EEE-211 (MSR) 16-09-2013 (E day) (1st)

Lecture - 1

Electronic circuit - I

What is electronics? what does it do?

Ans: Electronic circuit deals electronic devices.

& Electronic circuit deals with semiconductor devices.

→ It is the branch of Engineering that model the flow of electron.

→ It is simply modeling the flow of electron and create conductivity in semiconductor devicies in order to process singnal.

→ The main object of electronics is to process gin signal.

→ Converter → from AC singnal to D.C signal → Ex- charger.

→ Inverter → From D.C signal to AC. signal.

→ Filtering → Signal processing job

→ Filtering conversing signals.

How to process signals?

Signal → A physical variables as a function of time.

Any physical variable when converted to time domain function is known as signal.

Signal → (i) Temperature signal
(ii) Pressure signal → cause → air flow
(iii) Voice signal

Electronic circuit process electrical signal.

Transducer → Electronic device

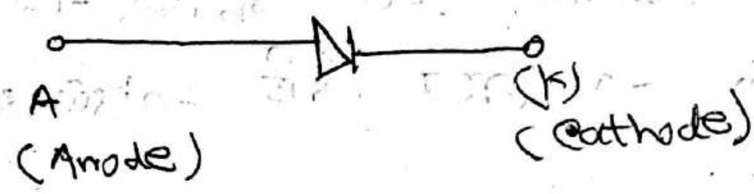
Transducer → Voice signal কে electrical singnal -এ পরিণত করে,

→ Non-electrical signal কে electrical signal কে পরিণত করতে যেই যন্ত্রকে Transducer বলে।

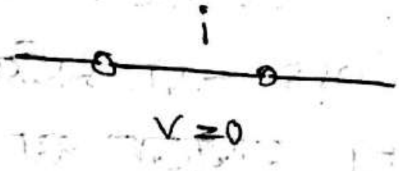
Micro phase → voice signal-কে electrical signal-এ convert করে,

* Physical signal → Transducer → Electrical signal.

P.N junction diode



When switch is on then we can assume it is a Ideal diode.



↳ It behaves as a short circuit.

When switch is off mode, তখন i=0 But voltage থাকে,

So, it is open circuit.

* Ideal diode এবং switch same জিনিস,

Semi-conductor → Si, Ga, In, Ge

↳ Valance electron → 4 or 5
* perfect

→ Valance Electron 8 হলে Insulator.

→ Valance Electron → 1 হলে perfect conductor

Plenty of Semiconductor → Si, Ge.

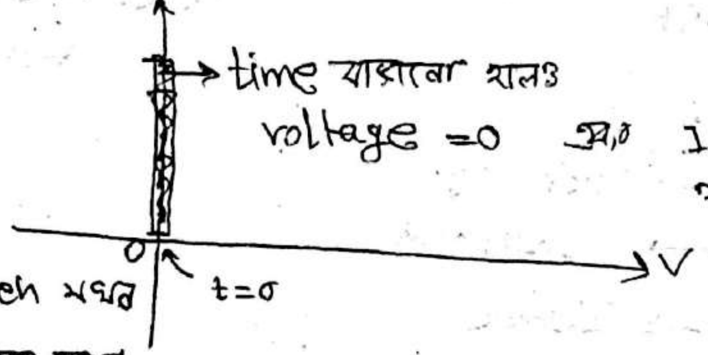
(iii) F.E.T → Field Effect Transistor

- J.F.E.T → Junction Field Effect Transistor
- Mos F.E.T → Metal Oxide Semiconductor Field Effect Transistor
  - C.MOS.F.E.T (Complementary)
  - V.MOS.F.E.T (vertical)

Diode: It is used as electronic switch.
Rectifiar (একমুখীকারক) হিসাবে use করা হয়।

** Diode is a switching device.

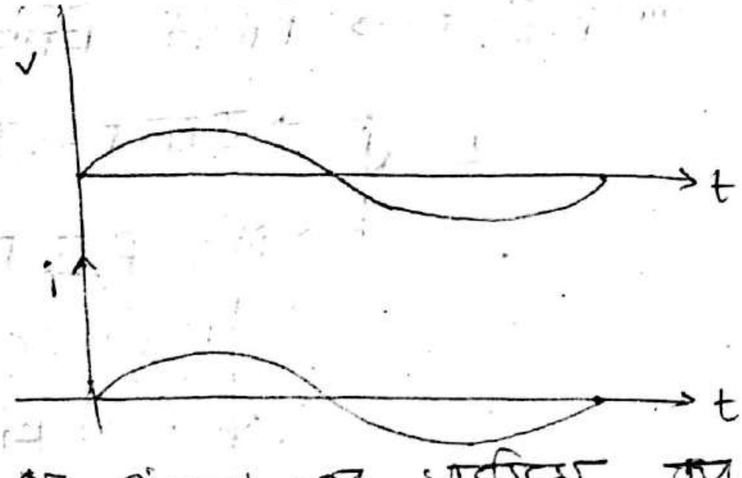
→ It is a P.N junction.



time বাড়ানোর পরেও voltage = 0 হয়, I এর কোনো মান থাকবে.

Switch যখন off থাকে তখন voltage

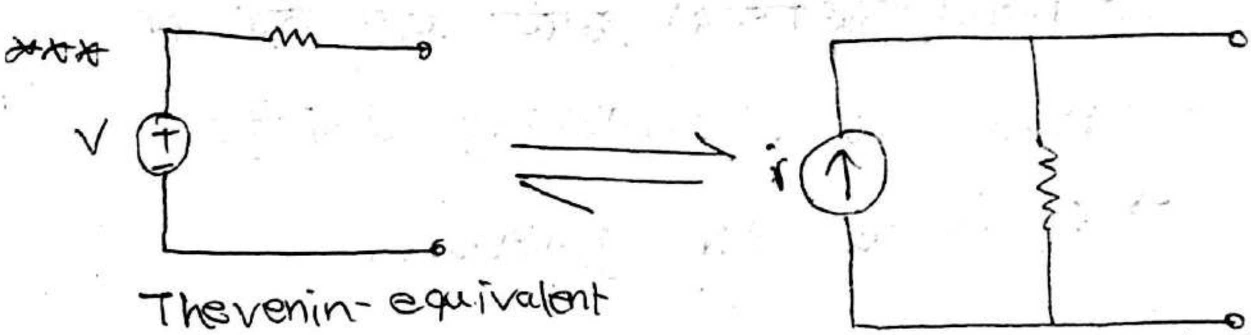
switch



Signal

Deterministic signal: যে Signal-এর মাধ্যমে তার পরের wave-টা কেমন ~~হবে~~ হবে তা জানা যায় তাকে Determinestic signal বলে।

Non-determinestic signal: → পরের wave টা কেমন হবে তা যদি না জানা যায় তবে সেটি non-determinestic signal.



Thevenin-equivalent circuit

Norton-equivalent circuit.

\# Electronic decives:

(i) Diode → Ordinary, Schottary, Zener
Two-terminal device

(ii) Transistor → (B.J.T) → Bipol Junction Transistor

Intrinsic Semiconductor: It is pure semiconductor. Nature থেকে Si, Ge -কে Original form -এ পেলে তাকে Intrinsic Semiconductor.

Extrinsic Semiconductor:

Intrinsic (pure) + ভেজাল (vagul) → Extrinsic Semiconductor

It is called dopping process -যার সাহায্যে Semi-conductor -এর conductivity বাড়ানো হয়।

17-04-2013 (A day → 2nd) $\boxed{\text{Lecture - 2}}$

Extrinsic Semiconductor 2 types

(i) P type	(ii) N type
Intrinsic + Trivalent atom	Intrinsic + pentavalent atom
Si/Ge + Al → ফাঁকা space তৈরি করে / hole তৈরি করে	Si/Ge + As free electron -তৈরি করে.
Minority carries → electrons	Majority carries electrons
majority carries → holes.	Minority carries holes.
Accepter atom Al → accepter (hole)	Donar atom As → donar.

→ Semiconductor -এর conduction -এ electron and hole current পাওয়া যায়।

→ Conductor -এর conduction -এ ~~onlp~~ only electron current পাওয়া যায়।

→ Deplition region → Insulator

→ Barriar potential → or junction or thresold potential.

→ Reverse Bias → source (−) এর সাথে P
source (+) এর সাথে N
থাকলে deplition region
বেড়ে যাবে → current flow নাই।

→ forward bias → (−) এর সাথে N and
(+) এর সাথে P থাকলে
deplition region কমে যাবে.
current flow হবে।

$\left.\begin{array}{l} \rightarrow Si \rightarrow 1.1\,V \\ Ge \rightarrow 0.75V \end{array}\right\}$ for Semiconductor.

→ Transition process → electron যখন valance থেকে conduction band -এ যায় → exiciting process

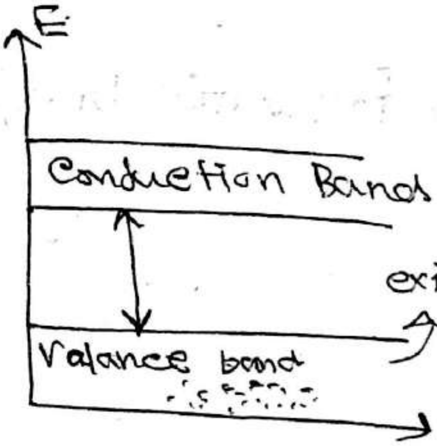
→ Recombination → Electron হলো conduction band থেকে valance Band নিচে আসা।

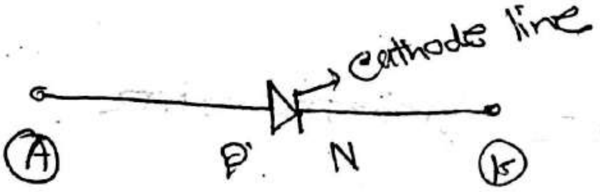
→ P.N junction Diode 3 types ~~of~~ of bias.

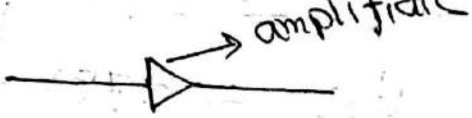
(i) No bias → কোন current নাই।

(ii) Reverse bias → Reverse saturation current(I_s) Idealy কোন current নাই।

(iii) Forward bias → forward current majority and minority current both আসে।







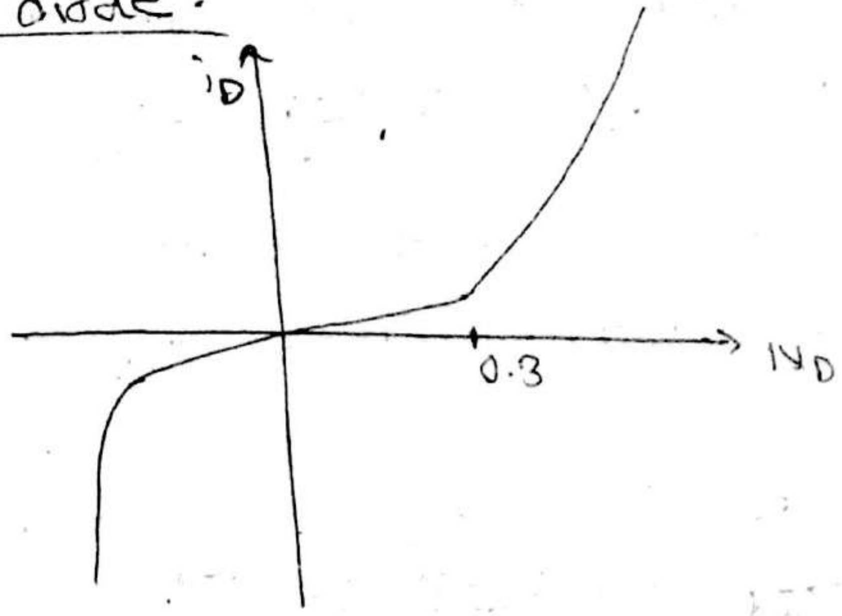
ON হওয়ার condition → $V_A > V_K$ [Because forward bias]

Off " " → $V_A < V_K$

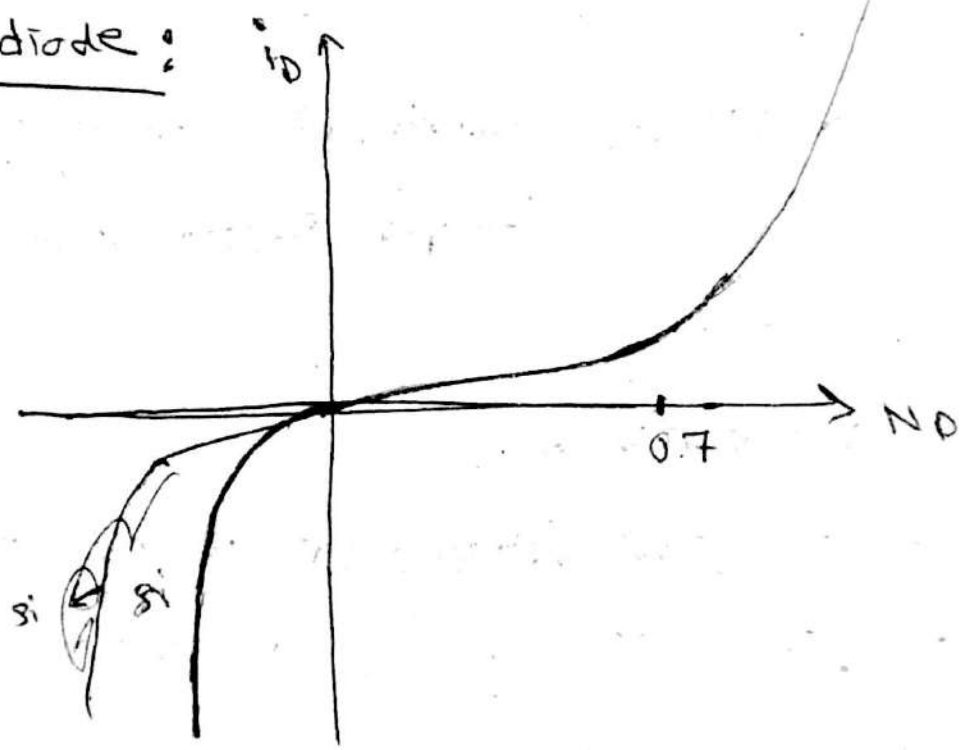
$V_A = V_K$ এ হলে No bias.

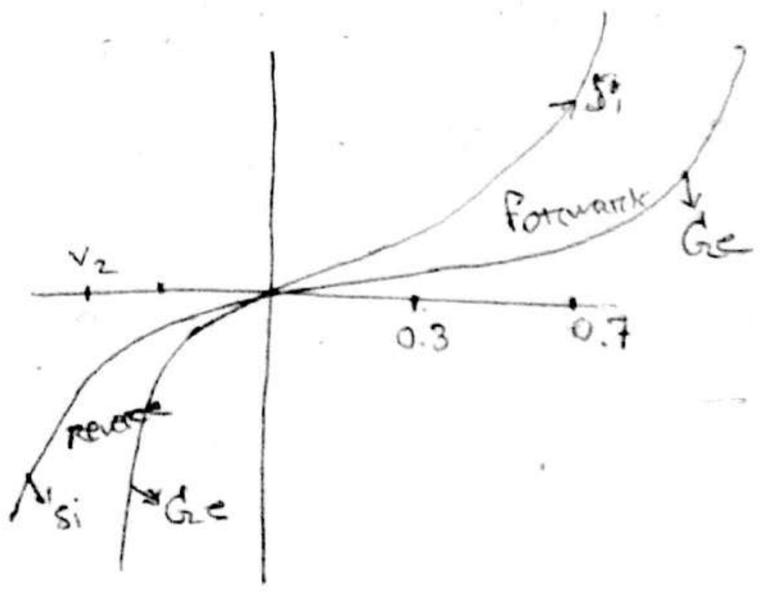
Scanned by CamScanner

Ge - diode:



Si - diode:





⟹ Diode equation:

$V_T \to$ thermal voltage.

$I_D = I_S \cancel{\left(e^{\frac{KV_D}{T_K}} - 1\right)}$ $\quad I_D = I_s\left(e^{\frac{V_D}{nV_T}} - 1\right)$

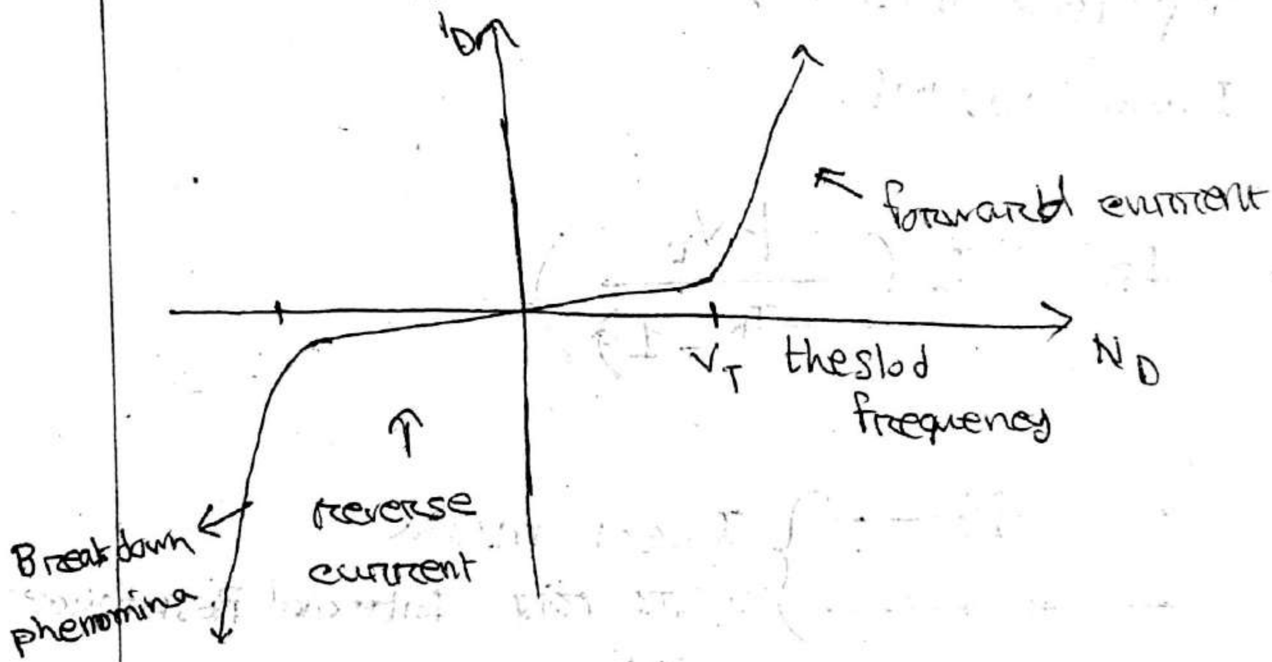
$I_D \to$ Diode current

$I_S \to$ reverse bias saturation current

$K \to$ Boltsman constant

$V_D \to$ Diode -এর accross -এর voltage.

$T_K \to$ kelvin temperature.



Zener ~~vo~~ region

Diode -এর Linear characteristic

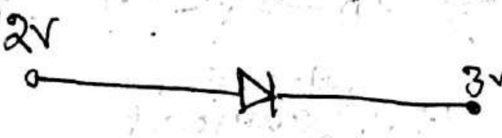
→ practical characteristic.

Ge diode এর ~~kne~~ $V_T = 0.3$

and Si " " $V_T = 0.7$

→ knee potential

3>2, current flow করবে,



2<3, current flow করবে না।

Diode models:

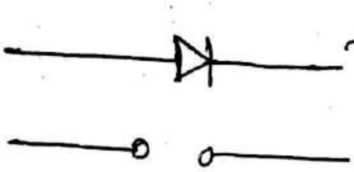
(1) Linear model

(2) Simplified model

(3) Ideal model.

$$\rightarrow \quad I_D = I_s \left(e^{\frac{kV_D}{T_K}} - 1 \right)$$

(3)

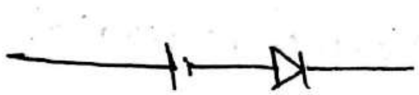


Ideal model

(i) যার কোন Internal Resistance নাই

(ii) Barriar potential নাই।

(1)

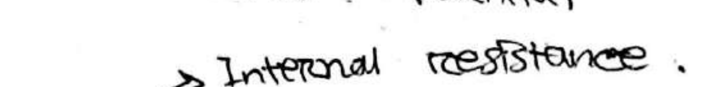


→ Simplified model.

→ barriar potential

(2)

→ Internal resistance.



→ Practical diode

Why we
~~কেন আমরা~~ prefer to Si-diode in comparison to Ge-diode. → (CT and final)

→ কারণ Si-diode -এর reverse current কম এবং reverse voltage বেশি হয়.

→ $R_T = R_0(1 - \alpha t)$

Heat বাড়ালে conductivity বাড়ে।

Books: → Micro electronic circuit

→ By Sedra and smith

Linear মানে হলো →

input-এ যেই রকম voltage বা current দিব output-এ সেই রকম voltage বা current পাব.

যেমন: যদি $v = V_m \sin\omega t$ voltage supply দেয়া হয় তবে output এর voltage

Non-linear-এ input ও ~~এবং~~ output আলাদা হবে।

EEE-211 (SMB) 29-04-2013 (E day)(2nd) Lecture - 3

Power Supply Unit (PSU)

power converter → convert AC into DC
convert

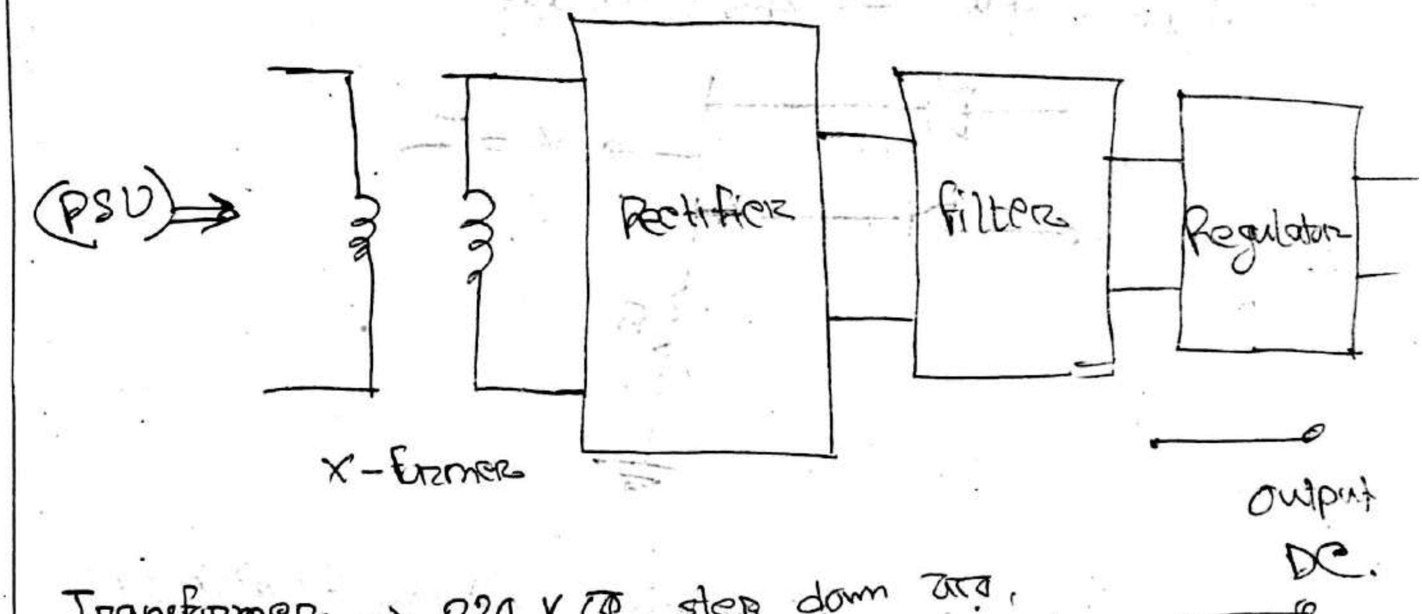
IPS → Instant power supply

converter ⟷ Inverter.

Battery → capacitive field

Acid water plate.

Types of Dry cell.



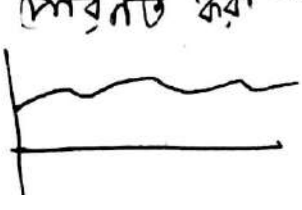
Transformer → 220 V কে step down করে।

Rectifier → Unit b direction করে।

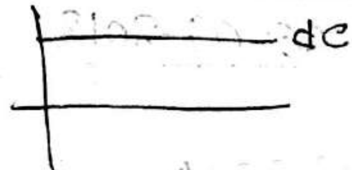
Filter → Filter circuit-এর

পরিণত করা

ripple (ঢেউ)

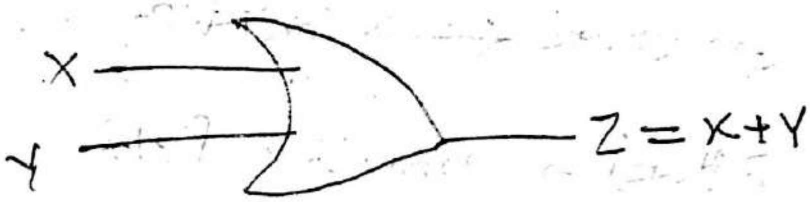


220V থেকে কত volt-এ step down transformer বাজারে পাওয়া যায়।

Regulator ⟶ 

⟶ Output-এ constant voltage দিবে।

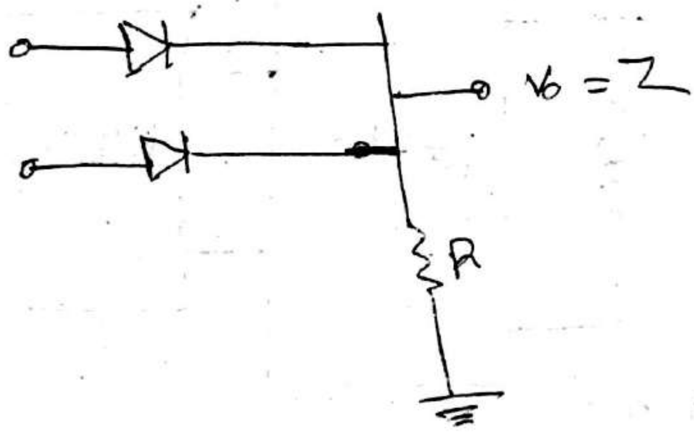
PSU – তৈরি করা ⟶ Assignment.



OR - Gate

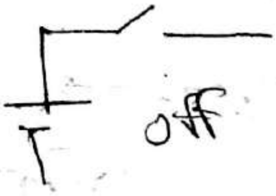
যে কোন ~~output~~ Input High হলে output High হবে।

High input → (+ive voltage

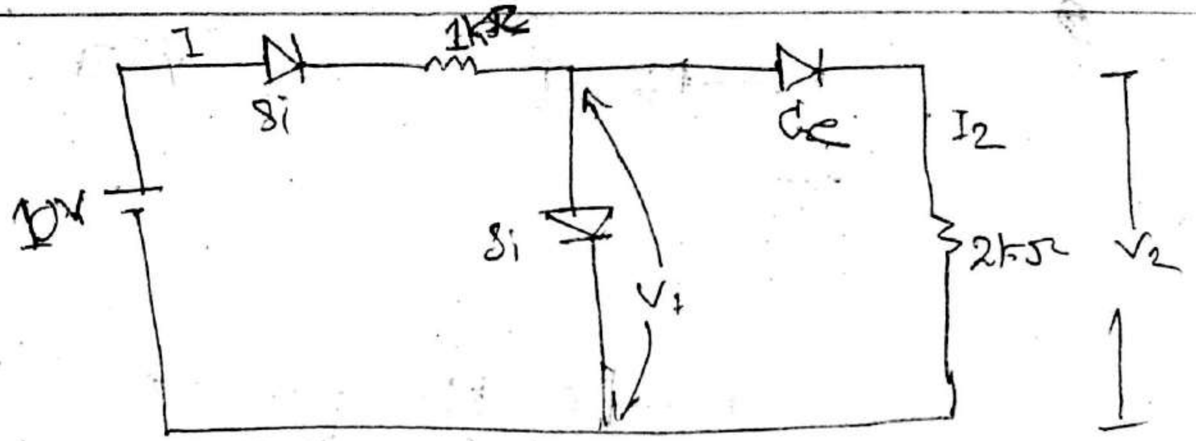


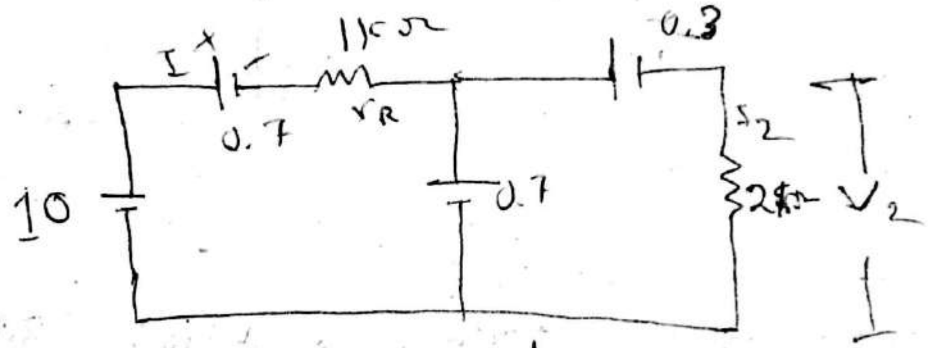
Logic ⟶ 1 ⟶ positive voltage (switch on)

0 ⟶ switch off (open



parallel - circuit-এ voltage same হয়।





$-10 + 0.7 + V_R + 0.7 = 0$

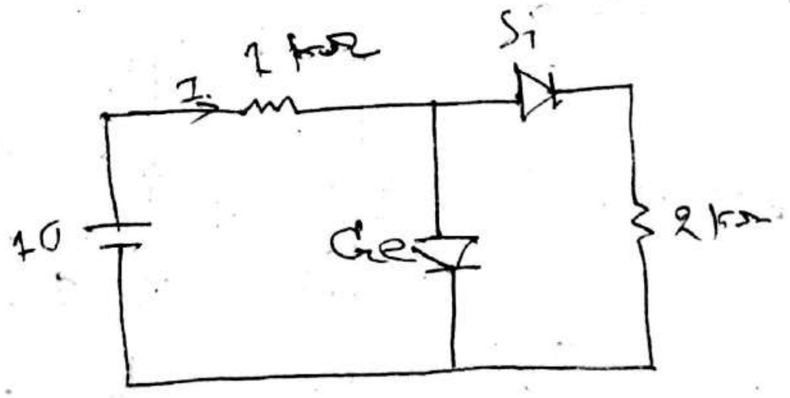
$V_R = 9.3 - 0.7 = 8.6$

$I_1 = \frac{V_R}{1k} = 8.6 mA.$

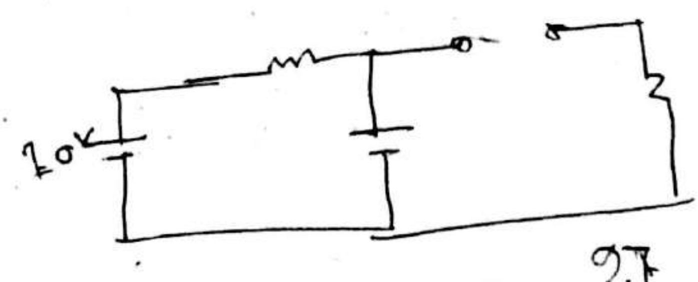
$-0.7 + 0.3 + V_2 = 0$

$\Rightarrow V_2 = 0.4 V$

$\Rightarrow I_2 = \frac{0.4V}{2k\Omega} = 0.2 mA$



Si–Ge parallel হলে Ge on হবে Ge threshold potential কম.

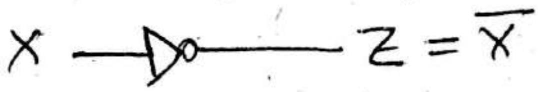


$V = (10 - 0.3) = 9.7 V.$

$I = \frac{9.7}{1k\Omega}$

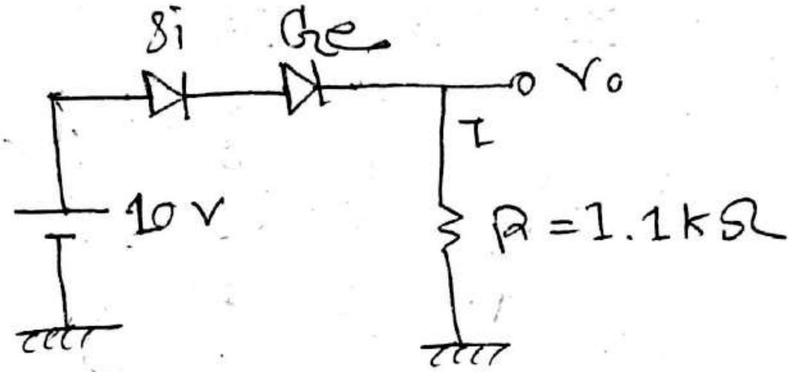
Not - Gate: single input & single output.

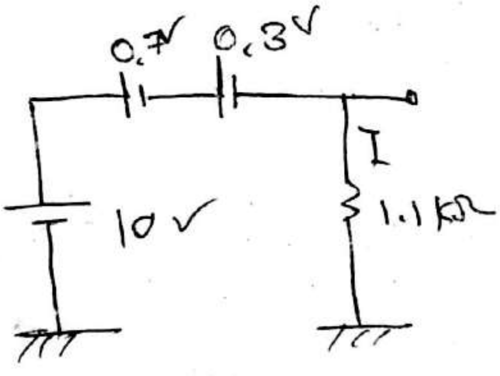
Input high & output low and vice-versa



X	Z
0	1
1	0

Home work
Not - Gate design করতে হবে





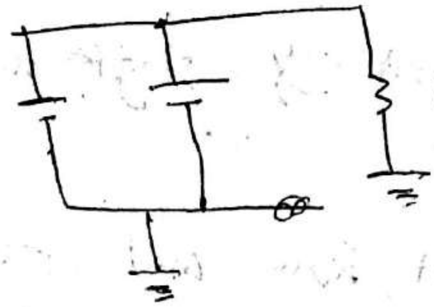
Diode Ideal হলে V_o = 10 V ~~হলে~~ হবে।

$$-10 + 0.3 + 0.7 + V_o = 0$$

$$\Rightarrow V_o = 9 \text{ V}$$

$V_o = 9$ V.

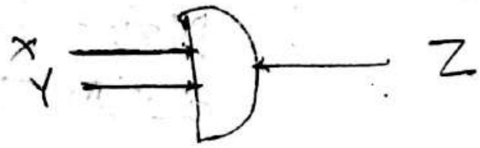
$$I = \frac{V}{R} = \frac{9\text{ V}}{1.1\text{ k}\Omega} = 8.182 \text{ mA}.$$



OR Gate

x	Y	Z
0	0	0
1	0	1
0	1	1
1	1	1

And Gate

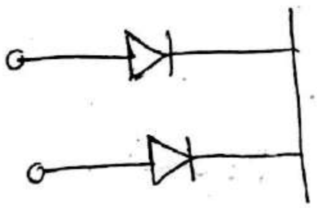


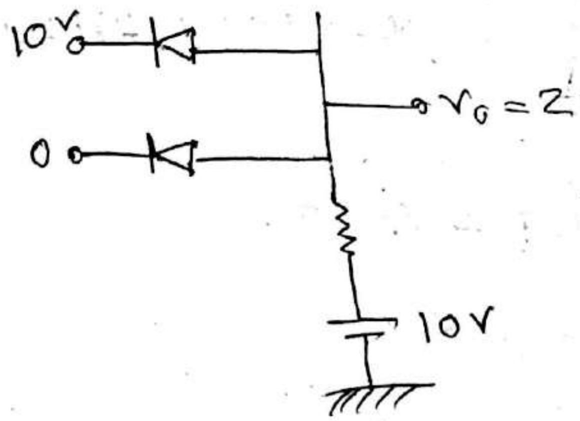
$\boxed{Z = x * y}$

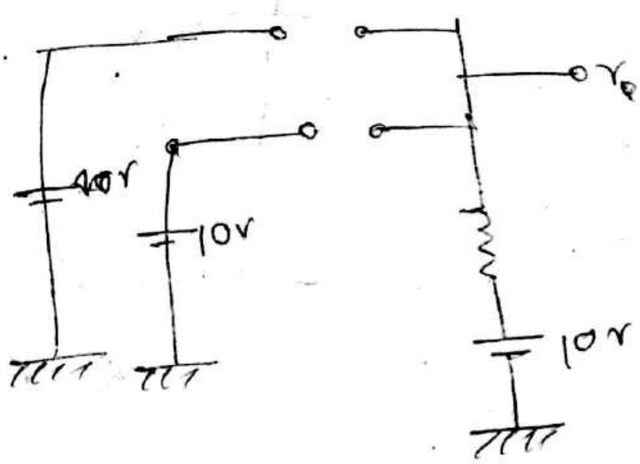
0+0=0
1+1=1
0+1=1
1+0=1

x	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

And Gate

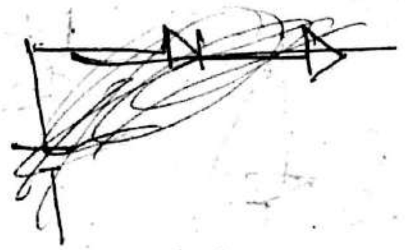


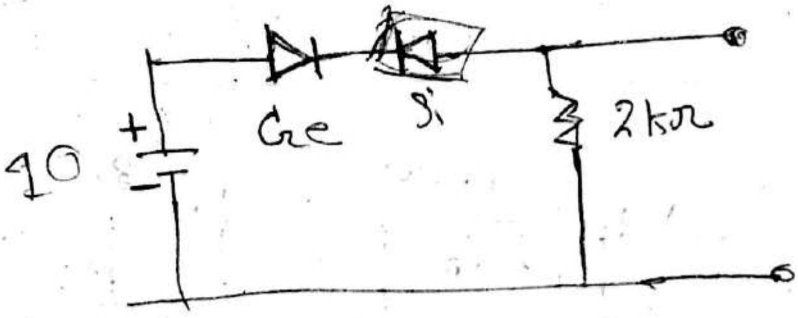




$I = \frac{V}{R} = IR$

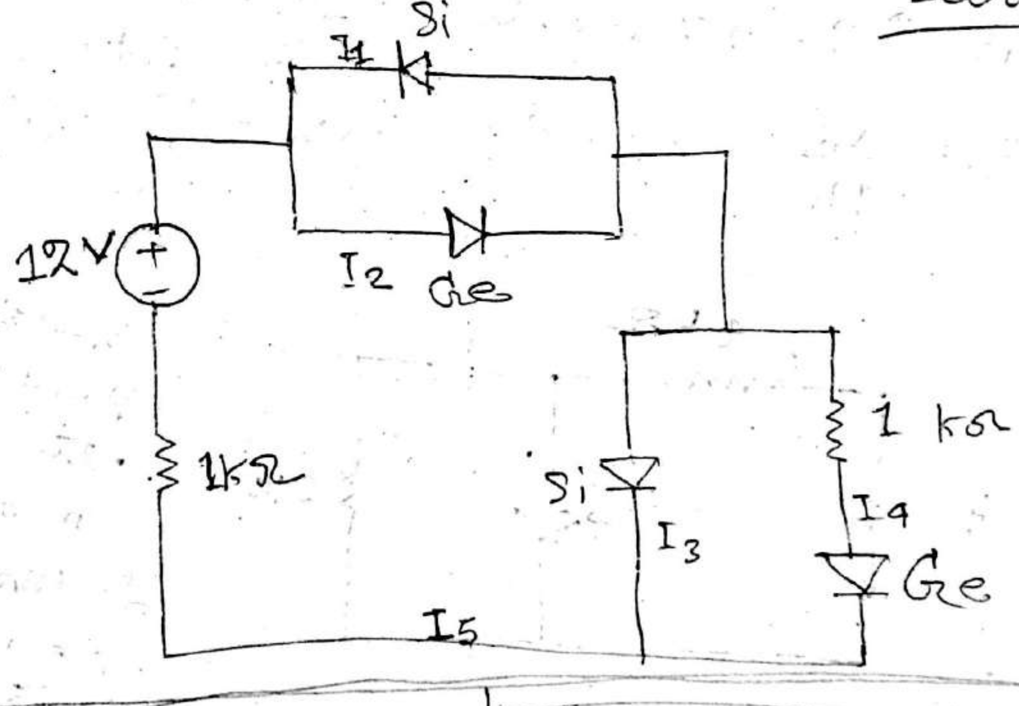
$V = IR$





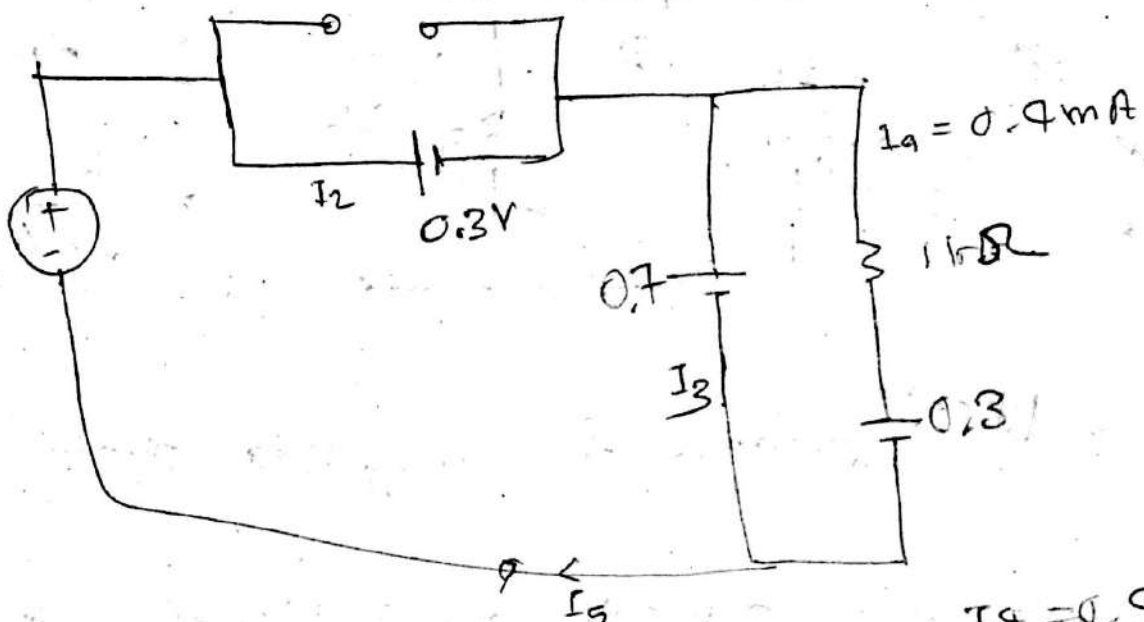
EEE-211 (SMR) (3rd cycle A day) 30-09-2013

Lecture-5



$-0.7 + V_0 + 10 = 0$

$\Rightarrow V_0 = 9.3$



$$I_5 = \frac{12 - 0.3 - 0.7}{1\,k\Omega}$$

$$= 11\,mA$$

$I_4 = 0.9\,mA$

$I_3 = 11 - 0.9\,mA$

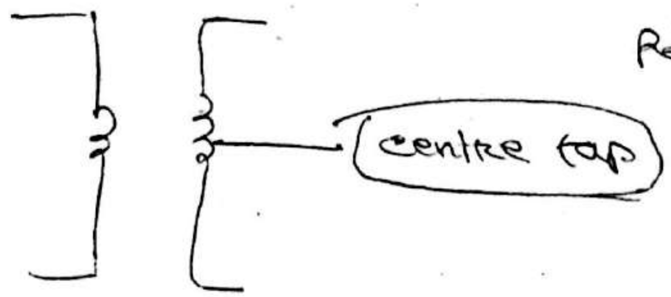
$= 10.6\,mA$

~~$I_2 = 10.6\,mA$~~

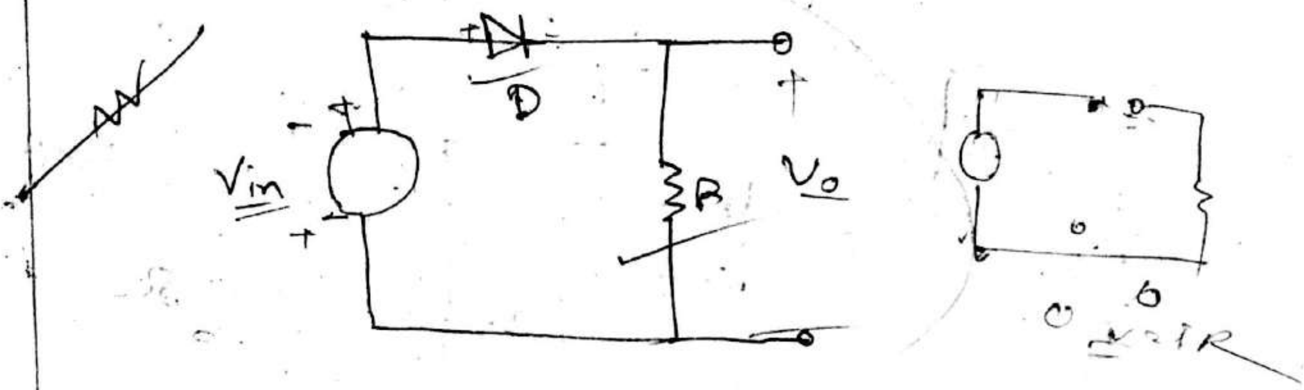
$I_2 = 11\,mA$

Rectification:

Rectifier
- HWR
- FWR
  - Bridge Rectifier.
  - centre tap transformer Rectifier



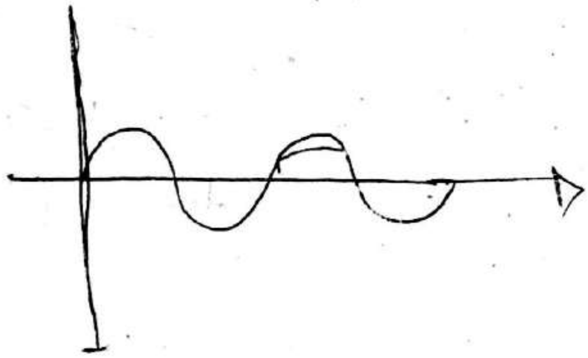
$\boxed{V_1 = V_m \sin \omega t}$



Rectification

process of ~~re~~negetive cycle.

Alternating current → unit direction current.

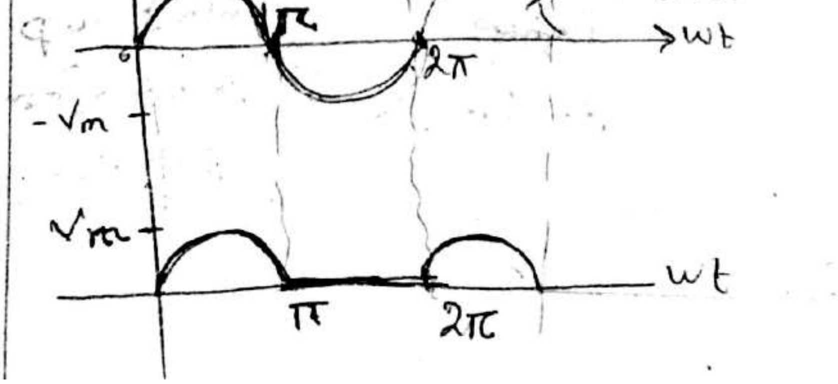


[Half wave rectifier - এর জন্য 1 টি Diode

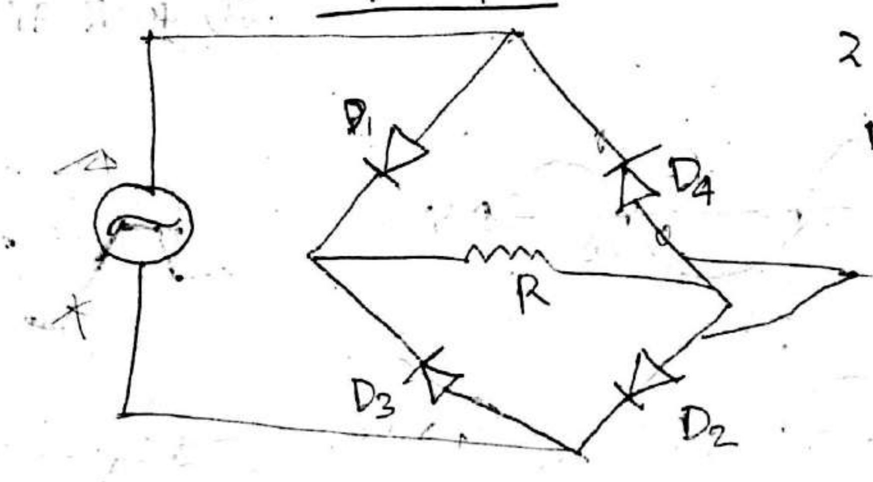
ও একটি resistor থাকবে. and

series - এর connect করতে হবে.]

AC → DC (Rectification)



FWR

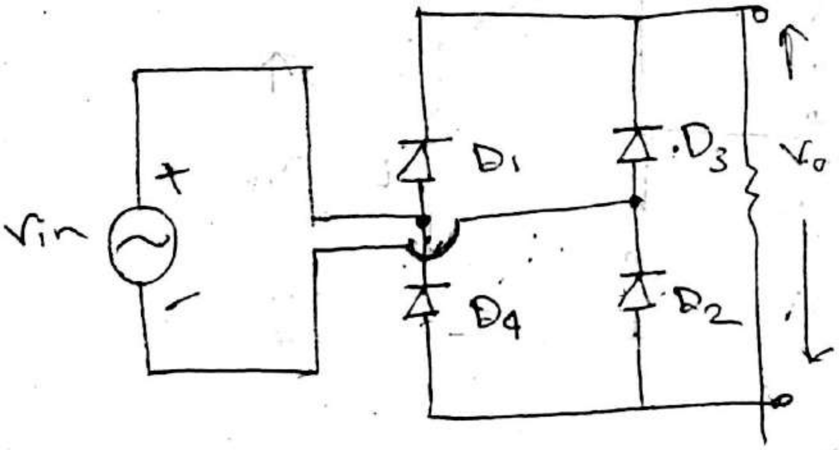


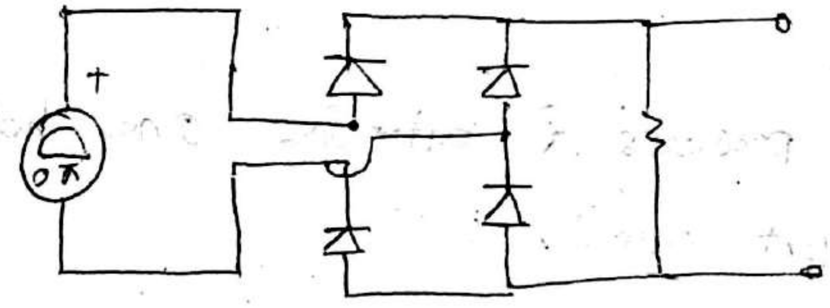
২ টা ~~বিপরিত~~ বিপরিত Diode একই দিকে

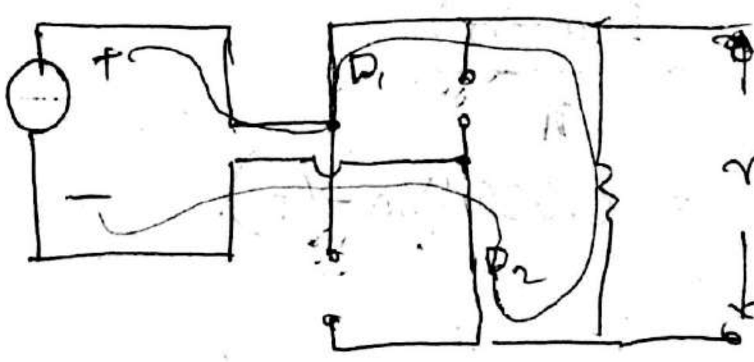
anode একই প্রান্তে
cathode একই প্রান্তে

(3rd cycle C Day) 05-05-2013
Lecture-6

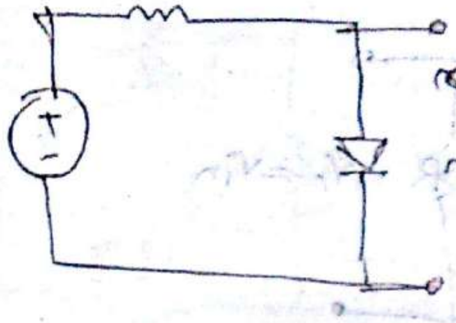
full wave rectifier:

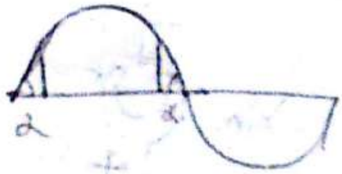


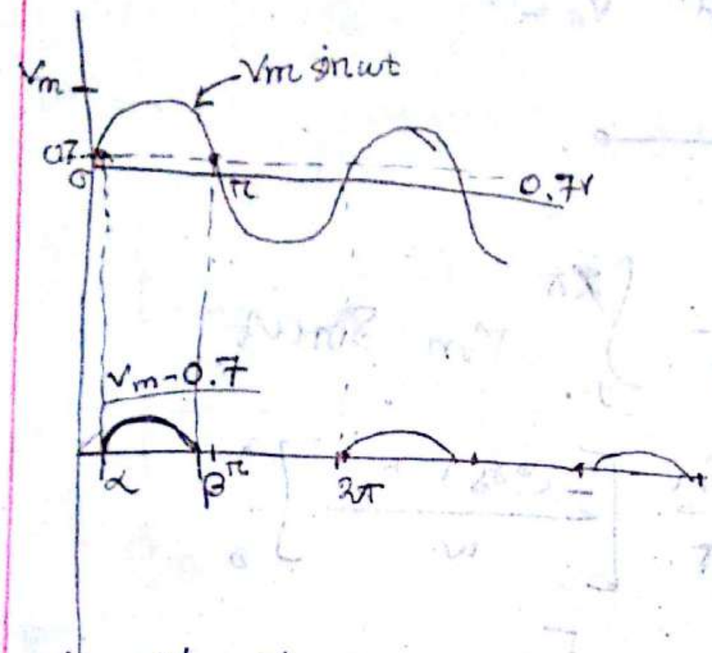


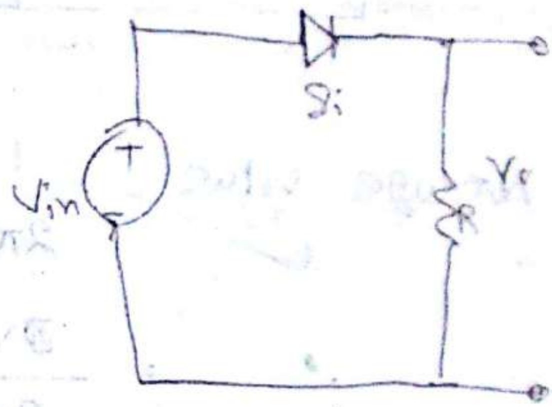


$v_o = V_{in}$









$V_{dc} = V_m - V_T$

$\beta = \pi - \alpha$

$\alpha = \sin^{-1}\left(\frac{V_T}{V_m}\right)$

$V_{in} = V_m \sin\omega t$

$\Rightarrow V_T = V_m \sin\alpha$

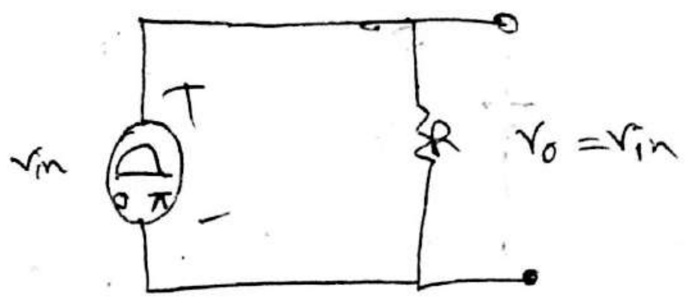
$\Rightarrow \alpha = \sin^{-1}\left(\frac{V_T}{V_m}\right)$

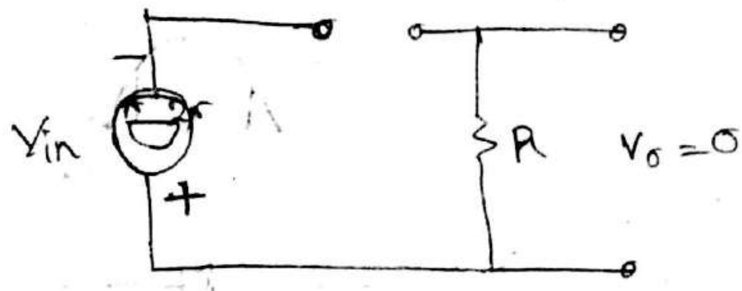
$\because V_{in} = V_m \sin\omega t$

$\Rightarrow V_T = V_m \sin\alpha$

$\Rightarrow \alpha = \sin^{-1}\left(\frac{V_T}{V_m}\right)$

$[\alpha = \omega t]$



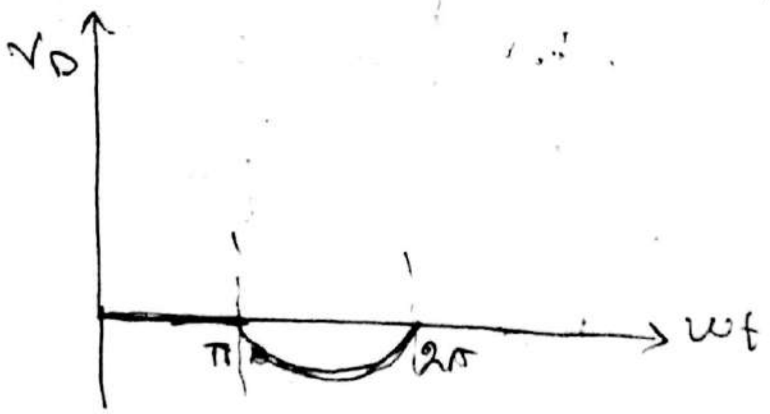


$$\text{Average value} = \frac{1}{2\pi}\int_0^{\pi} V_m \sin\omega t$$

$$= \frac{V_m}{2\pi}\left[\frac{-\cos\omega t}{\omega}\right]_0^{\pi}$$

$$\Rightarrow \frac{V_m}{2\pi}\left[+1+1\right]$$

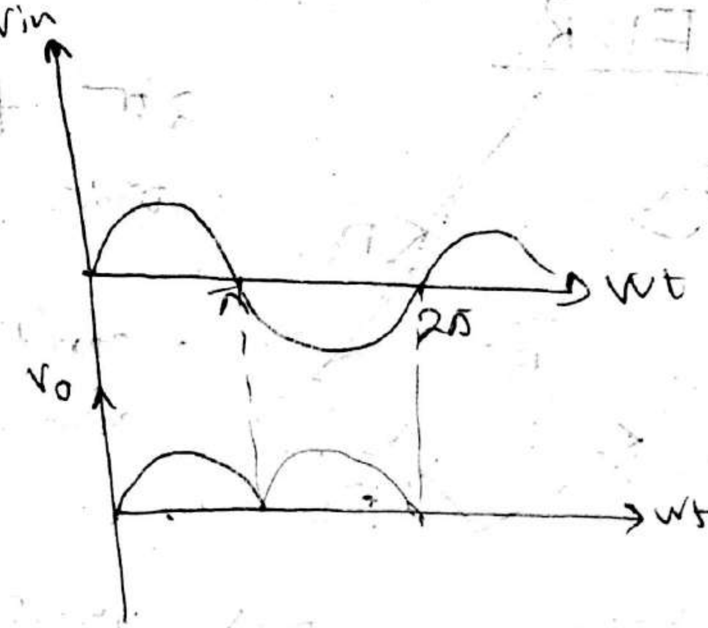
$$= \frac{V_m}{\pi} = 0.318\, V_m$$

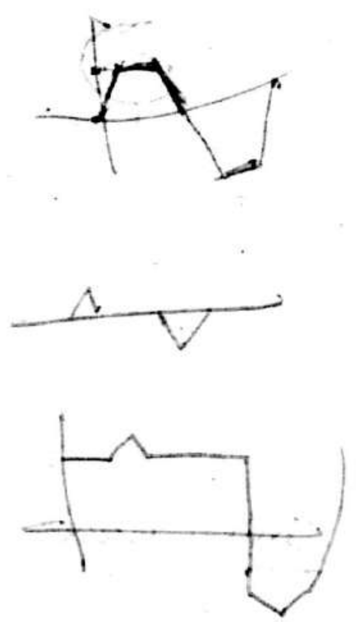


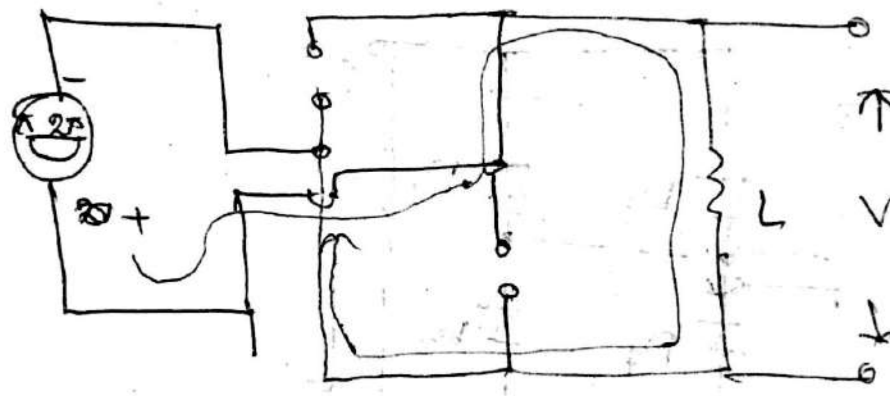
Supply voltage $\rightarrow V_i = V_o + V_D$

π

π ~~π π π~~







$V_0 = V_{in}$

This the process of altering one half of the input signal.

$$V_{dc} = \frac{2V_m}{\pi} = \frac{2(V_m - V_T)}{\pi}$$

$$= 0.636\,(V_m - V_T)$$

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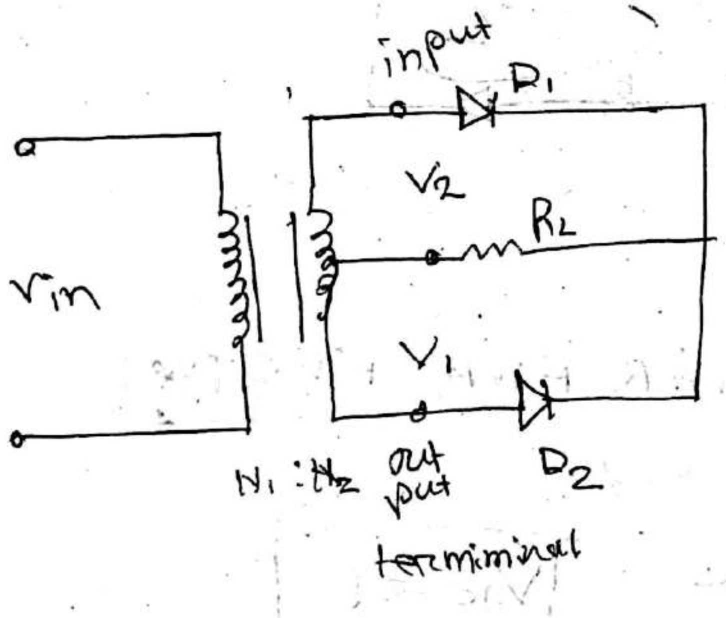
PIV → P Inverse voltage

PRV → " Reverse " → Reverse ~~ft~~ bias অবস্থায় ~~diode~~ -এর - এর across - এ যে ~~maxim~~ maximum voltage

Half wave: PIV $\geq V_m$

Full wave: PIV $\geq V_m$

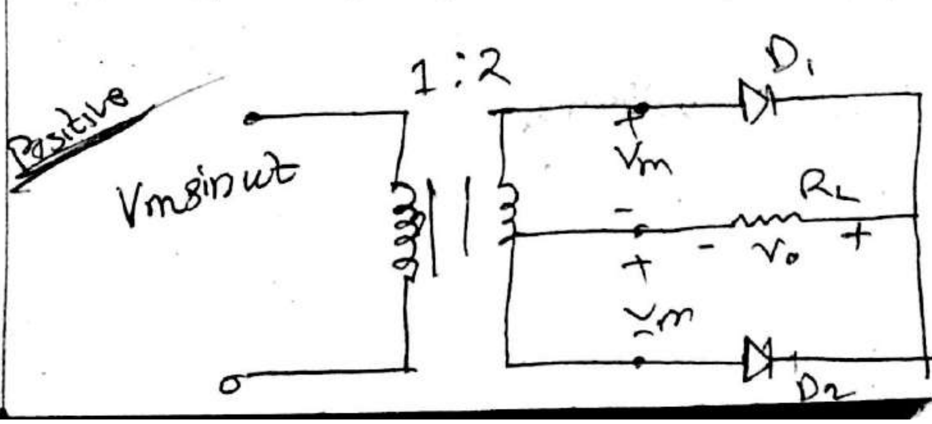
FWCTR → Full wave centre tab rectifier:

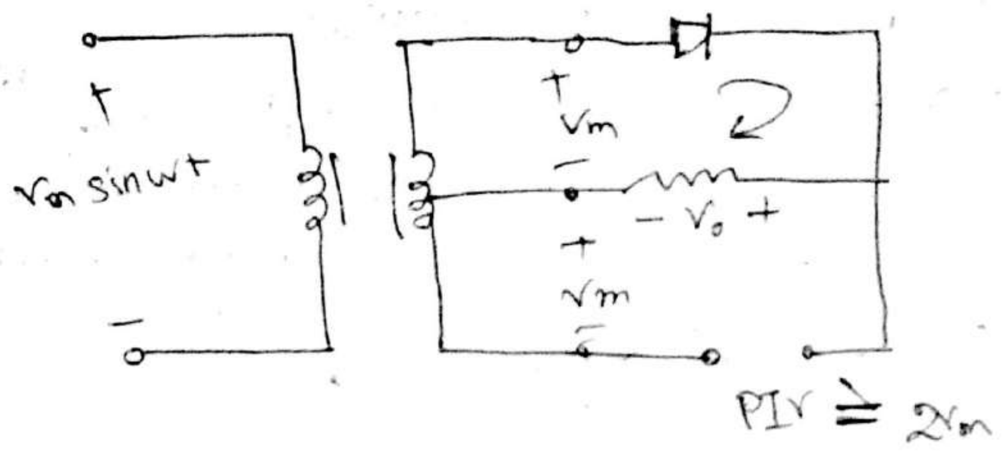


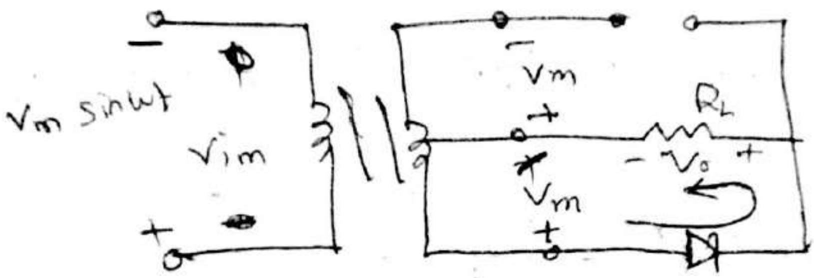
centre Tab use করলে full wave-এর জন্য ২টা Diode লাগবে.

input voltage < out put voltage. [step up] [1:2]

Input voltage > out put voltag [step down] [2:1]







Compare of HWR, FWR, FWCTR:

(i) Number of diode

(ii) Avaliable DC $\boxed{V_{dc} = ?}$

(iii) Number of transformer

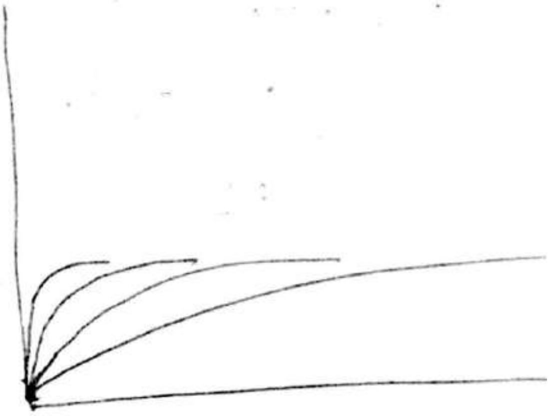
(iv) PIV rating.

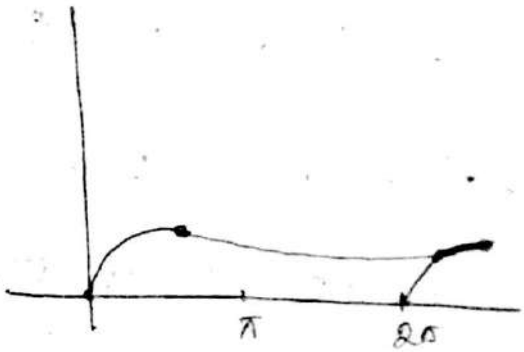
PIV: Peak inverse voltage.

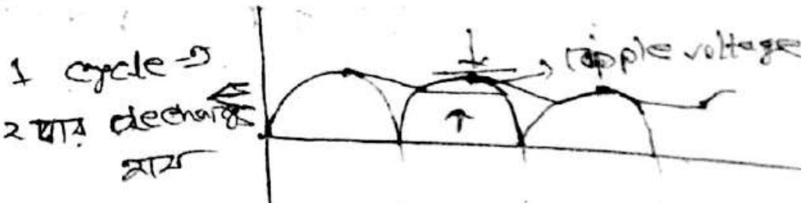
RC বড় হলে cha./decharge হতে বেশি সময় and ছোট হলে char/decharge হতে কম সময় লাগবে.

$R_dC << R_LC$

R_d - এর মধ্যে দিয়ে charge হবে
and R_L - এর " " decharge হবে



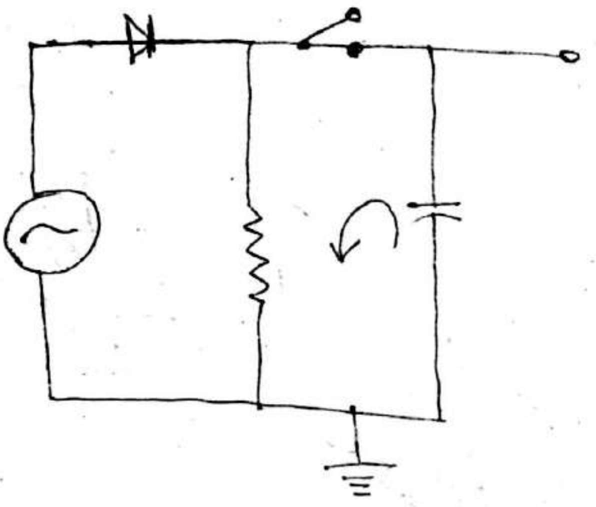


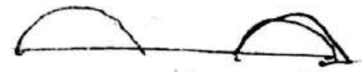


(i) Full wave ripple content কম.

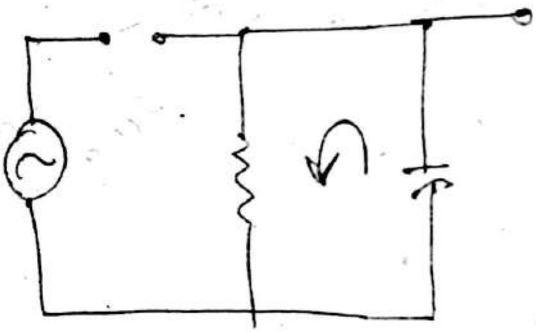
(ii) Diode - এর মধ্যে Half wave ripple হয়.

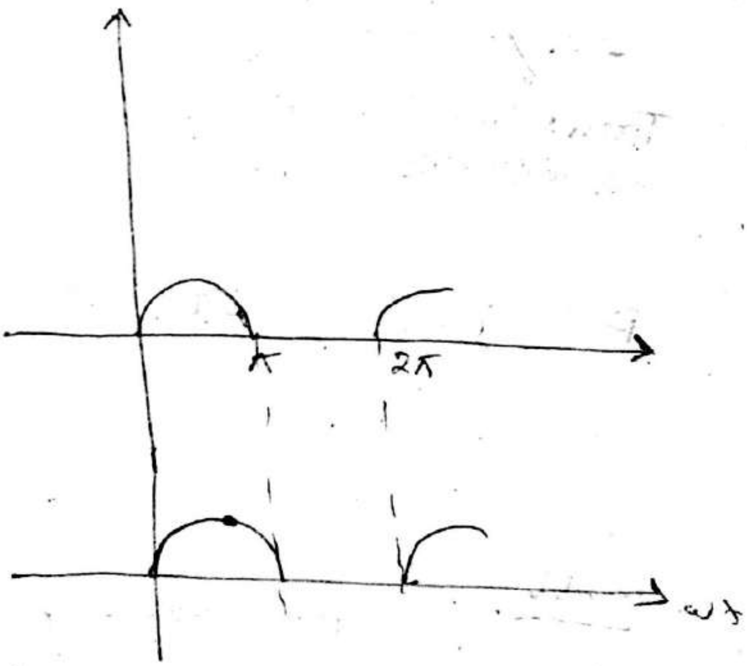
Lecture-7 4th cycle A day 13-05-13





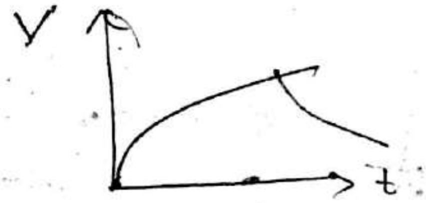
Unity Directional pulsecting DC





Charging

$V_o(t) = E(1 - e^{-t/RC})$

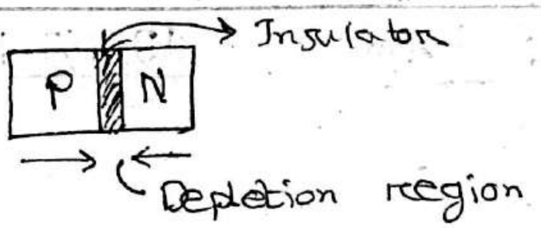


RC → time constant (Tau)

Recharging,

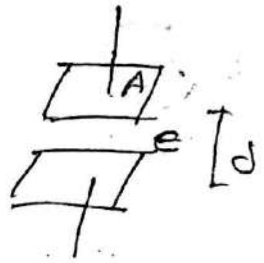
$V_c(t) = Ee^{-t/RC}$

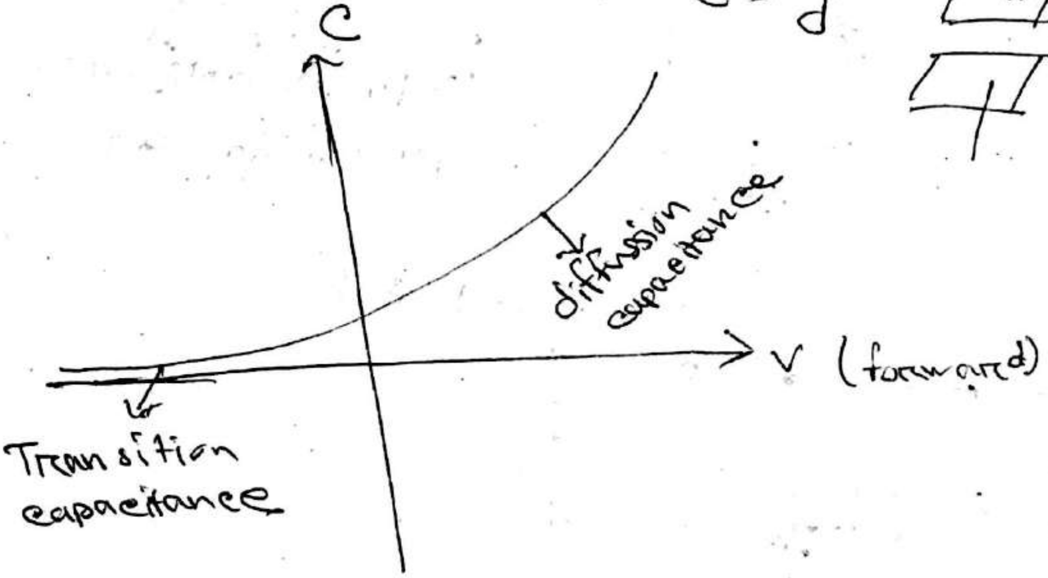
RC - এর 5 times (5RC) সময় charge বা decharge হয়,



~~Capatio~~ Capacitor

$$C = \frac{\epsilon A}{d}$$

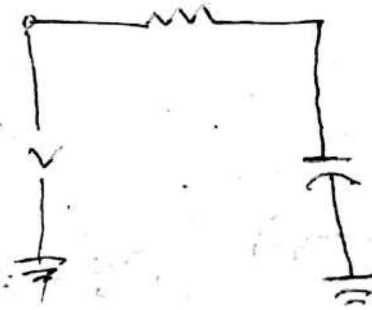




$\boxed{C_t \quad C_d}$

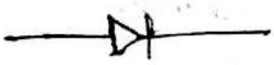
PN junction -এর $C \sim T$

H.W.



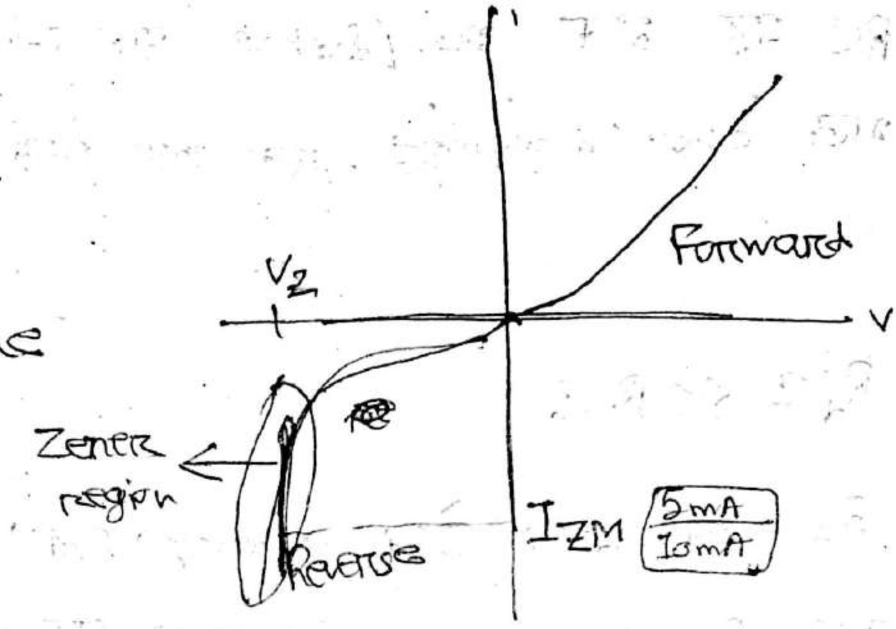
C এর across -এর voltage.

Regulation



Ordinary Diode

(i) Zener diode

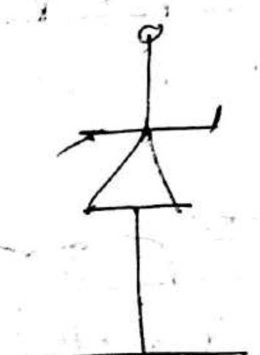


Ordinary diode -এ PIV V_Z -এর চেয়ে বেশি হলে diode damaged হবে.

⇒ Forward bias অবস্থায় ordinary and Zener Diode same হবে,

⇒ Reverse bias Zener diode-এ voltage V_Z এর আর কম হলে open হবে.

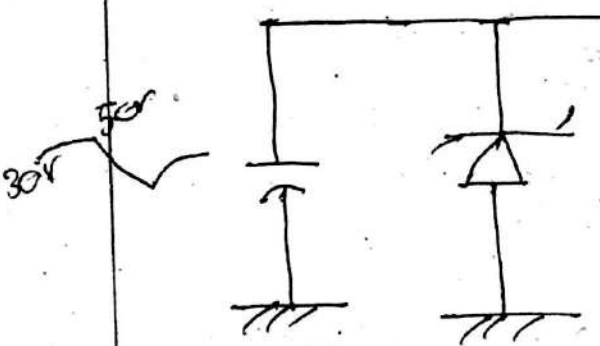
$$\boxed{\begin{array}{l} V < V_Z \rightarrow \text{off} \\ V \geq V_Z \rightarrow \text{On} \end{array}}$$



V_Z

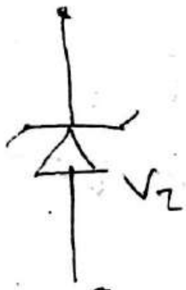
I_{Zm} Pmax

Tocon



ধর যদি output-এর 10 V চাই।

Zener diode:



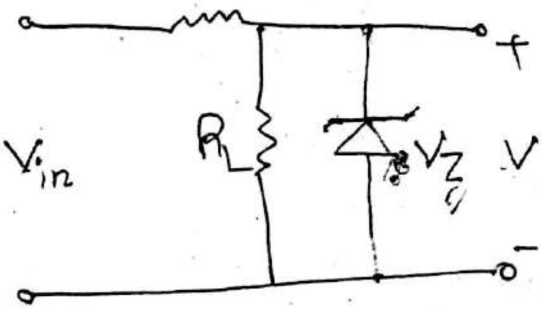
$\Rightarrow$

$V < V_Z$

$P_{max} \Rightarrow$

$V \geq V_Z$

0.6 0.7



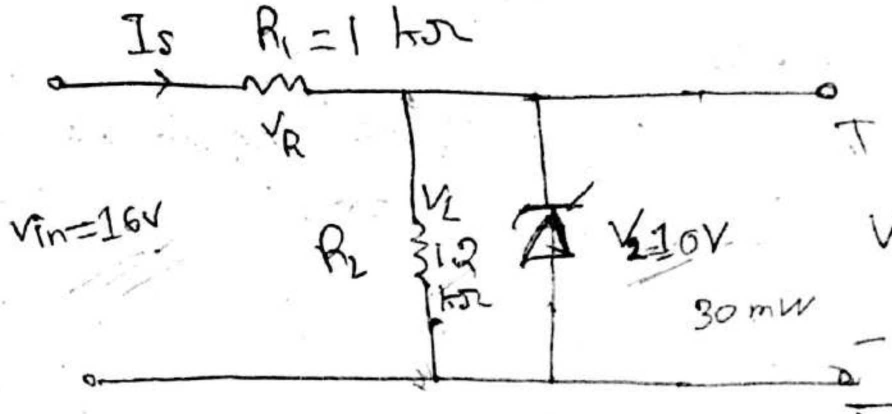
* reverse bias দিকে লাগাতে হবে।
+ দিকে cathode
− দিকে anode

(i) Reverse

(ii) V (Zener off) $V = \dfrac{R_L \times V}{R_1 + R_2}$

(iii) Test করা (V < V_Z হলে Zener off)

(V > V_Z হলে Zener on)



$\boxed{V_0 < V_Z}$

$$V_0 = \frac{1.2}{2.2} \times 16 = 8.727V$$

$V_0 < V_Z$ Zener off

Zener -এর ভেতর current নাই. $I_Z = 0$

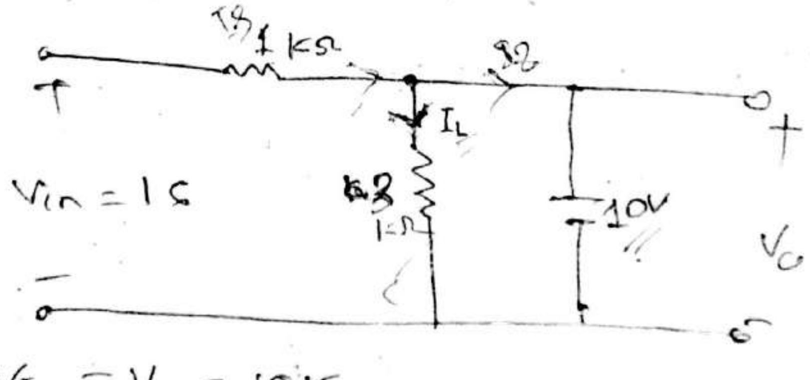
$V_L = V$

$R_L = 3\ k\Omega$ হলে,

$$V_0 = \frac{3}{4} \times 16 = 12\ V$$

$V_0 > V_Z$ ∴ Zener On

$I_S = I_L + I_Z$
$\Rightarrow I_Z = I_S - I_L$



$V_0 = V_L = 10V$

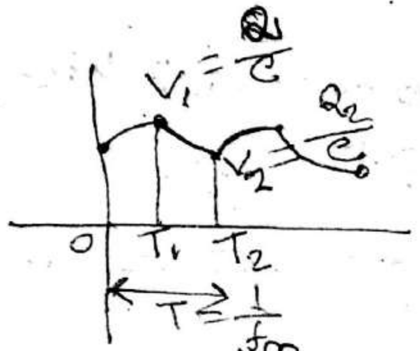
$$I_L = \frac{10}{3}\ \frac{V_Z}{R_Z} = \frac{10}{3}\ mA$$

$$I_S = \frac{16-10}{1} = 6\ mA$$

Ripple voltage → ~~Appendex~~.

$V_R = 1.21\%$

$= 48\%$ $\quad V_{rms} = \sqrt{\frac{2\pi}{2\pi}\int_0^{2\pi} V_m^2 ds}$

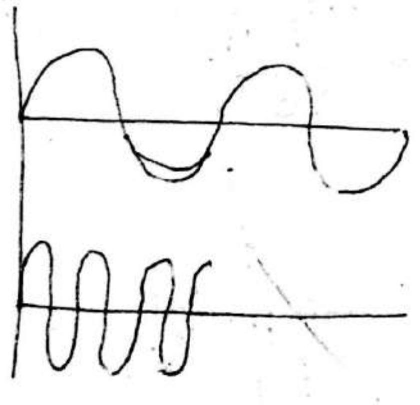


Ripple ⇒ difference detween V_1 and $V_2 = V_1 - V_2$

$= \frac{Q_1 - Q_2}{C}$

$C = \frac{Q}{V}$, $V = \frac{Q}{C}$

Frequency - এর সাথে ripple voltage-এর relation:



Charging time period ছোট and discharging time period বড় করব।

$T_1 - T_2 >> T_1$

$T_2 - T_1 = T$

∴ Ripple voltag ⇒ $\frac{V_1 - V_2}{T_2 - T_1} = \frac{Q_1 - Q_2}{C(T_2 - T_1)}$

$\Rightarrow \frac{V_1 - V_2}{T} = \frac{Q_1 - Q_2}{CT}$

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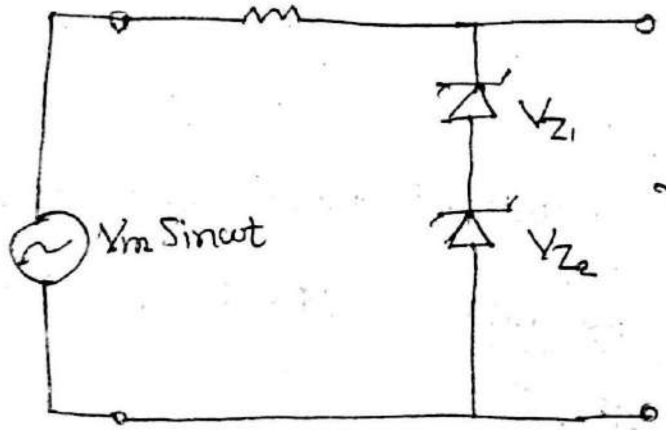
$\text{Max}^m \text{ current} \quad I_{max} = 60 \text{ mA}$

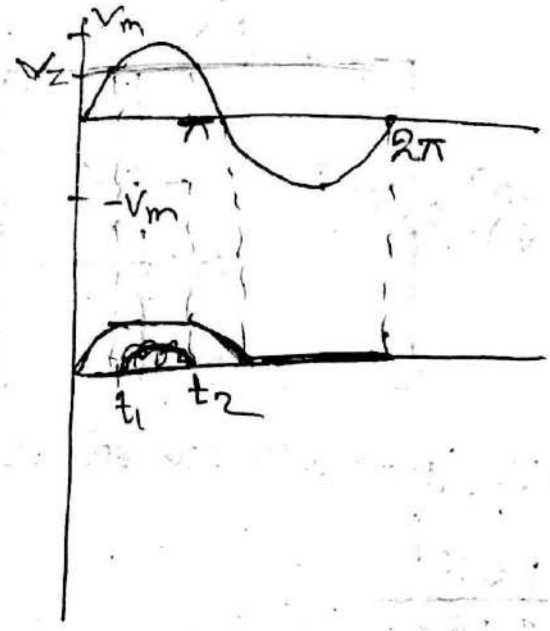
$I_{Lmax} = 20 \text{ mA}$

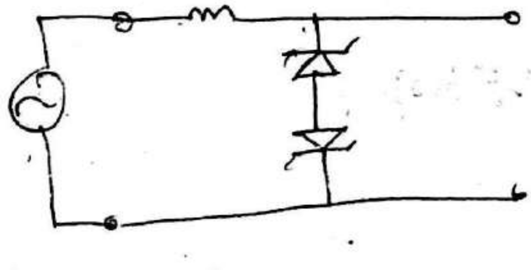
$I_{zm} = I_{max} - I_{Lmax} = 40 \text{ mA}$

~~I_{zm} যদি দেওয়া থাকে তা নেব~~

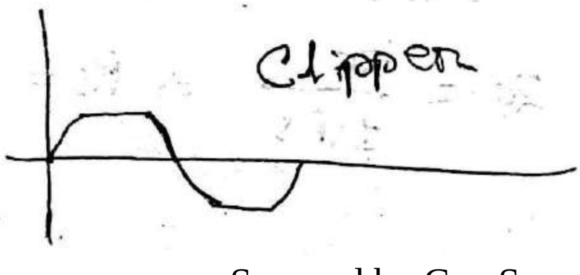
Voltage regulator
Rectifier
Filter

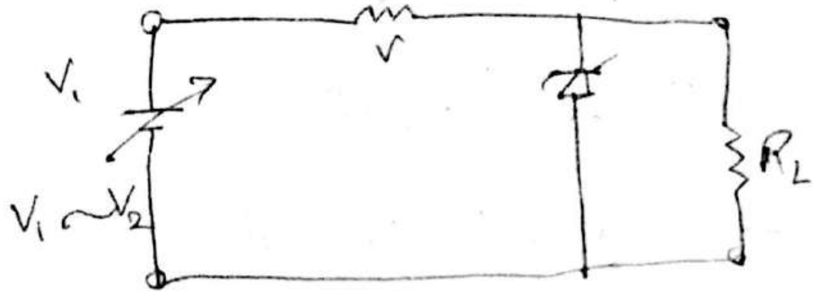






Clipper

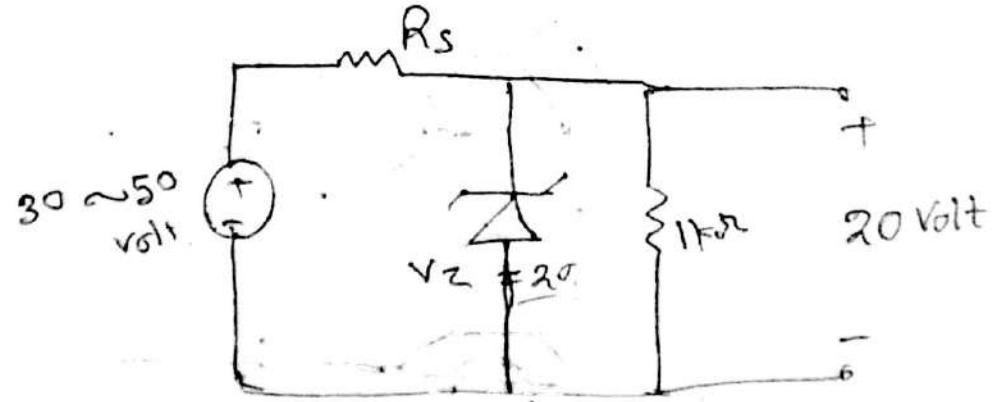




Low (10) এর জন্য Zener on/off করে test করাতে হবে। low এর জন্য Zener ~~[illegible]~~ on হবে Highest এর জন্য on হবে।

Exercise:

Design a voltage regulator that will maintain a output voltage of 20 volt across a 1 kΩ with a input that varies betn 30 - 50 volt.



$R_s = ?$
$V_{zm} = ?$
$I_{zm} = ?$

20 volt generate করতে চাই 30 volt লাগাতে হবে।

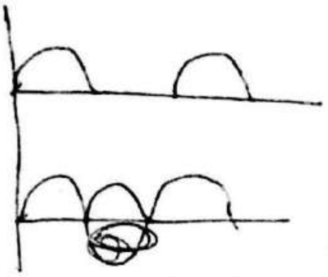
$$v = \frac{30 \times 1}{1 + R_s}$$

$$\Rightarrow 20 = \frac{30}{1 + R_s} \Rightarrow R_s = 0.5\, k\Omega$$

$I = \frac{Q}{T}$

$$\Rightarrow \frac{V_1 - V_2}{T} = \frac{1}{C}\left(\frac{Q_1 - Q_2}{T}\right) = \frac{I}{C}$$

$$V_r = \frac{IT}{C} = \frac{I}{fC}$$



→ Half-wave -এর V_r 2 গুণ

→ Full wave -এর V_r কম।

Static and dynamic resistance

$\underline{\text{Static}}$ DC resistance

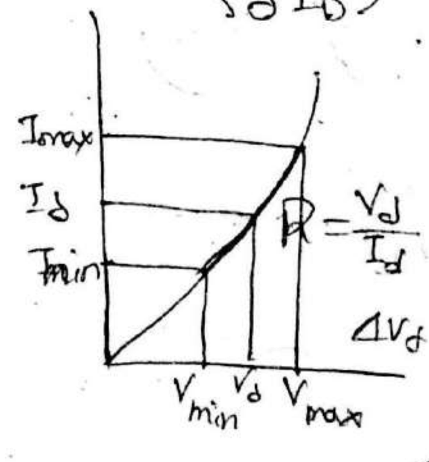
$\underbrace{\text{dynamic}}_{\text{AC resistance}}$

$$R_{DC} = \frac{V_{DC}}{I_{DC}}$$

$$\cancel{I_{DC}}\, R_{AC} = \frac{\Delta V_d}{\Delta i_d} = \frac{26\,mV}{I_D}$$

$$= \left(\frac{dV_D}{dI_D}\right)$$

$$I_D = I_S\left(1 - e^{\frac{KV_T}{V_d}}\right)$$



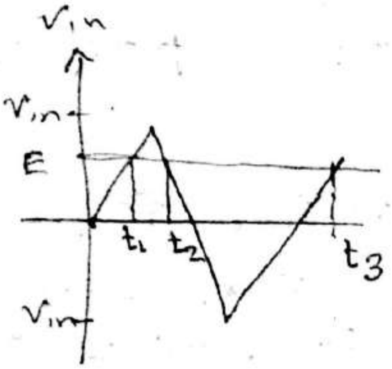
$R = \frac{V_d}{I_d}$

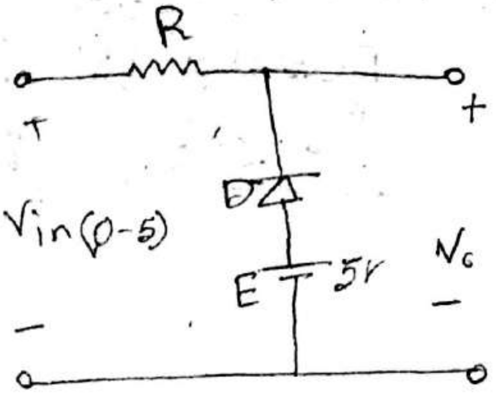
$\Delta V_d = r$

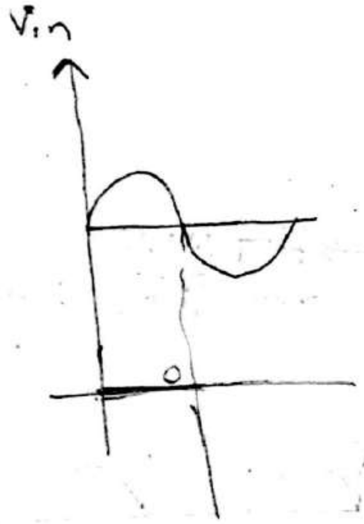
1st chapter

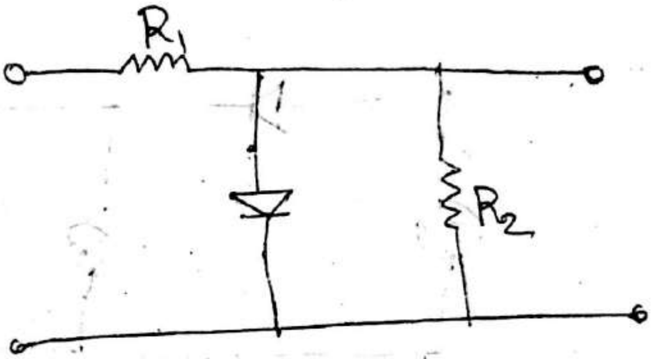
Otion

28-05-2013 4th cycle E Day









$(0-\pi) \rightarrow V_0 = 0$

$(\pi - 2\pi) \rightarrow V_0 = \dfrac{R_2 \, V_{in}}{R_1 + R_2}$

Riverse bias অবস্থায় ~ capacitance ~~Transi~~ Diffusion capasitance

D.C

Forward " " " " Transission capa

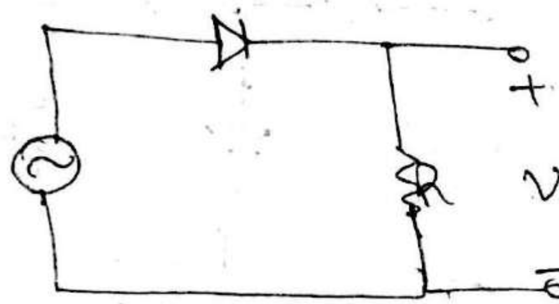
$$\boxed{\text{capasitance} = \frac{\epsilon A}{d}}$$

Reverse Recovery → এর semiconductor -এর switching speed.

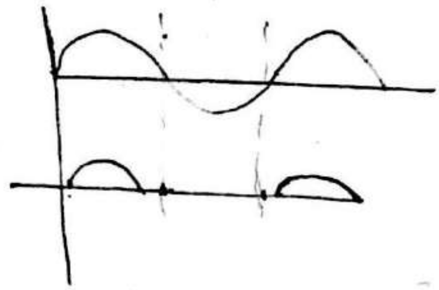
Reverse Recovery time $\propto \dfrac{1}{\text{switching speed}}$.

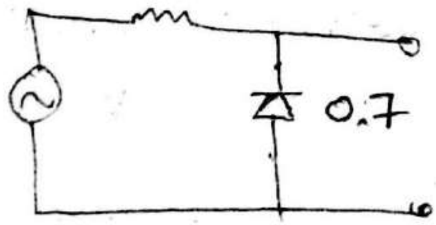
1 টা Diode forward থেকে Reverse-এ or vice versa যেতে যে time লাগে তাই Recovery time.

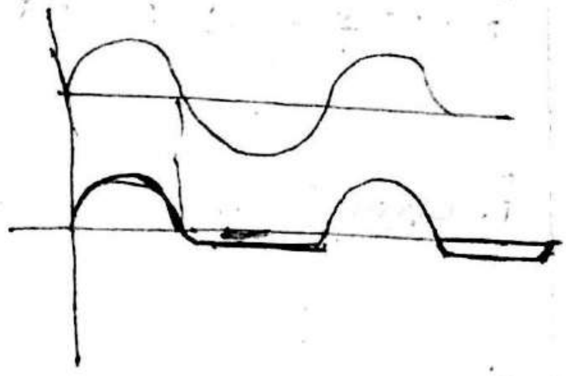
Schottky Diode → consists P or n junction থাকে.
একদিকে metal এবং অন্যদিকে P or n থাকে।



→ Half wave rectifier circuit.







Bridge :- V_m

center tab: $\geq 2V_m$

[Bridge-এ power loss বেশি]

Bridge → 2 টা Diode conduct

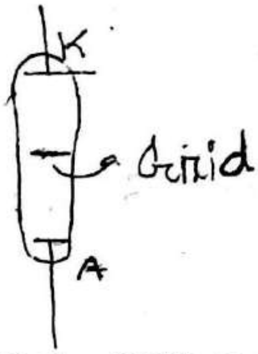
center tab → 1 টা " "

EEE-২11 5th .e Day 03-06-12

1

B J T (abbreviation)

Bipolar Junction Transistor.

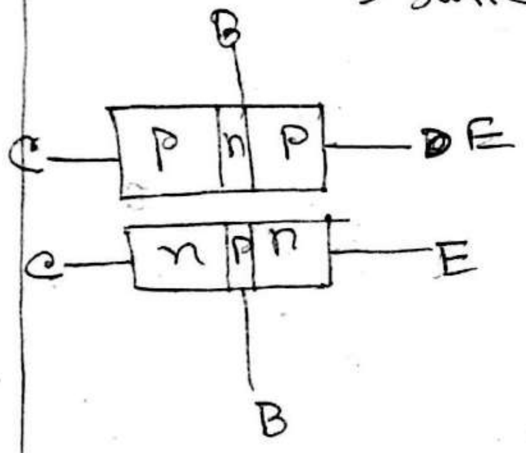


① 3 Terminal Device.

semiconductor transistor

Diode → ২ terminal device
→ switching - এর জন্য ব্যবহার করা হয়,

Transistor → 3 terminal device
→ switching and amplifier হিসাবে ব্যবহার করা হয়।



→ pnp transistor

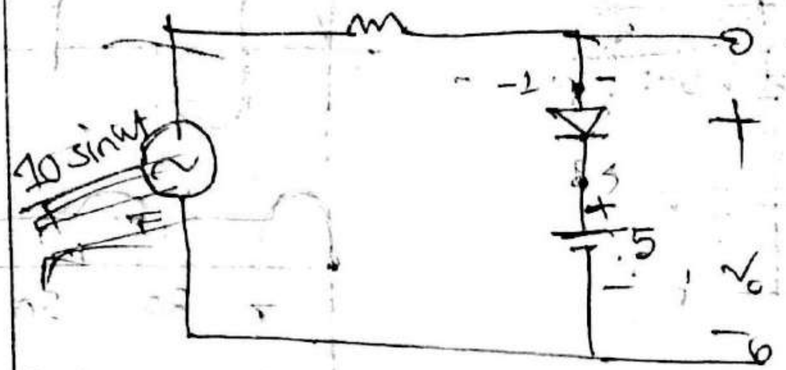
→ npn transistor

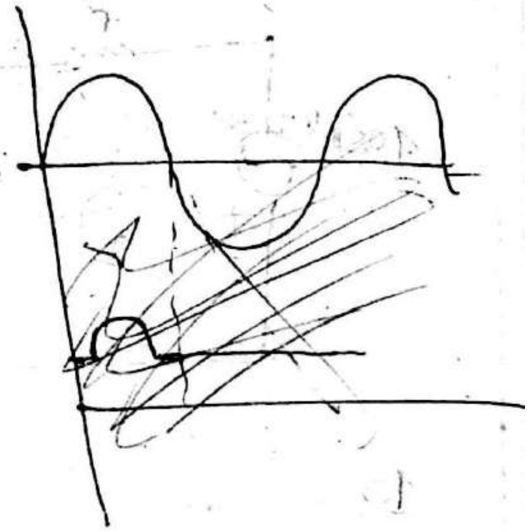
C ⇒ collector → collector বড় Emitter থেকে।

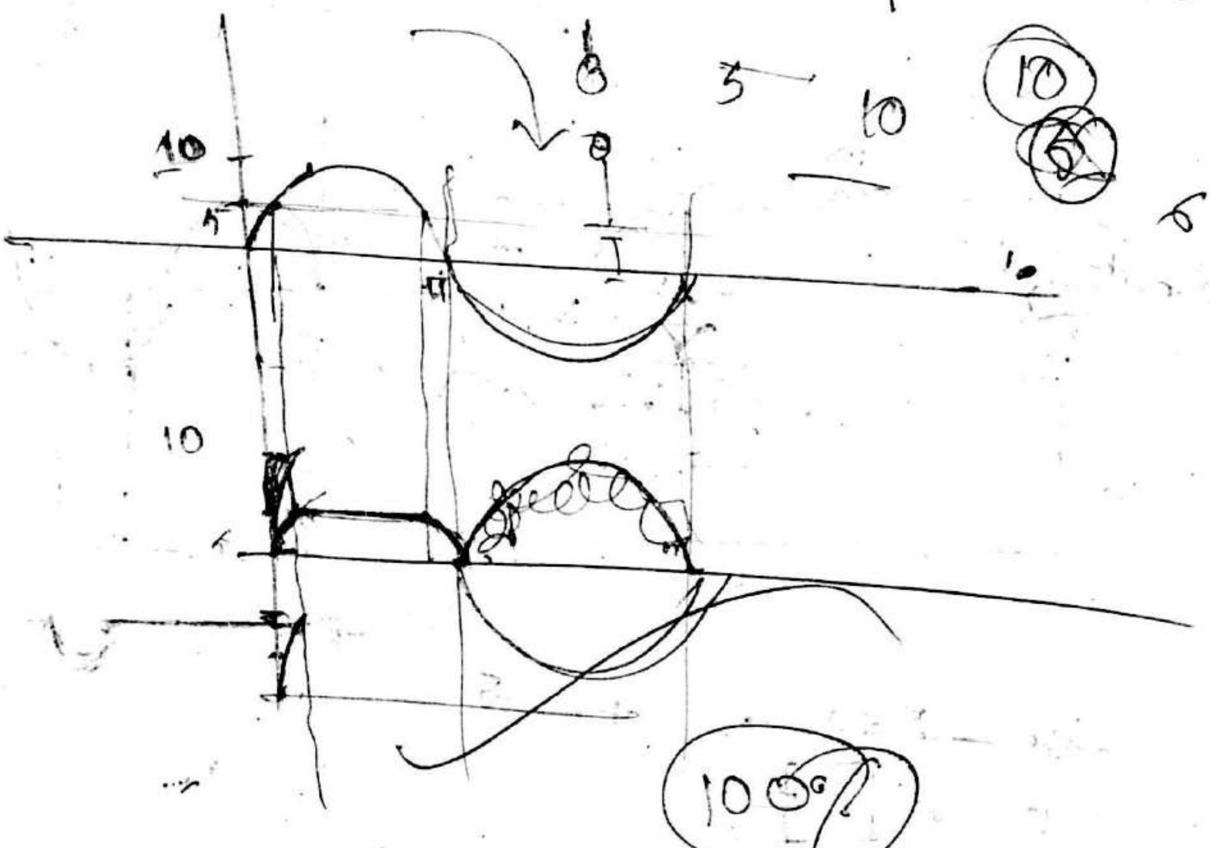
B → Base

E → Emitter

Diode - এর এক প্রান্ত Multimeter - এর (+) এর ছুয়ালে Resistance যদি অনেক বেশি আসে তাহলে সেটি cathode and → 0 আসলে সেটি Anode.







100%

10

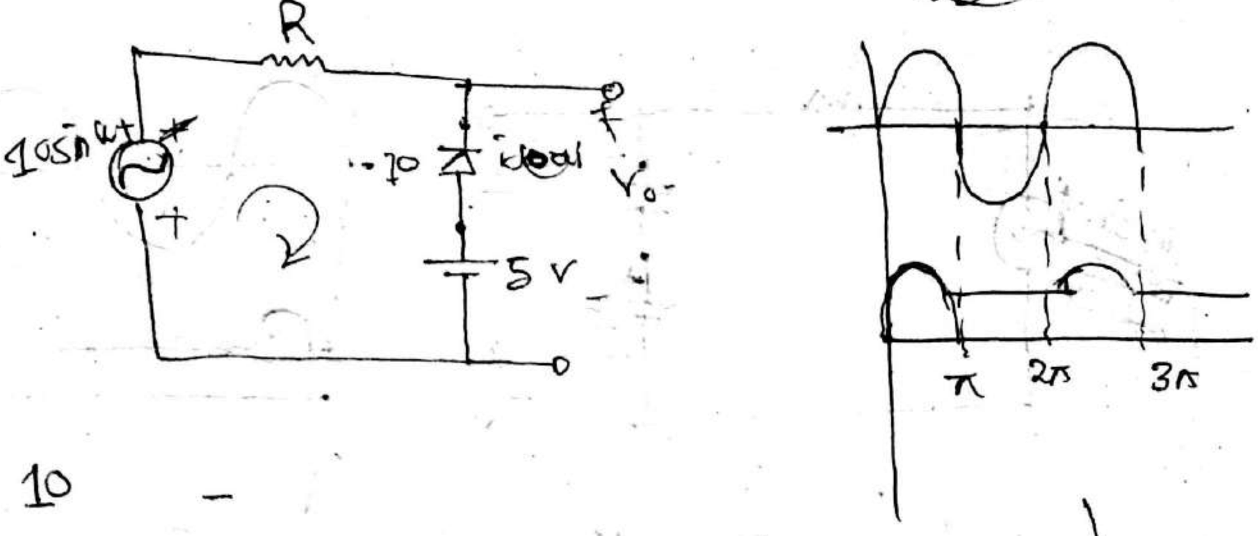
−1, −10

$V_1 - V$

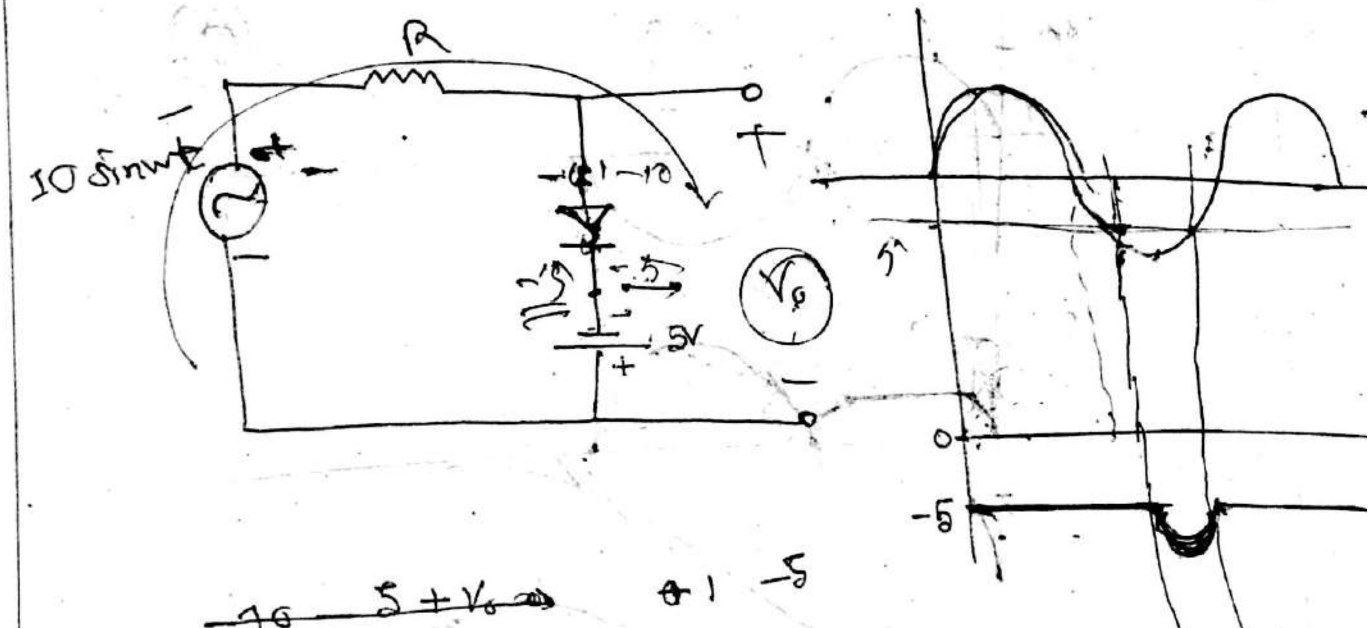
$5 - 5 = 4$

$-1 - 5 = -6$

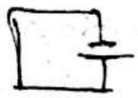
$-10 + V_0 + 5 = 0$



10 —



~~10~~ 5 + V_0 — 1 -5



-1 — -10

-5

V = 0

power transistor

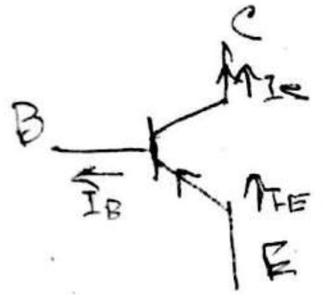
$\frac{220}{100} = \frac{1}{5}$

Base → এর Doping level সবচেয়ে কম

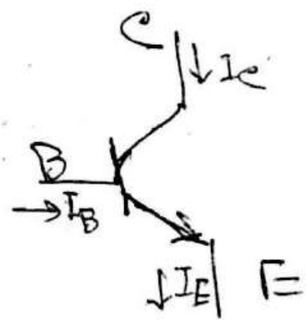
→ Resistance সবচেয়ে বেশি,

Base থেকে 100-150 গুণ বেশি Doping করা হয় Collector and Emitter.

Emitter- এর Doping level বেশি,



pnp



npn

$I_B + I_C = I_E$

↓ μA

$I_B + I_C = I_E$

↓ μA

$\alpha = \frac{I_C}{I_E}$ $\beta = \frac{I_C}{I_B}$

$$\frac{I_B + I_C = I_E}{I_C}$$

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

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

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

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

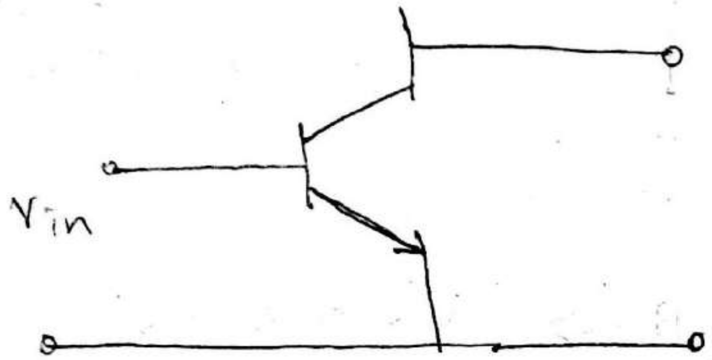
$$\Rightarrow \frac{1}{\beta} = \frac{1-\alpha}{\alpha}$$

$$\Rightarrow \beta = \frac{\alpha}{1-\alpha}$$

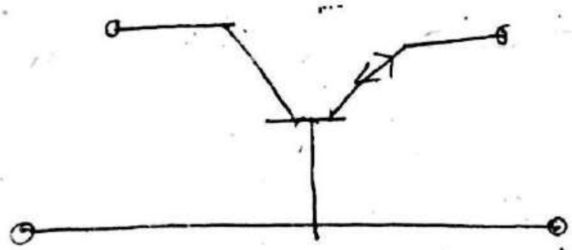
$\alpha < 1$

$B > 1$

Configuration:



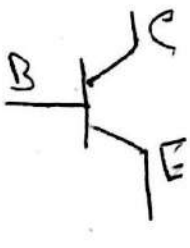
(1) common Emitter configuration (CE)

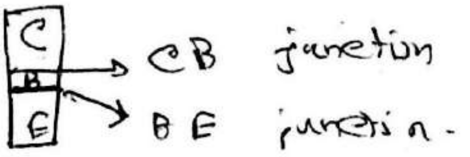


(2) common Base configuration (CB)

(3) Common collector configuration (CC)

CE → Amplifier



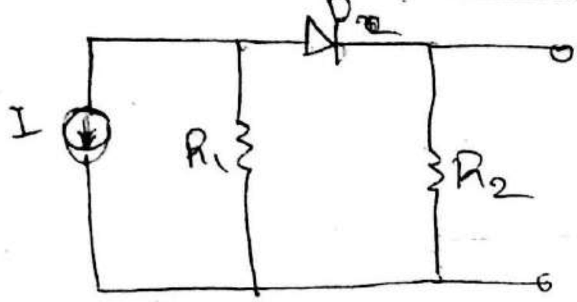


Amplifier হিসাবে use করলে. BE → forward bias(

CB → Reverse bias (RE

Tcer

Switch → on → Reverse bias (2 টা junction)
OFF → Forward bias (2 টা junction)

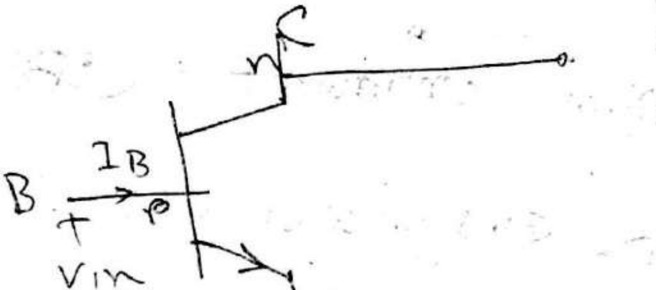


05-06-20

Si and Ge একসাথে Parallel থাকলে Si on হয়ে যায়।

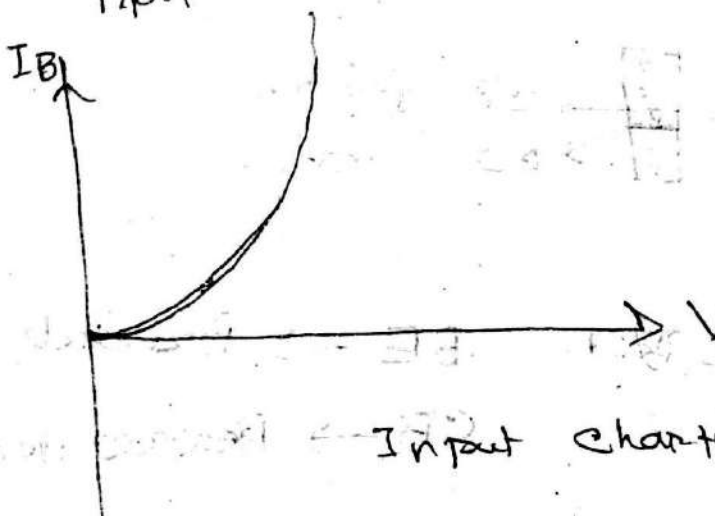
cutoff Switch Off [CB → Reverse bias
BE → " "

saturation Switch on [CB → Forward bias
BE → " "



→ Amplifier হিসাবে use করা

common Emitter,



Input charteristic

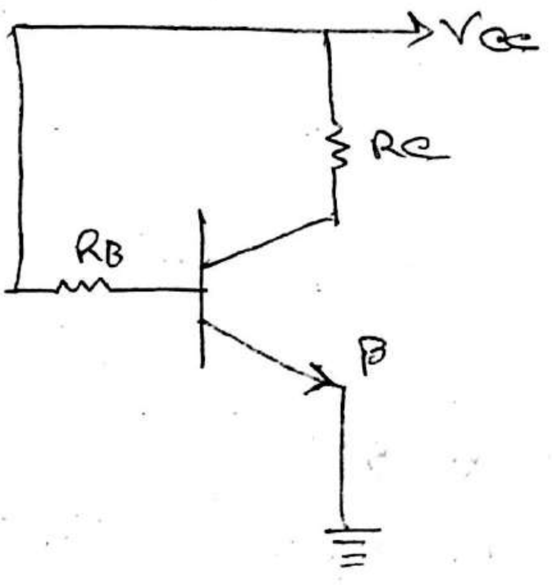
10-06-2013

50 volt ac → peak value $\sqrt{2} \times 50$

$\boxed{\text{50 volt rms value}}$

BJT biasing

(1) Fixed bias
2. Emmiter bias
(3). Voltage divider bias.
4. collector feedback.



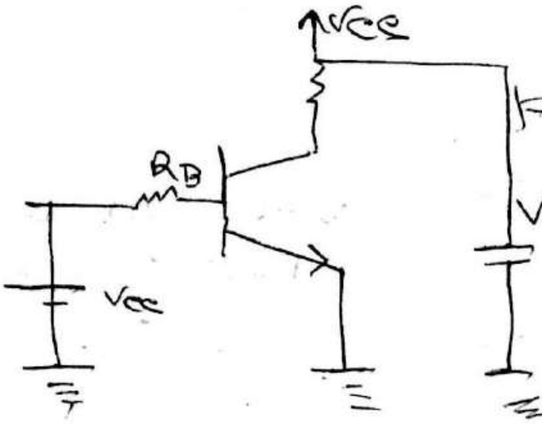
$V_{CE} = ?$
$I_c = ?$

(1) Input loop-এ KVL - apply করে I_c(current) বের করব.

(2) output loop-এ KVL apply করলে V_{CE} পাওয়া যাবে.

Fixed bias

At first KVL law apply করতে হবে input



KVL apply

$$V_{CC} - I_B R_B - I_{BE} = 0$$

$$\Rightarrow I_B = \frac{V_{CC} - 0.7}{R_B}$$

known

known

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

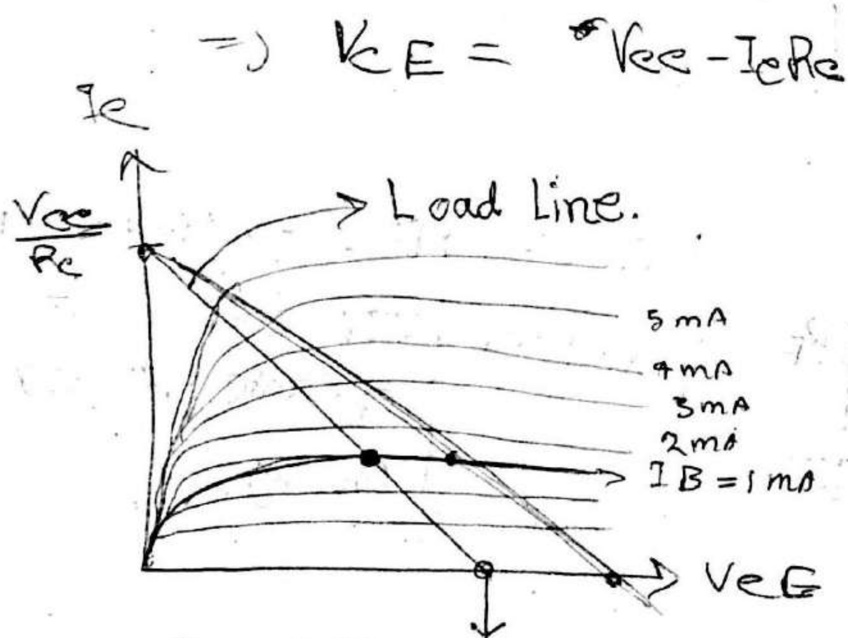
$$\Rightarrow \cancel{\beta = \frac{1}{}}$$

$$\Rightarrow I_C = I_B \beta$$

V_{CE}-এর জন্য output-loop-এ KVL apply করতে হয়.

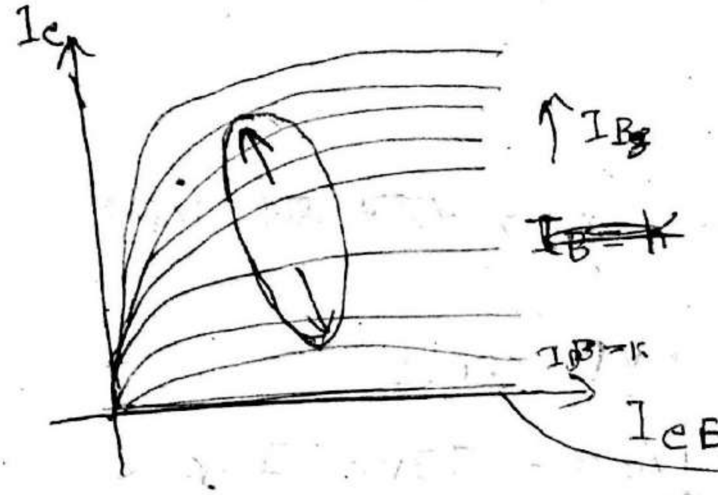
$$V_{CC} - I_C R_C - V_{CE} = 0$$

$$\Rightarrow V_{CE} = V_{CC} - I_C R_C$$



যে ঠ Level-এর Vcc use করি তার V_{CE} Vcc-এর মান half হয়।

$I_C = 0$ হলে $V_{CE} = V_{CC} \longrightarrow$ cut off.



→ cut-off region
Base-এ current থাকবে না

β → common Emitter current function .

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

→ 2 টা bias-ই reverse bias.

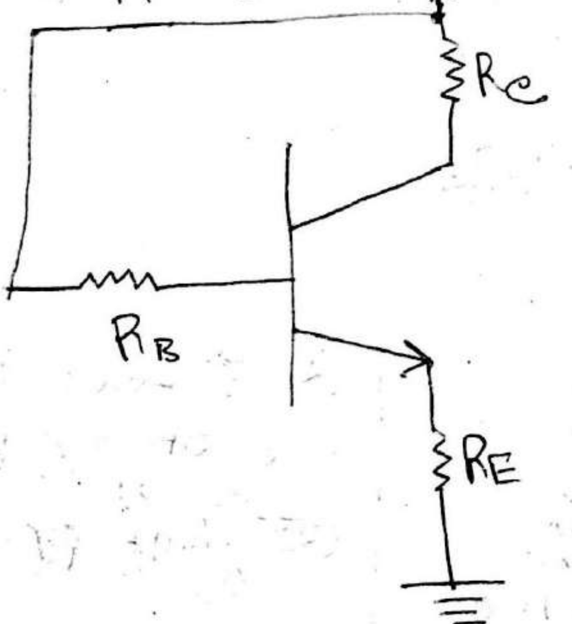
Cut-off region $I_B = 0$ ~~$E_{BE} = 0.7V$~~ $V_{BE} = 0.7$

Linear " → cutoff and saturation -এর মধ্যে region.

saturation " $I_B = max$, $V_{CE} \cong 0.2V$ (Si)

→ 2 টা bias-এ forward

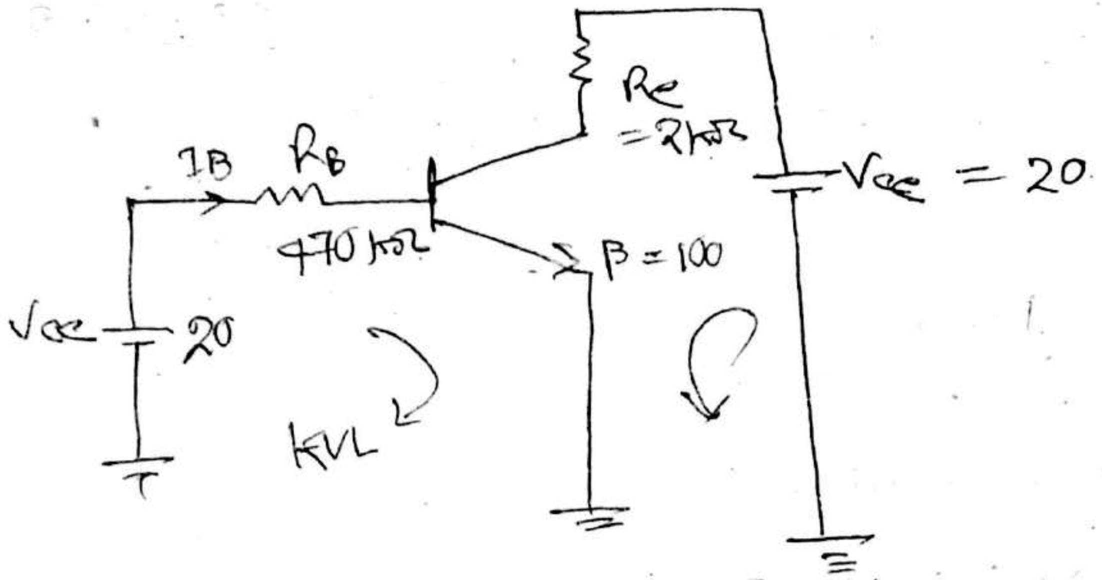
Q-pt → Quiescent point



Bias → DC-voltage apply করে Q-point টা operate করার জন্য, এটা Biasing.
Q-point

Fixed Bias

Switching-এর জন্য cut-off / saturation-এ নিতে হবে



$$V_{cc} - I_B R_B - \underbrace{V_{BE}}_{0.7} = 0$$

BJT $\to$
$V_{BE} = 0.7V$ always

$$\Rightarrow I_B = \frac{20 - 0.7}{470\,k\Omega}$$
$$= 0.041\ mA$$
$$= 41\ \mu A$$

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

$$\Rightarrow I_C = \beta I_B = 100 \times 0.041$$
$$= 4.1\,mA.$$

Out put loop.

$$V_{CC} - I_C R_e - V_{CE} = 0$$

$$\Rightarrow V_{CE} = V_{CC} - I_C R_e$$

$$\Rightarrow V_{CE} = 11.78$$

fatfful amplifier- এর জন্য যাতে Q-point Linear -এর মাঝে অবস্থানে থাকে।

$V_B = ?$ $V_E = ?$ $V_C = ?$ $V_{CB} = ?$ $V_{BE} = 0$

$V_{BE} = 0.7 \Rightarrow V_B - V_E = 0.7 \Rightarrow V_B = 0.7$

~~ef~~ $V_{CE} = 11.78$. $V_C - V_E = 11.78$

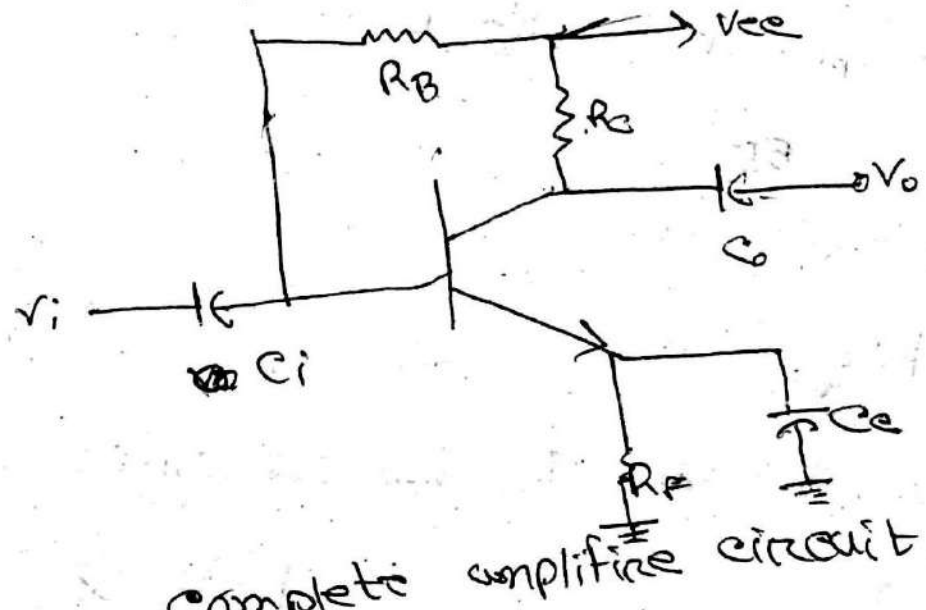
$\Rightarrow V_C = 11.78$.

$V_{BC} = \overset{0.7 - 11.78}{-11.08}$ ✓ (reverse)

$V_{CB} = 11.08$ (forward)

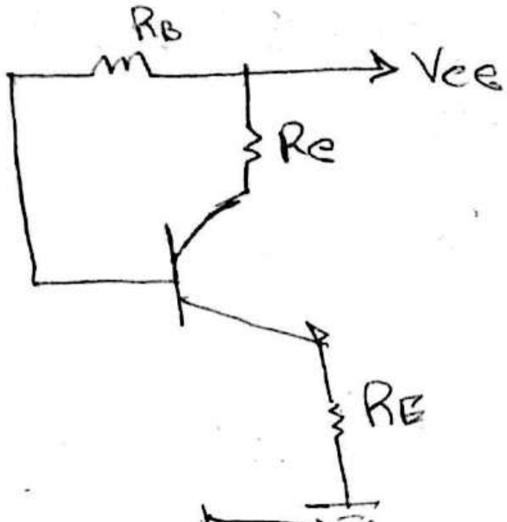
EEE-211 ~~Emitter~~ 12-June-2013

Emitter feedback bias.

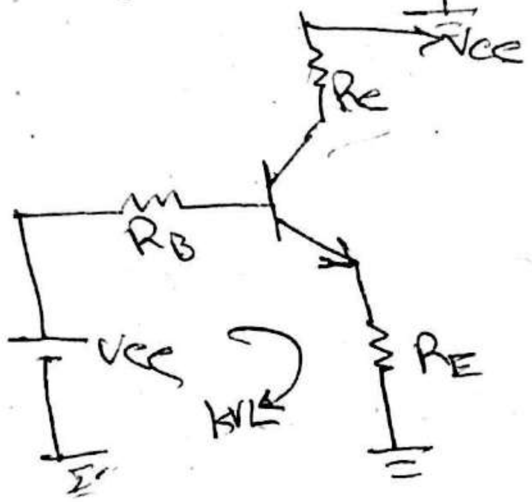


capacitor ac-এর জন্য short হয়,

complete amplifire circuit.



→ For DC



I_B - বের করব।

$\Rightarrow V_{CC} - I_B R_B - V_{BE} - I_E R_E = 0$

$\Rightarrow V_{CC} - I_B R_B - V_{BE} - (\beta+1) I_B R_E = 0$

$$\therefore I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1) R_E}$$

$\therefore I_C = \beta I_B$ ✓

Q - point বের করার জন্য I_C, V_{CE} বের করতে হবে।

Output loop →

$V_{CC} - I_C R_C - V_{CE} - I_E R_E = 0$

$\therefore V_{CC} - I_C R_C - V_{CE} - I_C R_E = 0$

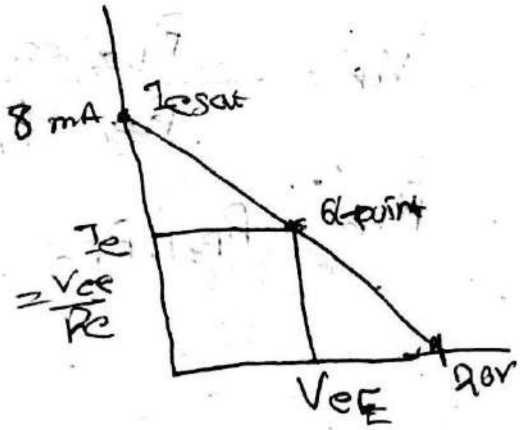
$I_E = \frac{I_C}{\alpha}$

$I_E \cong I_C$

$R_c = \frac{20}{8}$

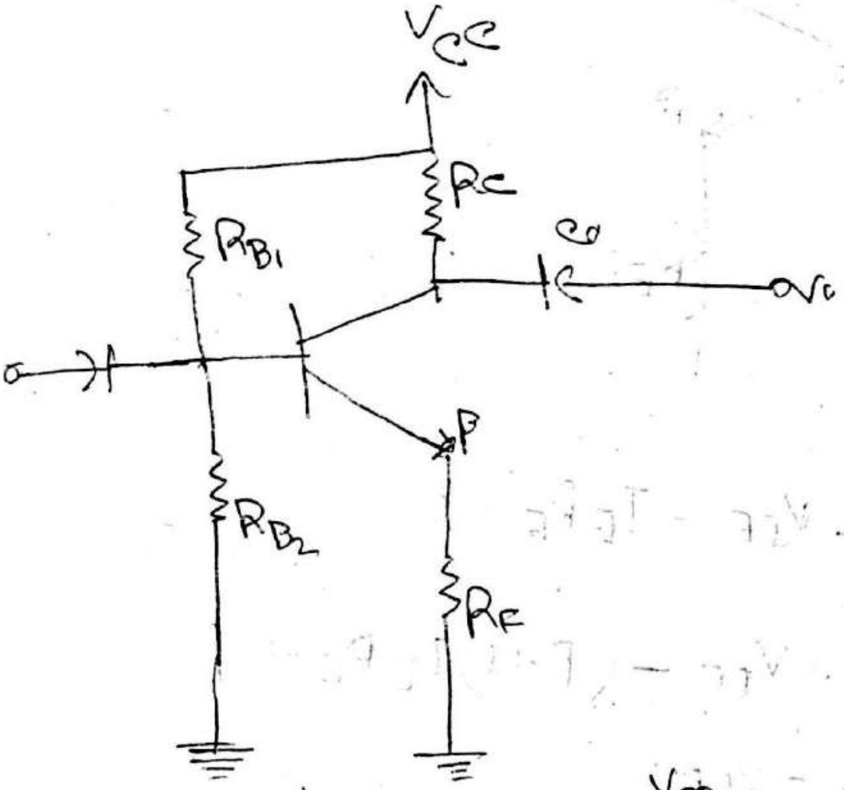
$I_e = ?$

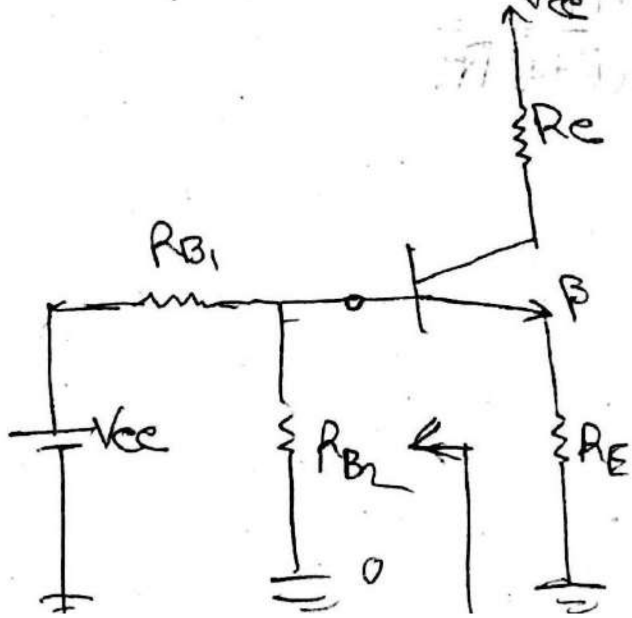
$I_B = ?$



EEE-211 7th A day 23-06-13

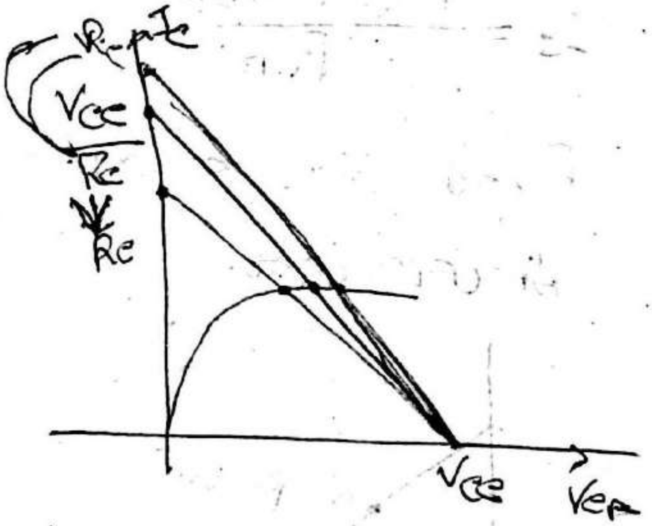
voltage divider bias:



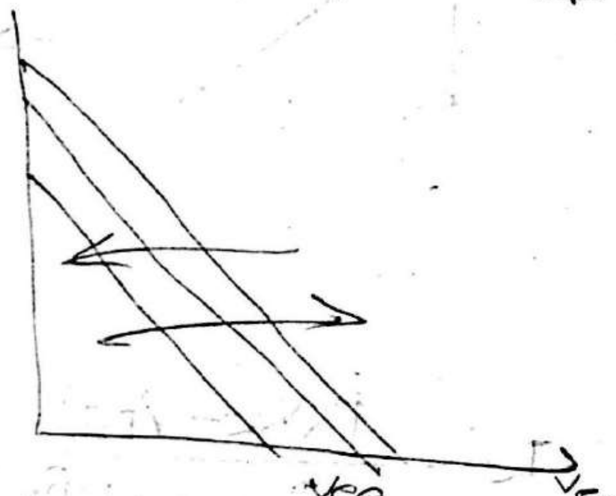


R_e, V_{cc} - এর effect on Q-point:

R_e বাড়লে Q point
~~এর~~ Right - এ যাবে
R_e কমালে Q-point
left - এ যাবে,



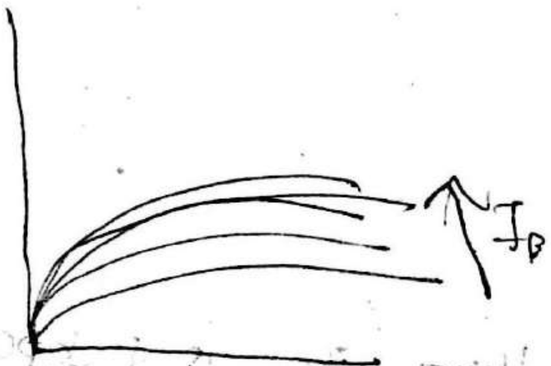
V_{cc} কমালে
Q-point Right - এ
and V_{cc} কমালে
Q-point left-এ যাবে.



I_B change করলে

R_B কমালে I_B বাড়লে

I_B ~~কম~~ বাড়লে Q-point
R_B কমালে
saturation - এর দিকে যাবে,



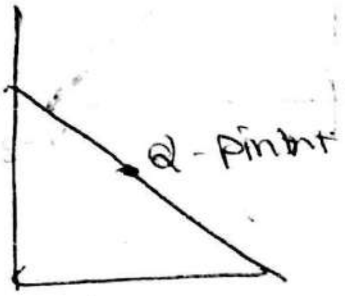
I_B কমালে Q-point
cut-off - এর দিকে যাবে

Fixed bias and Emitter feedback bias - এর Bools রে
problem করবে.

$$V_{CE} = V_{CC} - I_C(R_C + R_E)$$

$$I_C = \frac{\beta(V_{CC} - V_{BE})}{R_B} \longrightarrow \boxed{\text{Fixed bias}}$$

Fixed bias circuit-এ collector current β ~~di~~ dependent.



→ Q-point-এর variation temperature-এর উপর depend করে।
I_C কম বেশি-এর জন্য Q-point change হয়।
I_C → β variation-এর জন্য change হয়।
tem. variable " " β " "

$$I_C = \frac{\beta(V_{CC} - V_{BE})}{R_B + (\beta+1)R_E} \cong \frac{\beta(V_{CC} - V_{BE})}{R_B + \beta R_E}$$

If $\beta R_E \gg R_B$

$$\cong \frac{\beta(V_{CC} - V_{BE})}{\beta R_E}$$

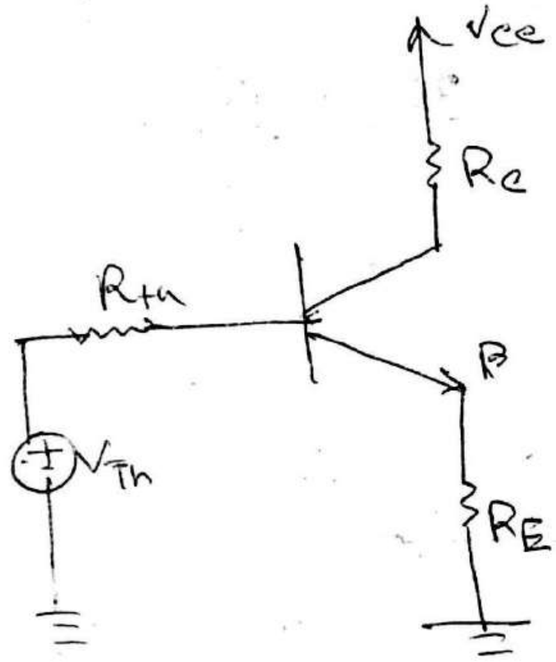
Here, I_C is independent on β.

∴ Emitter feedback bias circuit is more stability than Fixed bias circuit.

Scanned by CamScanner

$$V_{th} = \frac{R_{B2} V_{cc}}{R_{B1} + R_{B2}}$$

$$R_{th} = R_{B1} \| R_{B2} = \frac{R_{B1} R_{B2}}{R_{B1} + R_{B2}}$$



$$V_{Th} - I_B R_B - V_{BE} - I_E R_E = 0$$

$$V_{Th} - I_B R_B - V_{BE} - (\beta + 1) I_B R_E = 0$$

$$\Rightarrow I_B = \frac{V_{Th} - V_{BE}}{R_{Th} + (\beta + 1) R_E}$$

Scanned by CamScanner

$V_{cc} = 16V$, $R_C = 3.6\ k\Omega$, $R_E = 1.2\ k\Omega$, $R_{B1} = 91\ k\Omega$

$R_{B2} = \cancel{80k\Omega}$ $18\ k\Omega$, $\beta = 100$, $\boxed{I_B, I_C, I_E, V_B, V_C, V_E, V_{CE}, V_{BC} = ?}$

$$V_{th} = \frac{R_{B2} \times V_{cc}}{R_{B1} + } = 7.48\ V = 2.64$$

$$R_{th} = \frac{R_{B1} \times R_{B2}}{R_{B1} + R_{B2}} = \frac{91 \times 80}{\cancel{109}\ 171} = \cancel{15.027}\ 42.57 = 15.03k\Omega$$

$$I_B = \frac{V_{Th} - V_{BE}}{R_{Th} + (\beta+1) R_E} = \frac{7.48 - 0.7}{42.57 + 101 \times \cancel{1000}\ 1.2}$$

$$= 0.04\ mA = 0.0142\ mA$$

$I_C = \beta I_B$

$= 4\ mA = 1.42 mA$

$I_E = (\beta+1) I_B$ $\boxed{I_E = I_B + I_C}$

$= 101 \times 0.04 mA$

$= \cancel{40}\ 4.04\ mA$

$V_{cc} - I_C R_C - V_{CE} - I_E R_E =$

$\Rightarrow V_{CE} = V_{cc} - I_C R_C - I_E R_E$

$= V_{cc} - I_C R_C - \cancel{I_E R_E}\ (\beta+1) I_B R_E$

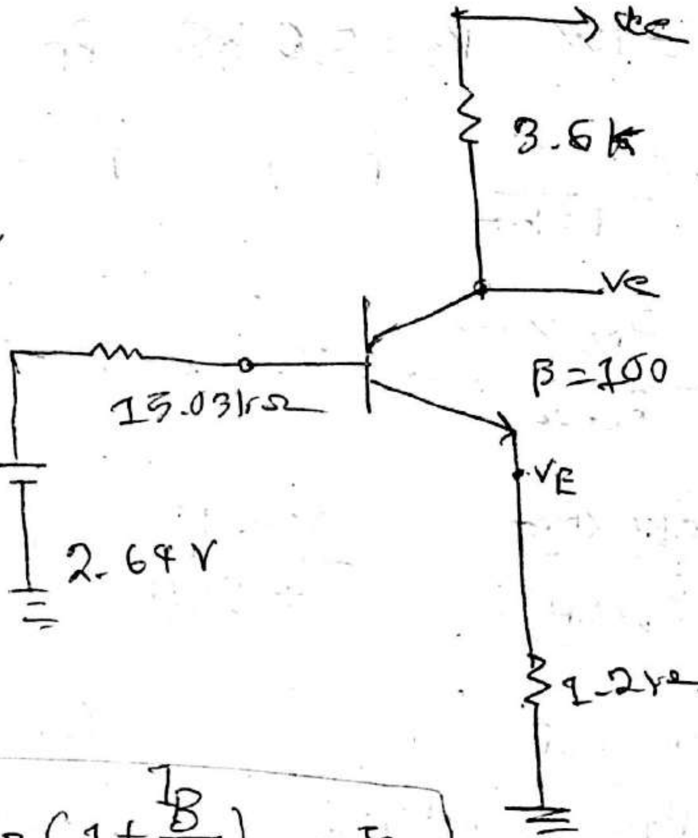
$= -3.78V.$

$V_B = 0.7 + V_E$

$V_C = V_{CC} - I_C R_C$

$V_{CE} = V_C - V_E = 9.16V$

$V_{BC} - V_B - V_C = -8.47V$



$\cancel{I_E = \frac{I_B}{I_C} \times I_B + I_B}$

$$\boxed{I_E = I_B + \beta I_B = I_B\left(1 + \frac{I_B}{I_C}\right) = I_B}$$

2nd CT

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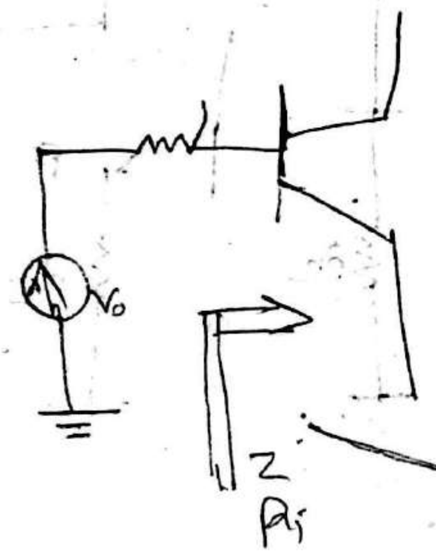
অর্থাৎ Vcc or Re -এর Standard value এ ধরে নিয়ে design করতে হবে।

Exam-এ একটা ~~Degine~~ Design problem থাকবে।

Emitter feedback bias,



$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta+1) R_E}$$

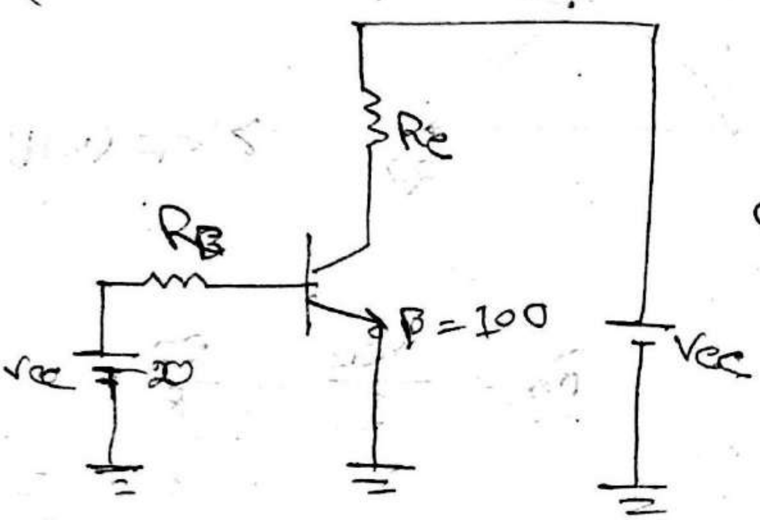
$\rightarrow R_B + \beta R_E$

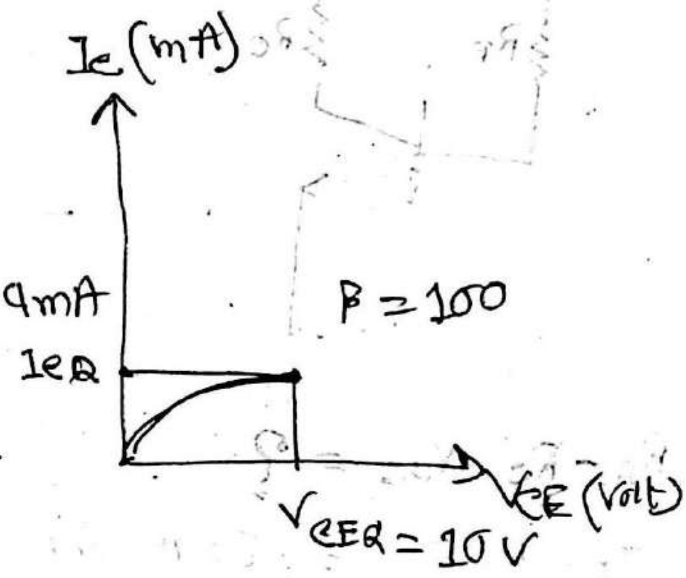
Input resistance হলো Emitter-এর যে resistance আছে তার β times reflected হয়েছে।

$V_{cc} - I_B R_B - V_{BE} = 0$

$R_B = \frac{V_{cc} - V_{BE}}{I_B}$ [I_B — 40 μA)

#





$B = \frac{I_B}{I_c}$

$\Rightarrow I_B = 100 \times 4 = 400\ mA$

Faitful Amplifier - এর জন্য Vcc হবে V_{CE} - এর double

$\Rightarrow \boxed{V_{cc} = 2V_{CE}}$

$V_{cc} - I_B R_B - V_{BE} =$

$\Rightarrow R_B = \frac{(20-0.7)V}{400\ mA}$

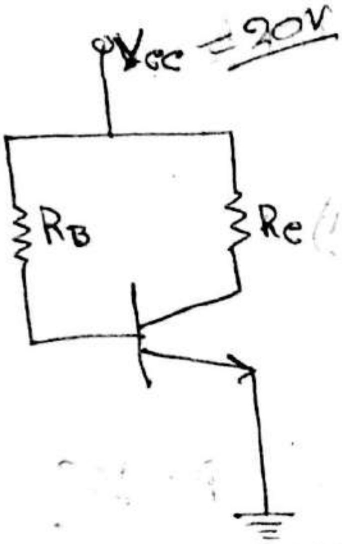
$= 48.25\ \Omega$

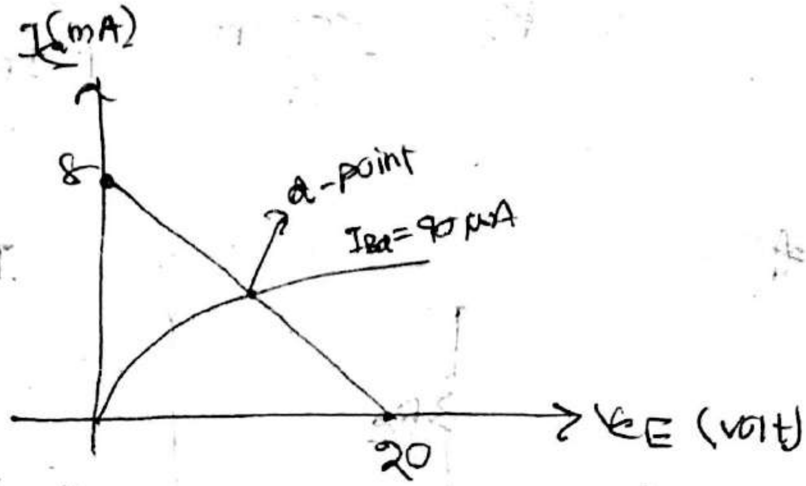
$V_{cc} - I_c R_c - V_{CE} = 0$

$\Rightarrow \cancel{R_c = \frac{V_{cc} - V_{CE}}{I_c}}$

Vcc ~~&~~ Rc unknown.

EEE-211   7th cycle 2 day   26-06-2013





$R_B, R_C, V_{CC} = ?$

$I_B = 40\ \mu A,\ I_C = 8\ mA,\ V_{CE} = 20$

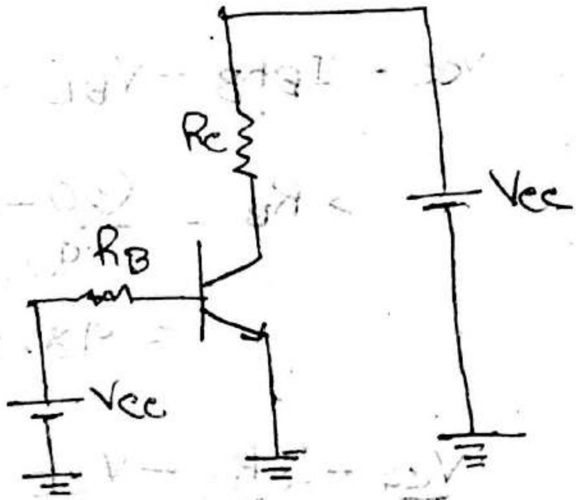
$$R_e = \frac{V_{CE}}{I_C} = \frac{20}{8} = 2.5\ k\Omega$$

~~$R_B = \frac{V_{BE}}{I_B} = \frac{0.7}{40\ \mu A} = $~~

$$R_B = \frac{V_{BE}}{I_B} =$$

$$V_{CC} - \underbrace{I_C R_C}_{0} - V_{CE} = 0$$

$\Rightarrow V_{CC} = V_{CE}\quad (I_C = 0)$



when, $V_{CE} = 0$,

$V_{CC} - I_C R_C = 0$

$$\Rightarrow I_C = \frac{V_{CC}}{R_C} = 8 \times 10^{-3}$$

$$\boxed{R_C} = \frac{V_{CC}}{I_C} = \frac{20}{8}$$

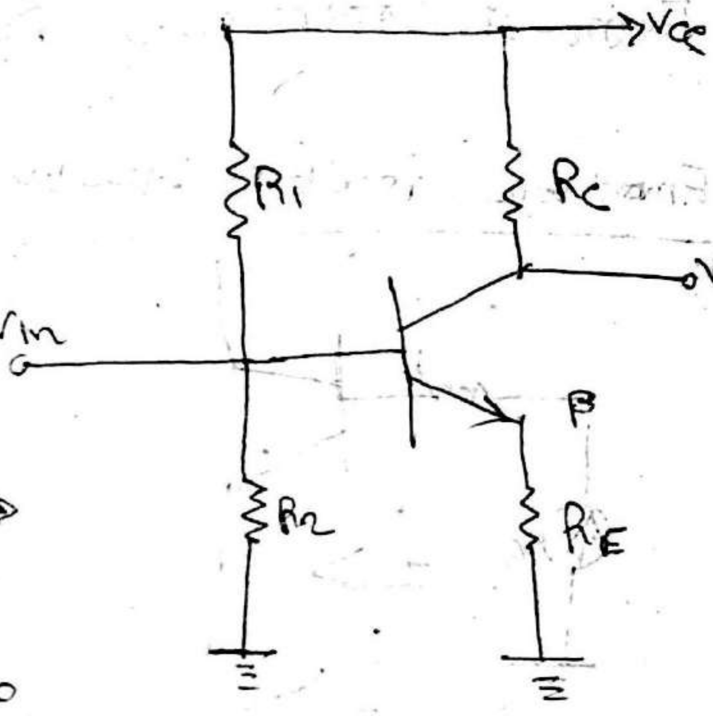
EEE-211 8th cycle A day 01-July 2013

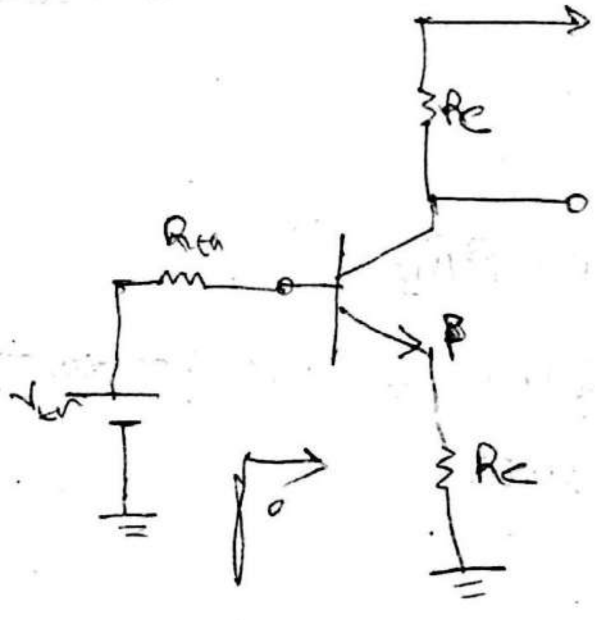
Approximate Analysis:

$$I_B = \frac{V_{th} - V_{BE}}{R_B + (\beta+1)R_E}$$

$$V_{th} = \frac{R_2 V_{cc}}{R_1 + R_2}$$

$R_B = R_1 \| R_2$





Base current approximately 0 হলে $I_1 = I_2$

$\boxed{\beta R_E \geq 10 R_2}$ হলে I_B প্রায় 0 হবে.

$$V_B = \frac{V_{cc} R_2}{R_1 + R_2}$$

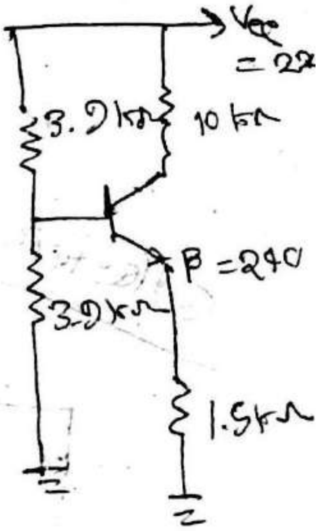
$V_B = V_{BE} + I_E R_E$

$I_E \cong I_C$ (I_B almost $= 0$)

$$\boxed{I_C = \beta I_B}$$

* I_E independent of β.

Q-point এর variation minimize করার জন্য $10R_2 \le \beta R_E$ হবে।



Exact:

$$I_B = \frac{\cancel{V_{CC}}\,V_{th} - V_{BE}}{R_{th} + (\beta+1)R_E}$$

$$= \frac{\cancel{22-0.7}}{}$$

$$= \frac{2-0.7}{3.545 + 241\times1.5}$$

$$= 3.56\ \mu A.$$

$R_{th} = R_1 \| R_2$

$$= \frac{39\times3.9}{39+3.9}$$

$$= 3.545$$

$$V_{th} = \frac{V_{CC}\times R_2}{R_1+R_2}$$

$$= \frac{22\times3.9}{42.9}$$

$$= 2$$

$\cancel{I_B}$ $I_C = \beta I_B$

$$= 240\times 3.56\ \mu A$$

$$= 0.854\ mA.$$

$I_E = I_B + I_C = 0.8582\ mA.$

$V_{CC} - I_C R_C - V_{CE} - (I_B + I_C) R_E = 0$

$\Rightarrow V_{CE} = 12.21\ V$

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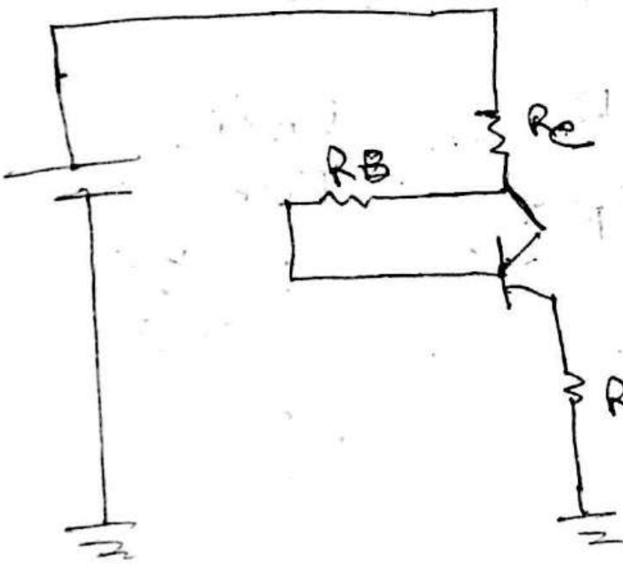
Approximate:

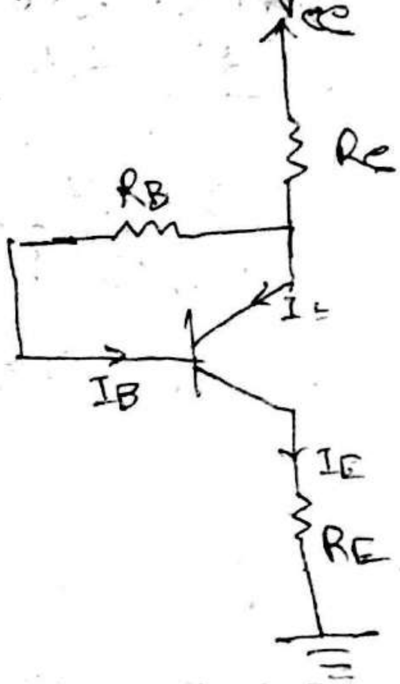
$V_{CC} - I_C R_C - V_{CE} - I_C R_E = 0$

$\Rightarrow V_{CE} = V_{CC} - I_C(R_C + R_E)$

$= 12.285$ ✓

Collector feedback:





I_B, I_C, I_E

V_{CC}.

$V_{CC} - I_E R_E - (I_B + I_C) R_C - I_B R_B - V_{BE} = 0$

$\Rightarrow V_{CC} - I_B R_B - (I_B + \beta I_B) R_C - V_{BE} - (\beta+1) R_E$

$\Rightarrow I_B = \dfrac{V_{CC} - V_{BE}}{R_B + (\beta+1)(\cancel{\beta} R_C + R_E)}$

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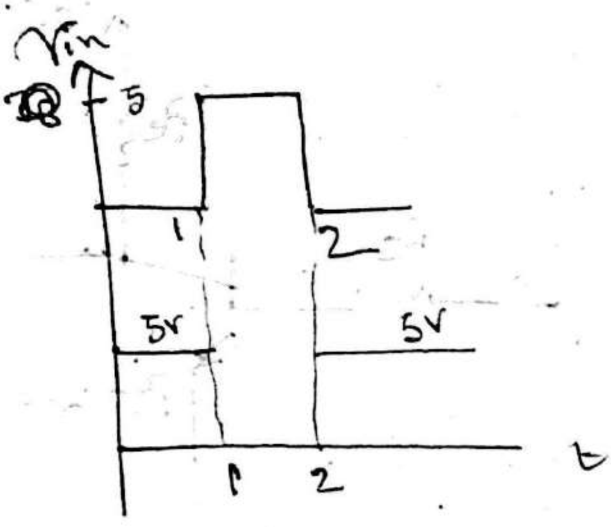
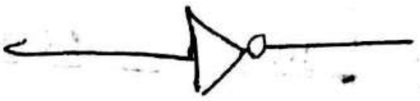


Input low → output high

Input high → output low

$\boxed{\text{not gate}}$



x	$\bar{x}$
1	0
0	1

Digital circuit → high volt
5 V → logic 1
Digit " → low volt
either 0 or −5V.

logic 0.

$$I_B = \frac{V_0 - 0.7}{R_B} = \qquad I_C = \beta I_B$$

Ideal switch → output volt 0.

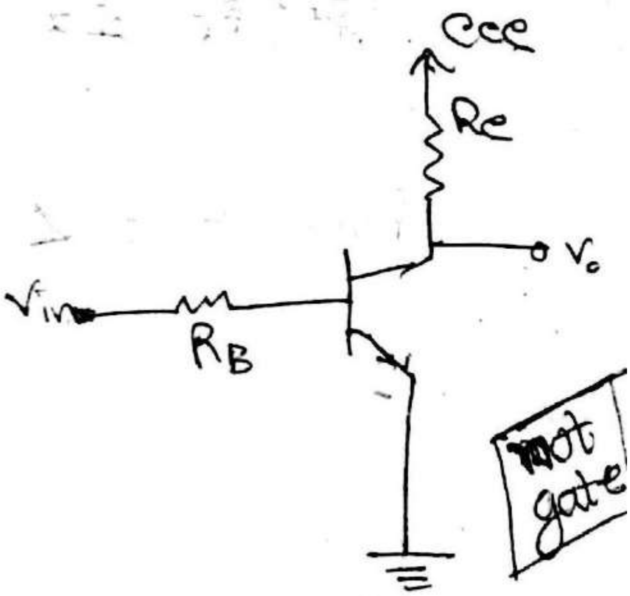
$I_C \geq I_{Csat}$

$I_C = I_{Csat}$ → soft saturation.

যে saturation হলে transistor আর ফিরে আসতে পারে না
যেটি আর ফিরে আসতে না পারে, সেটি Hard saturation.
Switch-এর জন্য Hard saturation-এ নিতে হবে যাতে β
vary-এর জন্য I_C change না হয়। $I_C > I_{Csat}$.

EEE-211 8th cycle K day 06 July 2013

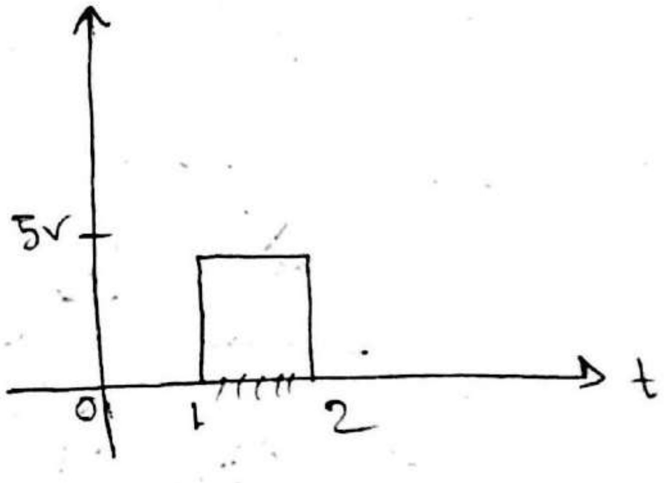
BJT as a switch:

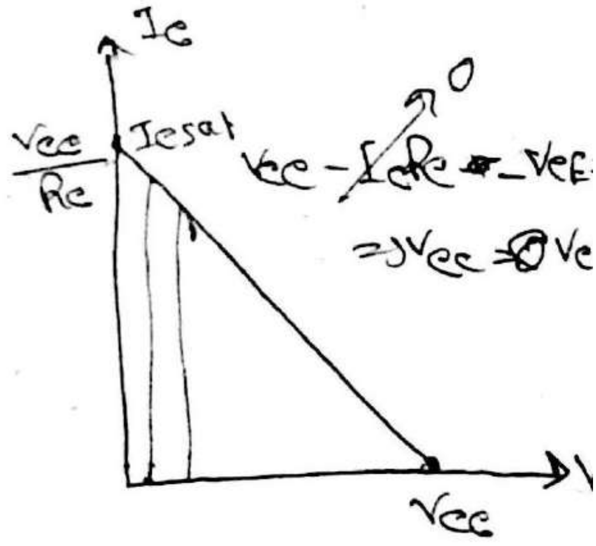


switch Off → cut off

on → saturation.

Input voltage < 0.7 v. হলে circuit cut off-এ থাকে,





$V_{cc} - \cancel{I_c R_c} - V_{CE}$

$\Rightarrow V_{cc} = V_{CE}$

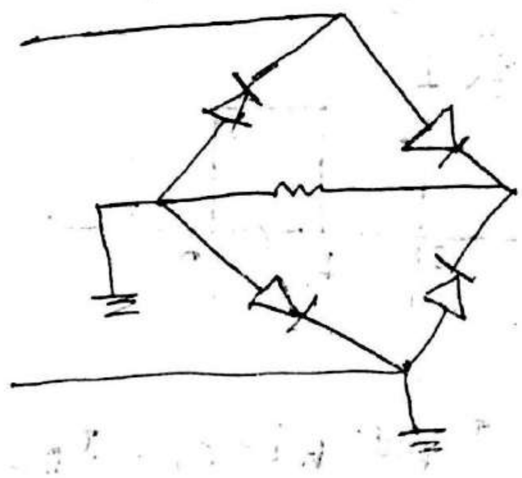
Input vol = 0, $I_B = 0$, $I_C = 0$, $V_{CE} = 5V$

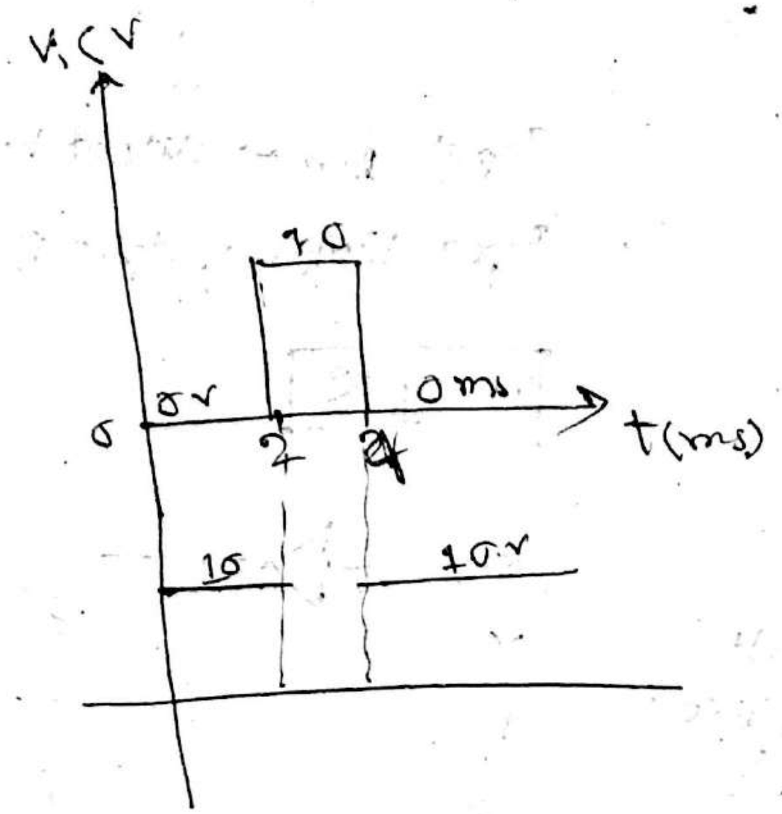
Collector resistance যোগ হওয়ায় এর Benifit

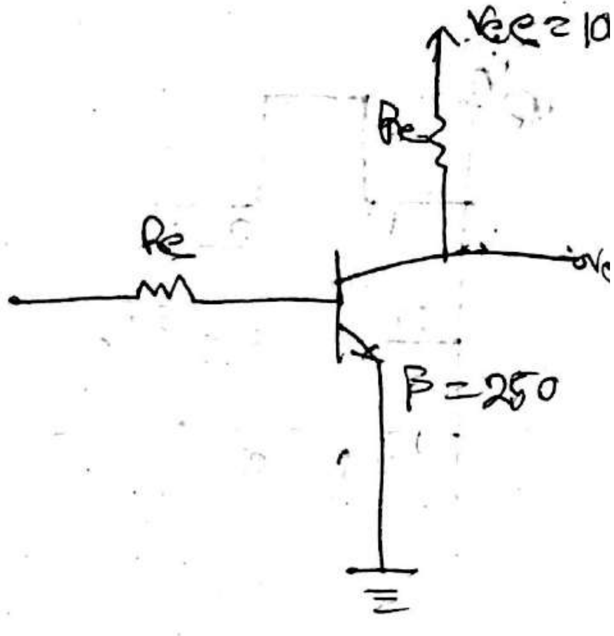
$(\beta+1)R_E$ হতে ~~হবে~~ $(\beta+1)(R_C+R_E)$ বেশি হবে

Fixed bias < Emitter feedback bias < collector feedback এর bias
voltage divider bias
সবচেয়ে বেশি
-এর stability.

npn - এর use বেশি.
pnp → এর use limited.
+ve volt হলে -ve dc voltage তৈরি করা difficult.







$I_{Csat} = 10mA$

t = 0 − 2 and 4 > Base-এ current নাই

output 10

$I_{sat} = \frac{V_{CC}}{R_C} = 10mA$

$\Rightarrow R_C = 1k\Omega$

Saturation-এ যাবে $I_{Bsat} = \frac{I_{Csat}}{\beta} = \frac{10\ mA}{250}$

$= 40\mu A$

I_{Bsat}-এর থেকেও বেশি saturation-এ নিয়ে গেলে তবে hard saturation-এ যাবে.

I_{Bsat} must be $> 40\ \mu A$.

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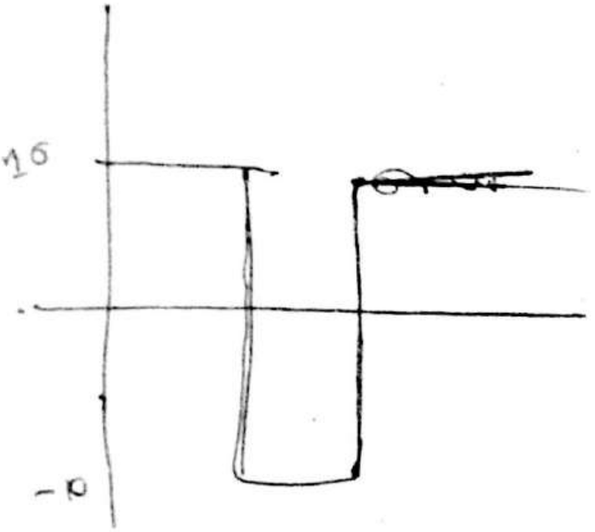
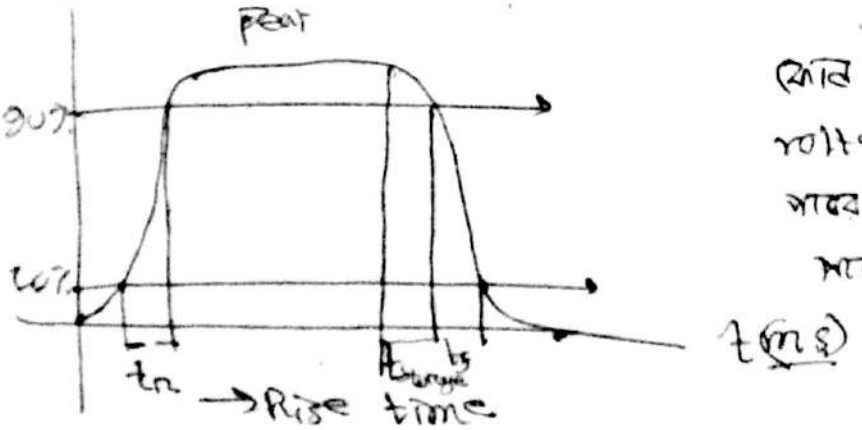
Let. $I_B = 50\mu A$. ধরি তবে. R_B বের ? করতে হবে

$$I_B = \frac{V_i - V_{BE}}{R_B}$$

$$\Rightarrow R_B = \frac{10 - 0.7}{50}$$

(অফ করার জন্য -ve voltage দিয়ে করতে হবে,)





কোন device t=0-এ voltage vary করতে পারে না / switch হতে পারে না।

V_{cc} - 5 হলে 5-এর 10 - 90% যেতে যে সময় তা Rise time

0 - 10% পর্যন্ত delay time

delay time + Rise time = On time (0 - 90%)

fall - এর আগের পর্যন্ত storage time

90% - 10% - এ আসতে fall time

Storage time + fall time → off time