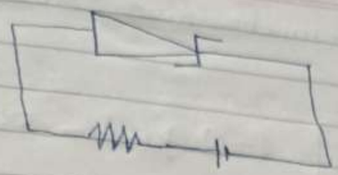


3] Zerner Diode.



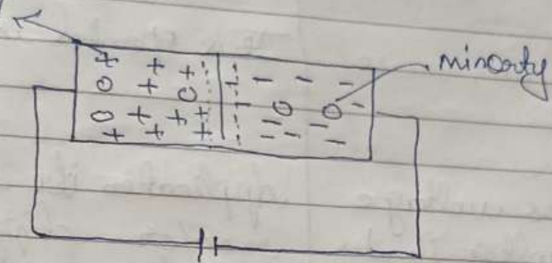
Symbiolic Representation of Zener Diode.

1]

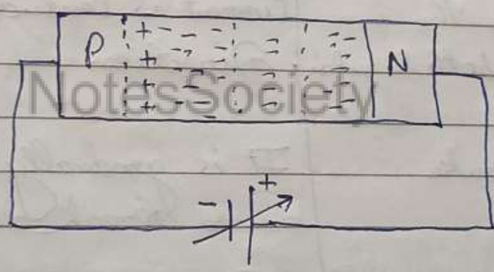


Ziner Diode in forward Biase.

2]

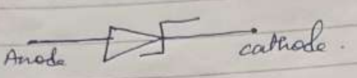
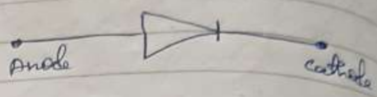


3]



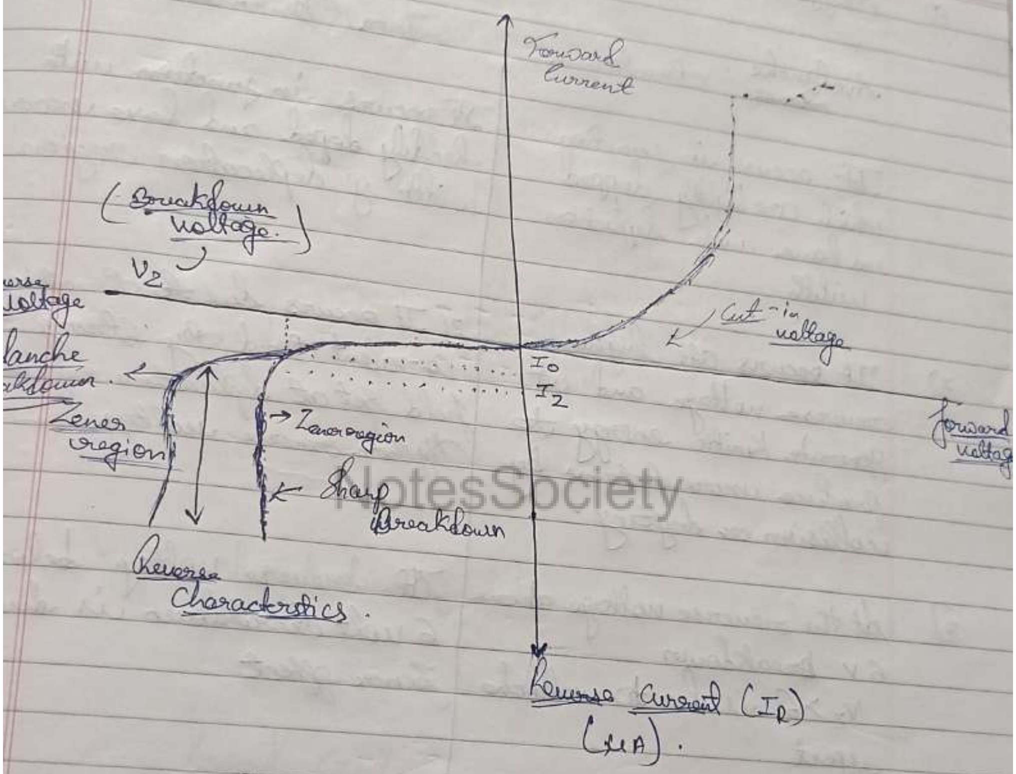
Reverse Biase Diode.

Q. Difference Between PN-Junction Diode and Zener Diode

	Zener Diode	P-N Junction Diode.
1]		
	It is operated in reverse Bias	It is operated in forward bias
2]	It is used as voltage regulator, voltage limiter	Application it is used in rectifier clipper and voltage multiplyer.
]	In Zener Diode the current flow in both Direction	Current is conducted in only one Direction
	It has sharp brake down region.	It is gradually increasing reverse Break down.

V-I characteristic of Zener Diode

V–I characteristic of Z.D.



Zener Breakdown → at small level.

Avalanche Breakdown → At large ~~cu~~ current.

① Difference Between Avalanche Breakdown and Zener Breakdown

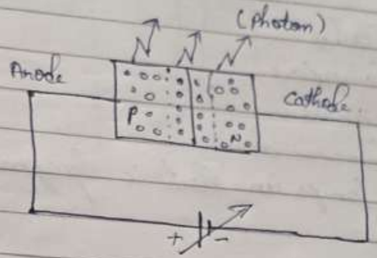
Avalanche Breakdown	Zener Breakdown.
It occurs in junction which are lightly dopped and have wide depliction width	It occurs in junction with heavily doped and have narrow width of deplication region.
It occurs at higher reverse voltage and it generate Kinitic energy to produce more electrons by collision or drifting.	2] It occurs due to Breaking of co-valent Bond By Strong electric field set at deplication region By there reverse voltage.
At the reverse voltage above 6 V breakdown $V_Z > 6$ is due to avalanche effect	At reverse voltage below 6 volt Breakdown is due to Zener effect
Electric field produce is less or weak in nature	Due reverse. voltage strong electric field is produce
Charge carrier obtain energy from the applied voltage	Zener current is independent of applied voltage.

① Difference Between Avalanche Breakdown and Zener Breakdown

Avalanche Breakdown	Zener Breakdown
It occurs in junction which are lightly dopped and have wide depliction width	It occurs in junction with heavily doped and have narrow width of deplication region
2) It occurs at higher reverse voltage and it generate Kinitic energy to produce more electrons by collision or drifting.	2] It occurs due to breaking co-valent bond by strong field set at deplication region by there reverse voltage.
3) At the reverse voltage above 6 V breakdown $V_Z > 6$ is due to avalanche effect	At reverse voltage below 6 volt breakdown is due to Zener effect
Electric field produce is less or weak in nature	Due reverse voltage strong electric field is produce
Charge carrior obtain energy from the applied voltage	Zener current is independent applied voltage.

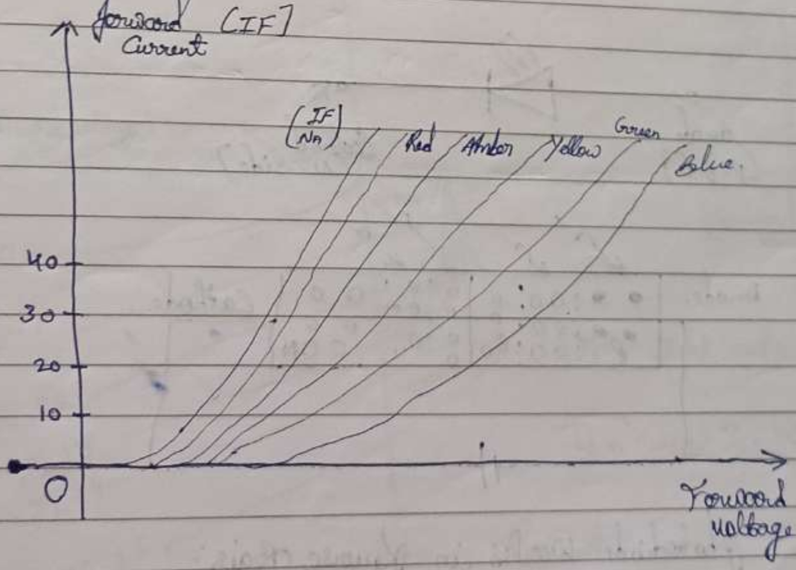
Led [Light Emitting diode]

Symbol of LED



V-I characteristics of Led.

1] Infrared
2] Red
3] Amber
4] Yellow
5] Green
6] Blue.



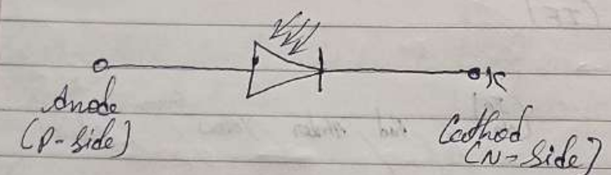
It work on principle electro-luminanse which converts electrical energy into light energy.

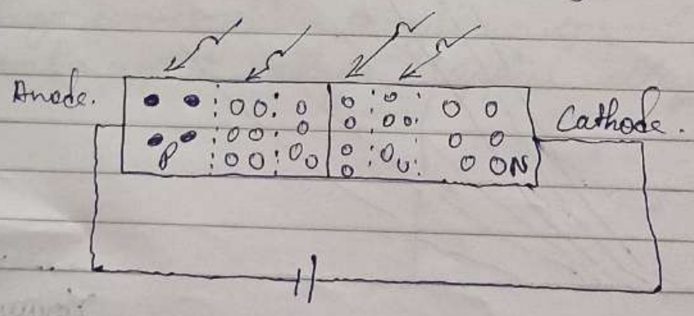
Application of LED.

1] LED.
2] Camera Flashes.
3] Digital Computers.
4] Traffic Signals.
5] Optical Communication.
6] Indicator lamps in Electric Equipment.

* Photodiode

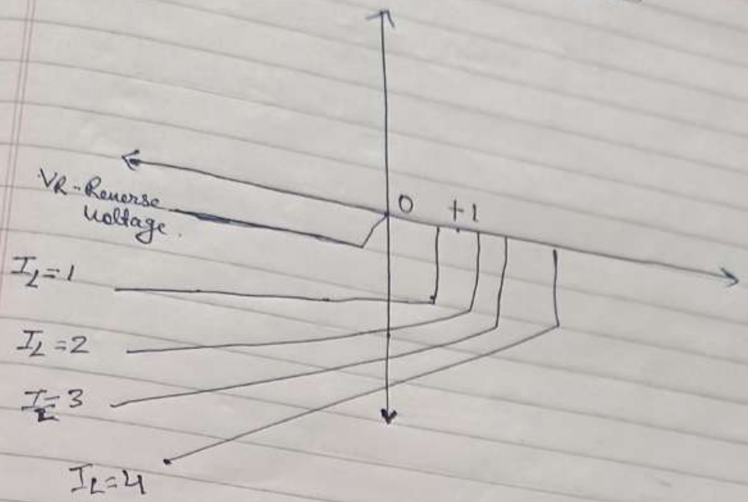
Symbol of photodiode.

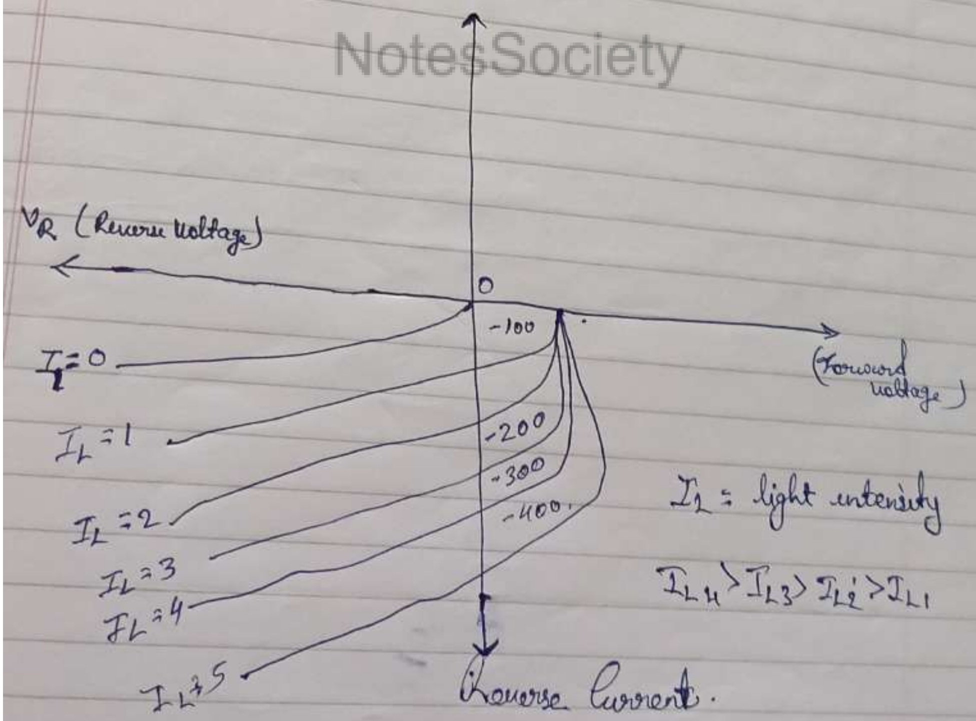




Photodiode works in Reverse Bais.

V-I characteristics of photo-Diode

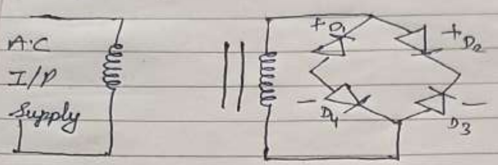




IL = light intensity

$I_{L4} > I_{L3} > I_{L2} > I_{L1}$

Imp. Bridge Rectifier



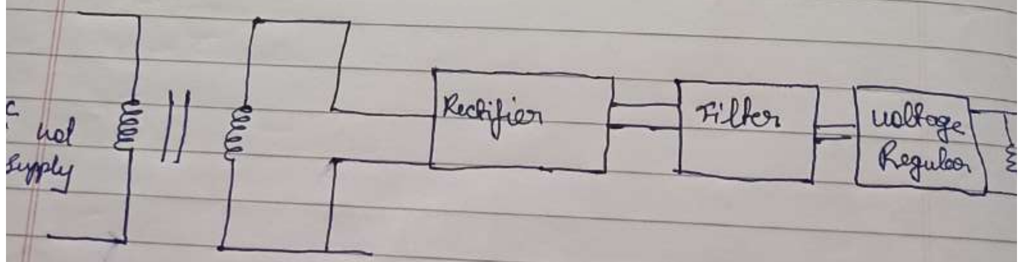
When +ve half cycle

$D_2 D_4 \rightarrow$ F.B.
$D_1 D_3 \rightarrow$ R.B.

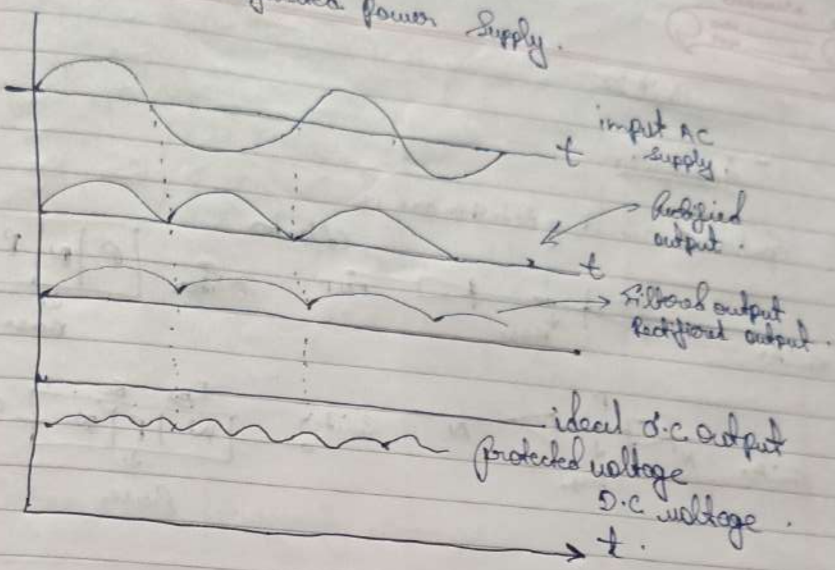
When -ve half cycle.

$D_1 D_3$ - F.B.
$D_2 D_4$ - R.B.

Block diagram of DC Regulated power supply.



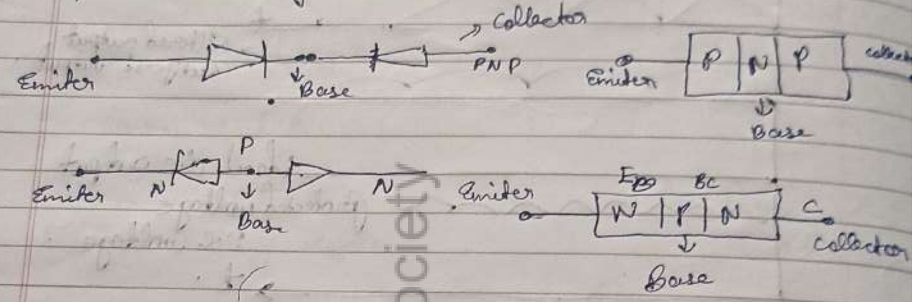
Waveform DC Regulated power Supply.



Unit II

Transistor

Equivalent circuit of transistor are.



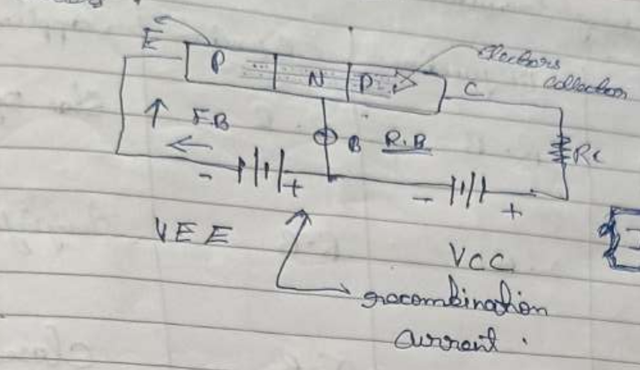
→

Transistor are 3 terminal device the terminals are emiter, Base, Collector it is current controlled devices The types of transistor are.

a] PNP → Transistor
b] NPN → Transistor

3] Equivalent Transistor.

Operation of N-P-N transistor.



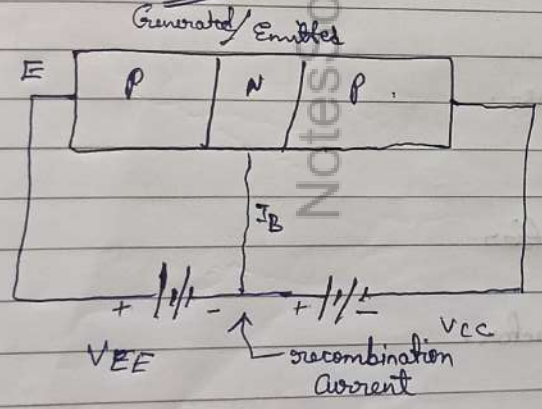
$I_E = I_C + I_B$

→ ① Electrons are majority carriers

② E- emitted & collected at collector

③ recombination.

Operation of P-N-P transistor.



Regions of transistor

Regions of transistor.

	Region	BE junction	CB junction	Application
1]	Cut-off region	R.B	R.B	Elas Open Switch
2]	Active region	F.B	R.B	Amplifier
3]	Saturation Region	F.B	F.B	Closed Switch

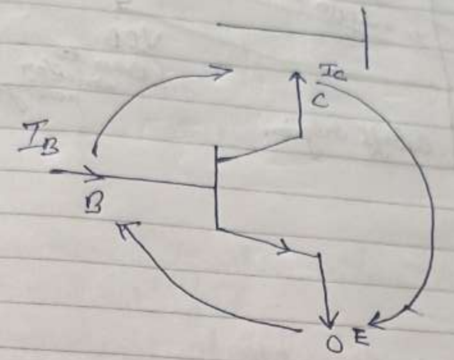
Configuration of transistor.

CB – Common Base.

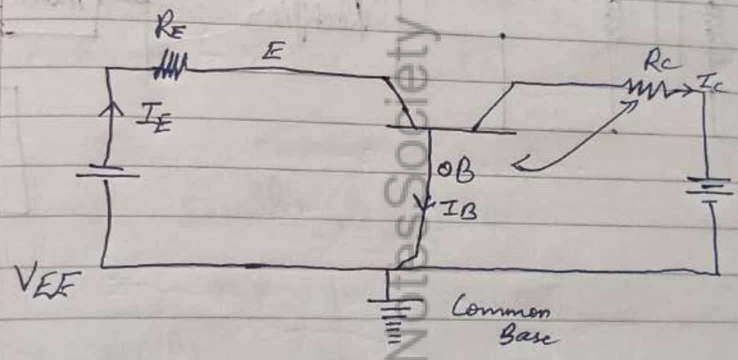
CE → Common emitter

CC → Common collector.

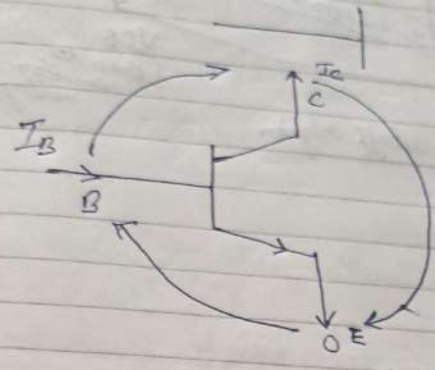
1] Draw Block-diagram of D.C supply power supply
2] & Explain working principle of n-p-n transistor
3] Explain working principle of p-n-p transistor.



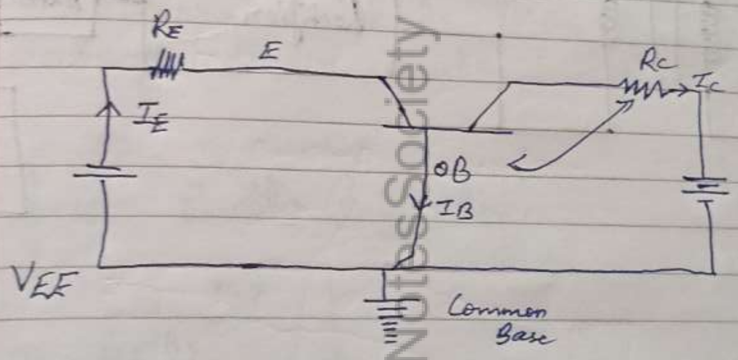
1] I_E
2] I_B
3] I_C
V_{CE}
4] V_{CE}
5] V_{BE}
6] V_{BC}.



1] Draw block-diagram of D.C supply power supply
2] & Explain working principle of n-p-n transistor.
3] Explain working principle of p-n-p transistor.



1] I_E
2] I_B
3] I_c
V_{CE}
4] V_{CE}
5] V_{BE}
6] V_{BC}.



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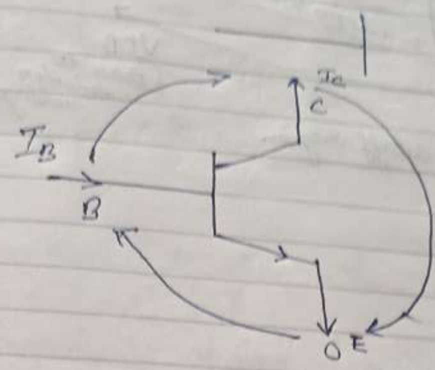
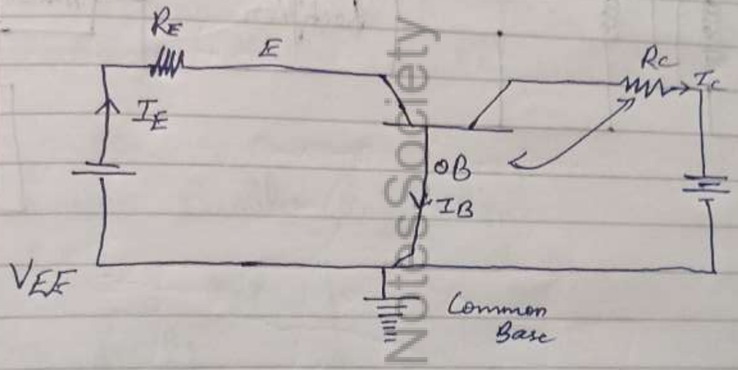


1] I_E
2] I_B
3] I_C
VCE
4] VCE
5] VBE
6] VBC.



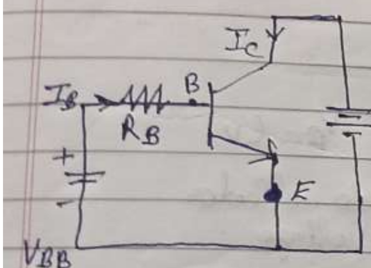
Configuration of transistor.

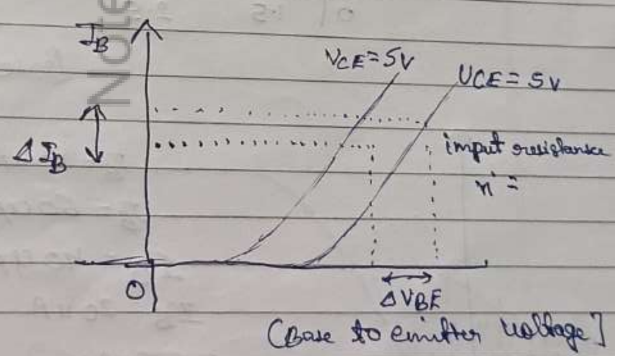
→ When any terminal of transistor kept constant types of configuration are

1) Common Base
2) Common Emitter
3) Common Collector.

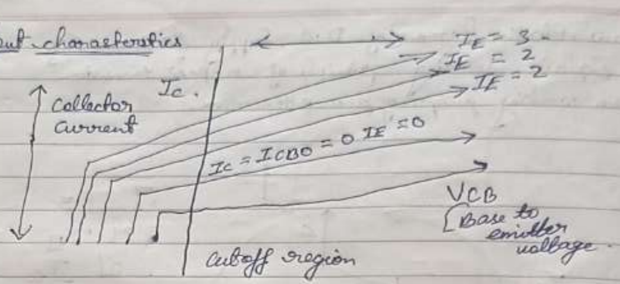
→ * Common Base Configuration where Base terminal is common to input and output.
The input is applied between emitter and Base terminal where V_{BE} and I are two parameter out
Output is taken across base and collector terminal
α = current amplification factor where α is the ratio of collector current to emitter current.

Common Emitter Configuration.



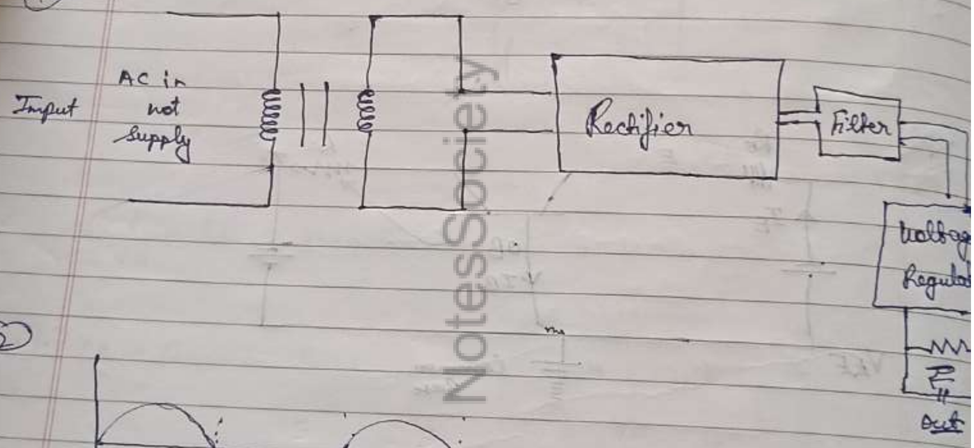


Output characteristics

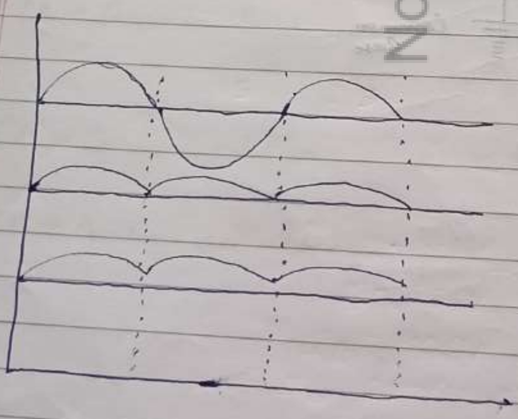


Q.

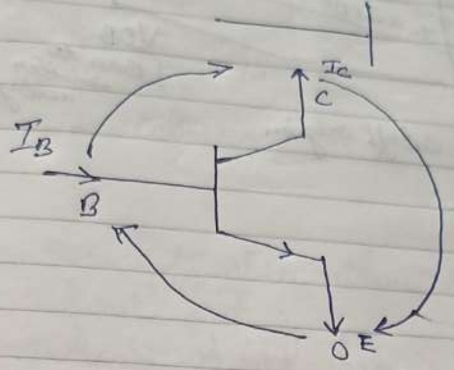
(1)



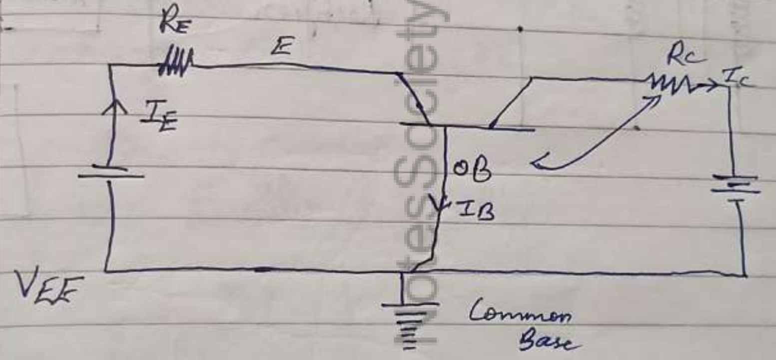
(2)



1] Draw Block-diagram of D.C Supply power supply
2] Q Explain working principle of n-p-n transistor
3] Explain working principle of p-n-p transistor.



1] I_E
2] I_B
3] I_C
VCE
4] VCE
5] VBE
6] V_{BC}.



Configuration of transistor.

Common collector configuration.

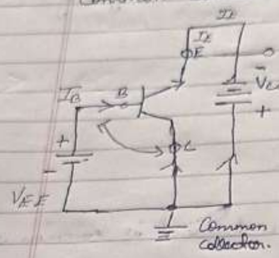
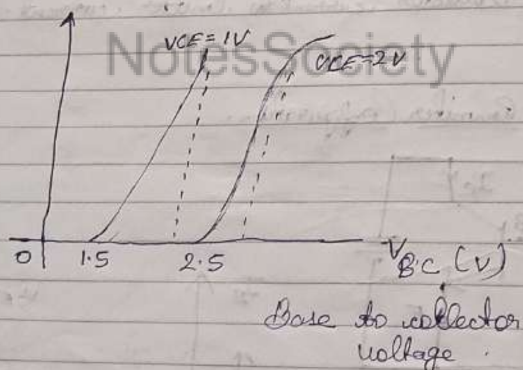


Fig Common Collector Configuration of NPN transistor or Emitter follower.

Input character.



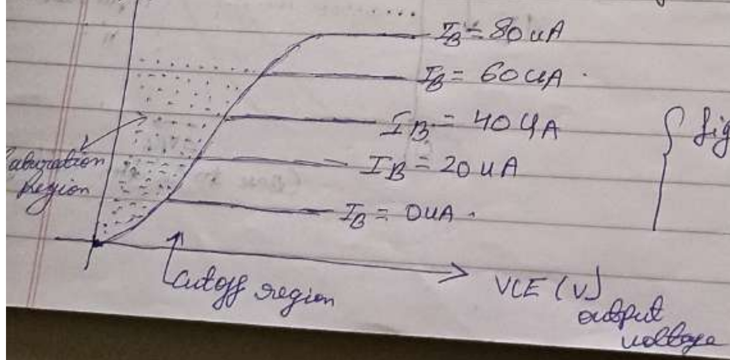


fig = Output Characterstic of CC Configration

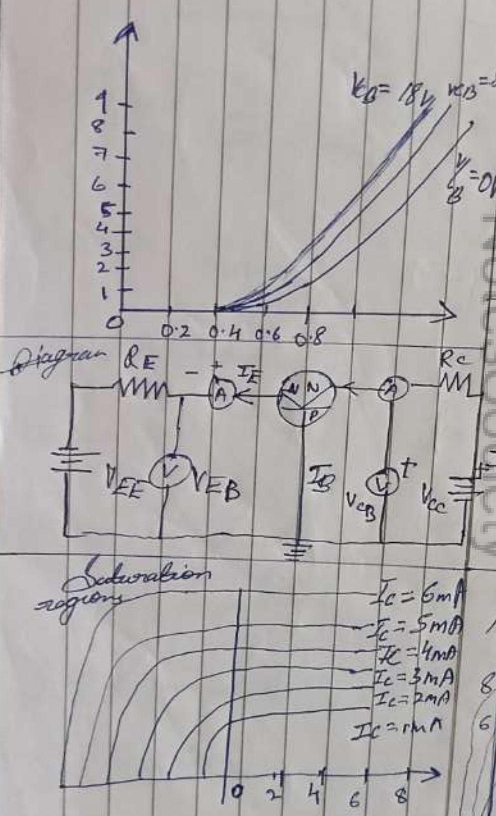
C- Configuration Application:

→ 1] It is used an audio-amplipher
2] Used in power ampliphers
3] Transistor is used as switch ~~as~~ &
4]

Application of CC configration

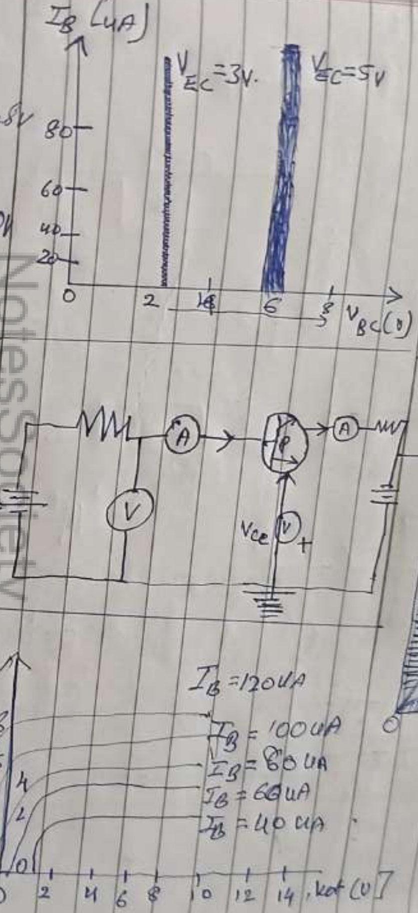
→ It is used in switching circuit.

CB



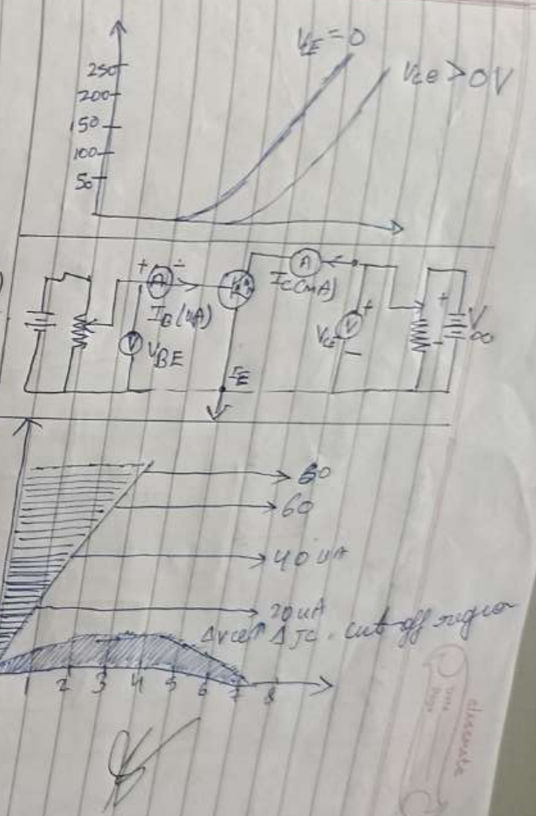
$V_{CB} = 18V$
$V_{CB} = 8V$
$V_{CB} = 0V$
Diagram
R_E
I_E
R_C
V_{EE}
V_{EB}
I_B
V_{CB}
V_{CC}
Saturation region
$I_C = 6mA$
$I_C = 5mA$
$I_C = 4mA$
$I_C = 3mA$
$I_C = 2mA$
$I_C = 1mA$

CE



I_B (uA)
$V_{EC} = 3V$.
$V_{EC} = 5V$
V_{BC} (V)
V_{ce}
$I_B = 120uA$
$I_B = 100uA$
$I_B = 80uA$
$I_B = 60uA$
$I_B = 40uA$

CE.



$V_{CE} = 0$
$V_{ce} > 0V$
I_B (uA)
V_{BE}
I_C (mA)
V_{CE}
I_E
V_{CC}
60
60
40 uA
20 uA
ΔV_{CE} ΔI_C . cut off region

Difference between CB, CE, CC configuration of transistor.

Parameter	Common Base	Common Emitter	Common collector
Input Terminal	Emitter	Base	Emitter
Output Terminal	Collector	Collector	Collector
Voltage Gain	Low	Moderate	Slightly less than [unity gain]
Current Gain	medium	High	Low current gain (Current Buffering)
Power gain	Low to moderate	Moderate to High	
Phase inversion	NO (Degree or 360 Degree	Yes [180 Degree)	NO (Degree or 360 degree
Input Impedance	Low (50 Ohm]	Moderate	High (300 kohm]
Output Impedance	High [1 m ohm]	moderate	Low (300 ohm]
Applications	High frequency amplifiers RF Circuits	General purpose Amplifiers Power Amplifiers	Voltage Buffering matching

Differen VJT transistor and Fet.

VJT	FET
→ 1) Three terminal device	3 terminal device have drain and gate terminal.
→ 2) It is used as current control device	It is voltage control device
3) It is use as high log switching application	It is used as high switching application.
4) It is use as Bipole device used as ampliphere	It is used as power c
5) It has high gain	It has low gain.

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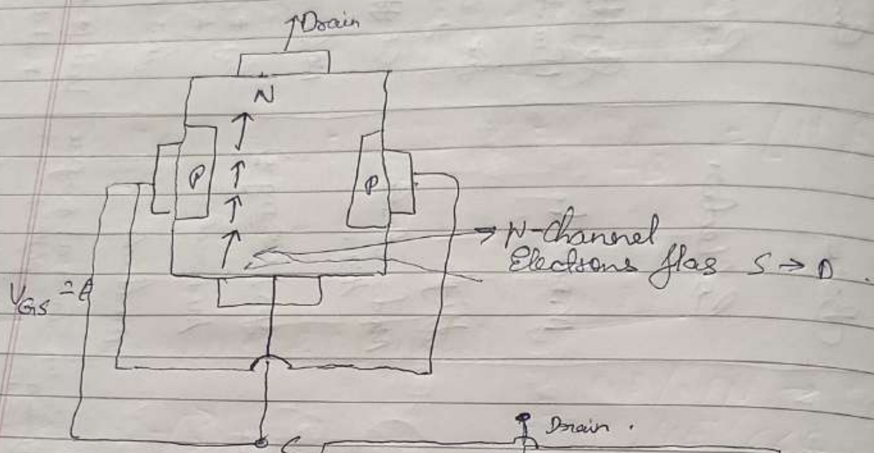
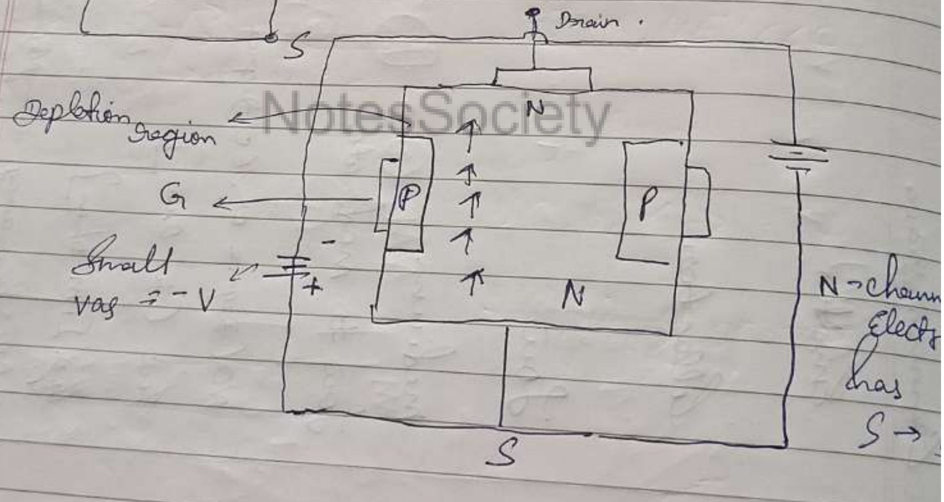
→ N-channel JFET construction:

1] When





① Small voltage is applied.

Differen VJT transistor and Fet.

VJT	FET
→ 1] Three terminal device	3 terminal device have drain and gate terminal.
→ 2] It is used as current control device	It is voltage control device
3) It is use as high log switching application	It is used as high switching application.
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5] It has high gain	It has low gain.

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CB CE CC

α β γ

Alpha Beta Gama. } current region.

$= \frac{IE}{IE}$ $\beta_{dc} = \frac{I_C}{I_B}$ $\gamma = \frac{I_E}{I_B} = [1+\beta_{dc}$

Unit II

N, Zener, LED, P.D Symbols.

tifier → HWR
→ FWR
→ Bridge.

er Supply

1) PNP/NPN → Equivalent
2) CB,/CE/CLC
3) Difference.
4) α, β, γ → relation
5) Region of operators.

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Unit II

PN, Zener, LED, P.D Symbols

Rectifier → HWR, FWR, Bridge.

Power Supply

1) PNP/NPN → Equivalent

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CB CE CC

α β γ

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$\alpha_{dc} = \frac{I_C}{I_E}$ $\beta_{dc} = \frac{I_C}{I_B}$ $\gamma = \frac{I_E}{I_B} = 1 + \beta_{dc}$

Unit II

PN, Zener, LED, P.D symbols

Rectifier → HWR, → Full wave, → Bridge

Power supply

1) ... NPN → Equation

2) CB / CE / CC

3) Difference

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CB CE CC

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Unit I

1) PN, Zener, LED, P.D Symbols.

2) Rectifier → HWR, FWR, Bridge.

Power Supply

Unit II

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Power Supply

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Current Amplification factor (γ)

$$\gamma = \frac{\Delta I_E}{\Delta I_B} = \frac{\text{output current}}{\text{Input current}}.$$

Relation between γ & α.

$$\alpha = \frac{\Delta I}{\Delta I_E} \quad \text{—(1)} \qquad \gamma = \frac{\Delta I_E}{I_B} \quad \text{—(2)}.$$

As we know $\Delta I_E = \Delta I_E + \Delta I_B$

$$\therefore \Delta I_B = \Delta I_E - \Delta I_C.$$

$$\gamma = \frac{\Delta I_E}{\Delta I_E - \Delta I_C}$$ {Put Value of ΔI_B in γ}

<u>Now</u>

~~N & B~~ ~~N & B~~ N & D of by ΔI_E

$$\gamma = \frac{\Delta I_E / \Delta I_E}{\Delta I_E / \Delta I_E - \Delta I_C / \Delta I_E}$$

$$\gamma = \frac{1}{1 - \alpha}$$

CB CE CC

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For Common emitter Configrations.

$\alpha = \frac{I_C}{I_E}$ { I_C = Collector - Current. I_E = Emitter - Current.

and $\beta = \frac{I_C}{I_B}$ { I_B = Base - Current.

Also relation b/w I_C, I_B & I_E is

$$I_E = I_B + I_C.$$

So

$$\alpha = \frac{I_C}{I_C + I_B}.$$

$$\frac{1}{\alpha} = 1 + \frac{I_B}{I_C}.$$

$$\frac{1}{\alpha} = 1 + \frac{I_B}{I_C}.$$

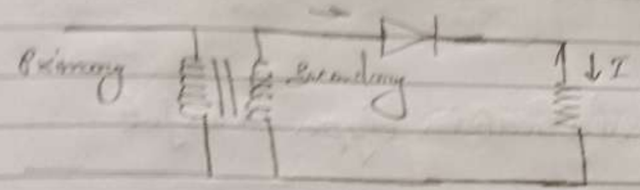
$$\boxed{\frac{1}{\alpha} = 1 + \frac{1}{\beta}}$$

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

{ $\beta = \frac{I_C}{I_B}$.

Q1] Which rectifier will conduct for half cycle? Draw the construction and explain it with waveforms.

→ 1] A half wave rectifier is a type of rectifier which converts the positive half cycle of the input signal pulsating DC output signal.



2] The AC source supplies alternating current to the circuit. The alternating current is often represented by a sinusoidal waveform.

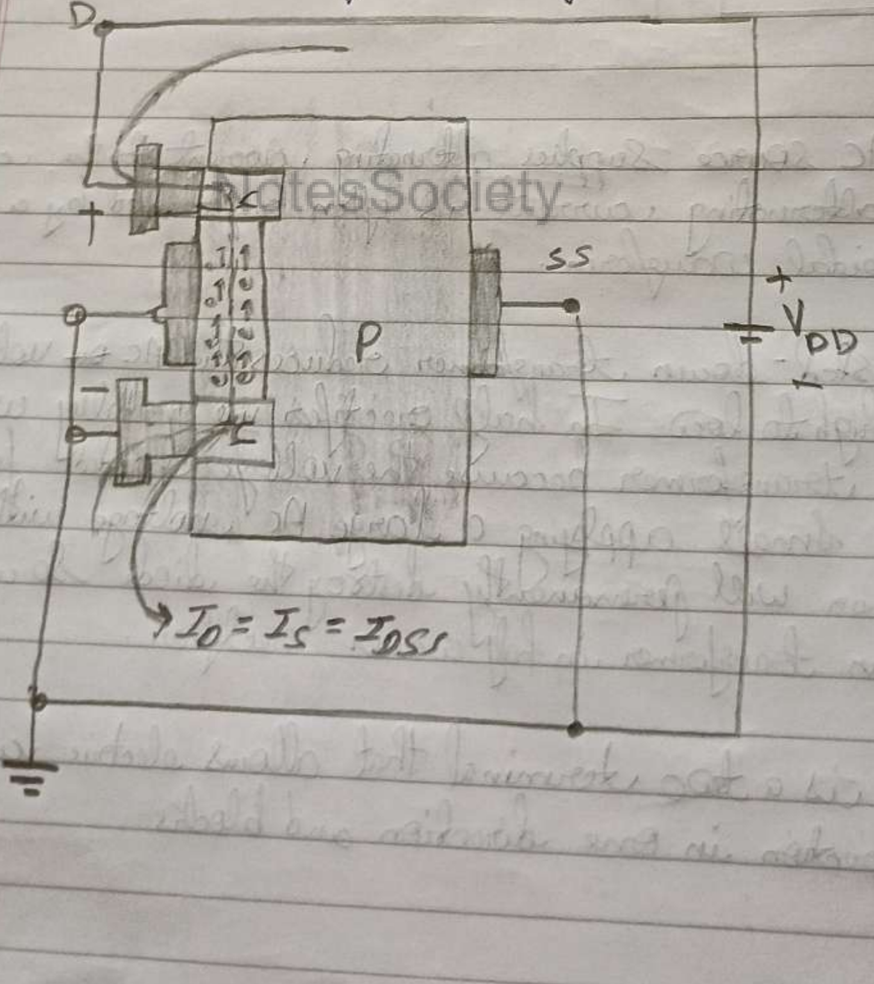
3] The step-down transformer reduces the AC ~~st~~ voltage from high to low. In half rectifier we generally use a step down transformer because the voltage needed for the diode is very small applying a large AC voltage without using transformer will permanently destroy the diode. So we use step-down transformer in half wave rectifier.

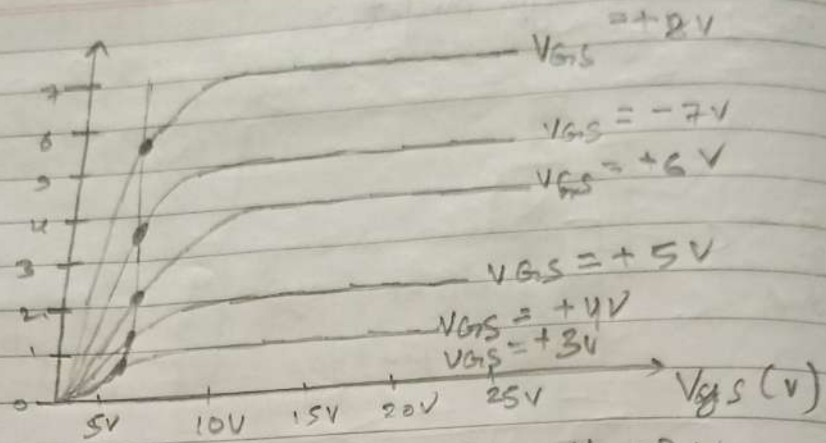
4] A diode is a two terminal that allows electric current in one direction in one direction and blocks

Classification of ~~fool~~ mosfet.

- Mosfet
  - Deplication
    - n-channels.
    - P-channel
  - Enhancement
    - P-channel.
    - n-channel

~~R~~ n-channel deplication type Mosfet

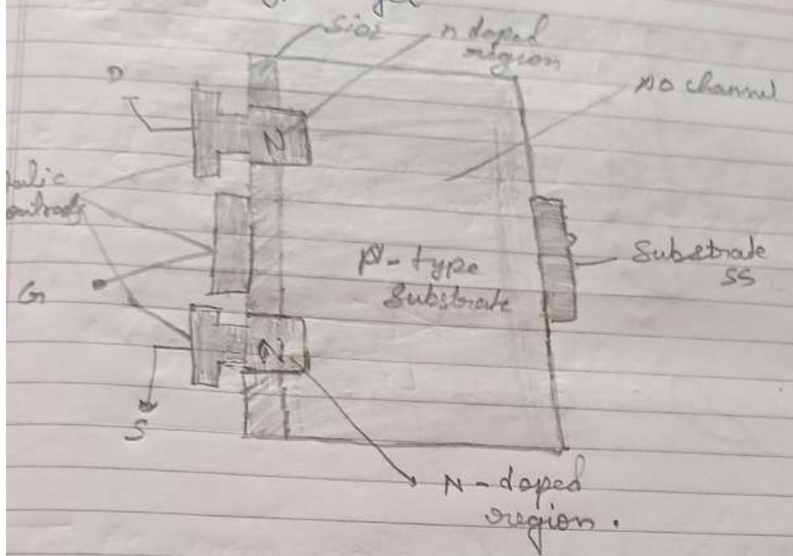




$V_{GS} = V_T = 2V$

Drain Characterstics.

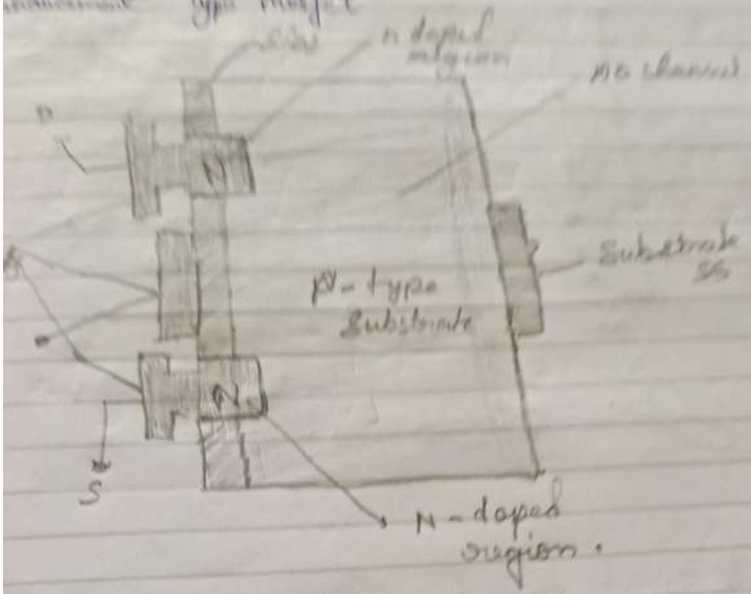
Enhancement Type mosfet.



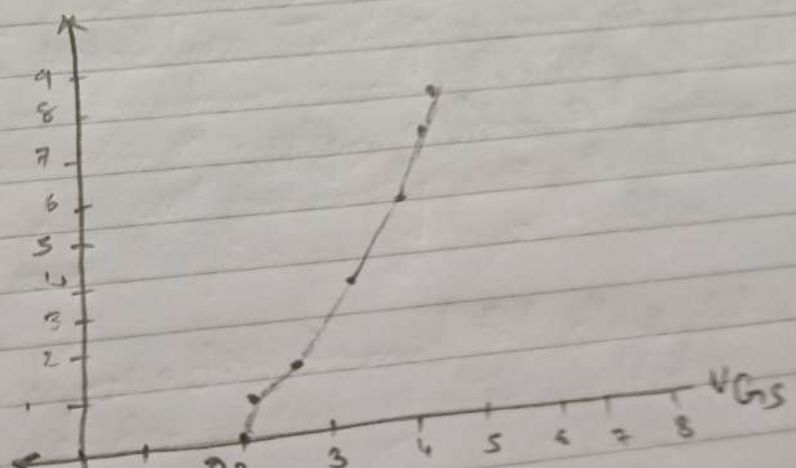
Transfor Characterstics.

Transfor Characterstic of an n-channel Enhancement mosfet.

Enhancement Type mosfet.



Transfer Characteristics.

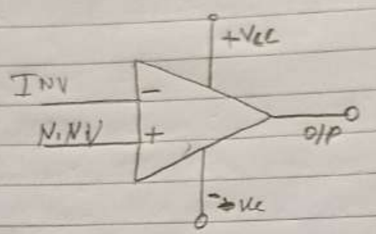


Transfer Characteristic of an n-Cha[nnel]
Enhancement mosfet.

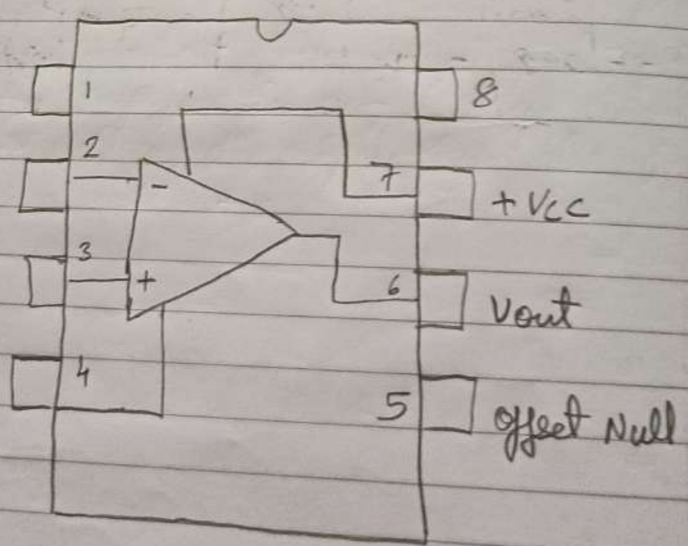
Operational Emplifier.

i] Operational Emplifier: Is a integrated icircuit which is used perform linear, non-linear mathemitical operator.

Constration of operational amplifier.

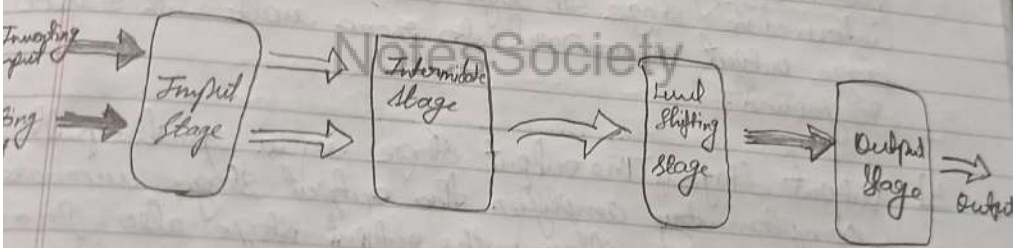


Structure of IC 741



1] Pin 1 : Offset Null.
2]
3)
4)
5)
6]
7)
8]

Block diagram of Operational A



input stage is the dual input
rential amplifier. This Stage
e voltage gain and introduces the
operational amplifier.

This stage is a dual input
unbalanced output differential
iven by the output of the first

: Since direct coupling is used
DC voltage the input of intermediate
round potential hence the
tor circuit is used after
shift the DC level at intermediate
rd to zero volts with respect

put Stage is a push-pull
ier the output stage increase
the output stage also provide
nce.

Ideal

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1] Inpu
2] Outpu
3] Open

4] If (
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5] (

Characteristic of an ideal op-amp -

1] Open loop again: Ideally op-amp should have an infinite open-loop again (practically it is hundreds of thousand of times larger than the potential difference between its input terminals].

2] Input impendence or resistance: Ideally op-amp should have infinite input resistance (practically it should be very high

3] Output: Output Impedence or resistance. Ideally op-amp should have zero output resistance (practically it should be very low].

4] Brandwidth: Ideally op-amp should have infinite bandwidth (practically it is limited].

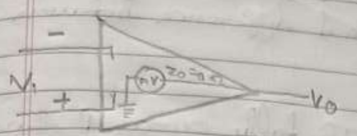
5] CMRR: Ideally op-amp should have infinite CMRR, common mode Rejection ration on the common noise voltage in the output becomes zero.

6] Slew rate: Ideally op-amp should have infinite SR, slew rate so that any change in the point voltage simultanously change the output voltage.

Explain inverting amplifier and Enlist characteristics of an ideal op-amp.

Ideal Op Amp.

1] An ideal op-amp exhibits the following characteristics



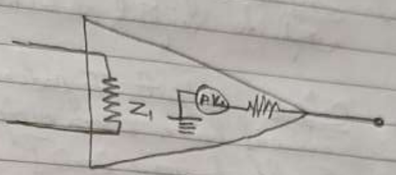
1] Input impedence $= Z_i = \infty\ \Omega$
2] Output Impedence $Z_O = 0\ \Omega$
3] Open loop voltage gain $A_V = \infty$
4] If (The differential) input voltage $V_i = 0V$ then the output voltage will be $V_O = 0V$.

5] Bandwidth is infinity it means an ideal op-amp will amplify the signals of any frequency and attenution

6] Common mode Rection [CMRR] is infinity

Practical Op-Amp.

Practically op-amp are not ideal and deviate from their ideal characteristics because of some imperfections during manufacturing the equivalent circuit of the practical op-amp is shown in the following figure.



A practical op-amp exhibits following characteristics:

Input impedence, Z_i in the order of mega ohms;

Out

1] Input Stage :- The input stage is the dual input balanced output differential amplifier. This stage provides most of the voltage gain and introduces the input resistance of operational amplifier.

2] Intermediate Stage: This stage is a dual input unbalanced output differential amplifier which is driven by the output of the first stage

3] Level Shifting Stage: Since direct coupling is used therefore the DC voltage the input of intermediate stage is above the ground potential hence the level shifting transistor circuit is used after intermediate stage to shift the DC level at intermediate stage output downward to zero volts with respect to ground.

4] Output Stage: The output stage is a push-pull complementary amplifier the output stage increase the output voltage the output stage also provide low output resistance.

Ideal op

$= V_1 = V_i$

$\Rightarrow V_o / V_i = R_1 + R_f / R_1$

$\Rightarrow V_o / V_i = 1 + R_f / R_1$

Non-Inverting amplifier

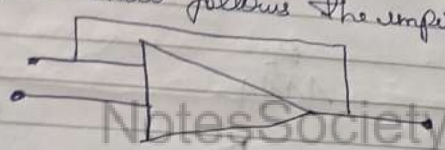
$1 + R_f / R_1 = V_o / V_i$.

Voltage Follower

→ ~~A voltage follower is an electronic~~

→ Explain unity gain amplifier. ($A_V = 1$

→ A voltage follower is an electronic circuit which produces an output that follows the input voltage.



$V_o = V_i$

Application - Operational Amplifiers

1] Inverting and non-inverting adder.
2] Substractor
3] Integrator
4] Differentiator
5] Logarithmic amplifier etc.

Nodal Equation at this terminal's node is as show below.

i) $(0 - V_i)/R_1 + (0 - V_0)/R_f = 0$

$\Rightarrow -V_i/R_1 = V_0/R_f$

$\Rightarrow V_0 = (-R_f/R_1)V_i$

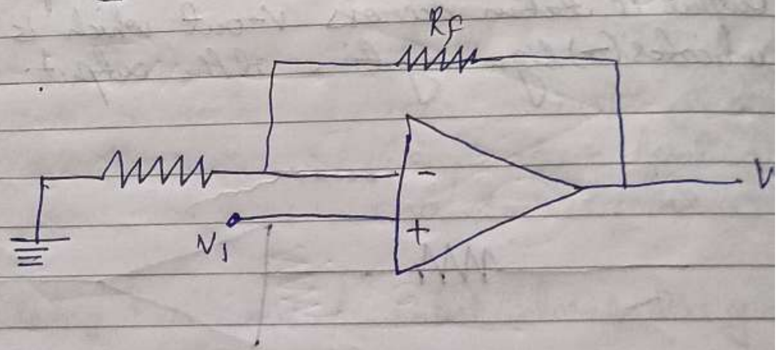
$\Rightarrow V_0/V_i = -R_f/R_1$.

Q. Explain amplifier which have gain $A_V = \frac{-R_F}{R_1}$

→ The gain of inverting amplifier is Equal to $\frac{-R_f}{R_1}$

Non - Inverting Amplifier.

1] A non-inverting



$\Rightarrow V_1 = V_0 [R_1 / R_1 + R_f]$

Basic Application of operation amplifier

1] Inverting amplifier
2] Non-inverting amplifier
3] Voltage follower

Inverting Amplifier

1] An inverting amplifier takes the input through its inverting through a resistor R_1 and produces its amplified version as the output. This amplifier not only amplifiers the input but also inverts it [changes its sign]

~~The i~~

1] When input is applied to the inverting terminal

2] Non Inverting terminal is grounded
3] Feedback resistor is applied between input and output termi
output is taken across V-out which is inverted output
indicates (-) sign negative at the output.