1C-day
02-04-16

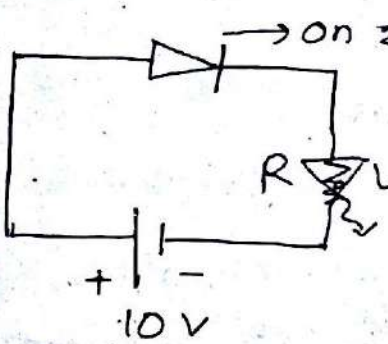
Electronics ①

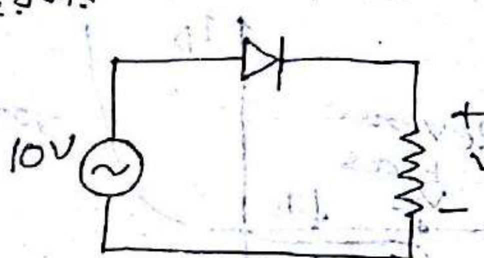
Semiconductor ও conductor এর মধ্যে পার্থক্য?

- intrinsic (বিশুদ্ধ)
- extrinsic (ভেজাল)
  - p-type
  - n-type

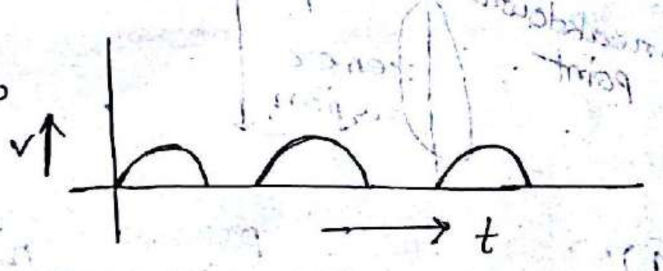
Vacuum tube → 1st semiconductor device
Diode (—▷|—) → 2nd ″ ″

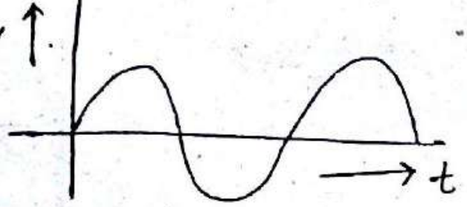
→ on হতে 0.7v দরকার





LED লাগালে current flow করে জ্বলে উঠবে



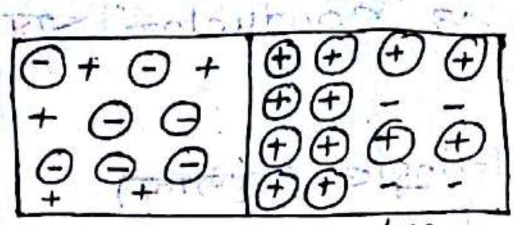


Specific resistance → আপেক্ষিক রোধ.

04-04-18
1(E)

②

Semiconductor diode / P-n diode



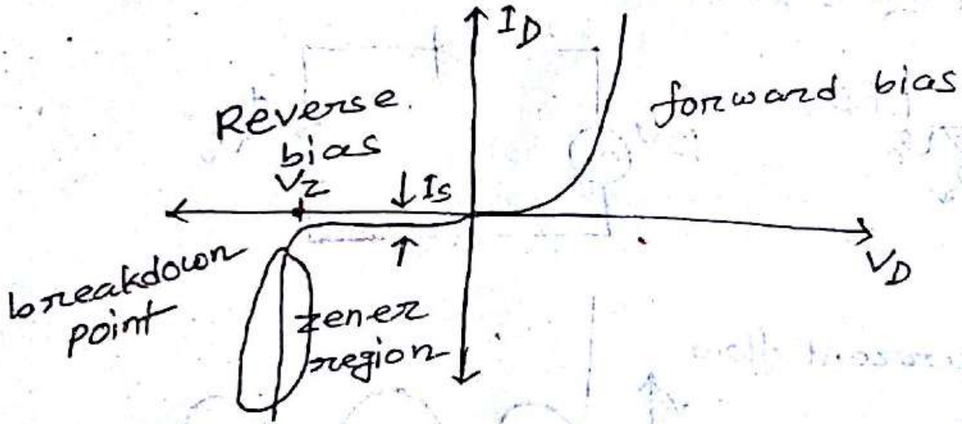
majority carrier

minority carrier

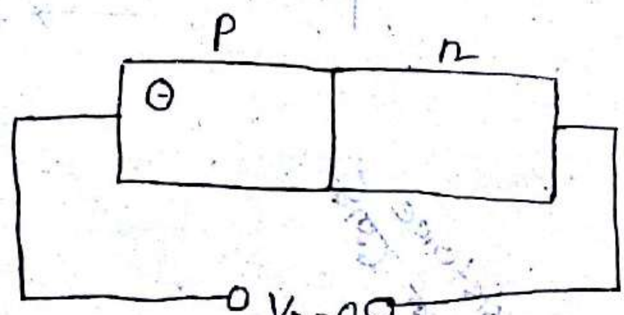
① NO bias condition

② Reverse " "

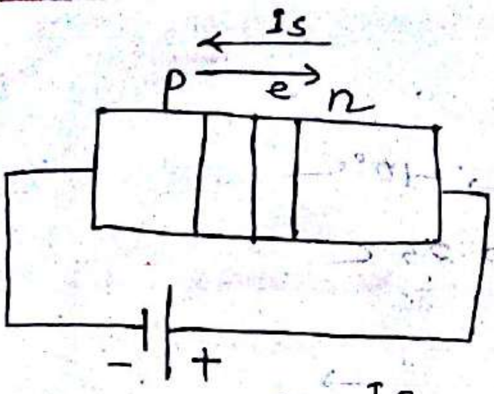
③ Forward " "



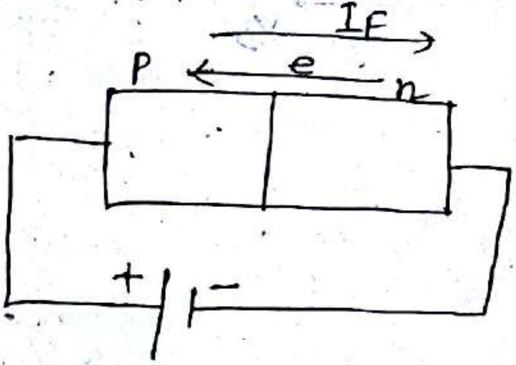
①



NO Bias অবস্থায় কোন current পাই না



② Leakage
~~Lieakge~~ current / Reverse saturation current



③ Forward current

$$I_D = I_{F(mA)} - I_S \ (\mu A)$$

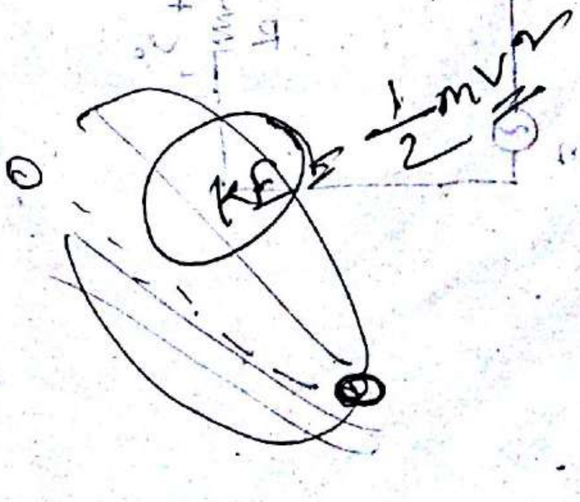
Direction হবে P হতে n এর দিকে

শুধুমাত্র Forward bias এই conduction এ, যাবে

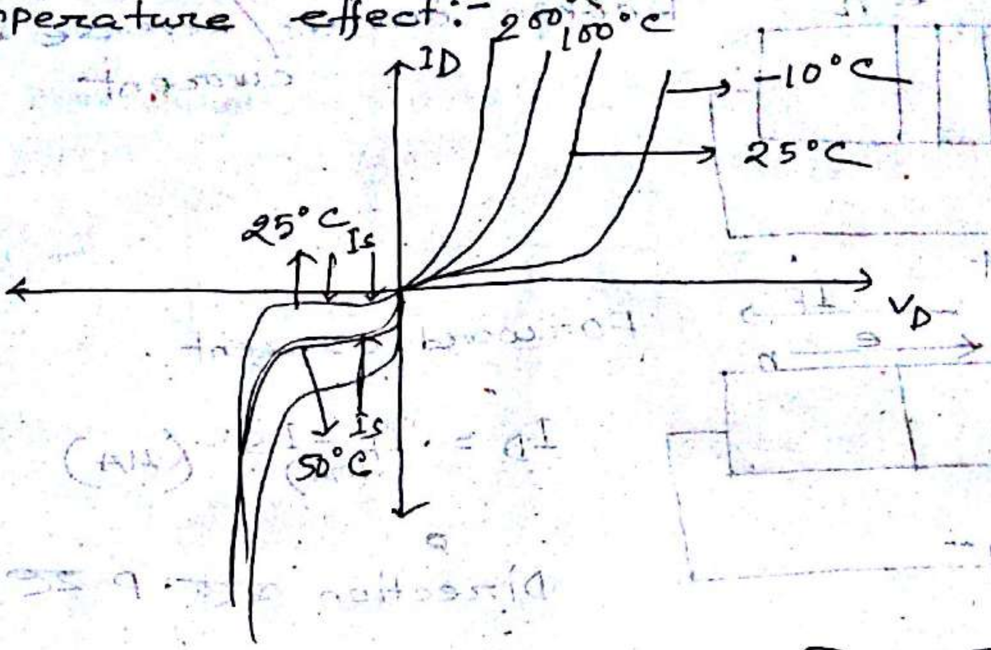
Breakdown ২টা:-

① Avalanche breakdown: Reverse bias অবস্থায় voltage টা বাড়ালে minority carrier এর বেগ এবং K.E. বাড়ে, collision বাড়ে বাড়ে, ফলে হয় breakdown

② zener breakdown: Doping level টা বাড়ায় দিব, electric field তৈরী হবে, এতে যে breakdown ঘটবে তাকে Zener breakdown বলে।



Temperature effect:-



10°c বাড়ালে lickage current দ্বিগুণ হয়।

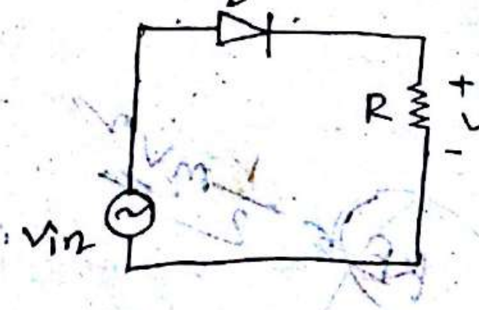
06-04-16
2(B)

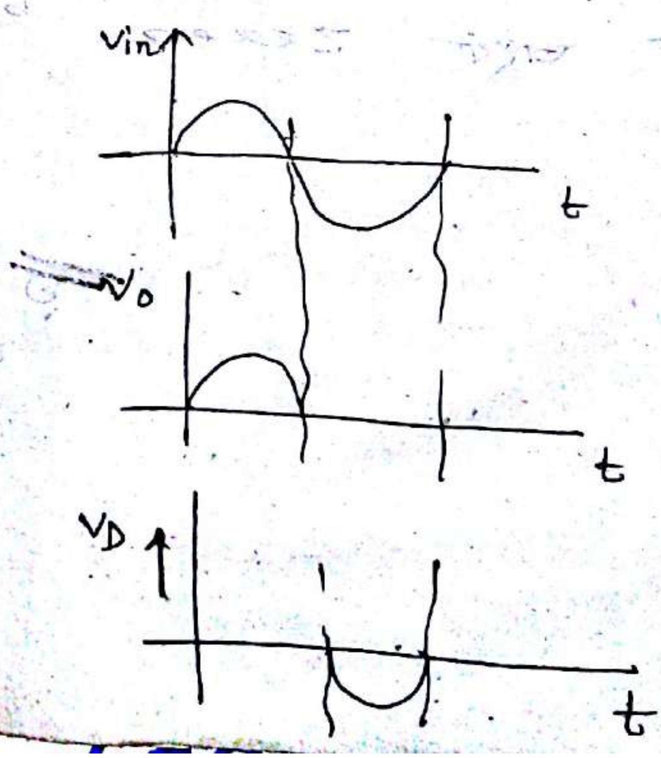
Electronics

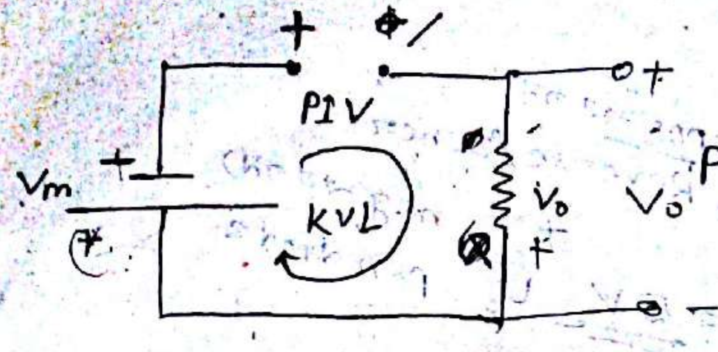
PIV or PRV rating:-

- Peak Inverse voltage → Reverse bias অবস্থায় সর্বোচ্চ যে voltage পাওয়া যায়

Peak reverse voltage   PIV ≥ V_m







$PIV = V_m - V_0 = V_m$

$V_m + V_0$

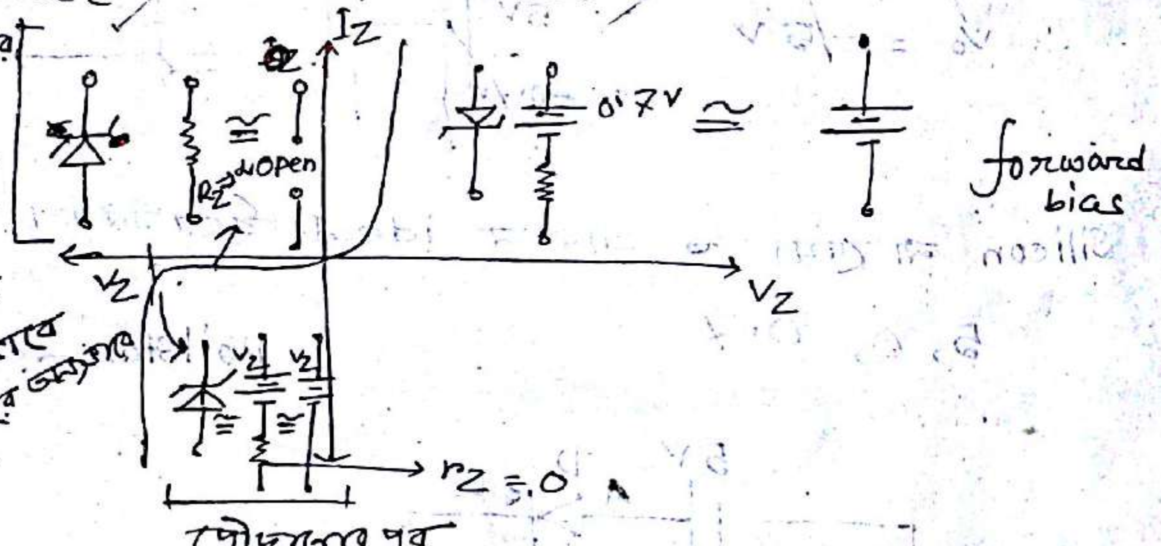
$+V_m + PIV + V_0 = 0$

$\Rightarrow PIV = -(V_m + V_0)$

একটা ~~...~~ circuit দিয়ে দিলে PIV rating কত?

Zener diode:

Zener diode   P-n diode



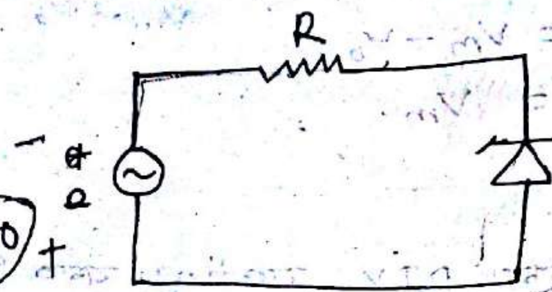
Reverse biase অবস্থায় কাজ করে Zener diode

P-n ~~এর মত~~ diode " " forward biase

Zener forward অবস্থায় P-n এর মত কাজ করে

Voltage regulator ~~...~~ তৈরী করা হয় Z. D দিয়ে

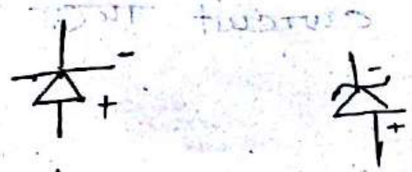
circuit:-

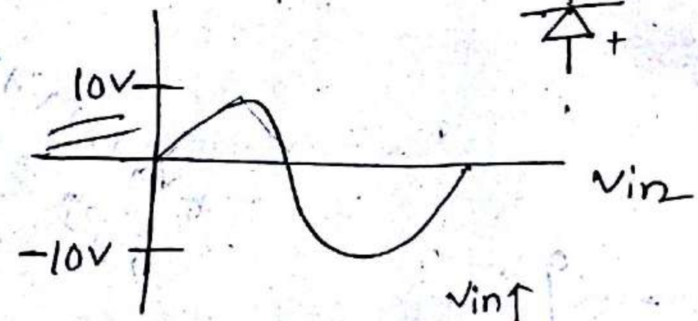


pos এর জন্য Reverse/Zener

+ neg এর জন্য p-n diode

V_0



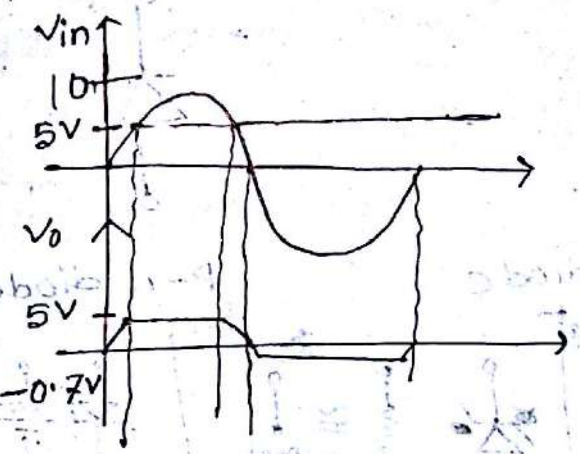


$PIV = \cancel{V_m + V_0}$

$\Rightarrow \cancel{10 - 5 = + V_0}$

$\Rightarrow \cancel{5 = + V_0}$

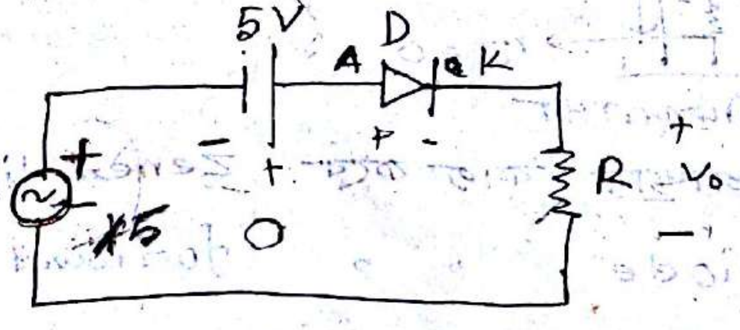
$\therefore \cancel{V_0 = -5V}$



Silicon না দেয়া থাকলে ideal ধরে নিব।

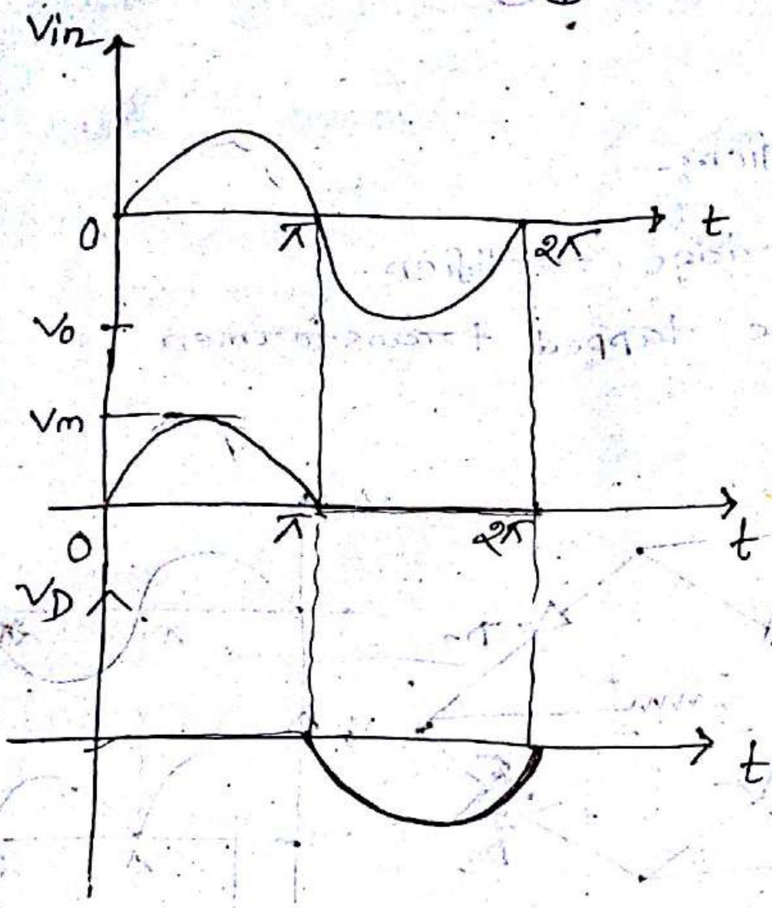
5, 0, 0.7

Boilstate এর math দেখাব



$v_i + 5 = 0$

$\Rightarrow v_i = -5V$



Voltage এর D.C. level কেমন করে বের করে, Diode Voltage

$$V_{dc} = \frac{1}{T}\int_0^T V_0\,dt = 0.318\,(V_m - V_\gamma)$$

$$= 0.318\,V_m$$

$$V_{dc} = \frac{1}{T}\int_0^T V_m \sin\omega t\,dt$$

$$= \frac{1}{T} \times V_m \left[\frac{-\cos\omega t}{\omega}\right]_0^T$$

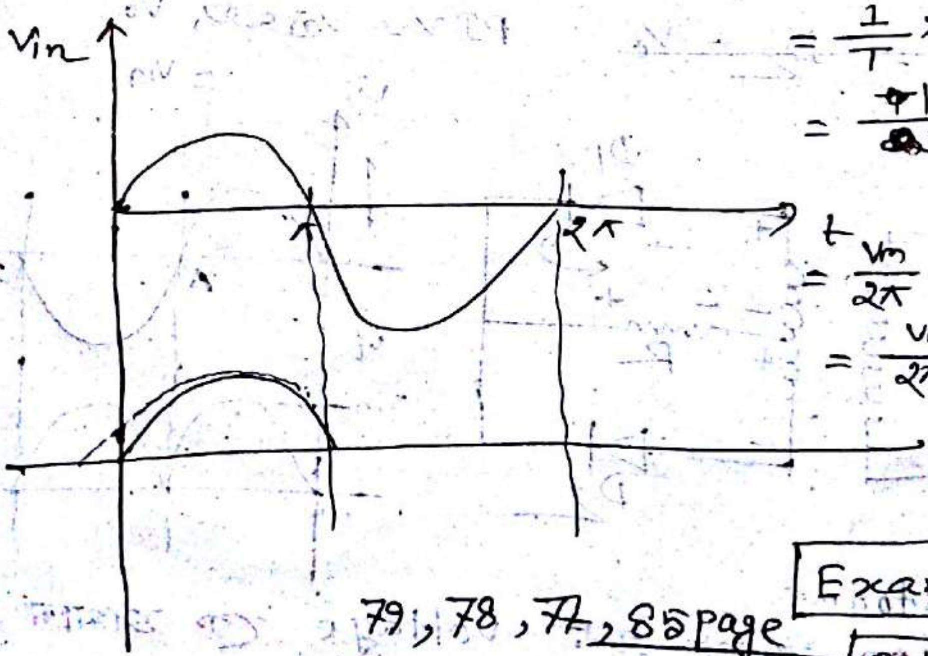
$$= \frac{1}{T} \times V_m \times \frac{1}{2\pi/T}\left[-\cos\frac{2\pi}{T}t\right.$$

$$= \frac{V_m}{2\pi}\left[-\cos 2\pi + \cos 0\right]$$

$$= \frac{V_m}{2\pi} \times 2$$

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

$$= 0.318\,V_m$$



Example + Exercise

Related Assignment

79, 78, 77, 85 page

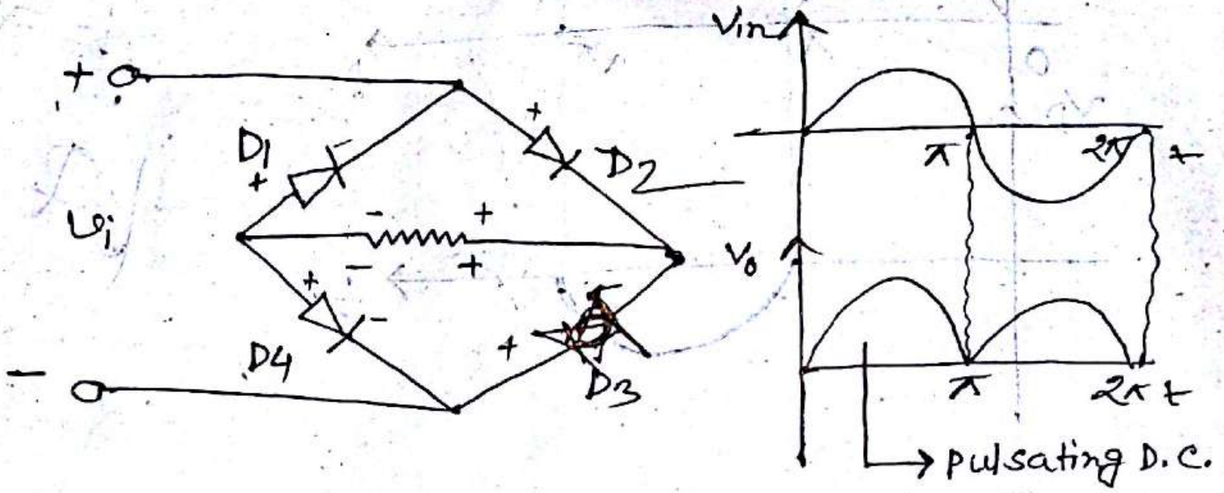
94 2:25 82 p. 83

09-04-16
C-day

- Full wave rectifier:-

(i) Full wave bridge rectifier
(ii) Using centre tapped transformer

(i)



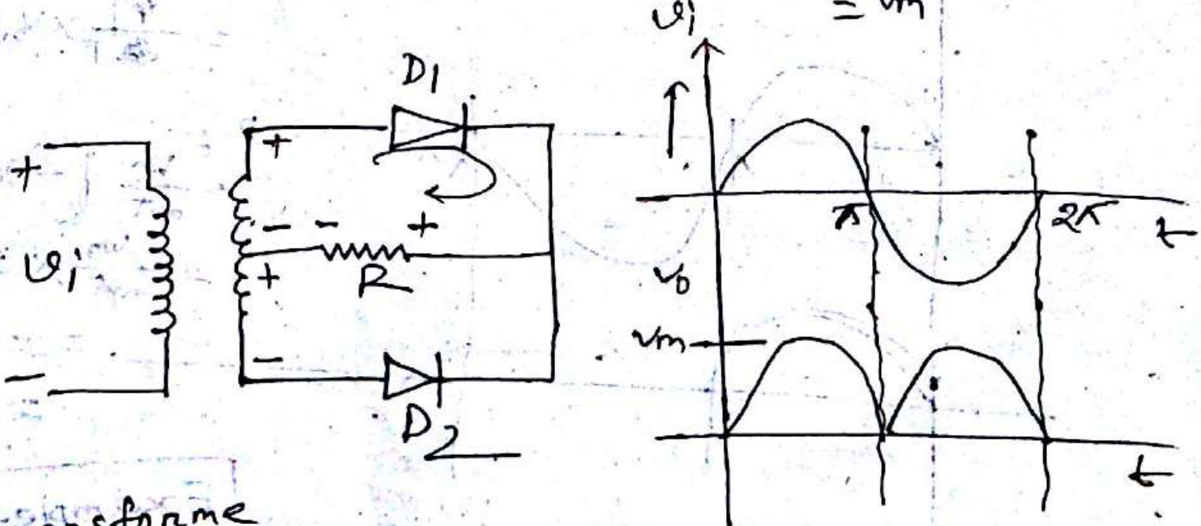
প্রত্যেকটা Diode এর PIV rating কত ?

~~$D_1 + D_2 + R_L$~~

~~PIV = $D_1 + D_2$~~

~~PIV = $D_2 - V_0$~~   PIV = ~~Vm~~ V_0
$= V_m$

(ii)



Centre transforme Tapping → এর কাজ হল voltage কে সমান দুইভাগে বিভক্ত করে।

~~PIV = Vm~~

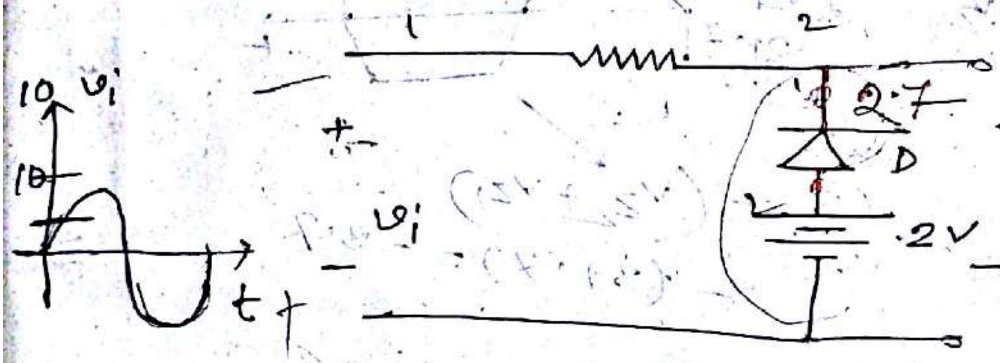
~~PIV = 2Vm~~

$$PIV = V_o + V_m$$
$$= V_m + V_m$$
$$= 2V_m$$

তেমনও যে bridge rectifier এর ক্ষেত্রে $PIV = V_m - V_o$
এবং Using centre tapped এর ক্ষেত্রে $PIV = 2V_m$

11-04-16
2(E) day

Clippers:



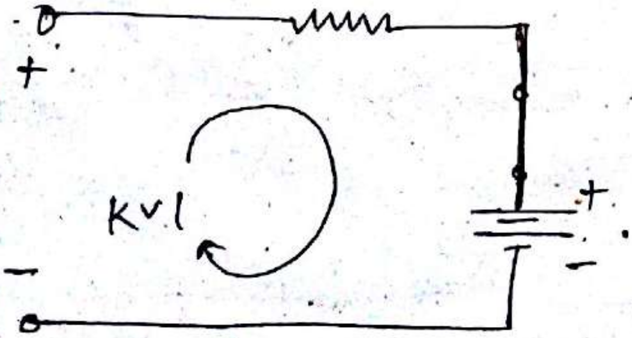
+ → Diode এর ক্ষেত্রে parallel

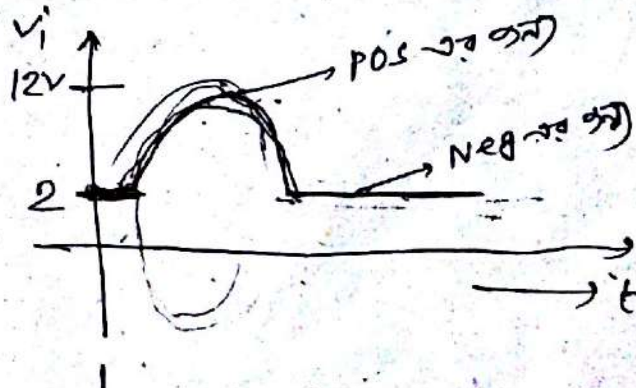
~~10+2~~
~~$v_i + v_o + 2 = 0$~~
$v_i = 12$
বা $v_i + v_o + 2 = 0$
$v_o = -12$

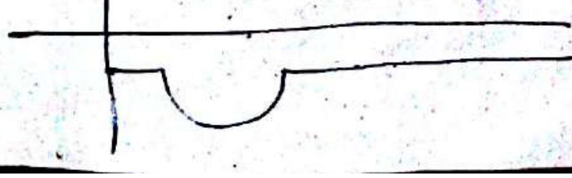
$v_i + 2 = v_o$
$v_i + 2$
$= 10 + 2$

clipper এমন একটি circuit যেটা input এর একটা অংশ কেটে দেয় বাকিটা অপরিবর্তিত থাকে

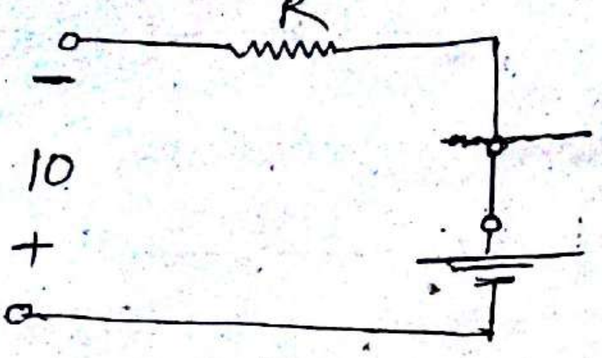
Diode যখন on.



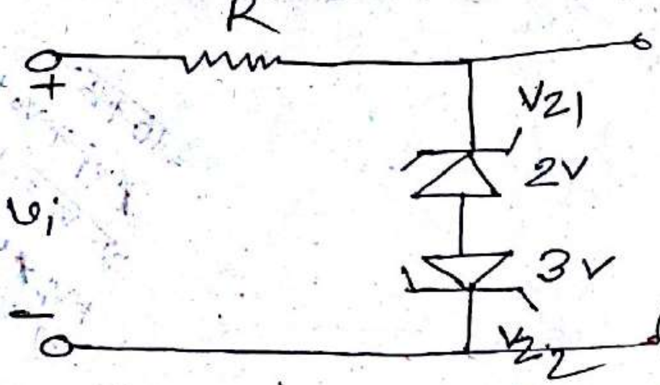


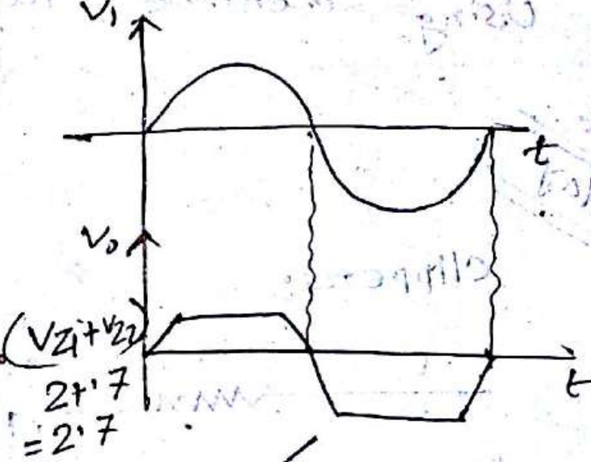


যখন $10 + 2 = 12$



=0=

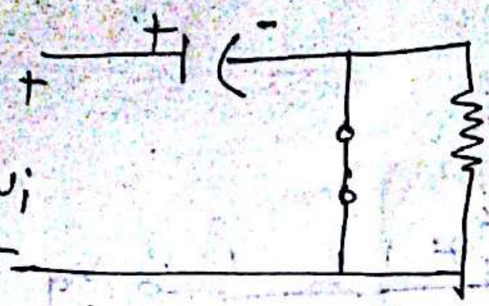


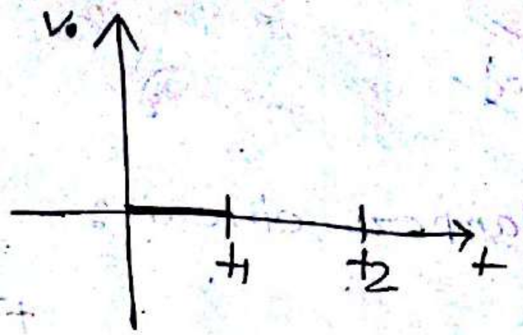


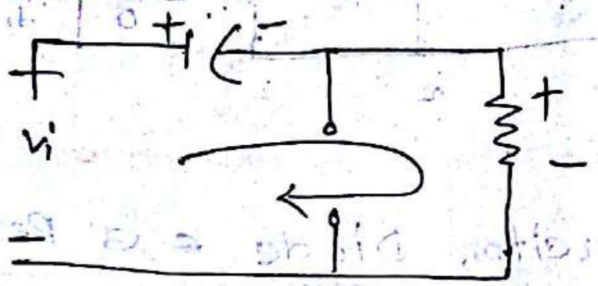
$-(V_{Z2}+V_{Z1})$

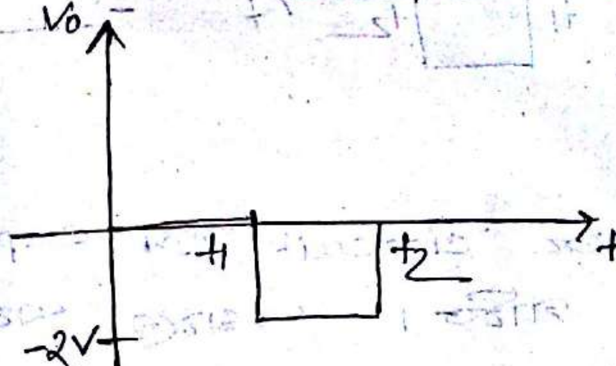
$-(3+.7) = -3.7$

Boilstead practice



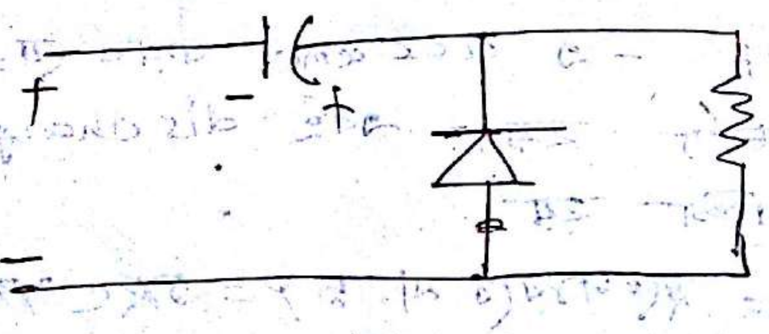


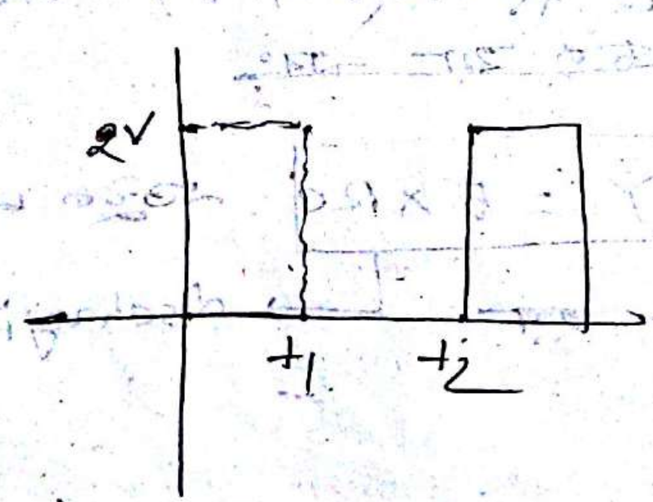




$$v + v + v_0 = 0$$

$$v_0 = -2V$$

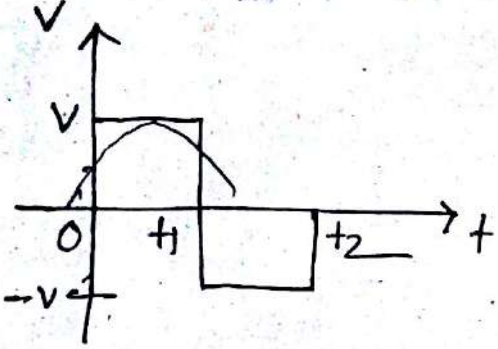


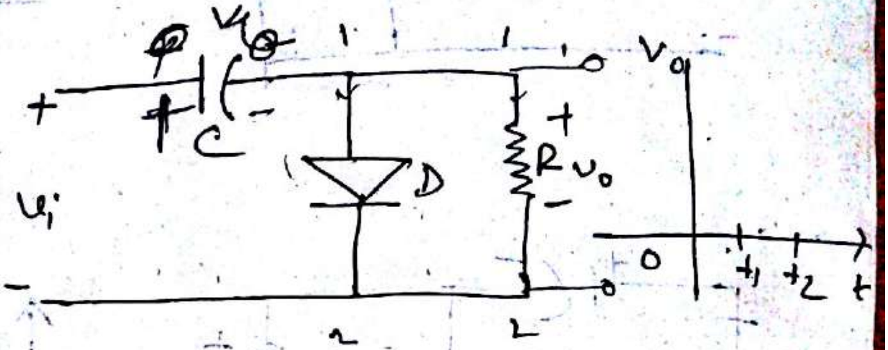


18-09-16
3E - day

AUB

clamper circuit :-





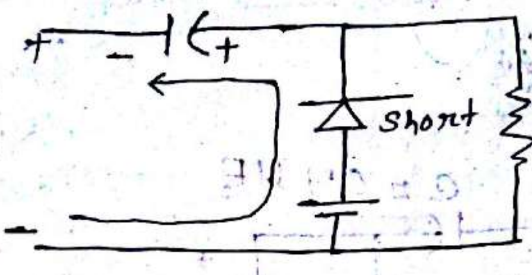
clamper circuit হল capacitor, Diode ও Resistor নিয়ে গঠিত। এখানে এক Level এর DC/AC থেকে অন্য level এর DC/AC করব

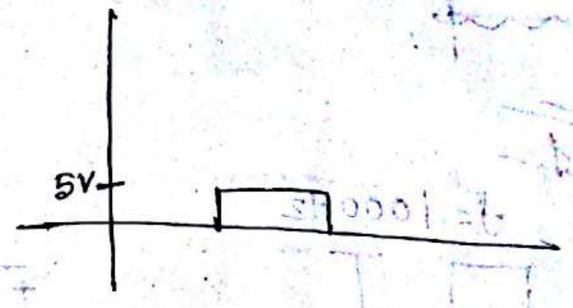
1. যে cycle থেকে forward এ যাবে
সেই " " ~~কাজ~~ শুরু করব

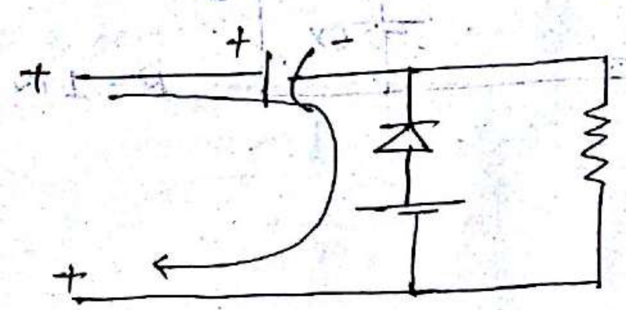
2. clamper circuit এ assume করব যে, খুবই অল্প সময় চার্জ হয়, এবং discharge এর সময় খুব বেশি হয়
dischare হতে পারবে না $5\gamma = 5RC$ সময় দিয়ে

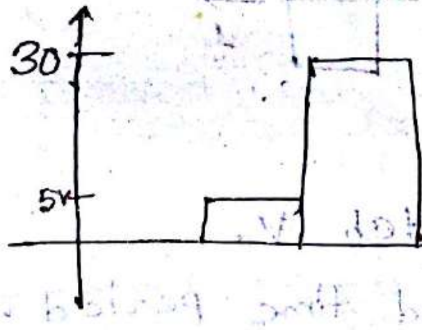
3. ~~instantaneous চার্জ হয় এবং~~

capacitor $\boxed{5\gamma = 5 \times RC}$ এতটুক চার্জ ধরে রাখবে
যে cycle এ চার্জ হয় → discharging time.

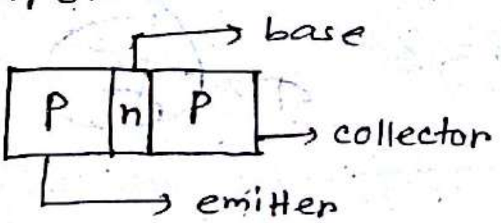


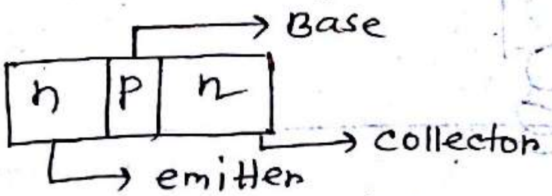






Bipoler Junction transistor (BJT)





Three region:-

(i) Active region - emitter - base forward biased
base - collector reverse "

(ii) Saturation - emitter - ~~emitter~~ base forward bias
Base - collector " "

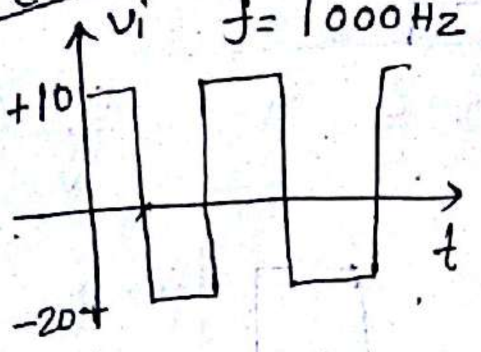
(iii) cut off - emitter - base reverse bias
Base - collector " "

জংশন দুইটা p-n, n-p

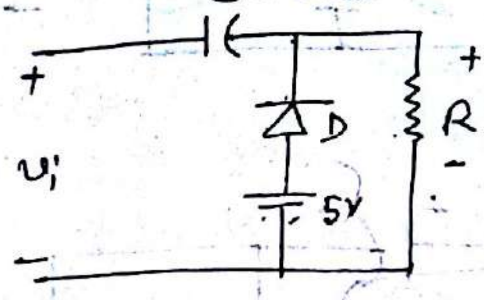
20-04-16

4 (B) day

$f = 1000\,Hz$



$C = 0.1\,\mu F$

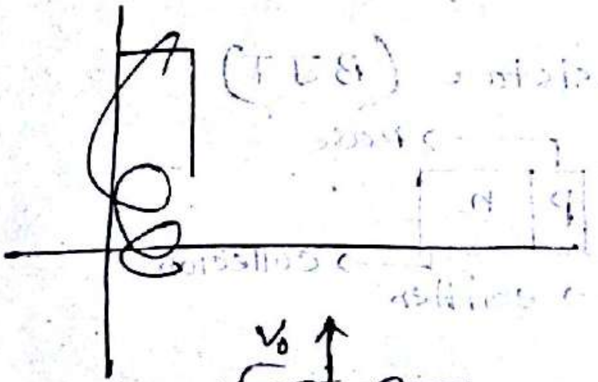


$R = 1K$

(i) sketch V_o

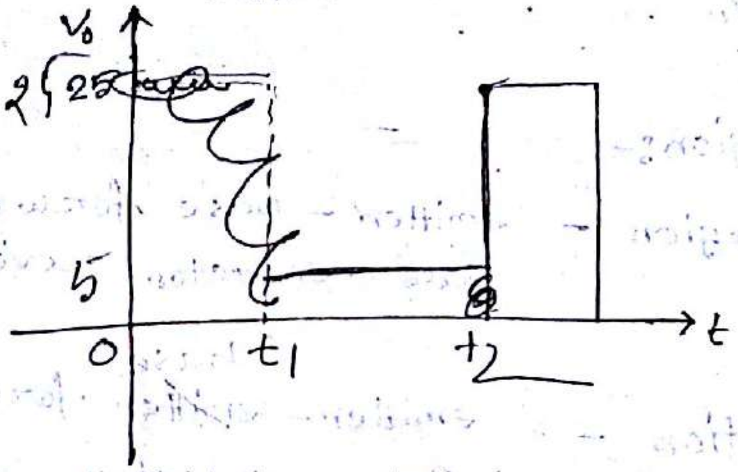
(ii) Find time period

(iii) find discharging time of the capacitor.



$T = \frac{1}{f}$

(ii)



(iii) $\underline{5RC} = 5 \times 1 \times 0.1 \times 10^{-6} \times 10^{3}$

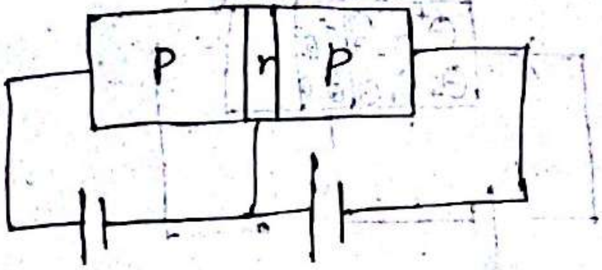
$= 10\,ns$

$5 \times 1 \times 10^{3} \times 0.1 \times 10^{-6}$

$= 10\,ms$ Ans

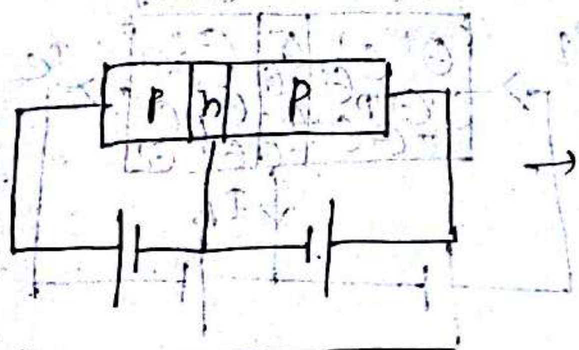
Bipolar → যেখানে দুই ধরনের carrier-ই current flow র জন্য দায়ী।

(i)



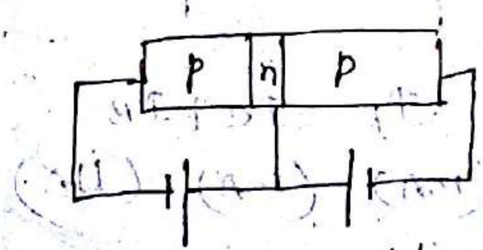
→ Active region (এই region → কাজ করে ~~en~~ Amplifier)

(ii)

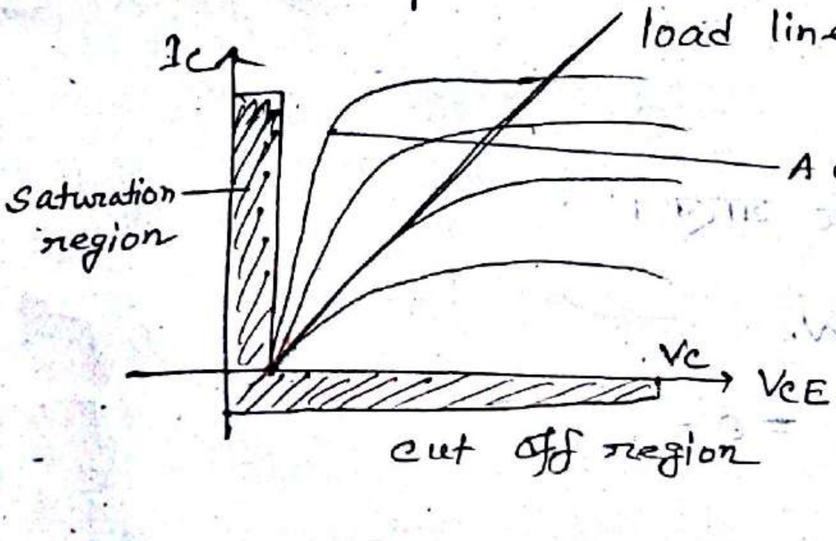


→ saturation

(iii)



→ cut off

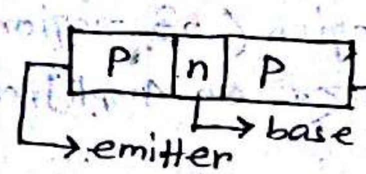


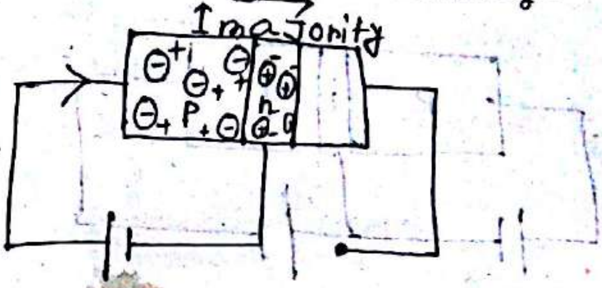
load line (এই line থেকে define করব যে কোনটা নিয়ে কাজ করব)

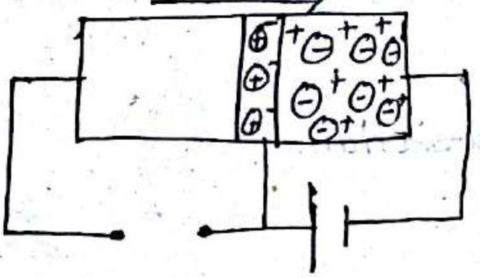
এই অধ্যায়ের প্রথম দুই বা তিন পৃষ্ঠা রিভিশন দাও।

25-04-16
4 (E)-day

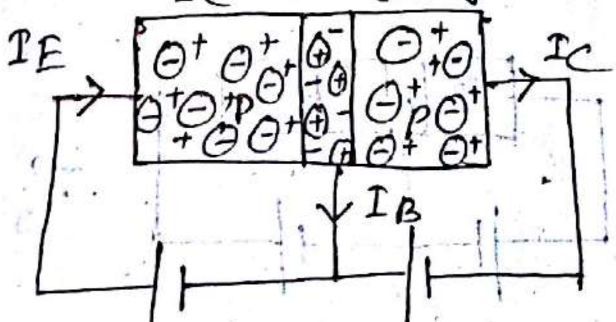
Working principle of p-n-p transistor :-







I_C = I majority + I minority



$$I_E = I_C + I_B$$

(mA) (mA) (µA)

আসলে আসলে

$$\boxed{I_E = I_C}$$

ক্ষুদ্রতার কারণে I_B বাদ যাবে।

n p n ⟶ H.W.

= 0 =

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

idieally $\alpha = 1$, practically = 0.99

$$\beta = 50 - 200$$

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

⑱

27-04-16
5 (B) daf

Show that (i) $\alpha = \frac{\beta}{1+\beta}$

(ii) $\beta = \frac{\alpha}{1-\alpha}$

$I_E = I_C + I_B$ ——— (i)

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

$I_E = \frac{I_C}{\alpha}$ ——— (ii)

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

$I_B = \frac{I_C}{\beta}$ ——— (iii)

$I_E = I_C + I_B$

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

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

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

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

$\Rightarrow (1+\beta)\alpha = \beta$

$\Rightarrow \alpha + \beta\alpha = \beta$

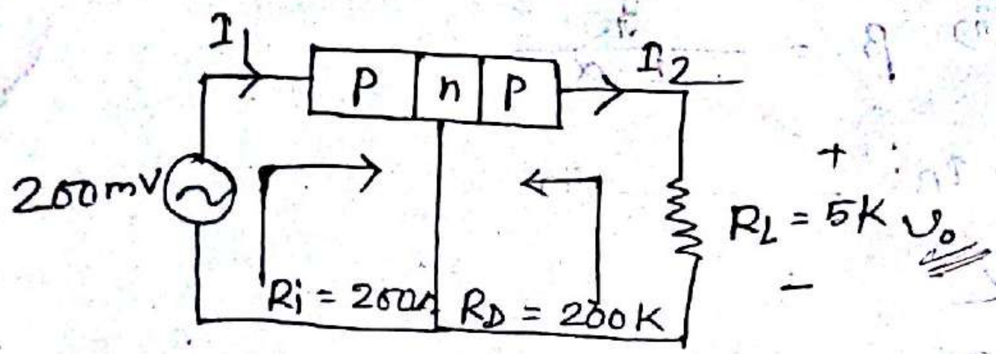
$\Rightarrow \alpha = \beta - \beta\alpha$

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

α ও β কিস প্রমাণ্য proof very very Important

** একটা transistor কিভাবে amplifier হিসেবে কাজ করে ??

Common-base transistor as Amplifier :-



clamper পর্যন্ত
CT 1

find voltage Amplifier ??

$$I_1 = I_E = \frac{200mV}{200}$$
$$= 1mA$$

$$I_2 = I_C$$

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

$$\Rightarrow 1 = \frac{I_C}{I_E} \quad [\alpha = 1]$$

$$\Rightarrow 1 = \frac{I_C}{1}$$

$$\therefore I_C = 1\,mA = I_2$$

$$V_0 = I_2 R_L$$
$$= 1mA \times 5K$$
$$= 5V \quad \text{(Ans.)}$$

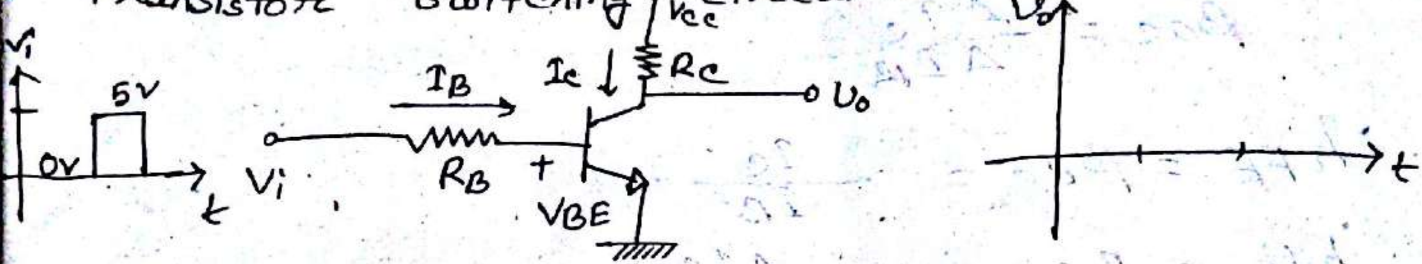
$$\text{Amplification} = \frac{5\times10^3}{200}$$
$$= 25$$

~~inpu~~ output টা input এর তুলনায় 25 গুণ বৃদ্ধি পেয়েছে

Amplification: ~~input volatage এর তুলনায়~~ $\dfrac{\text{input volatage}}{\text{output volatage}}$

$$= \frac{\cancel{200}^{40} \times 10^{-3}}{\cancel{5}}$$
$$= 40 \times 10^{-3}$$

Transistor switching circuit :-



Amplifier হিসেবে কাজ করবে → Active region

Switch " " " → saturation, & cut off region এ থাকবে

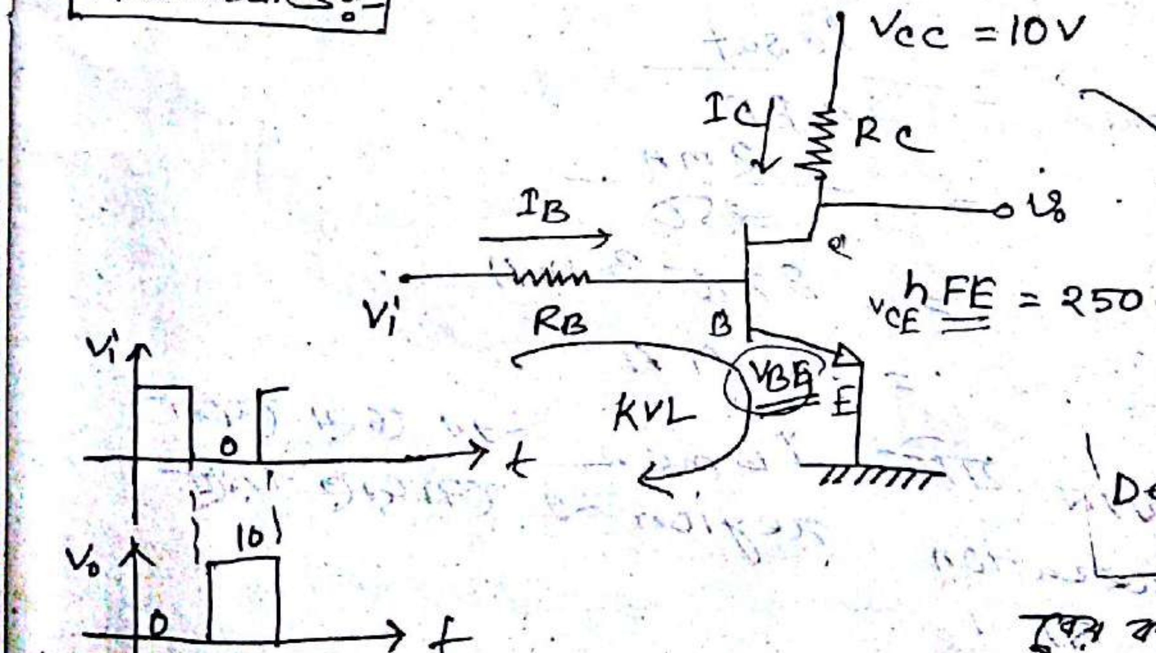
এখানে Low দিলে high পাচ্ছি

Saturation Level → short circuit হবে, current টা সর্বোচ্চ হবে (short

সুইচ হিসেবে কাজ করে।

0 দিলে 5 পাচ্ছি, 5 দিলে 0 পাচ্ছি তাই এটা inverter হিসেবেও কাজ করে।

$\boxed{\text{Mathmatics:-}}$



Ic = 2mA

→ KVL apply করে

Design the switching circuit

বের করতে হবে Rc, RB

Draw করা থাকতেও পারে নাও পারে না থাকলে Draw করতে হবে

$$\beta_{dc} = \frac{I_C}{I_B}$$

$$\beta_{ac} = \frac{\Delta I_C}{\Delta I_B}$$

$$h_{FE} = \beta_{dc} = \frac{I_C}{I_B}$$

$$h_{fe} = \beta_{ac} = \frac{\Delta I_C}{\Delta I_B}$$

ভাইটা on হতে হলে saturation এ কাজ করতে হবে,

$$I_{C_{sat}} = 2mA$$

$$V_{CC} = 10V$$

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

$$R_C = \frac{V_{CC}}{I_C}$$

$$= \frac{10}{2\ mA} = 5K\Omega$$

$V_{BE} \rightarrow$ silicon হলে $= 0.7V$

R_B জানতে হলে I_B জানতে হবে,

$$I_{B_{max}} = \frac{I_{C_{sat}}}{h_{FE}}$$

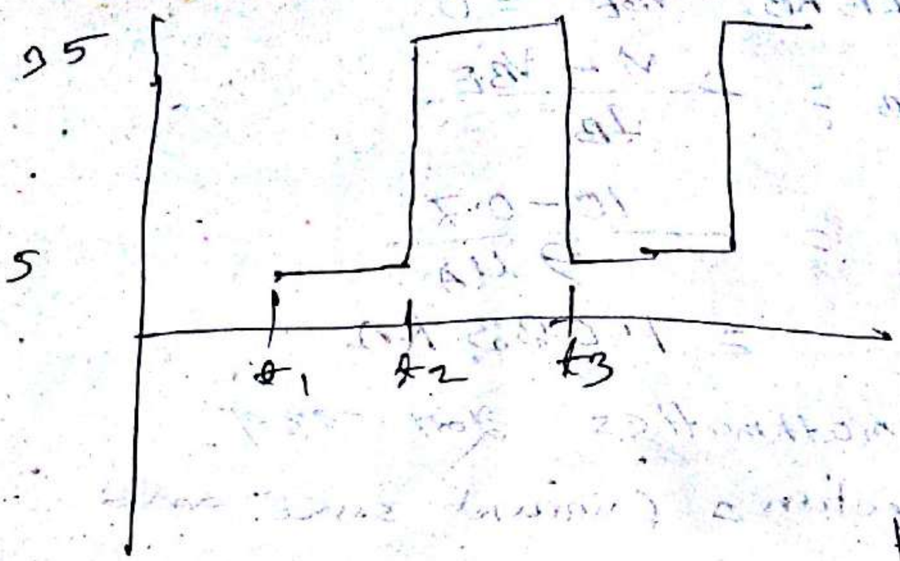
$$= \frac{2\ mA}{250}$$

$$= 8 \times 10^{-3}\ mA$$

$$= 8\ \mu A$$

I_B এর মান যদি $I_{B_{max}}$ এর চেয়ে বেশি না হলে saturation region এ পৌঁছাতে পারবে না।

Let, $I_B = 9\ \mu A$

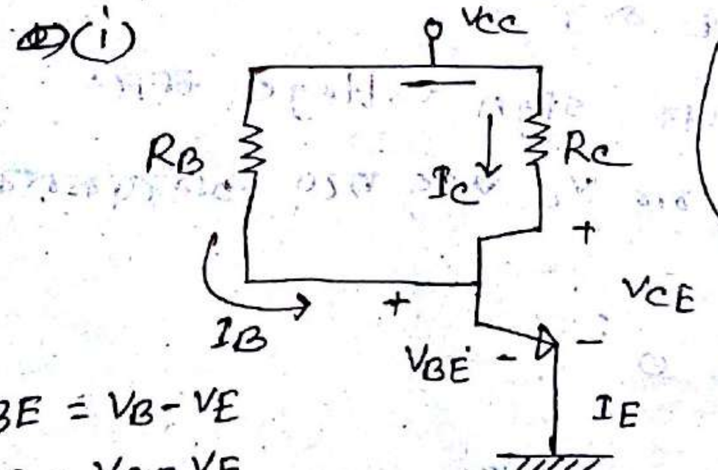


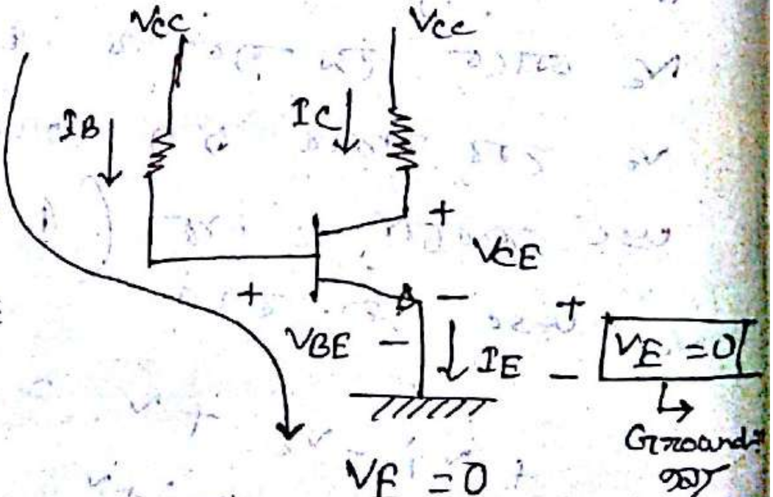
30-04-16
5(c) day

DC biasing of BJT (current control current source)

(i) Fixed bias configuration
(ii) Emitter stabilized bias configuration
(iii) Voltage divider bias configuration

(i)





$V_{BE} = V_B - V_E$

$V_{CE} = V_C - V_E$

$V_E = 0$

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

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

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

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

$$I_C = \beta I_B$$

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

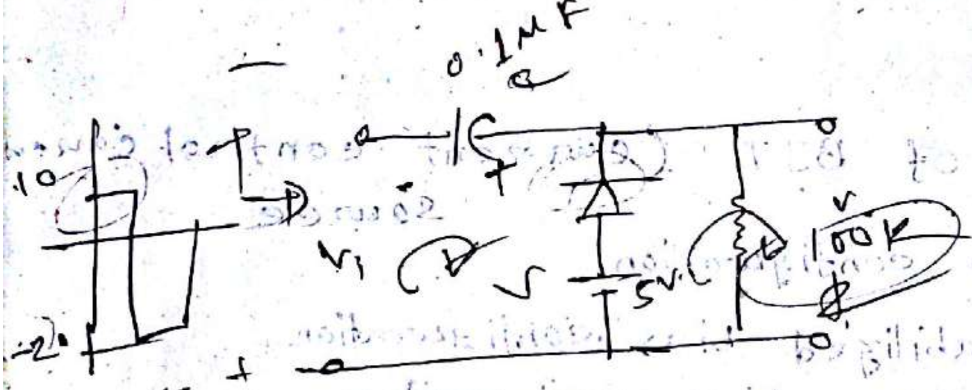
$$\Rightarrow R_B = \frac{V_i - V_{BE}}{I_B}$$

$$= \frac{10 - 0.7}{9\,\mu A}$$

$$= 1.033\ K\Omega$$

এই related mathmatics গুলা করবা

* seriese connection এ current same and
parallel " " voltage "



যে sign voltage (+ half cycle or (−) half cycle)
V_i আগে হয় তাহলে 1 ধরো
V_o হবে, তারপর যে অবস্থা sign voltage
use করবো 2 ধরো (1 ধরো V_c use হবে অন্যেরকম
use হয় না)

$$+V_i - V_c + V = 0$$

$$V_c = V_i + V$$

$$= 20 + 5 = 25\ V.$$

$$-V_o - V_c + V_i = 0$$

$$\Rightarrow V_o = V_i + V_c$$

$$= 10 + 25$$

$$= 35\ V$$

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

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

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

$$\Rightarrow \frac{V_{CC} - V_{BE}}{R_B + (\beta+1) R_E} = I_B \quad \text{——— (i)}$$

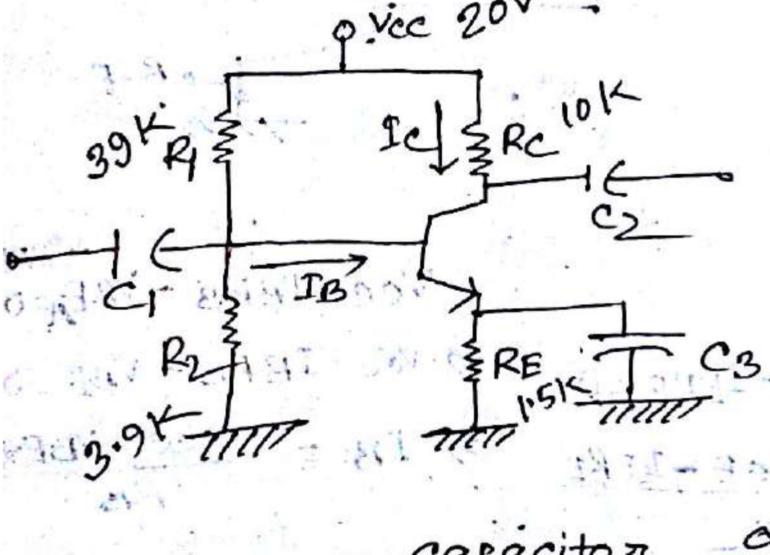
$$I_C = \beta I_B$$

$$I_E = I_B + I_C$$

⇒ ৩ নং example → stability হবেনা।

07-05-16
6(B) day

(iii) Voltage divider biasing configaration:-



$I_B = ?$

$I_C = ?$

$V_{CE} = ?$

$V_C = ?$

$V_B = ?$

$V_E = ?$

⇒ DC তে capacitor open

(i) Exect solving method,

(ii) Approximate " "

Biasing → external থেকে DC voltage supply দিয়ে, Biasing voltage use করে, operating point (Q point) locate করার জন্য

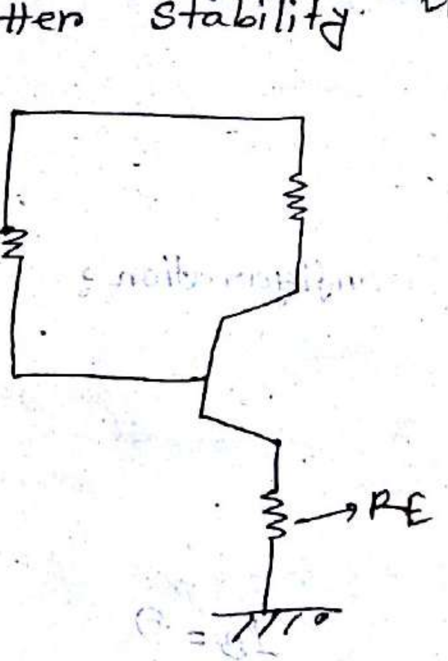
যেটা supply দিচ্ছি, সেগুলো নিচ্ছে সেগুলো সব বিয়োগ হয়ে 0 হয়ে যাবে

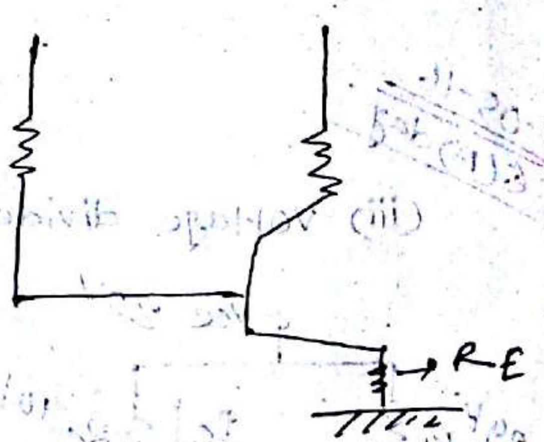
⇒ example → H.W.

Emitter fixed bias configaration:-

better stability পাওয়ার জন্য Resistor যোগ করে

(ii)





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

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

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

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

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

$$I_C = \beta I_B$$

$$V_{BE} = V_B - I_E R_E$$

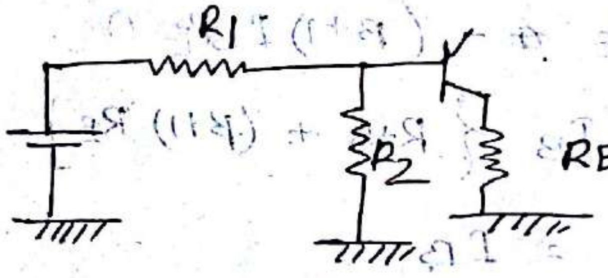
$$V_{CE} = V_C - I_E R_E$$

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

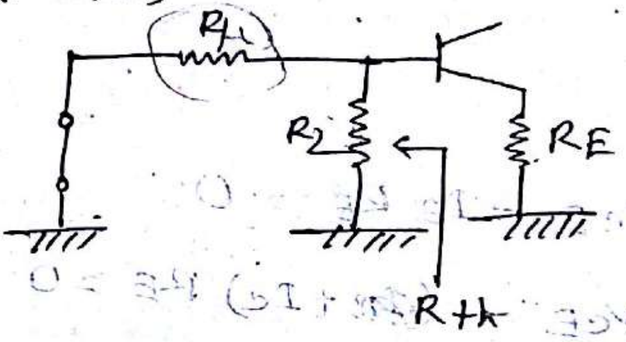
R Thevenin, V Thevenin

└→ source inactive · current 0, open ~~করব~~
Voltage " করা, ওকে short করতে হবে

Redraw,

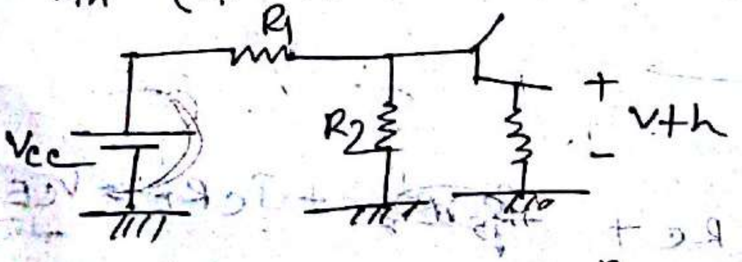


Rth বের করব, V কে short করব,

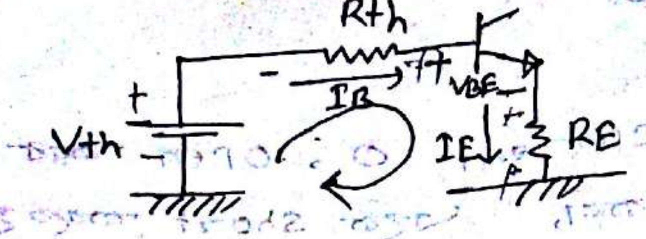


$R_{th} = R_1 \| R_2 = \frac{R_1 R_2}{R_1 + R_2}$

Vth বের করব



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



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

$$\Rightarrow -V_{th} - I_B R_{th} - V_{BE} - (\beta+1) I_B R_E \; 0$$

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

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

$I_E = (I_B + I_C)$

Emitter

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

$$\Rightarrow V_{CC} - I_C R_C - V_{CE} - (I_B + I_C) R_E = 0$$ [IB ছুটবাদ]

$$\Rightarrow V_{CC} - I_C R_C - V_{CE} - \cancel{(I_B + \quad)} (\tfrac{I_C}{\beta} + I_C) R_E$$

$$\Rightarrow V_{CC} - V_{CE} = I_C R_C + \cancel{\tfrac{I_C}{\beta} R_E} + I_C R_E$$

$$\Rightarrow \cancel{\frac{V_{CC} - V_{CE}}{R_C + \frac{1}{\beta}}}$$

$$\Rightarrow V_{CC} - I_C R_C + \cancel{\tfrac{I_C}{\beta} R_E} + I_C R_E = V_{CE}$$

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

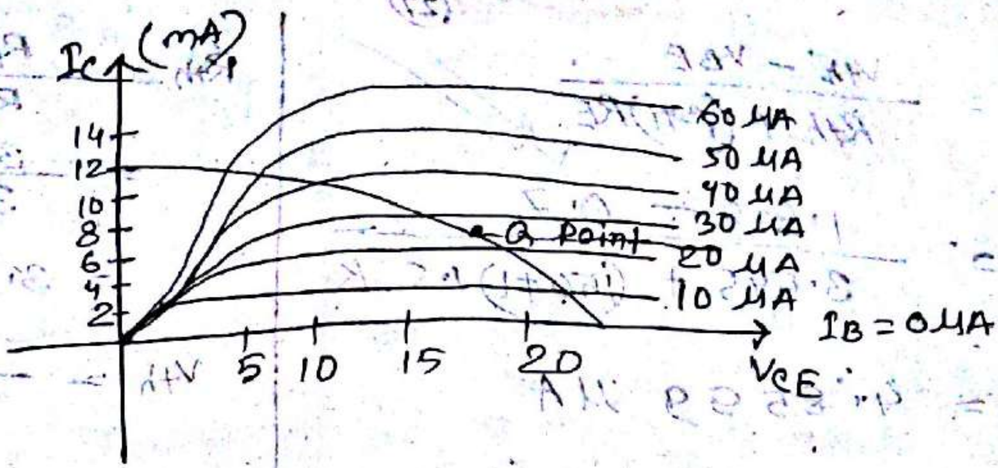
$$= V_{CC} - (R_C + R_E) I_C$$

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

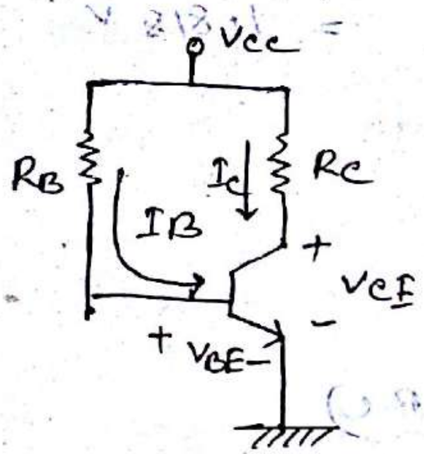
$I_E \cong I_C$

08-05-16

6(c) day



Find V_{cc}, R_B, R_C for fixed bias configuration



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

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

$$\Rightarrow 0 = 20 - I_C R_C$$

$$\Rightarrow I_C R_C = 20$$

$$\Rightarrow R_C = \frac{20}{12} \text{ mA}$$

$$= 1.67 \text{ k}\Omega$$

Operating point → Q → Q point ↳ amplifier

কাজ করবে

$$I_B = 25 \mu A$$

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

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

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

$$= \frac{1.818 - 0.7}{3.545 + (150+1)1.5\,K}$$

$$= 4.8599\ \mu A$$

$$I_C = \beta \times I_B$$

$$= 150 \times 4.8599\ \mu A$$

$$= 728.985\ \mu A$$

$$R_{th} = \frac{R_1 R_2}{R_1 + R_2}$$

$$= \frac{39 \times 3.9}{39 + 3.9}$$

$$= 3.545\ K\Omega$$

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

$$= \frac{3.9}{39 + 3.9} \times 20$$

$$= 1.818\ V$$

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

$$= 20 - (I_B + I_C)(R_E + R_C)$$

$$= 20 - (4.8599 + 728.985)(1.5 + 10)$$

$$= 20 - 733.8449 \times 10^{-6} \times 11.5 \times 10^3$$

$$= 20 - 8.4392$$

$$= 11.561\ V$$

$$V_C = V_{CC} - I_C R_C$$

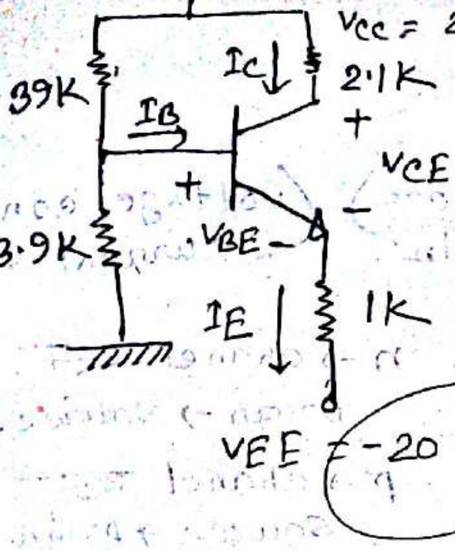
$$= 20 - 728.985 \times 10^{-6} \times 10 \times 10^3$$

$$V_C = 12.71015\ V$$

$$V_E = I_E R_E = I_C R_E$$

$$=$$

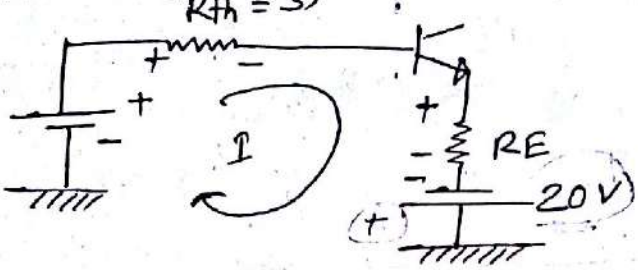
$$V_{BE} = V_B - V_E$$



$\beta = 150$ V

$$R_{th} = \frac{R_1 R_2}{R_1 + R_2} = \frac{39 * 3.9}{39 + 3.9}$$

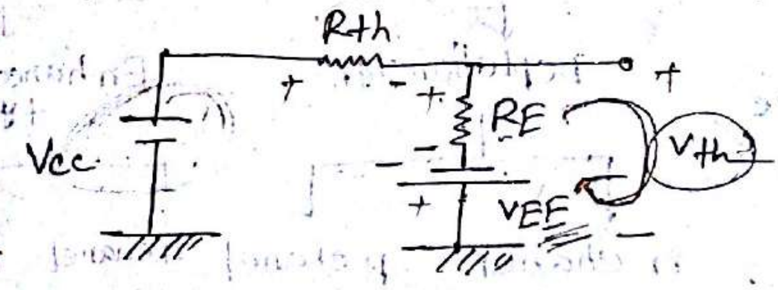
যেভাবে R_{th} আগের মতোই বের করব,



$$V_{CC} - IR_{th} - IR_E + V_{EE} = 0$$

$$\Rightarrow I(R_{th} + R_E) = V_{CC} + V_{EE}$$

$$\Rightarrow I = \frac{V_{CC} + V_{EE}}{R_{th} + R_E}$$



আগে current বের করব

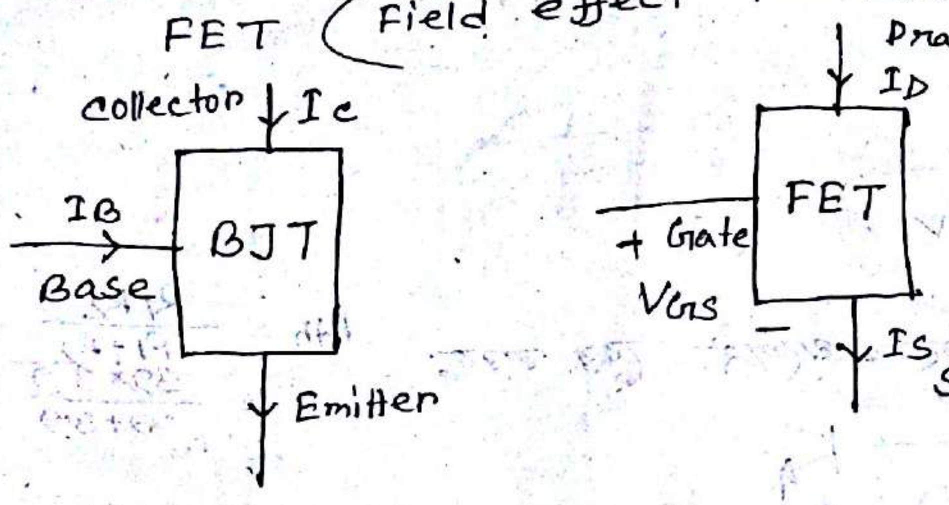
বাকি সব আগের মতই। (Ans:)

V_{BE} $V_{th} + V_{EE} - IR_E = 0$

$\Rightarrow V_{th}$

10-05-16
6 (E)

FET (Field effect transistor) (voltage control current source)



n → chanel চলে
Dran → source
p → chanel চলে
source → Drain

FET

- JFET (Junction field effect transistor)
  - n type
  - P-type
- MOSFET (Metal oxide semi-conductor FET)
  - Depletion type
    - n chanel
    - p chanel
  - Enhancement type
    - n chanel
    - p chanel

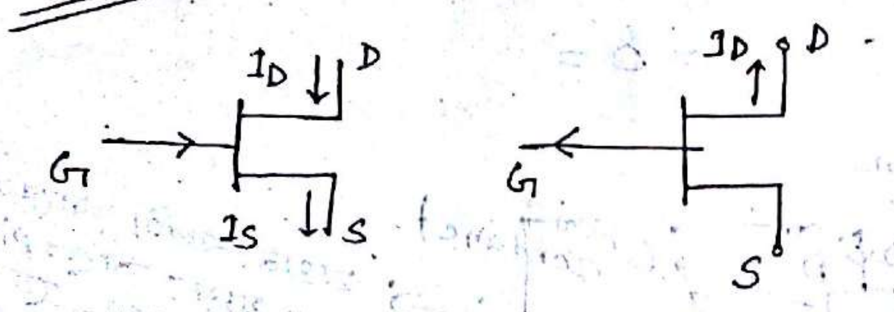
BJT → current control current source

FET → voltage " " "

যখন V_{GS} কে positive করলাম, বিন্দু পরিমাণ electron p type এর মধ্যে recombined হবে, chanel - এ current flow কম হবে। তাই সেক্ষেত্রে V_{GS} positive করা যাবে না।

কিন্তু p type FET এর জন্য অন্য হবে।

22-05-16
7(B)



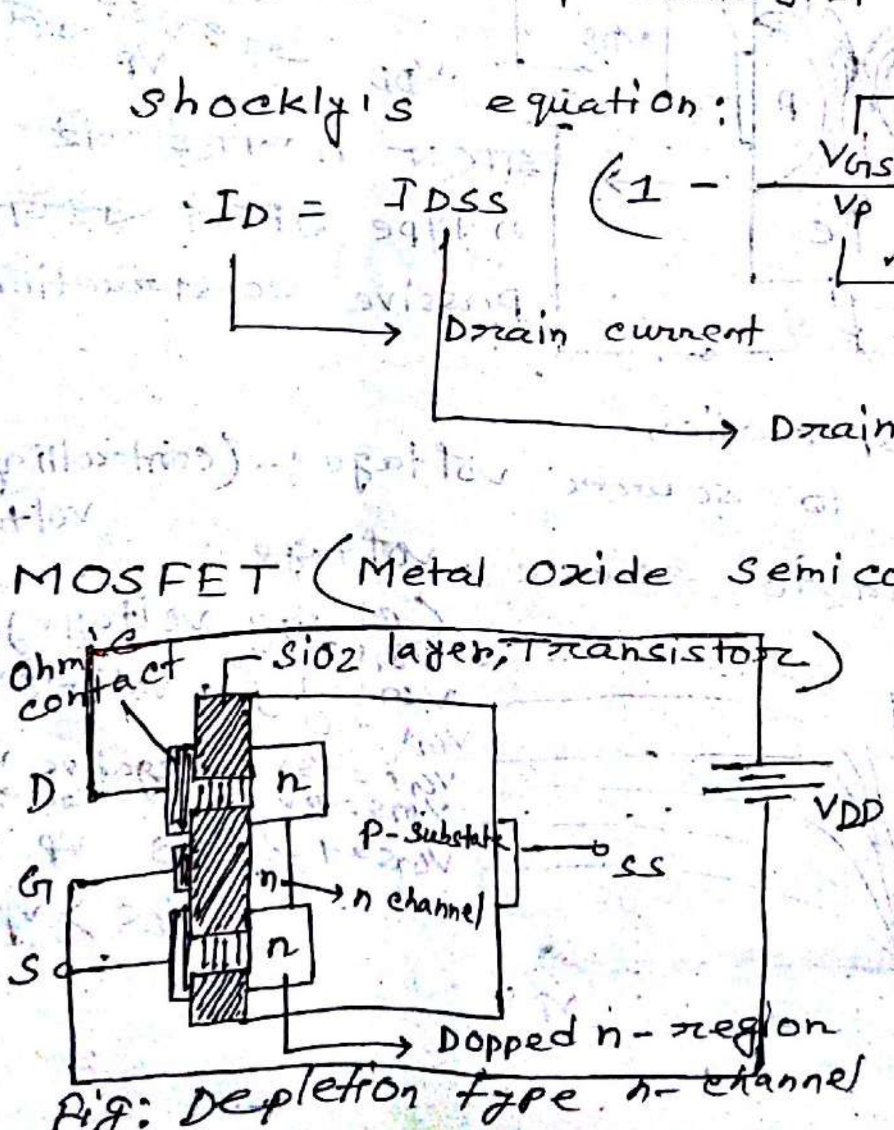
n-channel JFET   p-channel JFET

Shockly's equation:

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

V_{GS} → Gate voltage
V_P → Pinch off voltage
I_D → Drain current
I_{DSS} → Drain current at saturation

MOSFET (Metal Oxide Semiconductor Field effect Transistor)



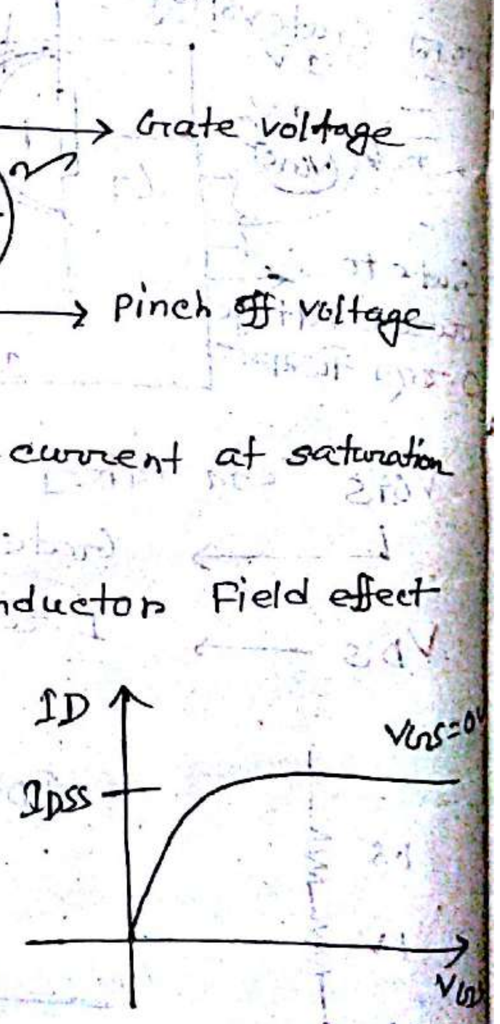


Fig: Depletion type n-channel MOSFET

সুবিধা:-
Amplifier → output → 0, input → ∞ হলে অবশেষে বেশি Amplifier পাওয়া

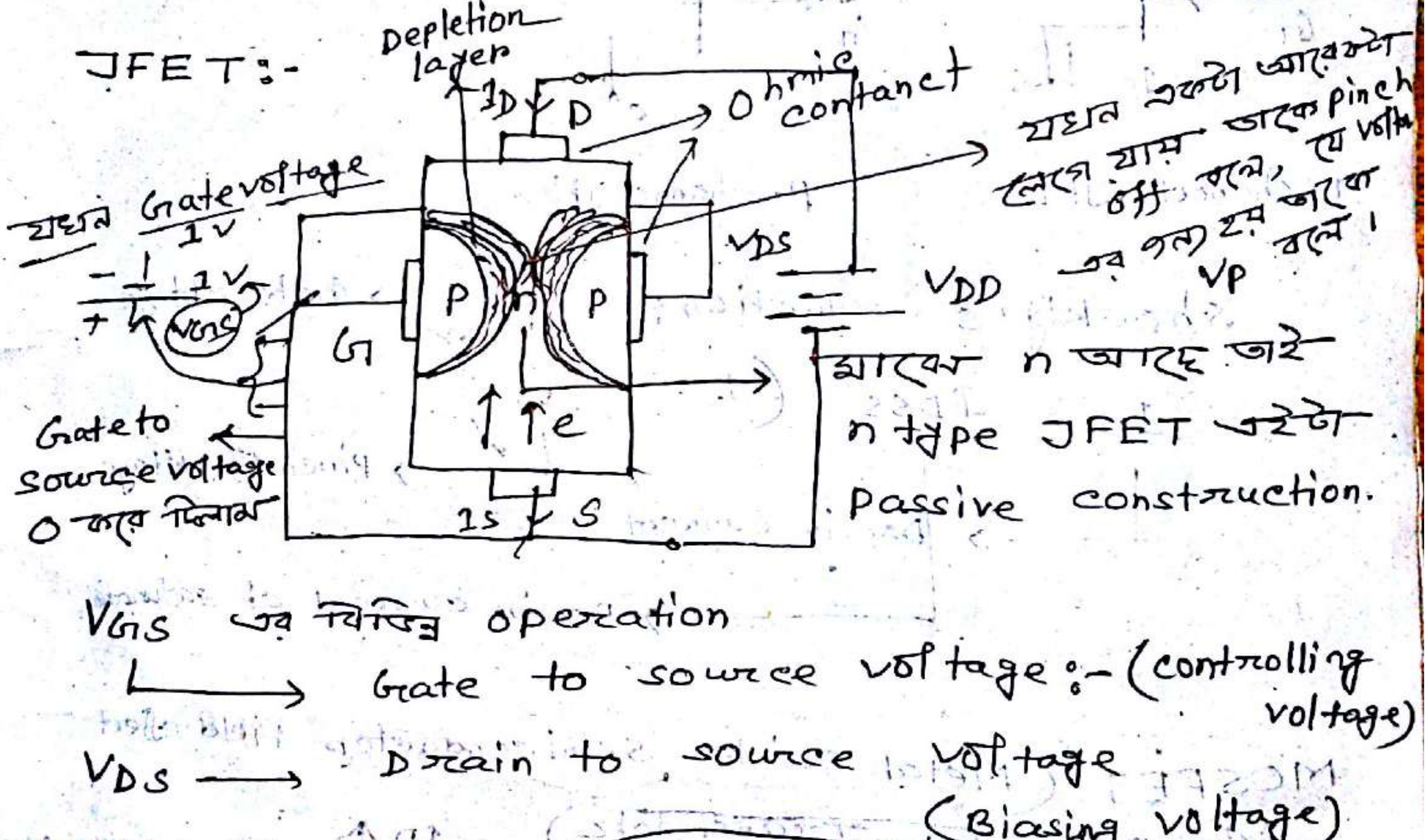
Gain টা বেশি $\left(G = \frac{V_o}{V_i}\right)$ (input দিচ্ছি ছোট output পাচ্ছি বড় যতটুকু বেশি পাচ্ছি তা হল gain)

Switch হিসেবেও ভালো → BJT এর থেকে

অসুবিধা:-
power haneling capacity BJT এর চেয়ে কম — এক্ষেত্রে BJT ই ভালো।

= O =

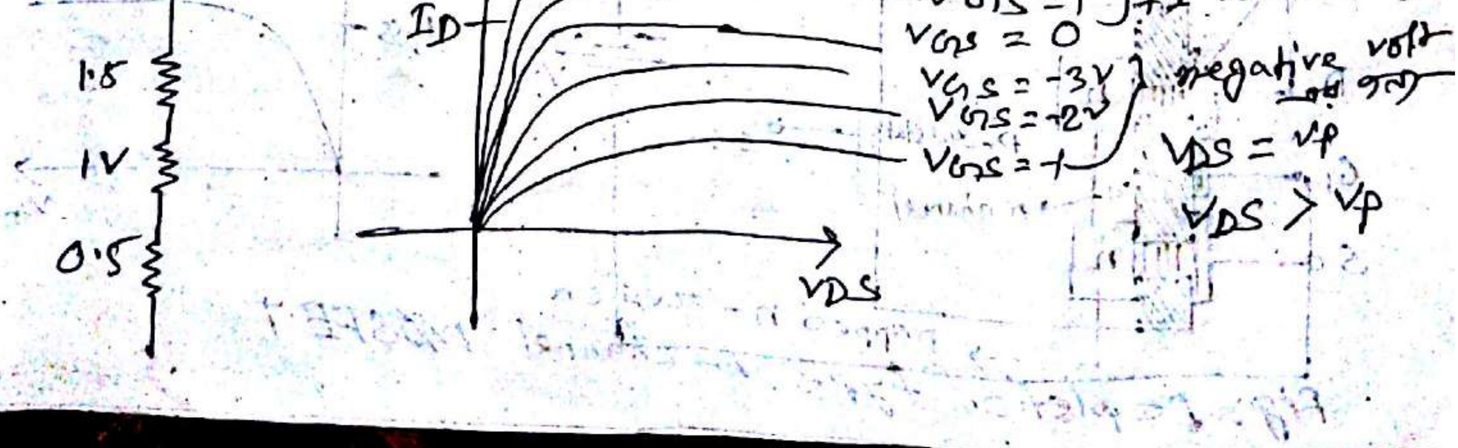
JFET:-



মাঝে n আছে তাই n type JFET এইটা.
Passive construction.

V_{GS} এর বিভিন্ন operation
└→ Gate to source voltage:- (controlling voltage)

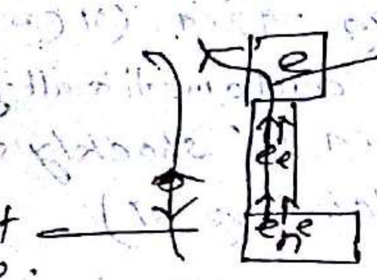
V_{DS} → Drain to source voltage (Biasing voltage)



G-connected না তাই ওর iput impedence বেশি হয়,
$I_G = 0$ হলে impedence (বাধা) অনেক বেশি হবে।
বেশি হয় লাগে ~~হয়~~ হয় MOSFET অন্যদের তুলনায়
তুলনামূলক better.

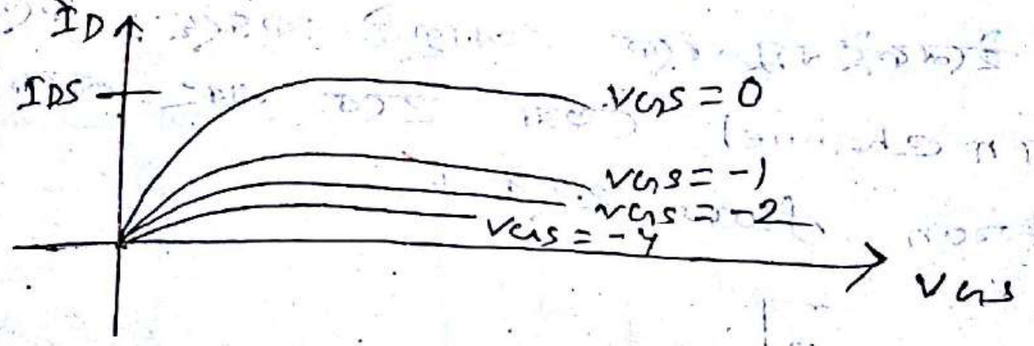
MOSFET কিভাবে কাজ করে?

অনেকটাই JFT এর মত। অর্থাৎ $V_{GS} = 0$
প্রথমে V_{GS} short করে দিলাম,
positive source V_{DD} লাগবেই।
dopped-n region → free electron, অর্থাৎ
এরা

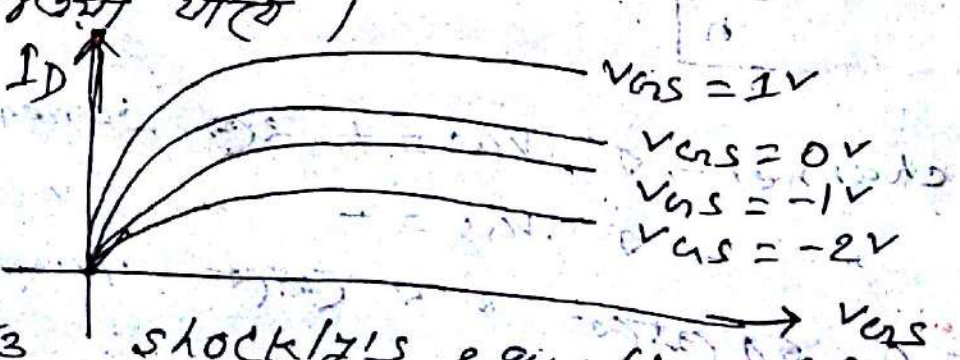


then current flow হবে electron flow এর বিপরীত হবে।

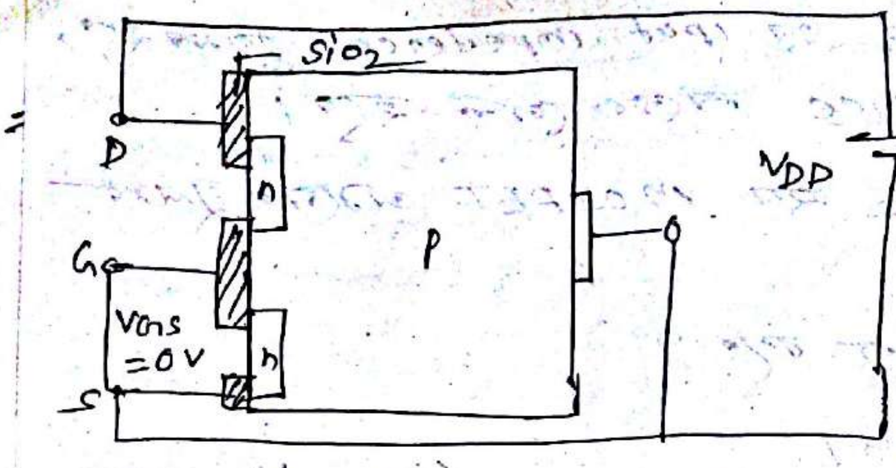
এখন V_{GS} = ~~1~~ (−) volt দিলে same ঘটনা টাই ঘটবে তবে,

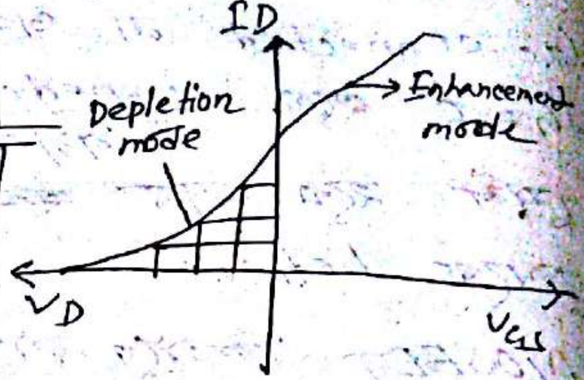


এখন V_{GS} = (+) volt দিলে positive এবং electron এর মধ্যে recombination হবে। তখন কারেন্ট টা কম পাওয়া যাবে।



MOSFET-ও shockly's equation follow করে।





enhancement এবং depletion এর channel এর মধ্যে পার্থক্য —

~~dep~~

→ n channel use করি (shockly's equation follow করে)

→ এখানে বাইরে থেকে দিবে না automatically তৈরী হবে। (shockly's equation follow করে না)

যখন,

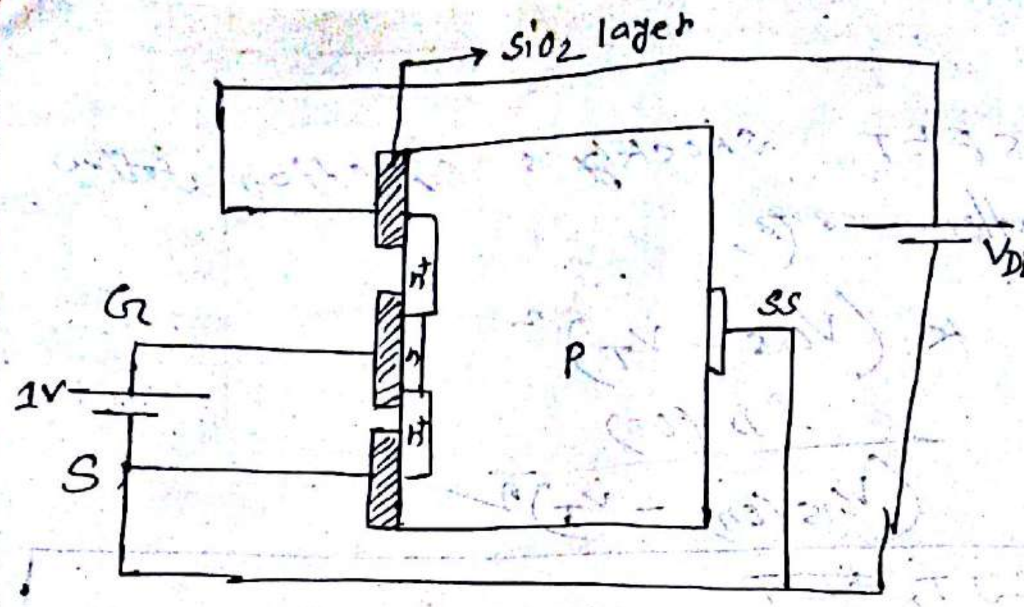
$V_{GS} = 0$ কোন current flow হবে না

$V_{GS} = +$ p টাইপের হোলগুলোকে দূরে সরায় দিবে এবং ইলেকট্রনগুলোকে আকৃষ্ট করছে, ফলে সেখানে একটা n channel তৈরী হবে এবং সেখানে electron flow হবে।

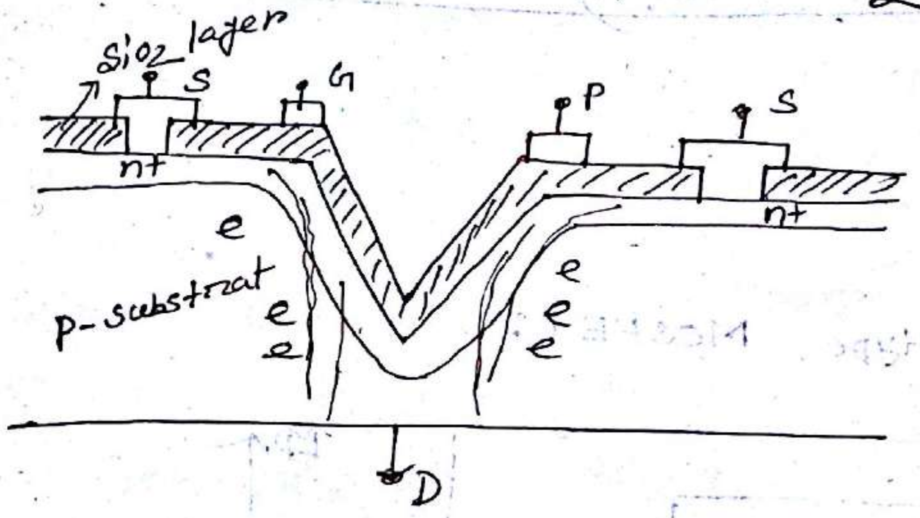
n channel → $V_{GS} = +$ হলে current পাওয়া যাবে

p " → $V_{GS} = -$ " " "

$V_{GS} = 0$ এর ক্ষেত্রে কোন ক্ষেত্রে পাওয়া যাবে না।



VMOS (vertical MOS) → $\underline{\underline{V.V.I.}}$ disadvantage & advantage খুলা পড়বা।



power handling capacity → BJT এর বেশি
FET " কম

বাড়ানো যায় VMOS এ

V-shape নিয়ে আসাতে → channel এর length কমবে
এক্ষেত্রে Resistence কমবে, current বাড়বে,
এক্ষেত্রে electron এর flow দুই পাশ দিয়ে হয়,
তাই power বেশি হবে ফলে power handling
capacity বেশি। 10 W পর্যন্ত power handing
পর্যন্ত করতে পারে।

~~[illegible]~~

Enhancement MOSFET shockly's equation follow করে না এটা follow করে,

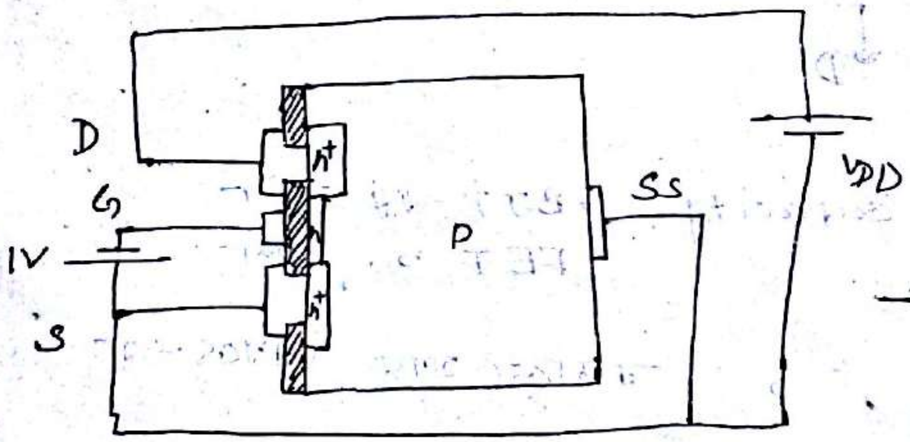
$$I_D = K(V_{GS} - V_T)^2$$

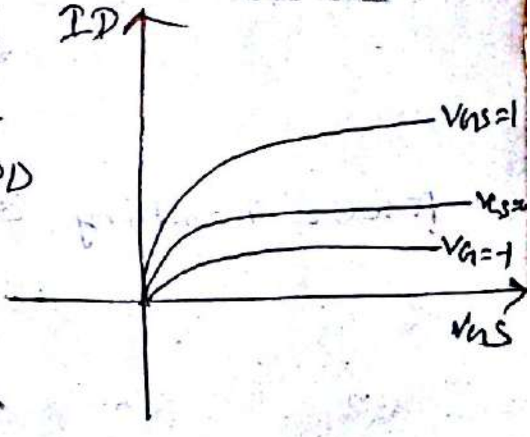
$$K = \frac{I_D(on)}{(V_{GS}(on) - V_T)^2}$$

class test → BJT, ~~FET~~
(construction, DC biasing (math), load line analysis
load line কাকে বলে,
কি হবে)

28-05-16
7th (E) day

Depletion type MOSFET:-





$V_{GS} = 0$ হলে free electron হবে electron attract হবে, ফলে আমরা current পাব।

$V_{GS} = -1$ হলে pn অংশে electron hole recombine করে, current কমে

$V_{GS} = +1$ হলে, current বেশি পাওয়া যায়

Ic current rating current কে পার করে দেয়, তাই এটা safty purpose এর জন্য use করবে না

Semicon

অন্যতম সুবিধা:-

positive tempertature coffiecient → T↑ C↑

Negative , → T↑ current ↓

Semi conductor

T↑ β↑, অথবা,

$$I_C = \beta I_B$$

ফলে I_C -এর মান বেড়ে যাবে ফলে T ↑ β এর মান আবার বাড়বে, ~~ফলে~~ I_C এর ~~থেকে বলা হয়~~ নষ্ট না হওয়া পর্যন্ত মান আবার বাড়বে, এভাবে চলবে।

এদেরকে বলা হয় Thermal runaway,

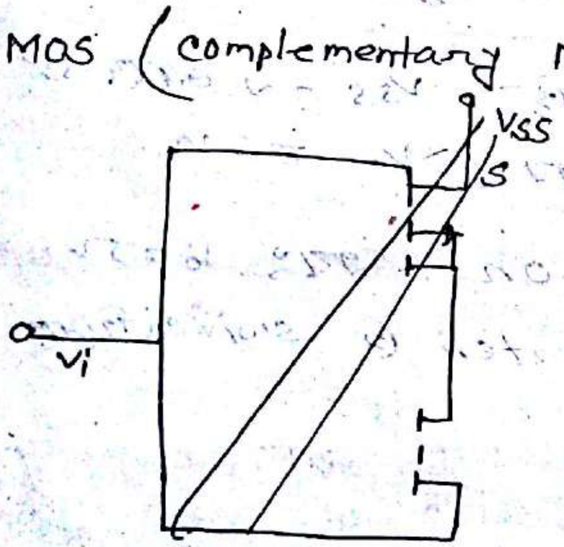
এক্ষেত্রে VMOS এর ক্ষেত্রে Thermal runaway নাই।

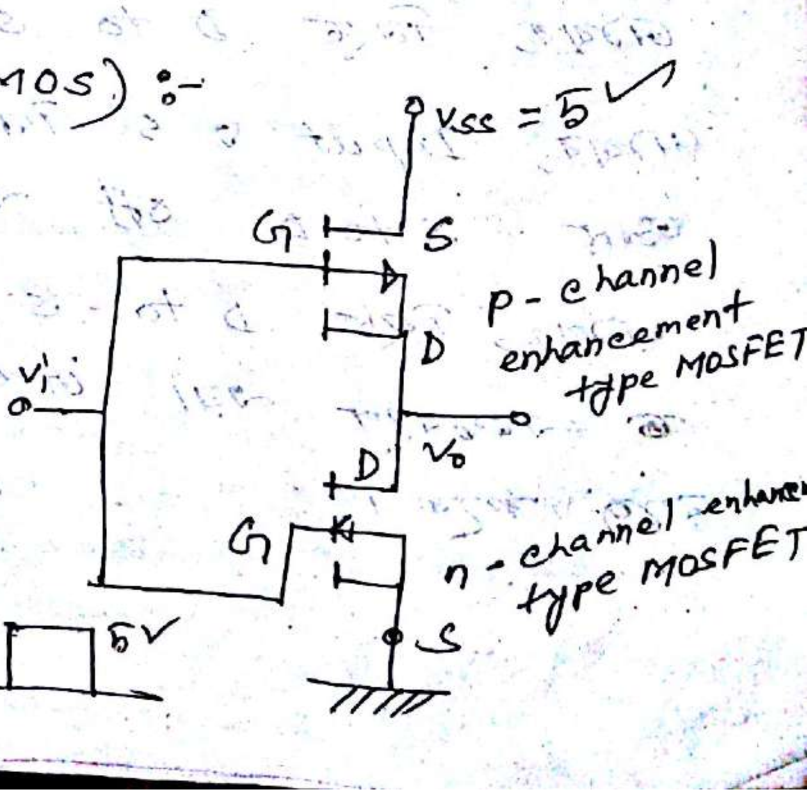
অসুবিধা:-

cost বেশি, sturcture টা complex

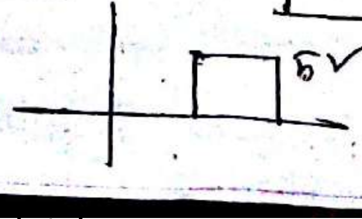
=0=

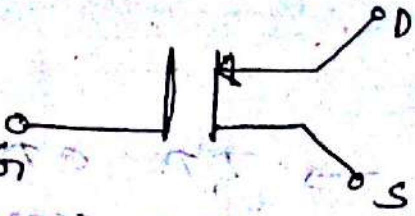
CMOS (complementary MOS):-



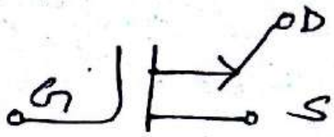


switch হিসে

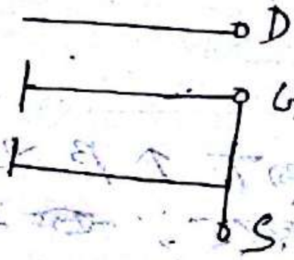




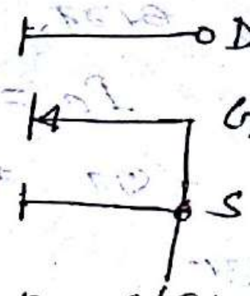
~~p-ch~~ n- channel.
depletion



P- channel
depletion



P- channel
enhancement



n- channel
~~d~~ enhancement.

CMOS কিভাবে switch ও converter হিসেবে কাজ করে ?

Input এ 0 v দিলে V_{SS} - এ আছে -5 v
~~তখন V_{SS}~~ তখন on হবে v_0 হবে +5 v_0.
তখন ~~D~~ S to D on.

আবার, নিচে D to S off.

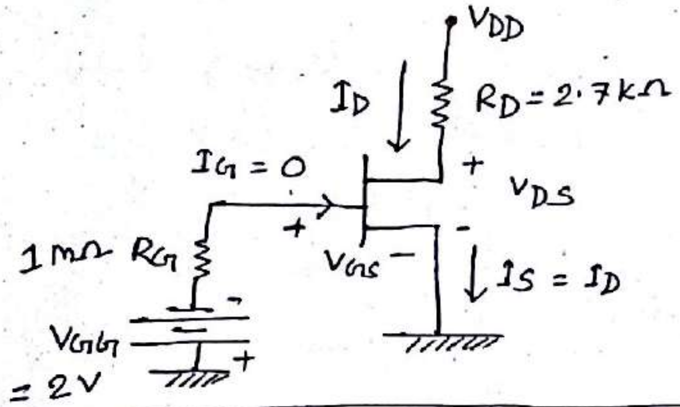
আবার, Input এ 5 দিলে V_{SS} - এ আছে -5V
তখন S to D off এবং V_0 = 0 V.
আবার, নিচে D to S on এবং v_0 = 5V
~~ক~~ এ কারণে করা inverter ও switch হিসেবে কাজ করে।

30-05-16
8th (B) day

FET DC Biasing:-

(i) Fixed Bias configaration
(ii) self " "
(iii) Voltage divider " "

(i) Fixed Bias configaration



$V_P = 4V$
$I_{DSS} = 8mA$
$V_{DD} = 16V$

$I_D = ?$
$V_{GS} = ?$
$V_D = ?$
$V_{DS} = ?$
$V_G = ?$

(i) $I_G = 0$
(ii) $I_D = I_S$
(iii) $I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$ [For JFET and depletion type MOSFET]
(iv) $I_D = K(V_{GS} - V_T)^2$ [For enhancement type MOSFET]

→ এই গুলা এর আগের অধ্যায়ের মুখস্থ রাখতে হবে।

যখন, $I_G = 0$ তখন, R_G short হবে

$$-V_{GG} - V_{GS} = 0$$
$$\Rightarrow V_{GS} = -V_{GG}$$

এই bias টাকে বলা হয় fixed bias configaration. V_{GG}, Gate to source volate এর সমান তাই,

এখন, I_D বের করতে হবে,

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$ [I_{DSS} ও V_P এর মান দেয়া থাকবে

V_{DS} কে একটা loop apply করলেই পাওয়া যায়,

= 0 =

Math:-

$$-V_{GG} - V_{GS} = 0$$

$$\therefore V_{GS} = -2V$$

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

$$= 8\times10^{-3}\left(1 + \frac{2}{4}\right)^2$$

$$=$$

$$V_{DD} - I_D R_D - V_{DS} = 0$$

$$\Rightarrow V_{DS} = V_{DD} - I_D R_D$$

$$= 16 - I_D R_D$$

~~$V_{DS} = V_S - V_D$~~ $V_{DS} = V_D - V_S$

$$= V_D - 0$$

$$= V_D$$

$$V_{GS} = V_G - V_S$$

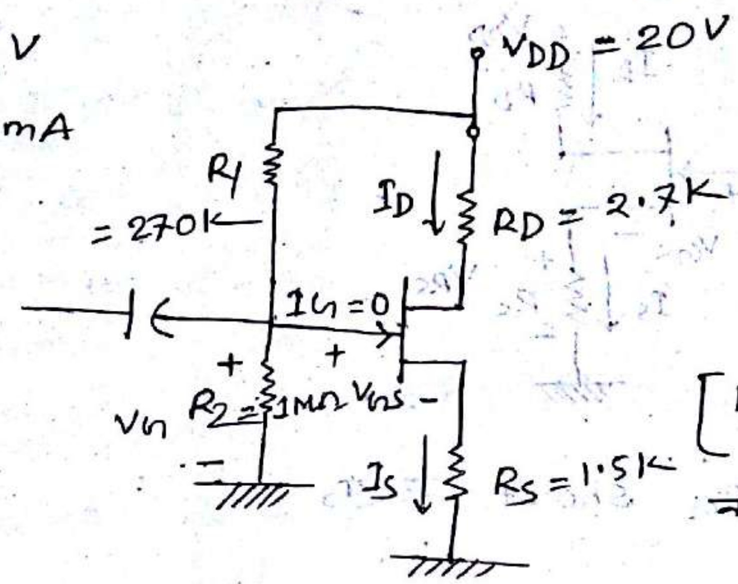
$$= V_G - 0$$

$$= V_G$$

(iii) Voltage divider configaration:-

$V_P = 4V$

$I_{DS} = 8mA$



Find

$I_{DQ} = ?$

$V_{GSQ} = ?$

$V_{DS} = ?$

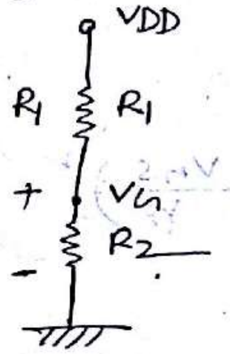
$V_D = ?$

$V_S = ?$

$V_G = ?$

[DC তে capacitor থাকাও যা, capacitor না থাকাও তা]

যখন $I_G = 0$ তখন,



V_G বের করতে হবে,

$$V_G = \frac{R_2}{R_1 + R_2} V_{DD}$$ (voltage divider Rule)

LOOP Apply করে পাই,

$$\boxed{V_{GS} = V_G - I_D R_S}$$

→ এটা একটা straight line এর equation

$c = V_G, \ y = V_{GS}, \ x = I_D, \ m = R_S$

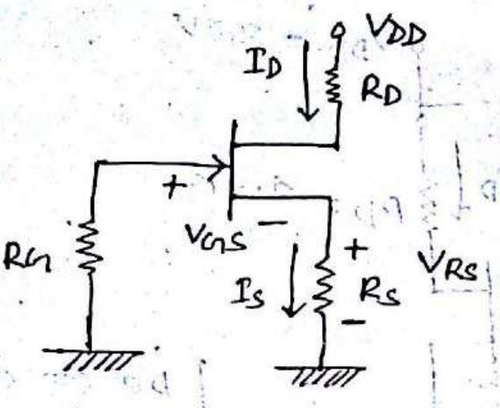
একবার, $I_D = 0$

তখন, $\boxed{V_{GS} = V_G}$

আবার, $V_{GS} = 0$

$$\boxed{I_D = \frac{V_G}{R_S}}$$

(ii) Self bias configaration :-



$I_G = 0$ হলে R_G short হবে,

$$+V_{GS} + V_{RS} = 0$$
$$\Rightarrow V_{GS} = -V_{RS}$$
$$= -I_D R_S$$

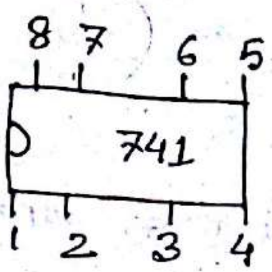
$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$ [I_{DSS} ও V_P এর মান দেয়া থাকবে]

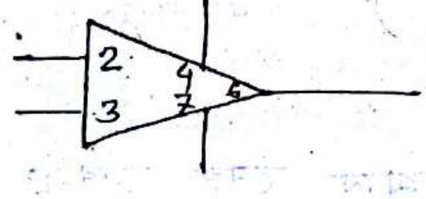
I_D পেয়ে গেলে,

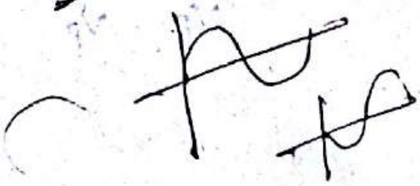
$$V_{DD} - I_D R_D - V_{DS} - I_S R_S = 0$$
$$\Rightarrow V_{DD} - I_D R_D - V_{DS} - I_D R_S = 0 \quad [I_S = I_D]$$
$$\therefore V_{DS} = V_{DD} - I_D (R_D + R_S)$$

12-07-16
8th (E) day

Op-Amp (Operational Amplifier)







1, 5 → offset Null (Offset গুলোকে remove করার জন্যে)

2 → Inverting Input (করবে)

3 → Non " " (")

4 → −ve power supply } → এদের Range 5V-24V

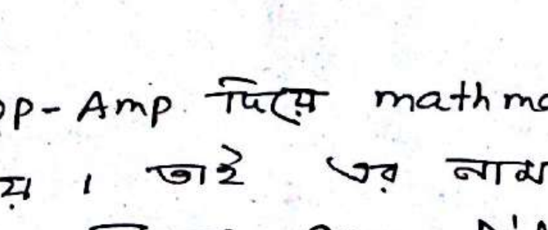
7 → +ve " "

8 → Ground

6 → output

দুইগুলা নিয়ে lab এ কাজ হবে

EQV circuit:- এই voltage controll voltage source



$V_d = V_2 - V_1$

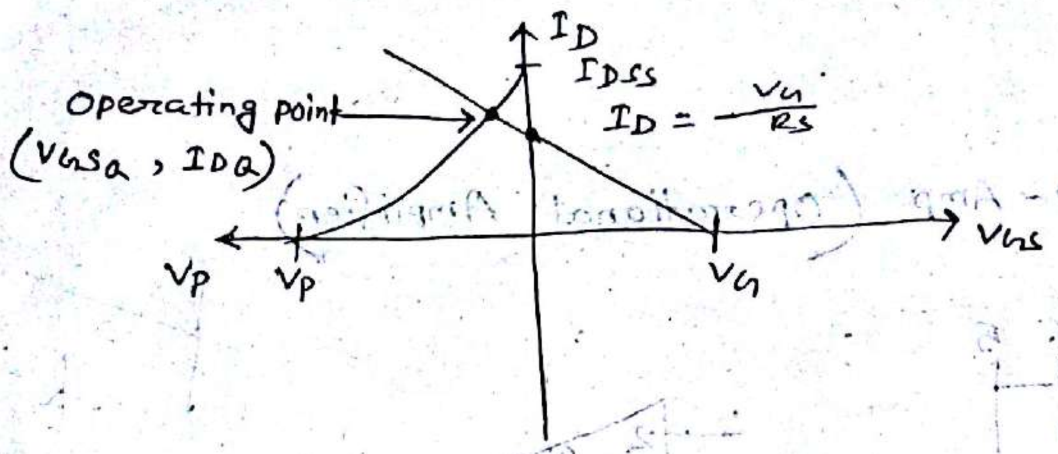
$V_0 = A V_d$

→ open loop gain (feed back ছাড়া যে gain)

Op-Amp দিয়ে mathmatical operation চালানো যায়। তাই এর নাম Operational amplifier.

এটা দিয়ে sum, <u>Differenciation</u>, <u>Intigr</u>—

এখানে Ri অনেক high, যেন মনে হয় এতে কোন কারেন্ট flow করবে না। ফলে এর <u>input</u> <u>impedence</u> বেশি



V_P ও I_{DSS} এর মান বের করতে হবে, বা দেওয়া থাকবে,
সেখান থেকে এই curve পাব, লেখে বসাবো ও পরে ত
পরে, V_G ও I_D এর মান নির্ণয় বিন্দুর এ রেখার সাথে যে
বাড়িয়ে দিব যা: ছেদ করবে তাই (V_{GSQ}, I_{DQ})
বিন্দুতে ছেদ করবে

=0=

Math,

$$V_G = \frac{R_2}{R_1 + R_2} V_{DD}$$

$$= \frac{\cancel{1 \times 10^3 \times} 270}{(10^3 + 270)} \times 20 = 4.25\ V$$

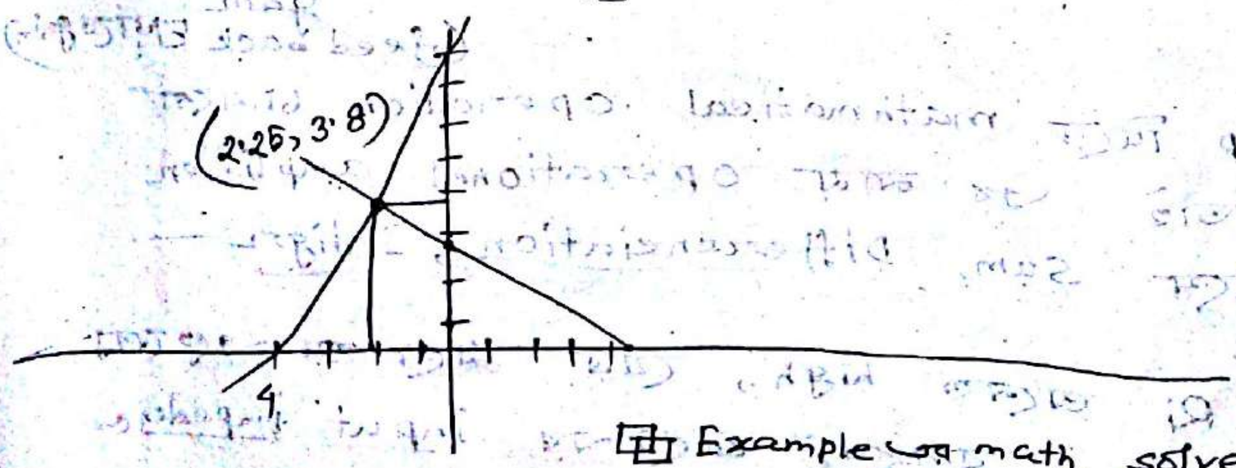
(15.75, 0)

(0, 10.5)

$$V_{GS} = V_G - I_D R_S$$

$$V_{GS} = V_G = 4.25\ V$$

$$I_D = \frac{V_G}{R_S} = 2.83$$



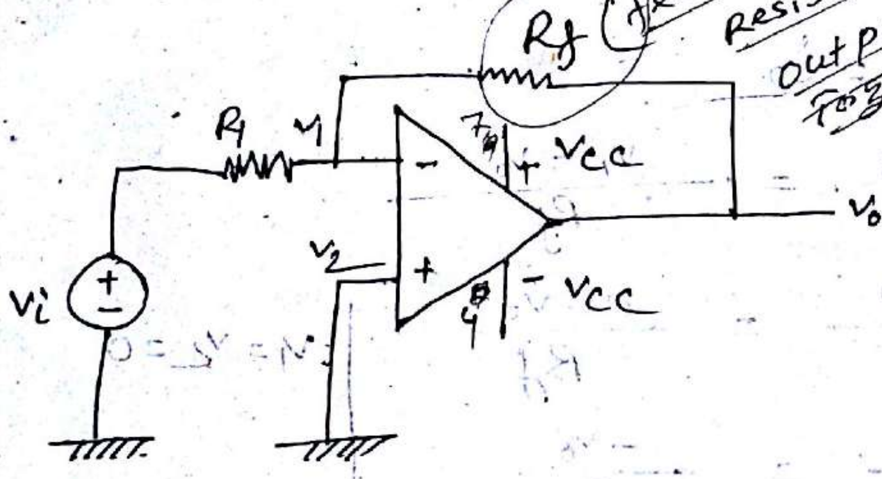
Example এর math solve করতে হবে

Viva, Quiz

$\left.\begin{array}{l}\text{input impedence} \\ \text{output impedence} \\ \text{gain}\end{array}\right\}$ Numerical মান গুলো 1st sem বই থেকে দেখে নিবা

Virtual ground:- (যে ground না কিন্তু ground এর মত কাজ করে)

Rf (feed back Resistance, output এর কিছু অংশ feed করে)



$\boxed{V_1 = V_2}$

Here $V_1 = V_2$

V_2 হল ground, $V_2 = 0$

$\therefore V_1 = 0$

V_1 তো ground নাই তবুও $V_1 = 0$ তাই এটি virtual ground

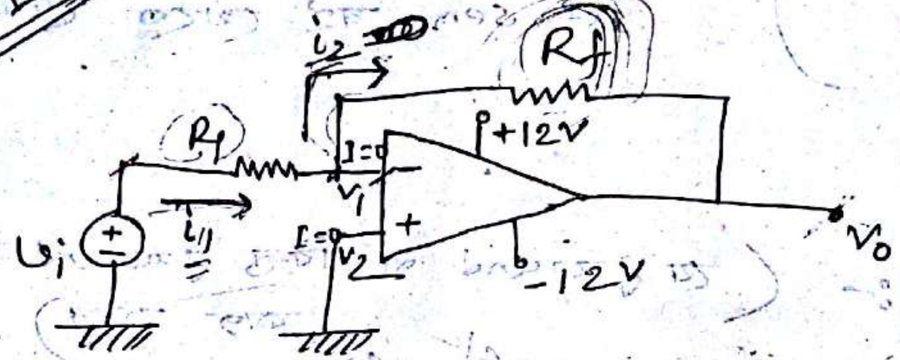
এখন, $V_2 = 2V$ হলে

$V_1 = 2V$

Always, $V_1 = V_2$

Inverting Amplifier :-

V. V. I



$$i_1 = i_2$$

$$\Rightarrow \frac{v_i - v_1}{R_1} = \frac{v_1 - v_0}{R_f}$$

$$\Rightarrow \frac{v_i - 0}{R_1} = \frac{0 - v_0}{R_f} \qquad v_1 = v_2 = 0$$

$$\Rightarrow \frac{v_i}{R_1} = \frac{-v_0}{R_f}$$

$$\Rightarrow v_0 = -\boxed{\frac{R_f}{R_1}}\, v_i$$

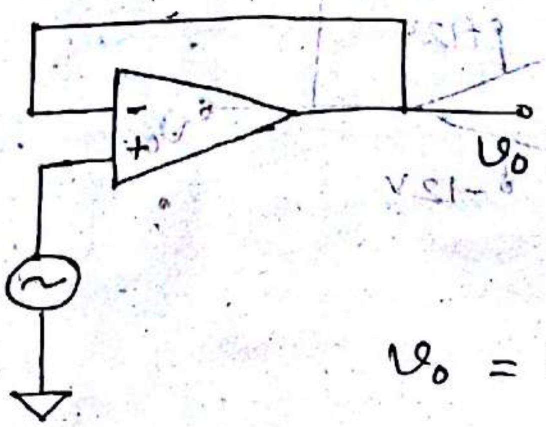
→ closed loop gain (feed back এর যে gain পাওয়া যায়)

120mV

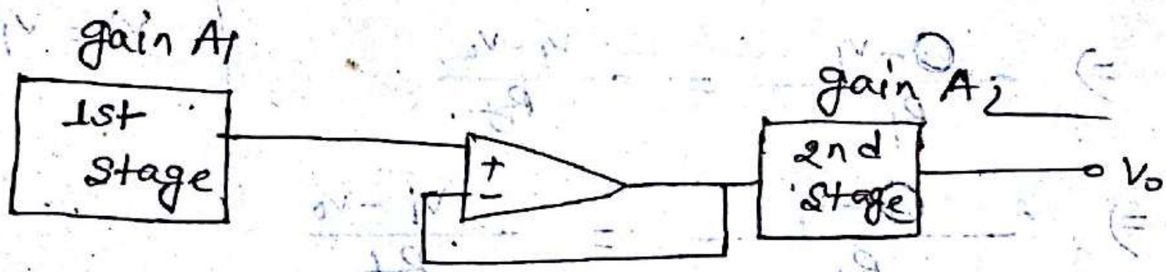
1.2V

1000

Voltage buffer / voltage follower :→ (যেটা input দিব সেইটাই পাব, input impedence বেশি) এইটাই সুবিধা



$$v_o = v_i$$



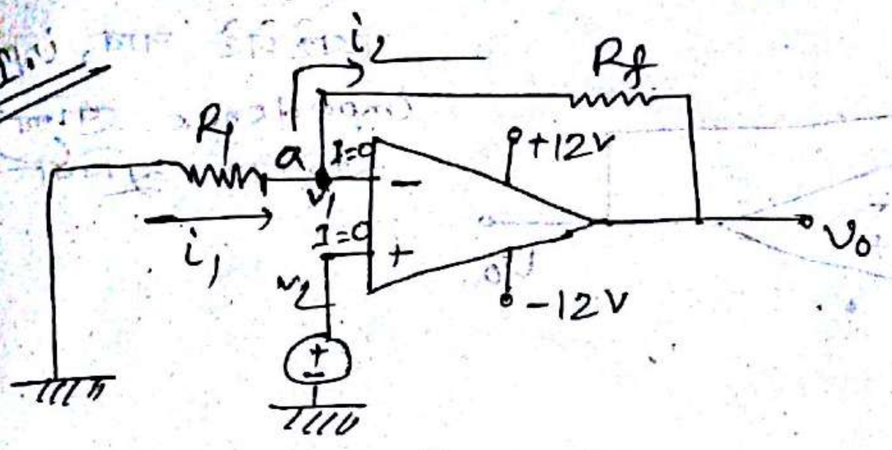
এক্ষেত্রে loading effect থাকে না, যেইটা gain চাই সেইটাই পাই।

দুইটা multistage এর isolation এর জন্য ব্যবহার করা হয়।

loading effect

Non-inverting Amplifier

V.V.I.



$$i_1 = i_2$$

$$\Rightarrow \frac{0 - v_1}{R_1} = \frac{v_1 - v_0}{R_f}$$

$v_1 = v_1$

$$\Rightarrow \frac{0 - v_i}{R_1} = \frac{v_i - v_0}{R_f}$$

$$\Rightarrow \frac{-v_i}{R_1} = \frac{v_i - v_0}{R_f}$$

$$\Rightarrow \frac{-v_i}{R_1} \times R_f = v_i - v_0$$

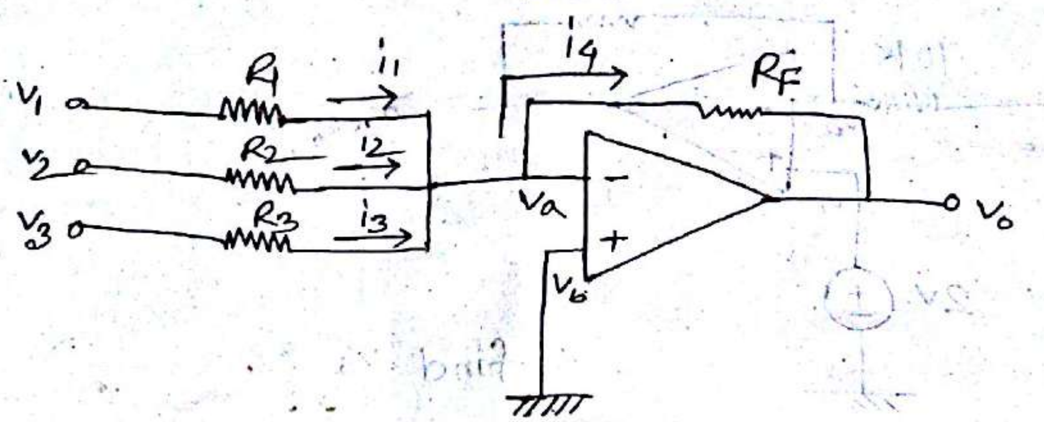
$$\Rightarrow v_0 = v_i + \frac{v_i}{R_1} \times R_f$$

$$\therefore \boxed{v_0 = v_i \left(1 + \frac{R_f}{R_1}\right)}$$

$$= v_i \left(\cancel{\frac{R_1 + R_f}{R_1}}\right)$$

Inverting, Non-inverting → proof দুইটা লাগবে

Summing Amplifier :-



একের অধিক input এর জন্য sum দরকার তখন এই circuit use করা হয়।

Using KCL,

$$i_1 + i_2 + i_3 = i_4$$

Here,

$$i_1 = \frac{v_1 - v_a}{R_1}$$

$$i_2 = \frac{v_2 - v_a}{R_2}$$

$$i_3 = \frac{v_3 - v_a}{R_3}$$

$$i_4 = \frac{v_a - v_o}{R_f}$$

$$i_1 + i_2 + i_3 = i_4$$

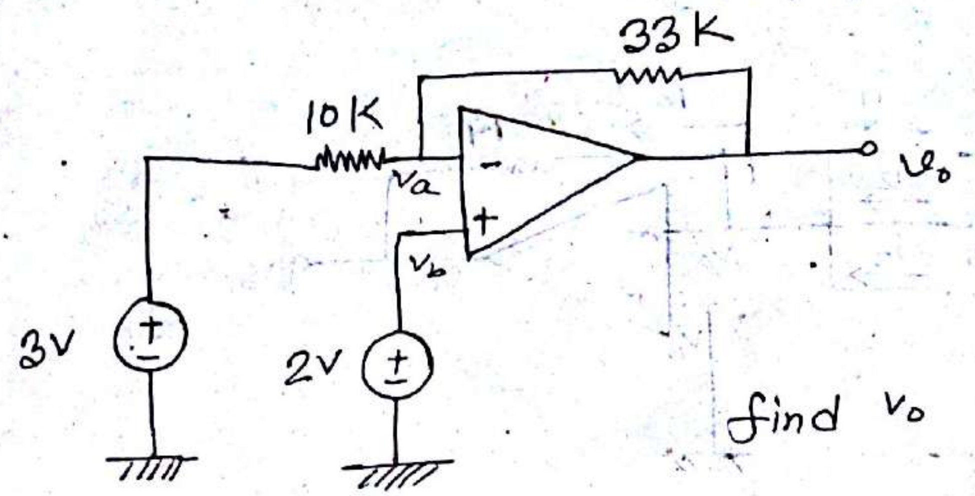
Here, $V_a = V_b = 0$

$$\Rightarrow \frac{v_1 - 0}{R_1} + \frac{v_2 - 0}{R_2} + \frac{v_3 - 0}{R_3} = \frac{v_a - v_o}{R_f}$$

$$\Rightarrow \frac{v_1}{R_1} + \frac{v_2}{R_2} + \frac{v_3}{R_3} = \frac{v_a - v_o}{R_f}$$

$$\Rightarrow R_f \left(\frac{v_1}{R_1} + \frac{v_2}{R_2} + \frac{v_3}{R_3} \right) = v_a - v_o$$

16-07-16
9 (B) day



find v_o

$$\frac{v_i - v_1}{R_i} = \frac{v_i - v_0}{R_f}$$

$$\Rightarrow R_i (v_i - v_0) = R_f (v_i - v_1)$$

$$\Rightarrow R_i v_i - R_i v_0 = R_f (v_i - v_1)$$

$$\Rightarrow R_i v_1 - R_f (v_i - v_1) = R_i v_0$$

$$\Rightarrow \frac{R_i v_1 - R_f (v_i - v_1)}{R_i} = v_0$$

$$=$$

Superposition theorem:- (solution)

$$v_{o1} = -\frac{R_f}{R_i} v_i$$

$$v_{o2} = v_i \left(1 + \frac{R_f}{R_i}\right)$$

$$v = v_{o1} + v_{o2}$$

$$V_0 = V_a - R_f \left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \right)$$

if $R_f = R_1 = R_2 = R_3$

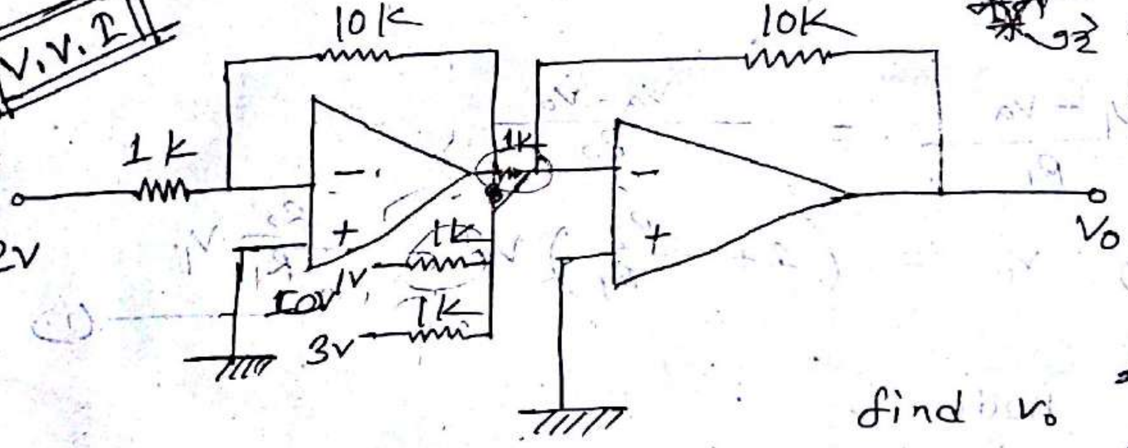
$$V_0 = 0 - (V_1 + V_2 + V_3)$$

$$\therefore V_0 = -(V_1 + V_2 + V_3)$$

Example → 10.1 — 10.10 ⊕ V.V.I (এই অধ্যায়ের)

$\boxed{\text{V.V.I}}$

এই নিয়মের একটা math থাকবে



find V_0

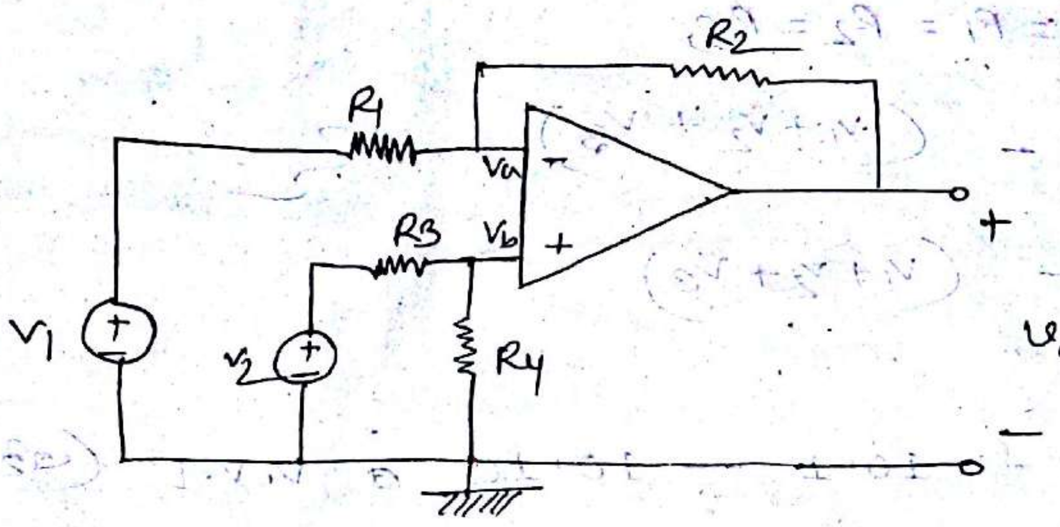
প্রথম inverting Amplifier এর

$$V_0 = -\frac{10}{1} \times 2$$
$$= -20V$$

পরের inverting

$$V_0 = -\left(-\frac{20}{1} + \frac{1}{1} + \frac{3}{1}\right) \times R_f$$
$$= (-20 + 4) \times 10K$$
$$= (-16) \times 10^3 V$$

Difference Amplifier :-



$$\frac{V_1 - V_a}{R_1} = \frac{V_a - V_o}{R_2}$$

$$\Rightarrow v_o = \left(1 + \frac{R_2}{R_1}\right) V_a - \frac{R_2}{R_1} V_1 \quad \text{—— (i)}$$

At node b

$$\frac{v_2 - V_b}{R_3} = \frac{V_b - 0}{R_4}$$

$$\Rightarrow V_b = \frac{R_4}{R_3 + R_4} v_2 \quad \text{—— (ii)}$$

$$V_a = V_b$$

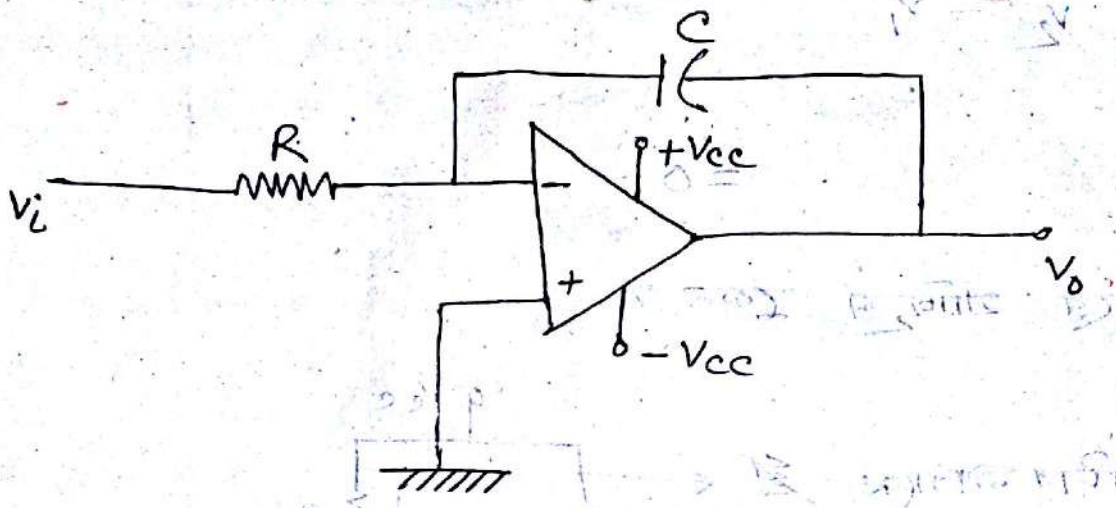
from; (i)

$$V_o = \left(1 + \frac{R_2}{R_1}\right) \frac{R_4}{R_3 + R_4} v_2 - \frac{R_2}{R_1} v_1$$

$$= \frac{R_2}{R_1} \frac{\left(1 + \frac{R_1}{R_2}\right)}{\left(1 + R_3/R_4\right)} v_2 - \frac{R_2}{R_1} v_1$$

17-07-16
9th (c) day

Integrator :-



$$X_C = \frac{1}{2\pi f C} = \frac{1}{SC}$$

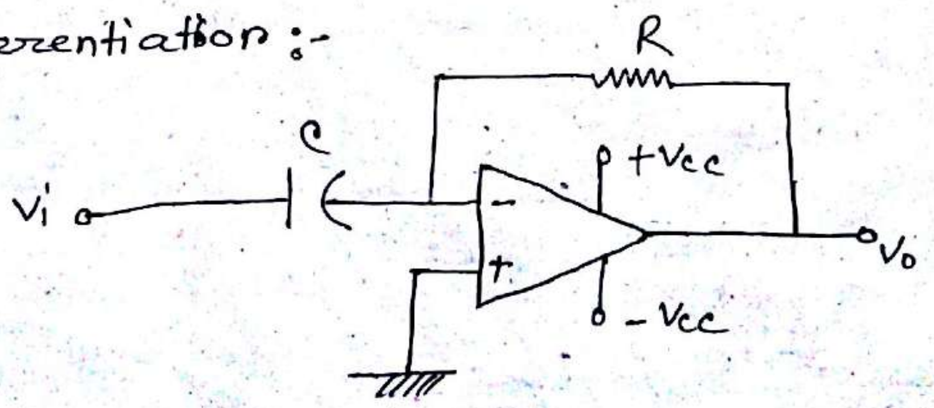
$$V_o = -\frac{R_f}{R_1} \times V_i$$

$$= -\frac{X_C}{R_1} \times V_i$$

$$= -\frac{1}{SCR} \times V_i$$

$$= -\frac{1}{RC}\int V_i\, dt \qquad \left[S = \int dt \right]$$

Differentiation :-

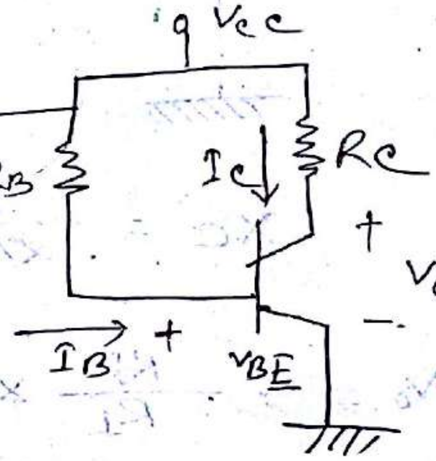


$$\boxed{\frac{R_1}{R_2} = \frac{R_3}{R_4}}$$

$$V_0 = \frac{R_2}{R_1}(V_2 - V_1)$$

$$V_0 = V_2 - V_1$$

I_C টা পুড়ে যাচ্ছিল কেন?



পটেনশিওমিটার লাগালে ← এইটা remove করা সম্ভব

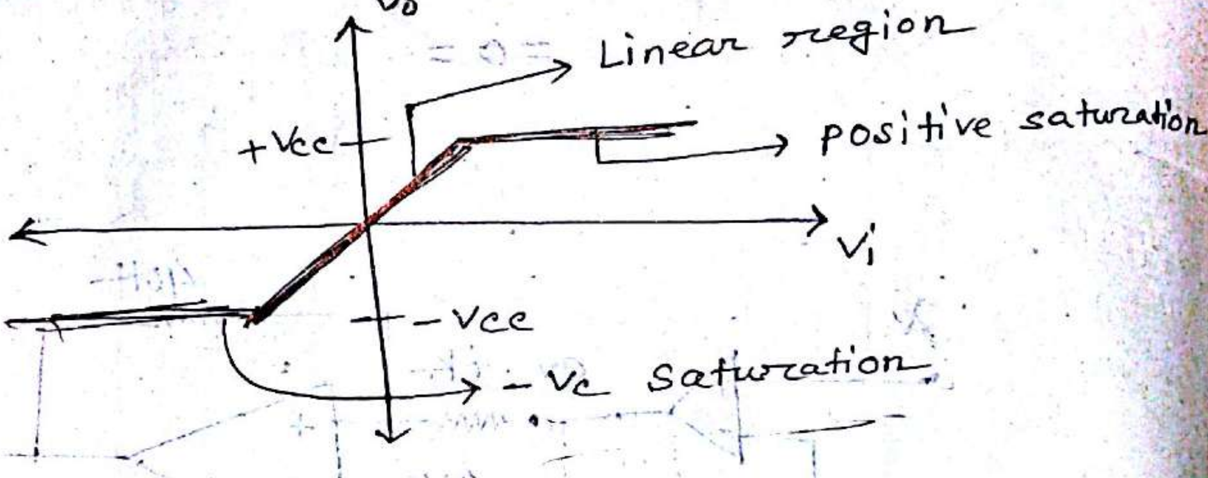
I_C এর মধ্যে দিয়ে 0.1 mA সহ্য করতে পারে। কিন্তু R_B এর দুই প্রান্তে লাগার কারণে এইটা শর্ট হয়ে যায়, ফলে পুরো কারেন্ট প্রবাহিত হয় এবং পুড়ে যায়।

$$V_0 = \frac{R_2\,(1 + R_1/R_2)}{R_1\,(1 + R_3/R_4)}$$

$$i_0 = \frac{V_0}{R}$$

→ Another process

$\boxed{\text{Opmp এর Example 10 টা + Exercise :-}}$ → Assignment



এতোদিন যেগুলা circuit দেখেছিলাম সেগুলো Linear region এ কাজ করে। $\boxed{-V_{cc} < V < V_{cc}}$

এখন যে circuit দিয়ে কাজ করবো সেগুলো positive saturation এ কাজ করবে।

$V = V_{cc}$ → positive saturation

$V = -V_{cc}$ → $-ve$,,

Gayakord Caughlin এর বই থেকে পড়তে হবে

- Comparator circuit
- SHMITT trigger circuit
- Zero crossing detector ,,

$$-V_{CC} < V < V_{CC}$$

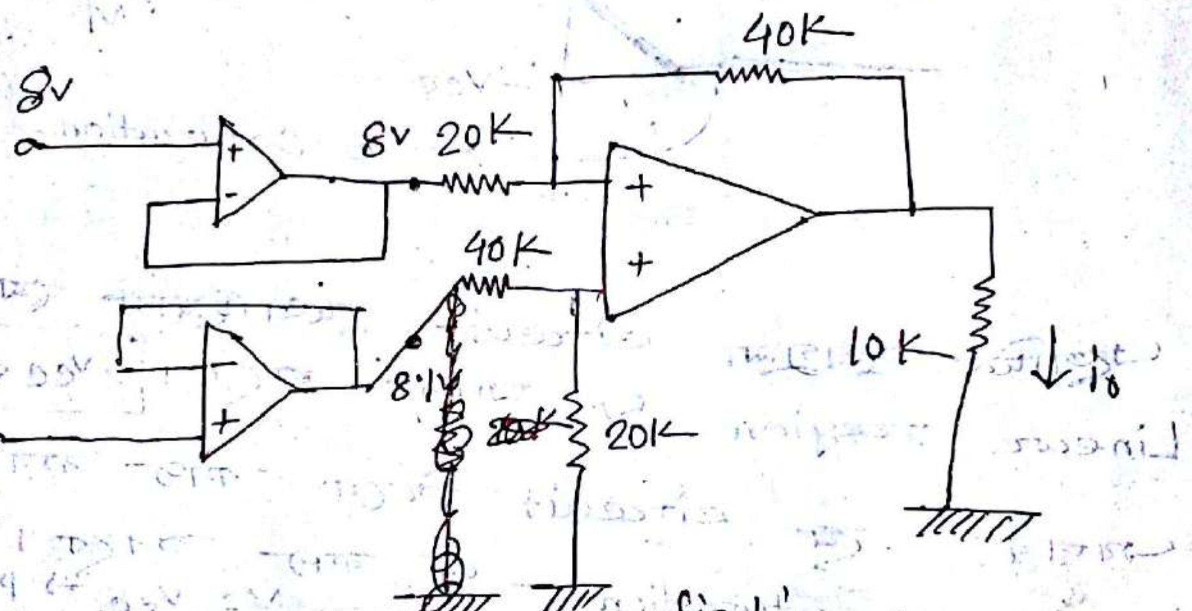
$$X_c = \frac{1}{2\pi f C} = \frac{1}{sC}$$

$$V_o = -\frac{R}{X_C} V_i$$

$$= -sRC\, V_i$$

$$\boxed{V_o(t) = -RC\frac{dV_i}{dt}}$$

= 0 =



find i_0

প্রথম দুইটে buffer circuit, যেটা input সেটা output
পরের টা diff Amplifier,

$$V = (8.1 - 8) = 0.1\ V$$

$$R = 10K$$

$$I = \frac{0.1}{10K}$$

$$= 0.1 \times 10^{-3} \times 10^{-3}\ Amp$$

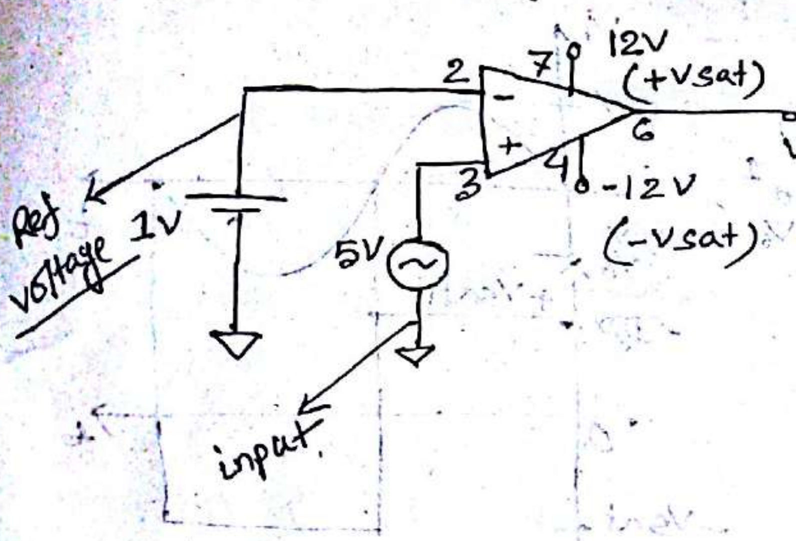
$$= 10^{-7}\ Amp$$

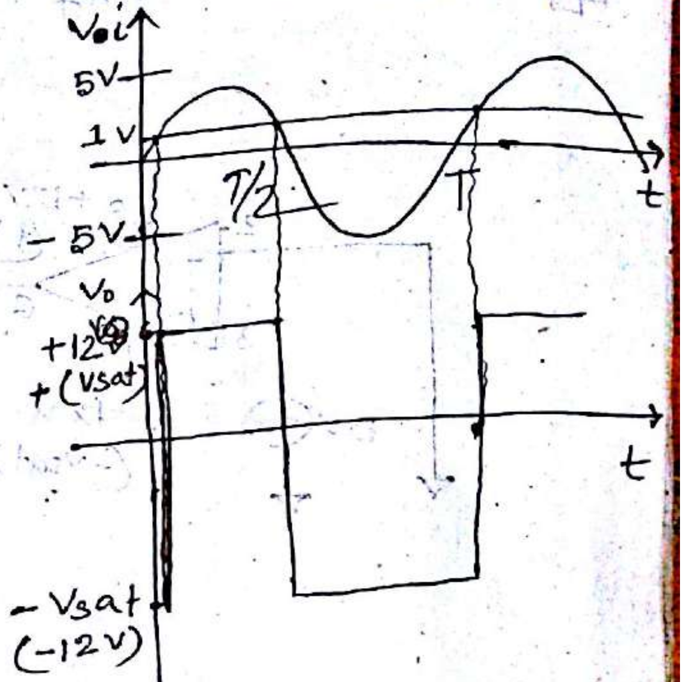
(Ans:)

→ one process

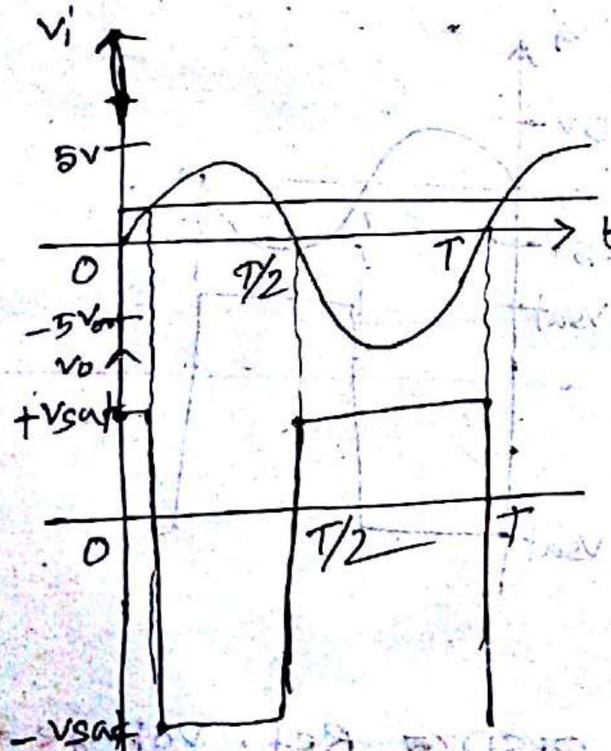
24-07-16
10th (D) day

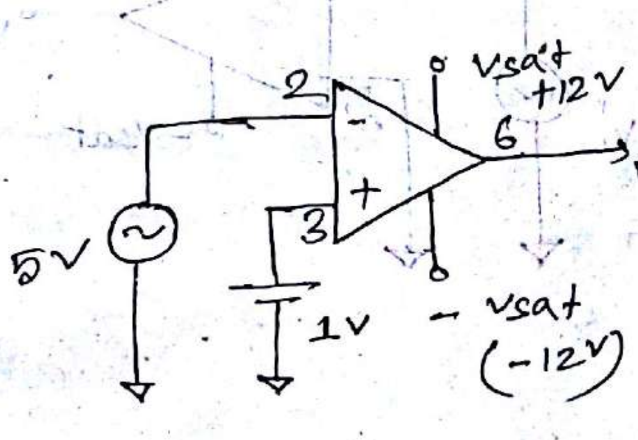
Comparators:- (এখান থেকে math আসে না)





** (-1) v - Ref voltage হলে কেমন হবে ?

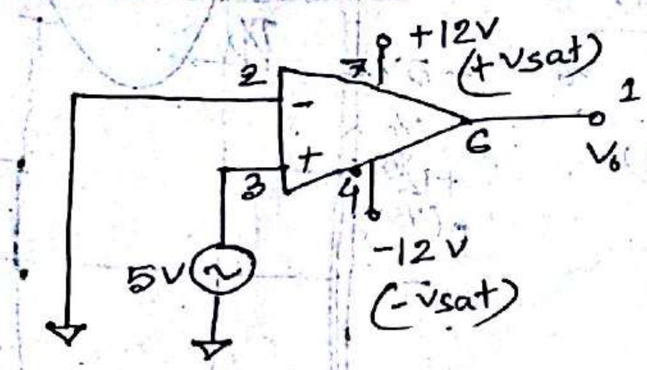


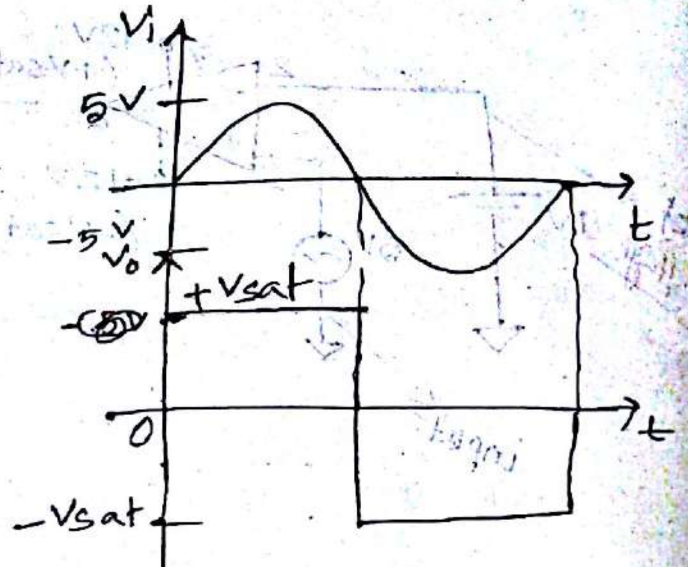


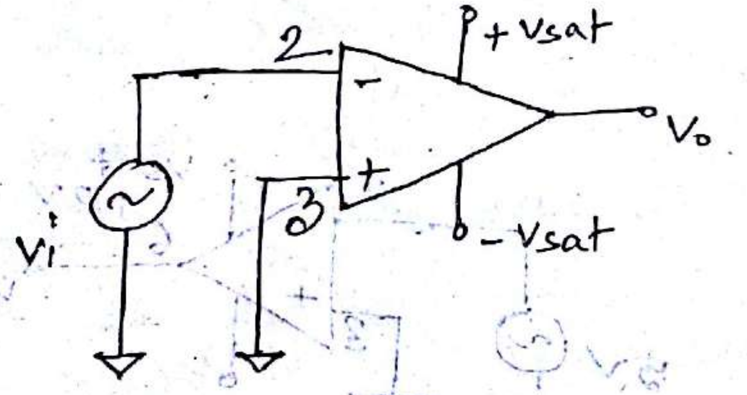
** (-1) v - Ref voltage হলে কেমন হবে ?
জানা মানের সাথে input voltage এর তুলনা করার জন্য ব্যবহার করা হয়। এদের Feed back নাই। এটি saturation region এ কাজ করবে। ~~input টা AC~~

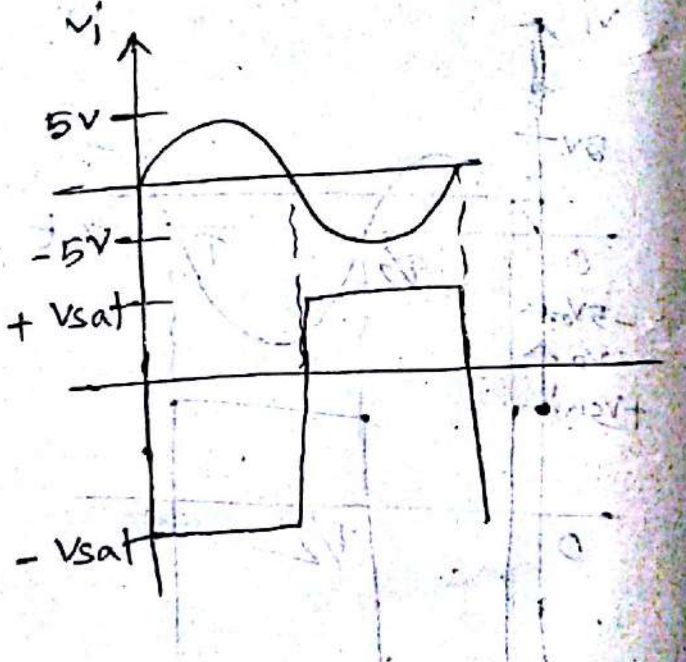
Ref-এর উপর উঠে গেলে + Vsat, নিচে হলে − Vsat

Zero crossing detector:-

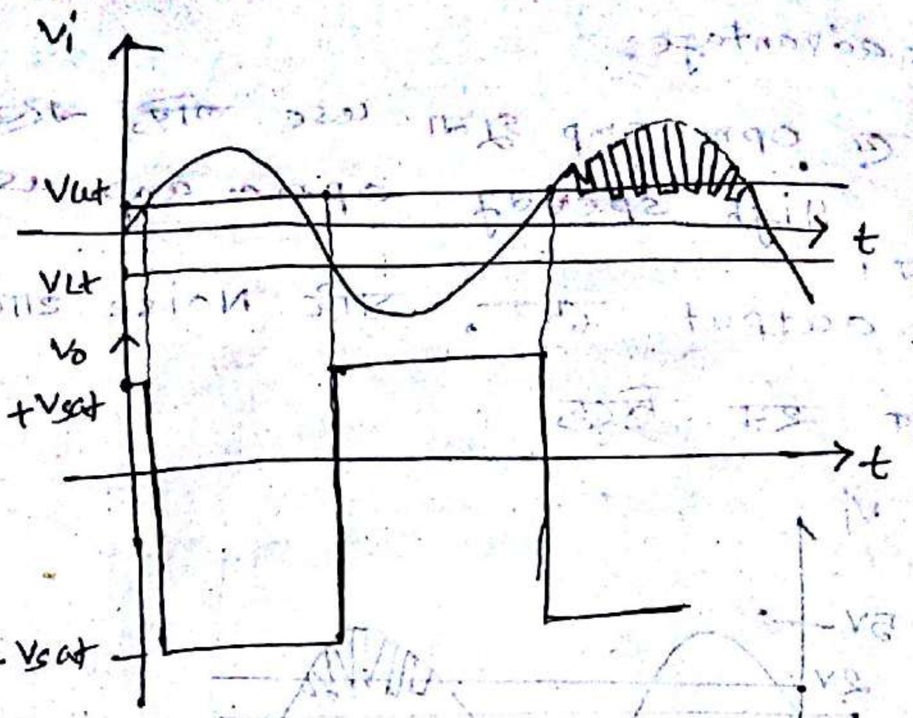








One kind comparator, যেখানে Ref. voltage = 0
0 কে cross করলেই + Vsat (Non-inverting)
আর না করলে + Vsat (inverting pin)



ওখানে, দুইটা Ref voltage, + Vut, ও Vlt.

Noise গুলো Vut এর নিচে আছে

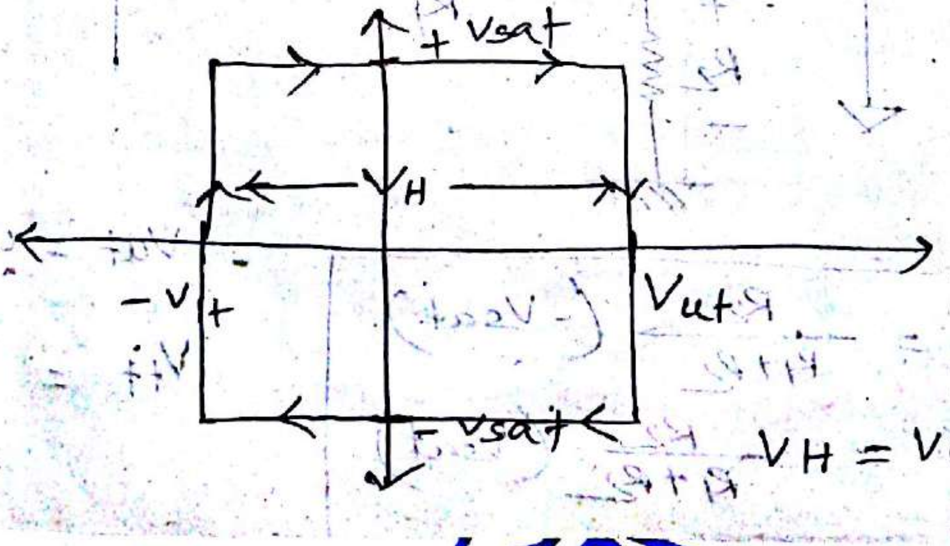
+ Vsat ⟶ − Vsat Vut কে cross করতে হবে

− Vsat ⟶ +Vsat Vlt কে cross করতে হবে

দুইটা voltage এর উপর dependent করছে

ফলে এটা ... remove হয়।

** এখান থেকে math আসে।



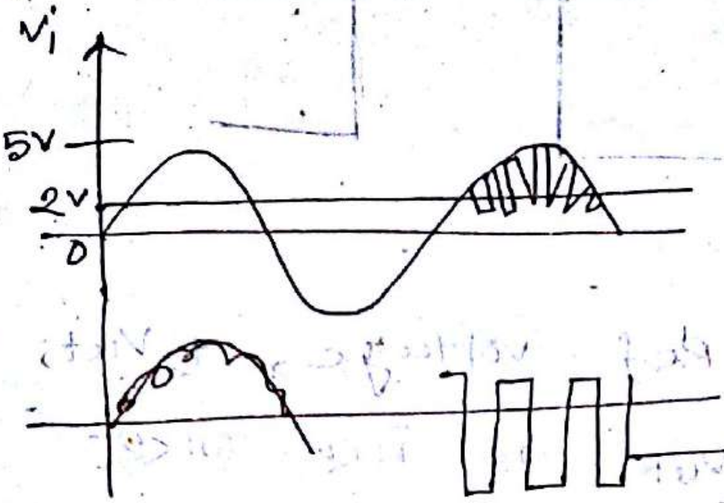
$V_H = V_{ut} - V_{lt}$

comp. dis.advantage:

(i) আমরা যে opm-amp গুলা use করি, এগুলো sharply হয় না। High speedy opm-amp use করে দূর করা যায়।

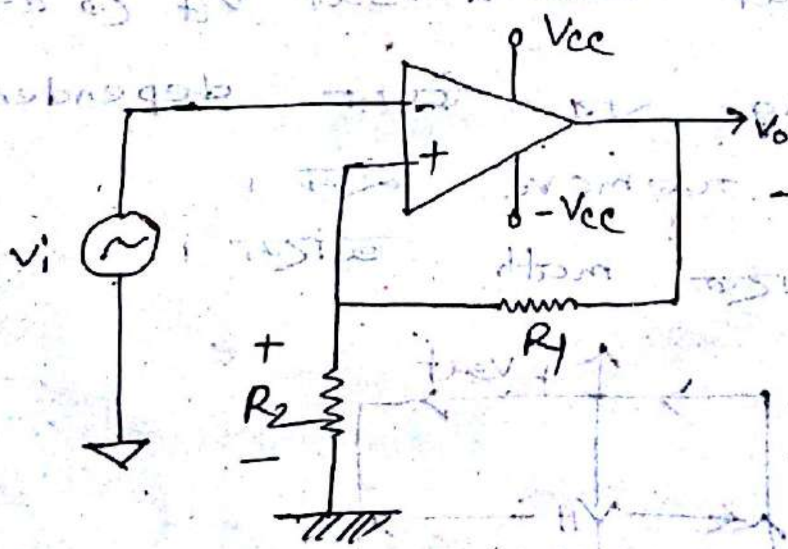
(ii) False output দেয়, যদি Noise থাকে।

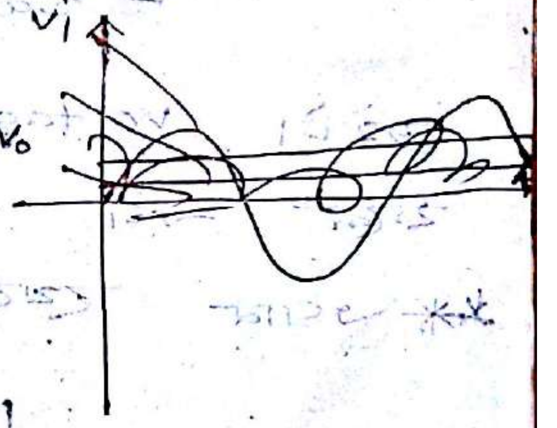
কিভাবে হয় নিচে



Noise এর কারণে এই False output এর কারণে, Noise dete

solve করার জন্যে SCHMITT Trigger circuit





$$\boxed{\begin{aligned} V_{ut} &= \frac{R_2}{R_1+R_2}(-V_{sat}) \\ V_{lt} &= \frac{R_2}{R_1+R_2}(V_{sat}) \end{aligned}}$$

V_{ut} = upper threshold voltage

V_{lt} = lower " "

Flip-flop → 00 দিলে — 00 একটা memory হিসেবে কাজ
01 " →
করে।

Trigger → দুইটা mood এ কাজ করে,
Trigger pass করে
" " না "

5 pin → voltage control করে

upper threshold → 2/3 Vcc
Lower " → 1/3 Vcc

Application:- of 555 timer:-

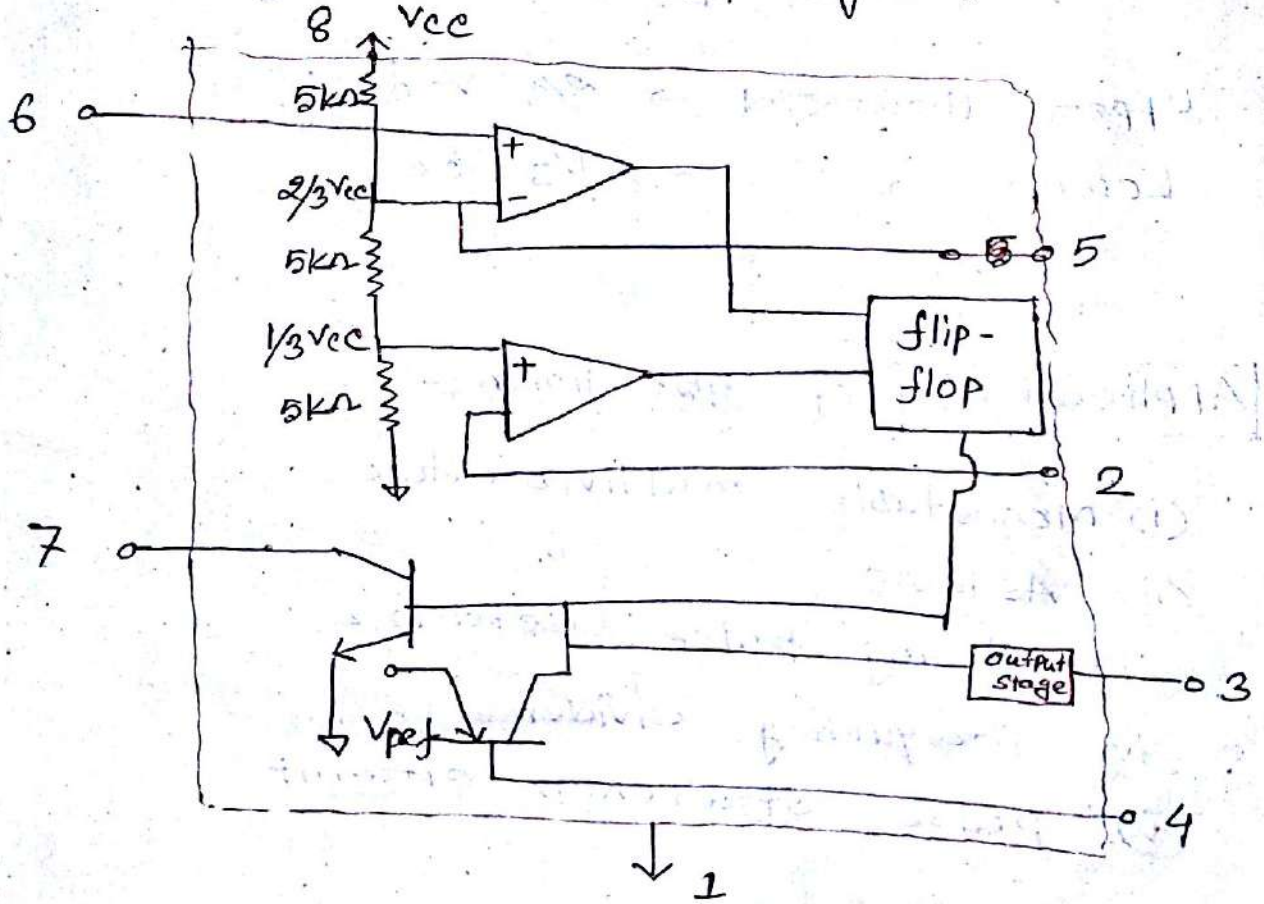
(i) Monostable multivibrator
(ii) Astable "
(iii) Missing pulse detector
(iv) Frequency divider
(v) pulse stretcher circuit

⊞ Math আসতে পারে।
সব কিছু দেয়া থাকলে circuit degin আসতে পারে।

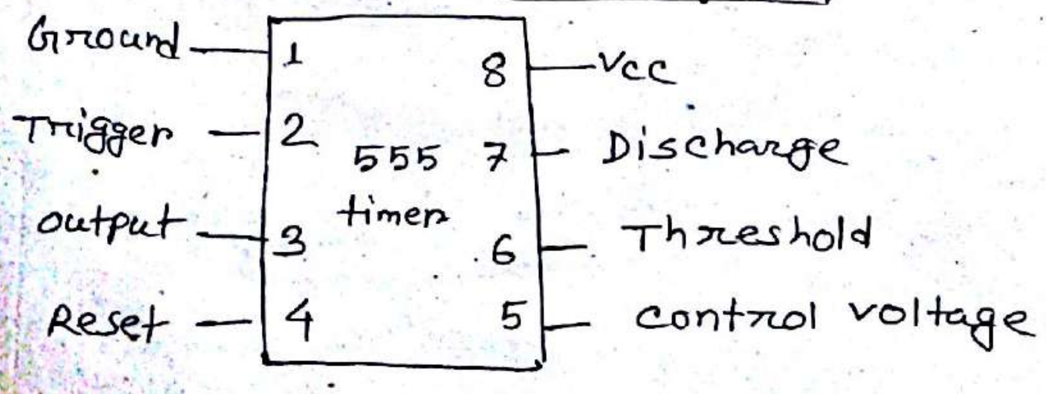
30-07-2016
11th (B) day

555 timer (Integrator circuit, দুইটা comparator circuit, দুইটা transistor,

Block Diagram

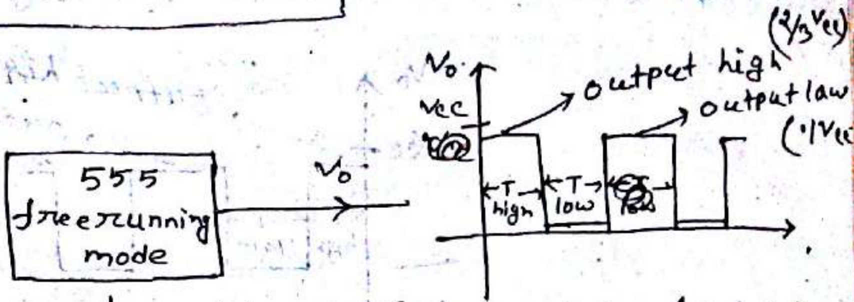


Pin diagram

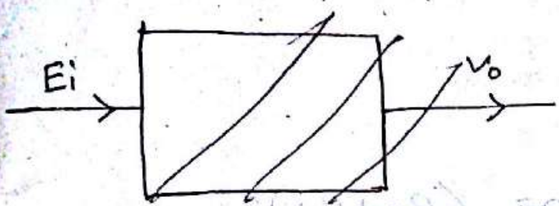


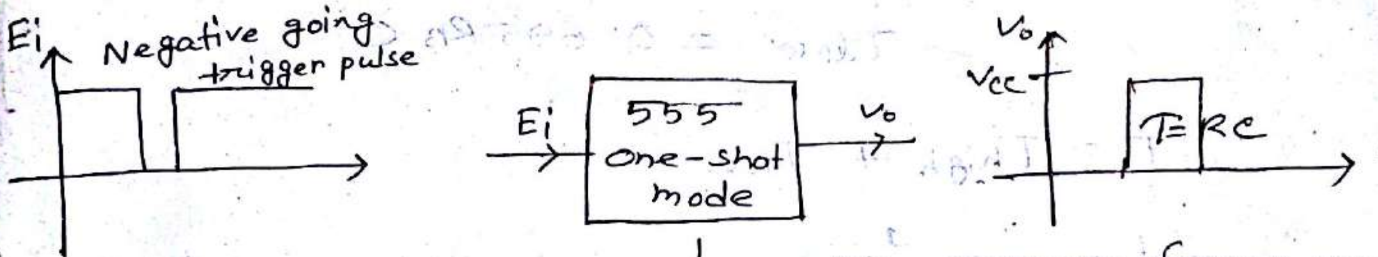
Operating modes of 555 timer :-

যেখানে trigger করাই না
তাই free running mode



↳ এইটা একধরনের mode (Astable mode)



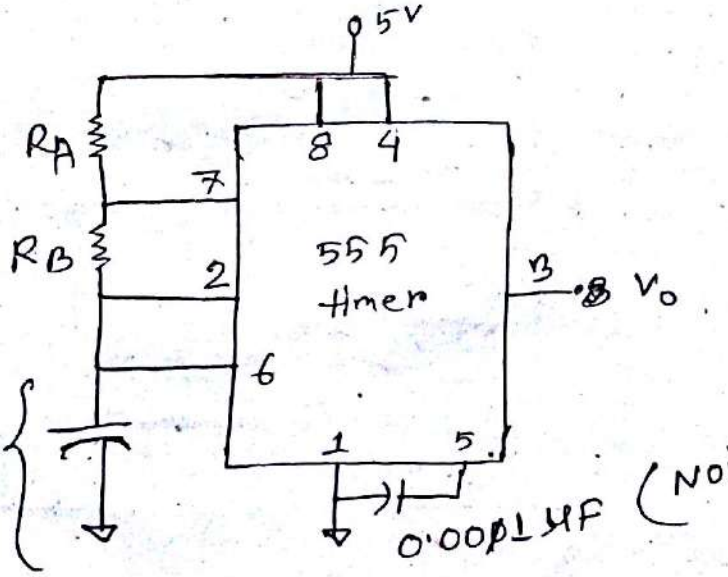


যেখানে trigger করাই

↳ এইটা আরেক ধরনের mode

T এর উপর dependent
করবে কতক্ষণ high থাকবে

~~multivibrate~~ →

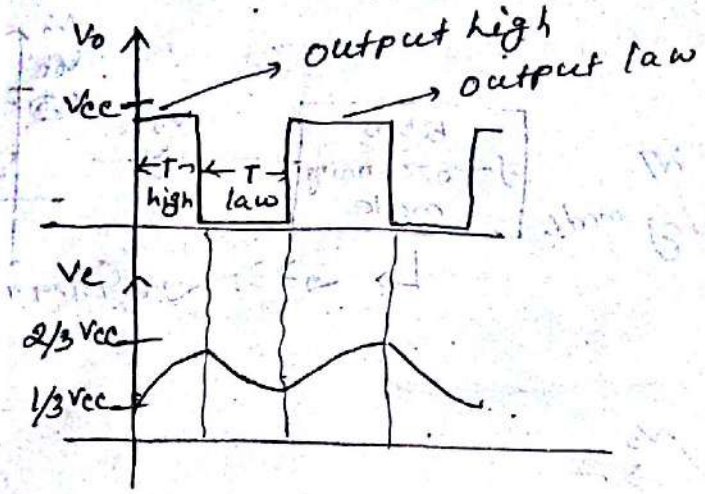


(Noise গুলোকে filter করবে এই capacitor টা)

$$T_{high} = 0.695 (R_A + R_B) C$$

$$T_{low} = 0.695 R_B C$$

Capacitor এর Accross এ voltage = (এখান থেকে ছোট ছোট math আসে)



$$T_{high} = 0.695\,(R_A + R_B)C$$

$$T_{low} = 0.695\,R_B C$$

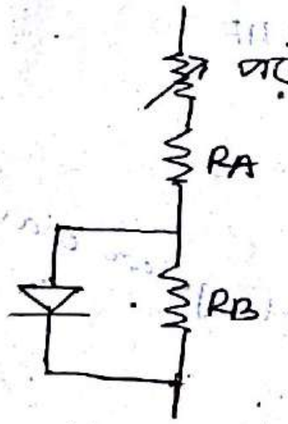
$$T = T_{high} + T_{low}$$

$$f = \frac{1}{T}$$

** duty cycle 50% output wave কেমন হবে?

সেক্ষেত্রে square wave পাব।

R_A এর সাথে পটেনশিওমিটার use করা হয় এবং R_B এর সাথে diode যুক্ত করতে হবে। এক্ষেত্রে R_A এর মান 0 করলেই হবে but R_A এর মান 0 করলে circuit সঠিকভাবে কাজ করবে না ফলে ঐ পটেনশিওমিটার use করি।

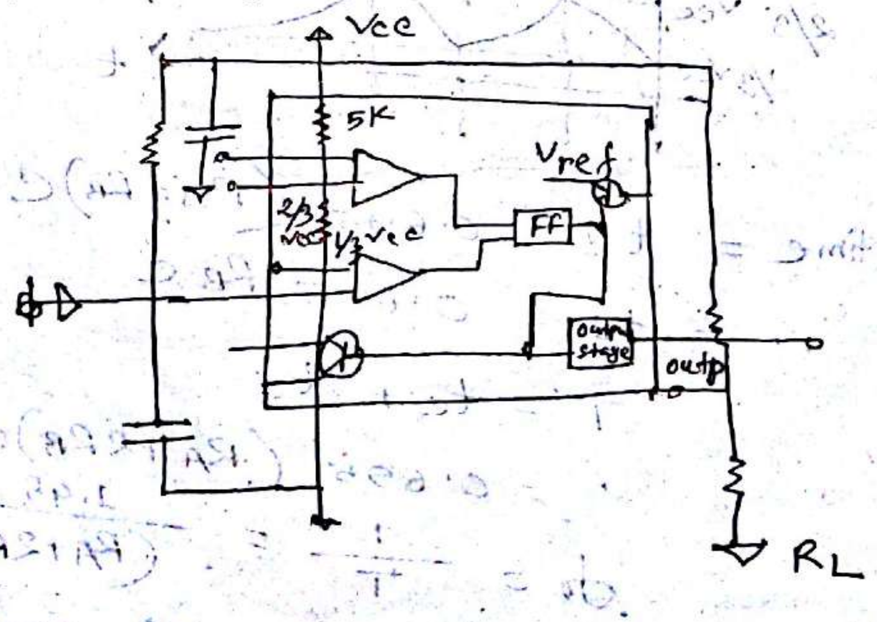


বাকি অংশ Astable multivibrator এর মত

** এর related ছোট ছোট math দেখবো

=0=

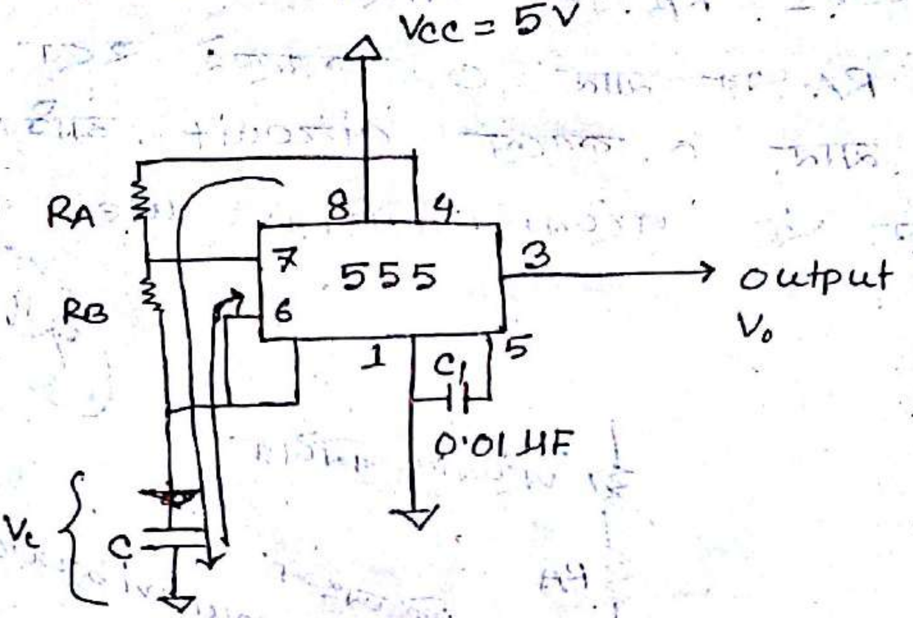
Monostable multivibrator:-

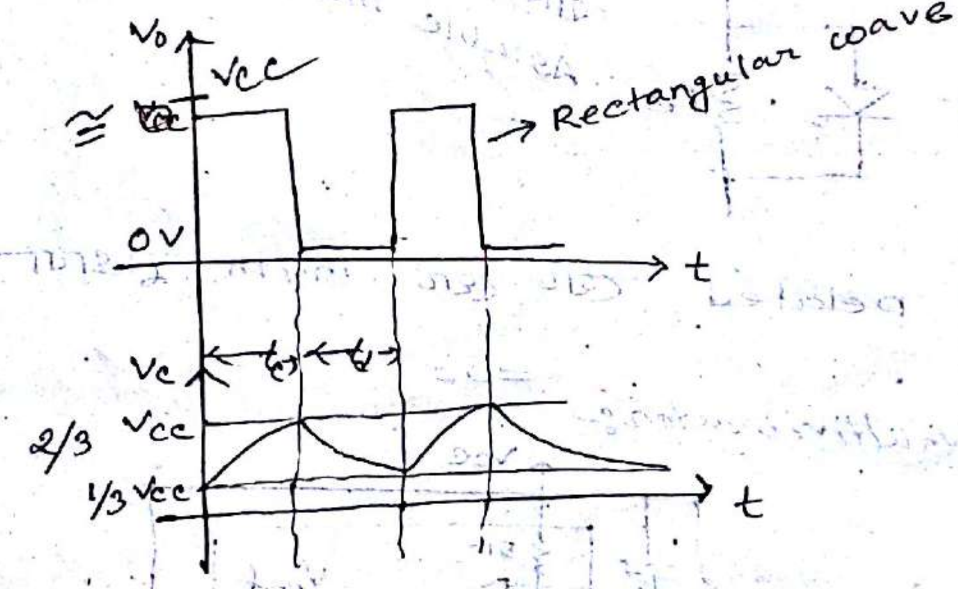


31-07-2016

11 th (c) day

Astable multivibrator:-





charging time = $t_c = 0.695\,(R_A+R_B)C$

Dis " " = $t_d = 0.695\,R_B C$

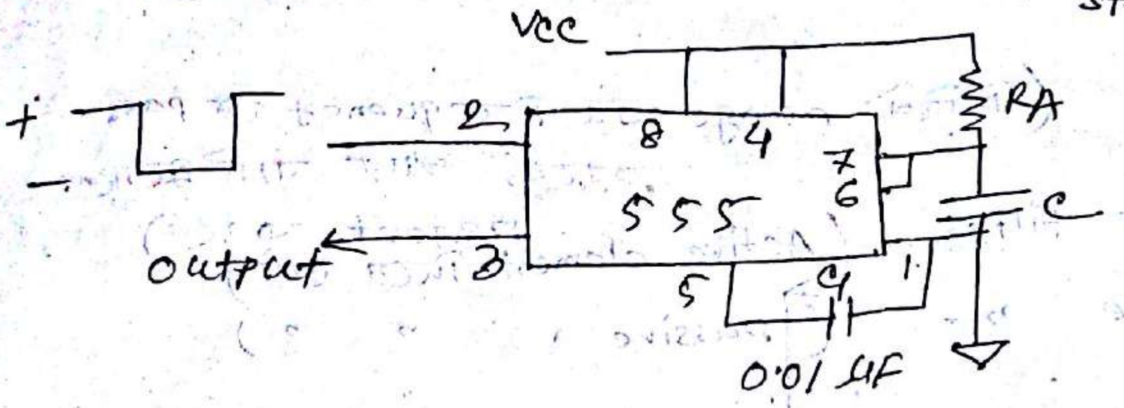
$$T = t_c + t_d$$

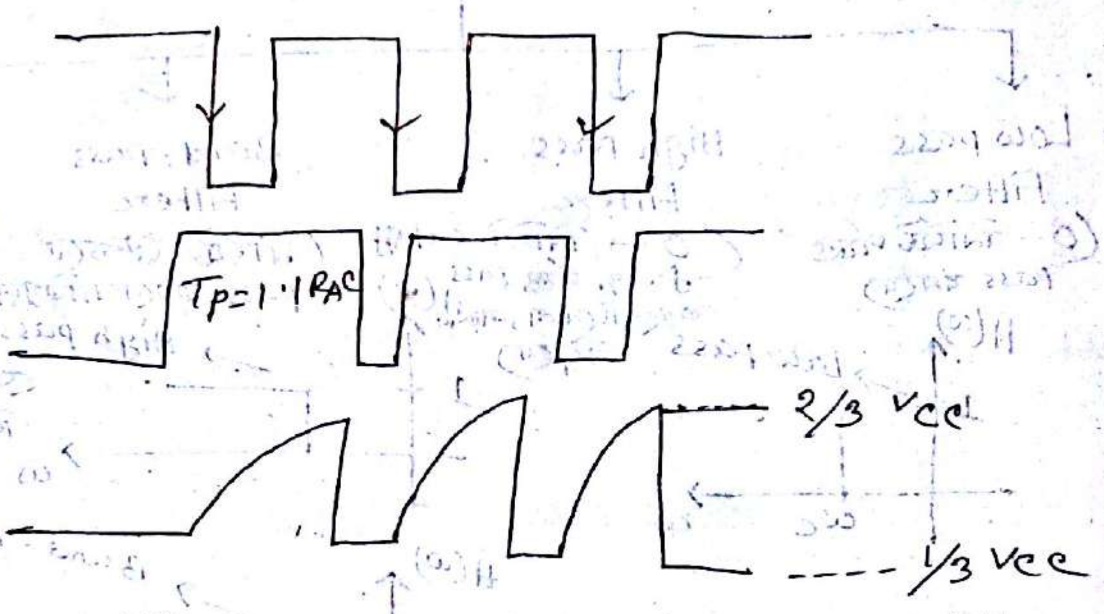
$$= 0.695\,(R_A+2R_B)C$$

$$f_0 = \frac{1}{T} = \frac{1.45}{(R_A+2R_B)C}$$ ↳ frequency of oscillation

duty cycle = $\frac{t_c}{T} \times 100\%$ ~~50%~~

Monostable multivibrator: (externerly 1 টা RA, হয় দিয়ে ~ trigger pulse দিয়ে stable state থাকে (low)





High টা কতক্ষণ থাকবে depend করবে RA ও C এর উপর।

High থাকা অবস্থায় negative pulse দিলে কোন change হবে না।

Gray kord এর বই দেখো।

~~Astable~~ → ~~stable multivibra~~

02-08-16
11th (E) day

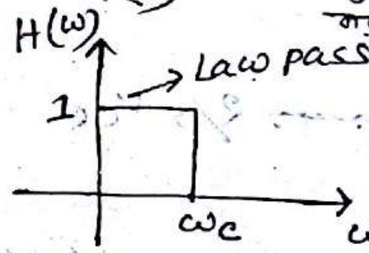
Timer + Filter
ct-4 – Syllabus

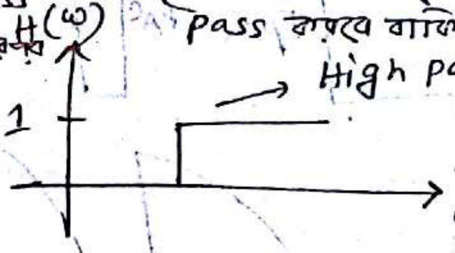
Filters:- (নির্দিষ্ট range এর Frequency কে pass করবে, আর বাকিগুলোকে reject করবে)

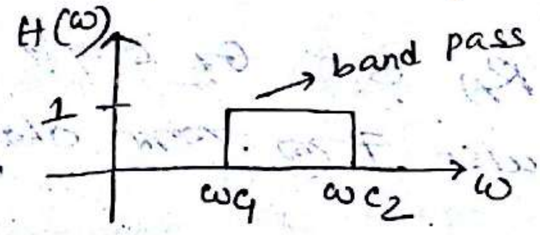
(i) Active Filter (Active element দিয়ে তৈরী)

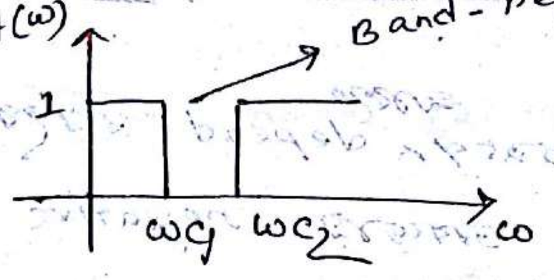
(ii) Passive " (passive " " ")

- Low pass Filter (0 – নির্দিষ্ট পর্যন্ত pass করবে)
- High pass Filter (0 — নির্দিষ্ট cut off freq. পর্যন্ত pass করতে দিবে না, তারপর দিবে)
- Band-pass Filter (নির্দিষ্ট রেঞ্জকে pass করবে বাকিগুলো না)
- Band-reject/Band-stop filter (সব কিছুই কে pass করবে নির্দিষ্ট রেঞ্জের ω কে করতে দিবে না)





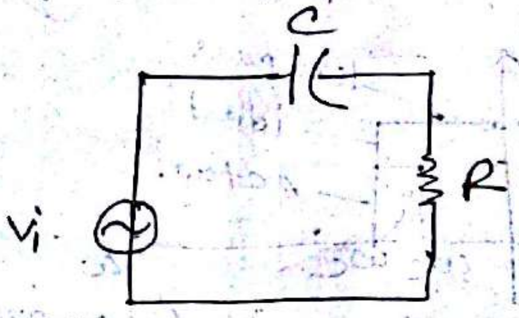


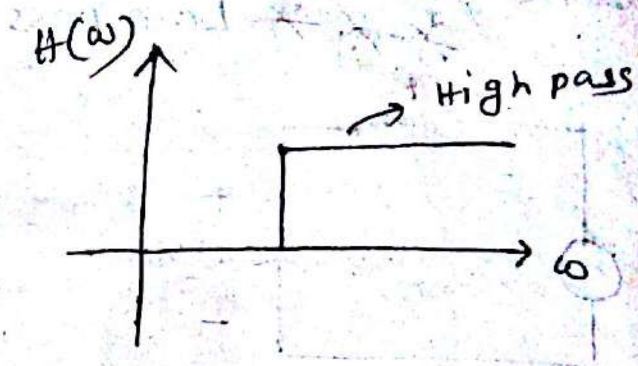


Op-amp দিয়ে যে filter তারা Active.

cut off frequency = corner frequency
= Roll off frequency.

High pass filter:





$$H(\omega) = \frac{V_0(\omega)}{V_i(\omega)}$$

$$= \frac{R \times \cancel{1}}{R + 1/J\omega C \cancel{\times 1}}$$

$$= \frac{R}{R + 1/J\omega C}$$

$$= \frac{R}{\frac{RJ\omega C + 1}{J\omega C}}$$

$$= \frac{RJ\omega C}{1 + RJ\omega C}$$

$\omega = \infty \Rightarrow H(\omega) = \dfrac{RJ\omega C}{1 + RJ\omega C}$

$$= \frac{1}{1 + 1/RJ\omega C}$$

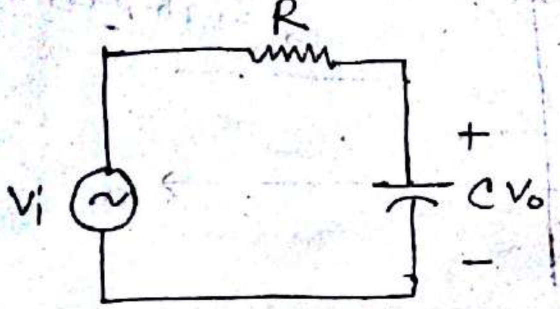
$$= 1$$

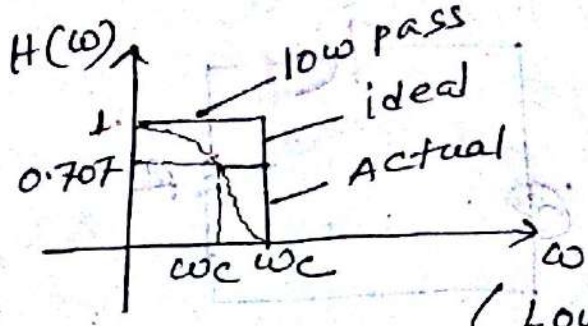
$\omega = 0, \quad H(\omega) = 0$

এ low গুলোকে pass করছে না high গুলোকে pass করছে।

passive Filter:-

~~Low~~ Low pass





(Lowpass filter)

$$H(\omega) = \frac{V_o(\omega)}{V_i(\omega)}$$

Transfer function

$$= \frac{1/J\omega C \times I}{(R + 1/J\omega C) \times I}$$

$$\therefore H(\omega) = \frac{1}{1 + J\omega RC}$$

$$\boxed{\begin{aligned} \omega = 0,\ H(0) = 1 \\ \omega = \infty,\ H(\infty) = 0 \end{aligned}}$$

তাই low pass filter

$$|H(\omega)| = \frac{1}{\sqrt{1 + \omega^2 R^2 C^2}}$$

if $\omega = \frac{1}{RC}$

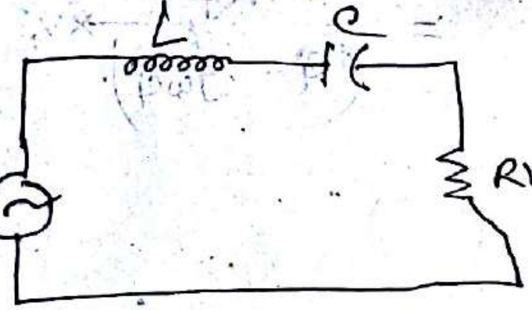
$$|H(\omega)| = \frac{1}{\sqrt{2}} = 0.707$$

** যে frequency response টা 0.707 তে নেমে আসবে তাকে cut off frequency বলে। (Actual filter) when $\omega_c = 1/RC$ = cut off frequency

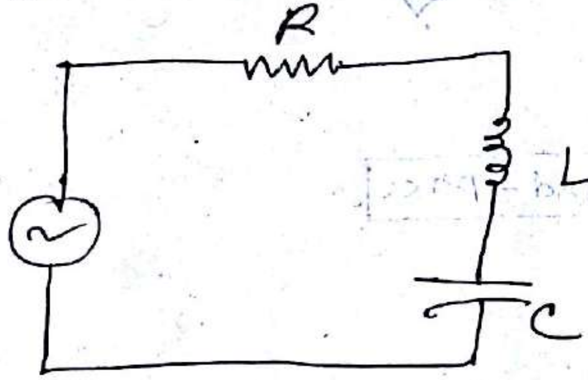
$$\therefore \cancel{H(\omega)} = \frac{1}{\sqrt{2}}$$

* circuit দেয়া থাকলে R, C দেয়া আছে, cut off ~~freq~~ frequency কত ?

=0=



band pass

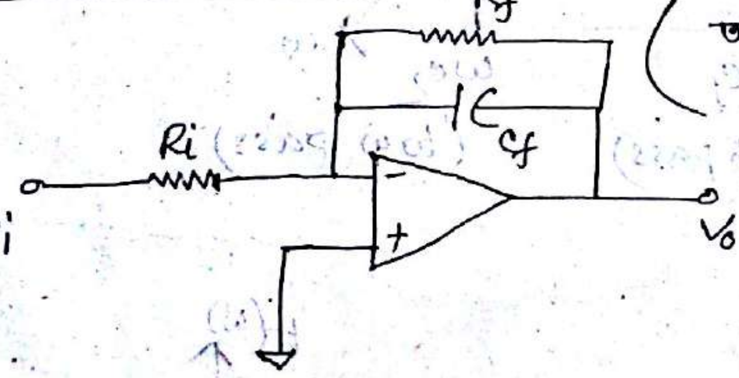


band reject

$$H(\omega) = \frac{R}{R + J\left(\omega L - \frac{1}{\omega C}\right)}$$

$$H(\omega) = \frac{J\left(\omega L - \frac{1}{\omega C}\right)}{R + J\left(\omega L - \frac{1}{\omega C}\right)}$$

$\boxed{\text{Active filter:-}}$ → Low-pass



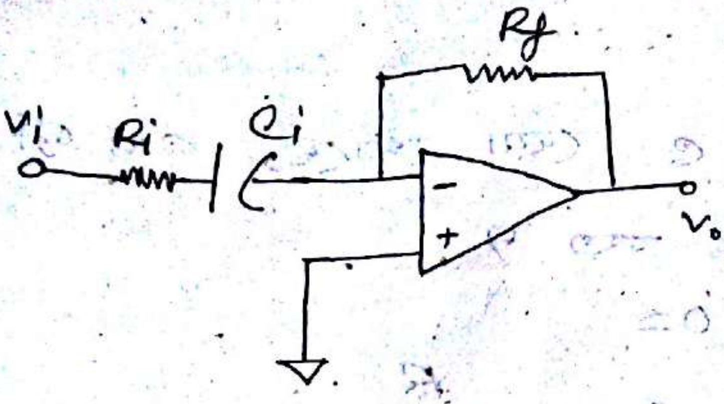
(অতিরিক্ত কারেন্ট C_f এর মধ্যে যাতে flow না হয় তাই R_f)

$$Z_f = \frac{R_f \cdot \frac{1}{J\omega C_f}}{R_f + \frac{1}{J\omega C_f}}$$

$$\frac{V_o}{V_i} = -\frac{Z_f}{Z_i}$$

$$= -\frac{R_f}{R_i} \cdot \frac{\frac{1}{J\omega C_f}}{R_f + \frac{1}{J\omega C_f}}$$

High - pass



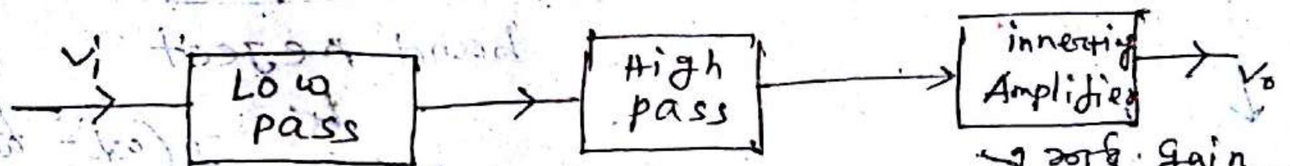
$$R_i + \frac{1}{j\omega C_i}$$

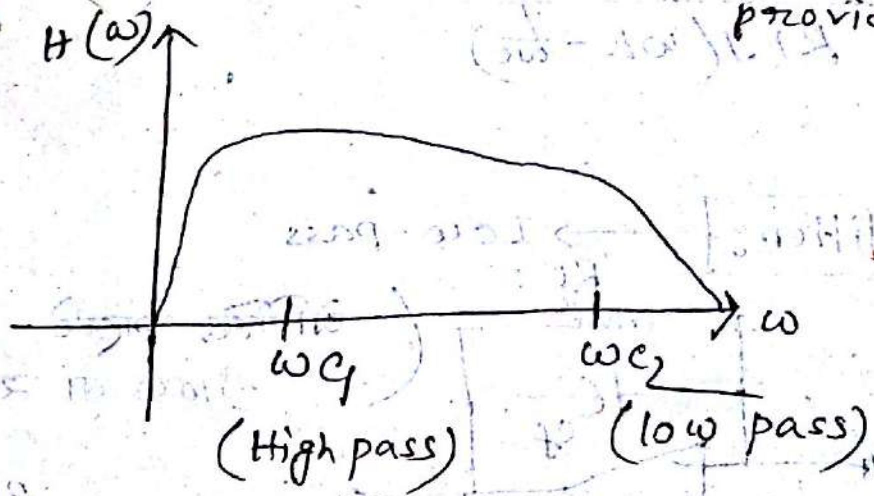
$$Z_f = \cancel{\frac{R_f}{R_f + \frac{1}{j\omega C_f}}}$$

$$\frac{V_o}{V_i} = -\frac{Z_f}{Z_i}$$

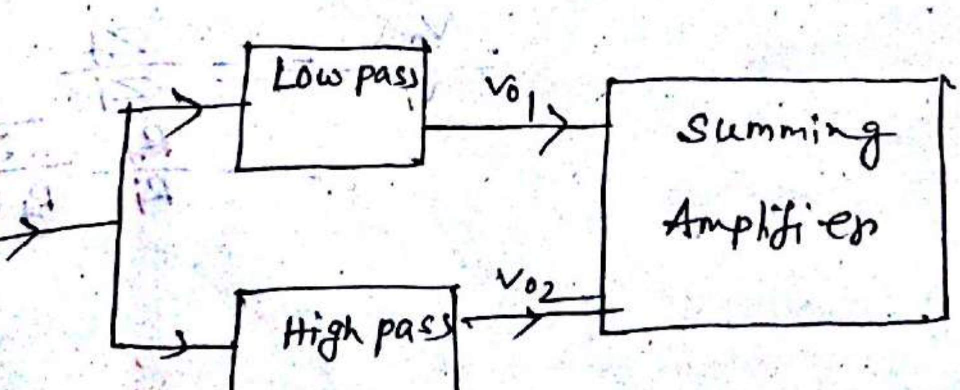
$$= \frac{-R_f}{\left(R_i + \frac{1}{j\omega C_i}\right)} \times V_i$$

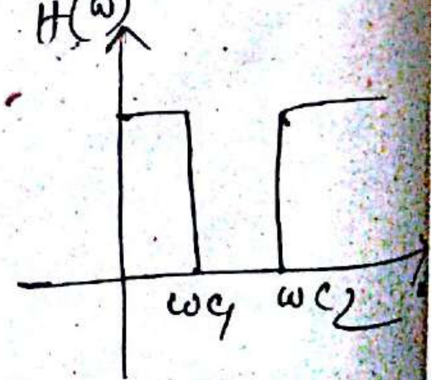
Band - pass





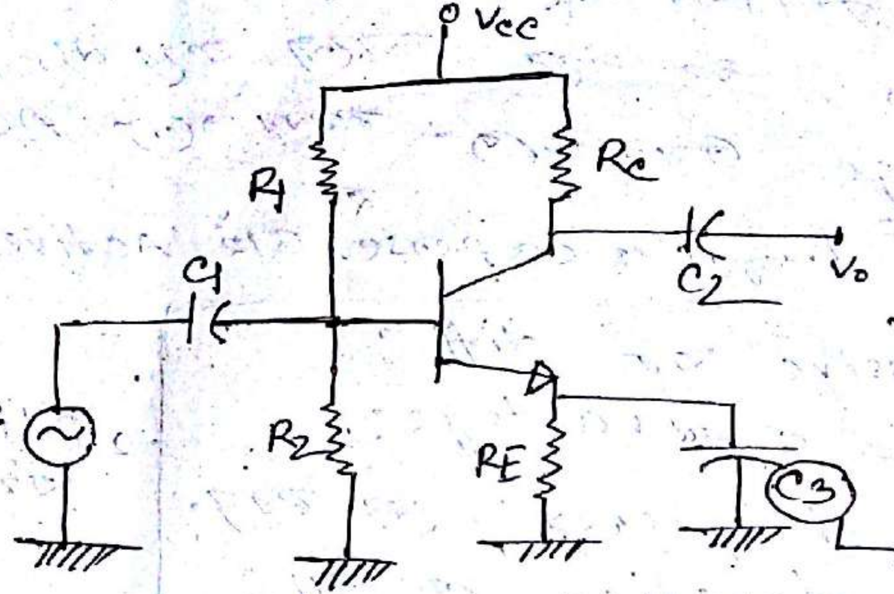
Band reject :

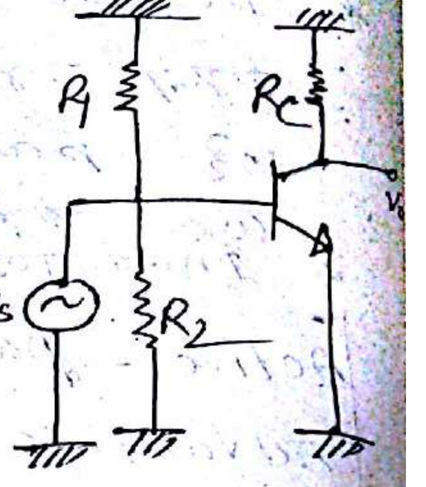




06-08-16
12th(B)day

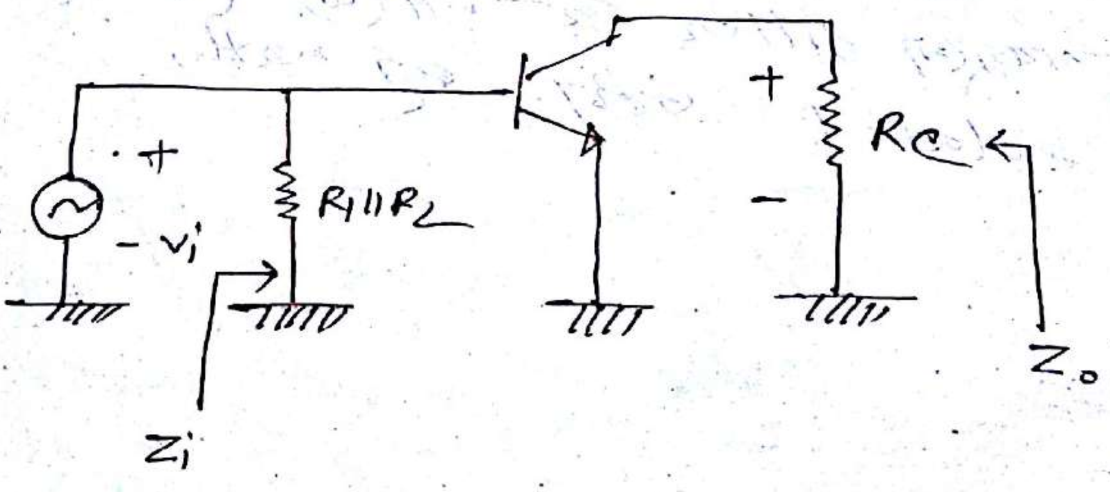
BJT AC analysis:-





→ Bipas capacitor (AC টাকে bipas করে)

এক্ষেত্রে capacitor গুলা short করব.
〃 DC supply গুলা 0 করে দিব



input impedence, $Z_i = R_1 \| R_2$

oupt 〃, $Z_o = R_c$

passive থেকে Active কেন use করব?

* gain provide এর জন্য
* passive filter গুলো 300 - 3000 Hz এ ভালো কাজ করে, এর পরে ভালো কাজ করে না, এই range এর বাইরে কাজ করার জন্য Active filter use করি। হয়
* Inductor গুলো expense তাই Active use করি

Active - passive এর diff.:
Advantage - disadvantage:
cut off frequency বের করা:
Transfer function বের করা:

→ Filter থেকে এই গুলো

Assignment:-

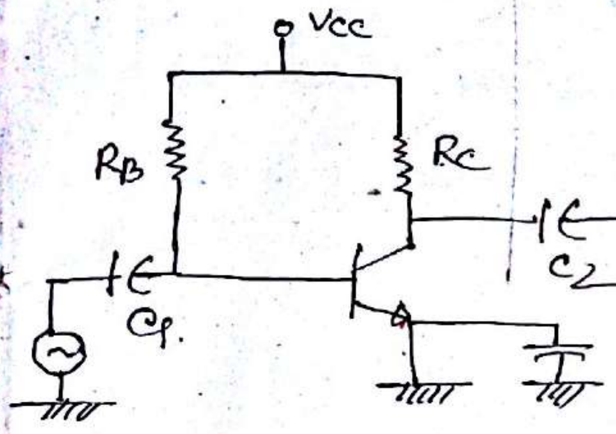
সবগুলো filter এর $H(\omega)$ বের করতে হবে এবং related এটি আর math, Model :

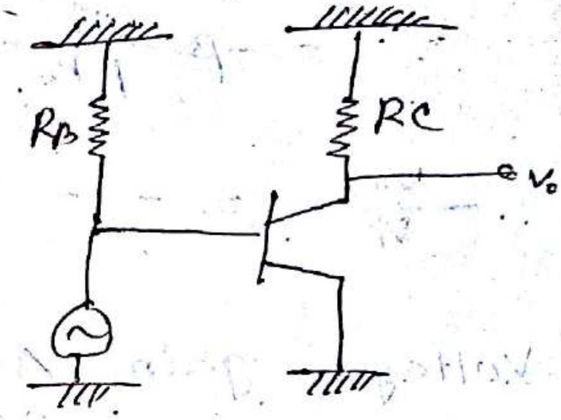
(i) re Model (সিলেবাসে আছে)

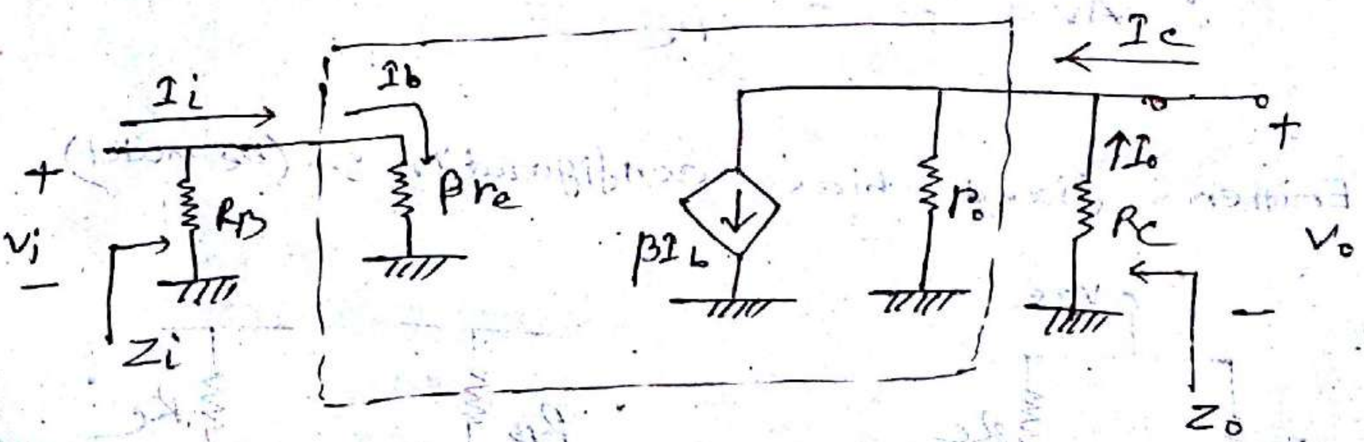
(ii) π " (" নাই)

(iii) hybrid " (" নাই)

Fixed Bias configuration (re Model)







BJT r_e model

$$r_e = \frac{26\,mV}{\cancel{I_E}\; I_E}$$

AC তে small suffix I_e

DC " capital " I_E

$Z_i = R_B \parallel \beta r_e$

$Z_o = R_c \parallel r_o$

If $R_B \geq 10\beta r_e$

$Z_i = \beta r_e$

If $r_o \geq 10 R_C$

$Z_o = R_C$

$V_o = -\beta I_b (R_C \| r_o)$ | $I_b = \frac{V_i}{\beta r_e}$

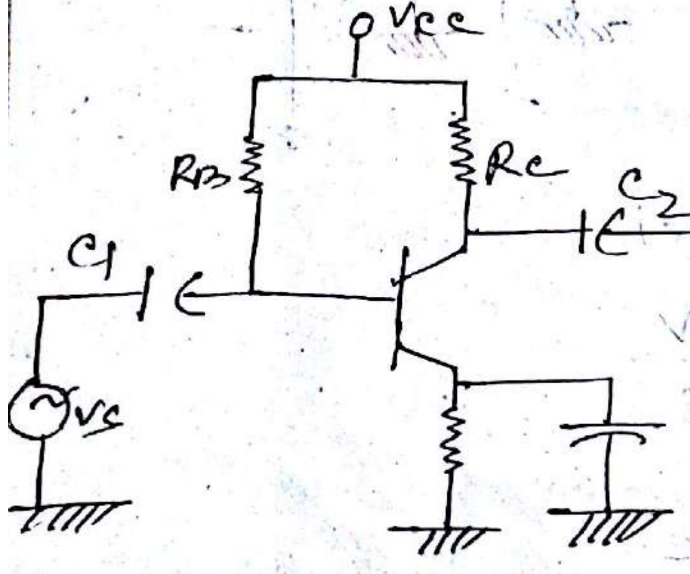
$= -\beta \frac{V_i}{\beta r_e} (R_C \| r_o)$

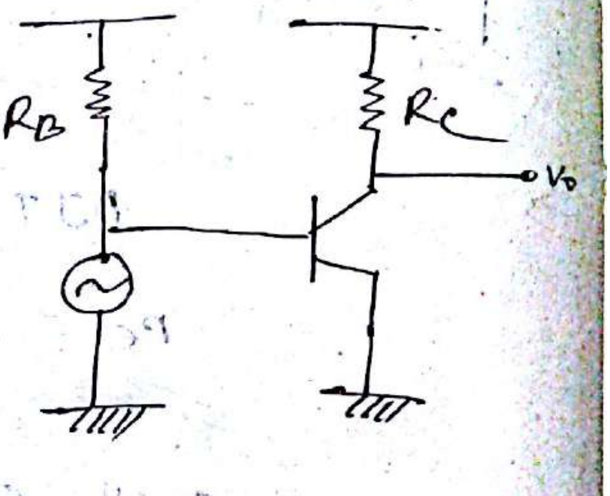
$\frac{V_o}{V_i} = -\frac{R_C \| r_o}{r_e}$

Voltage gain, $A_V = \frac{V_o}{V_i}$

$\therefore A_V = -\frac{R_C \| r_o}{r_e}$

Emitter fixed bias configaration :- (re model)





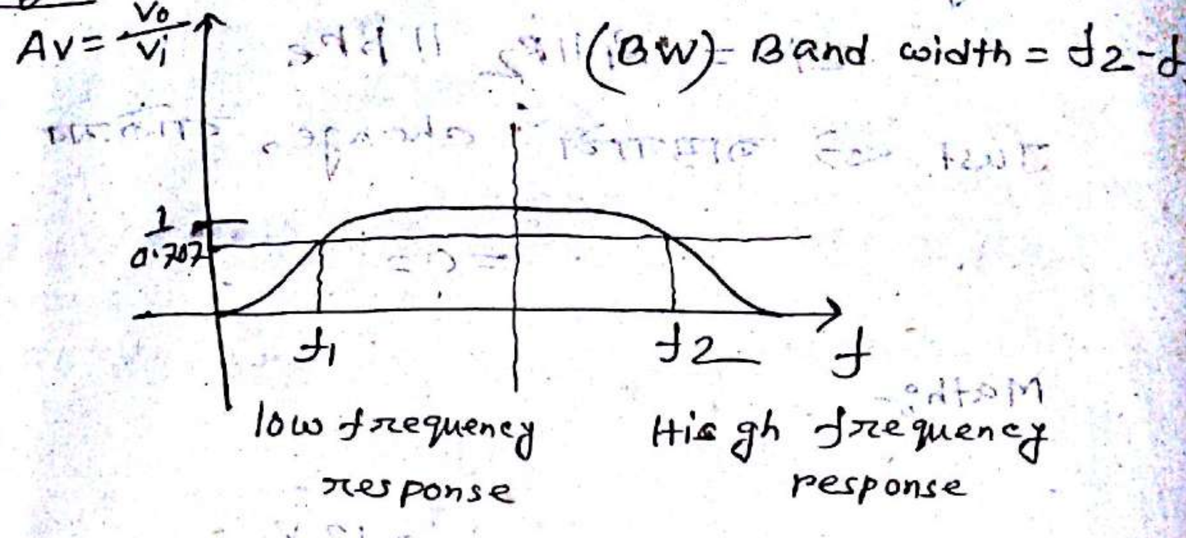
এখানে আগের মত হবে

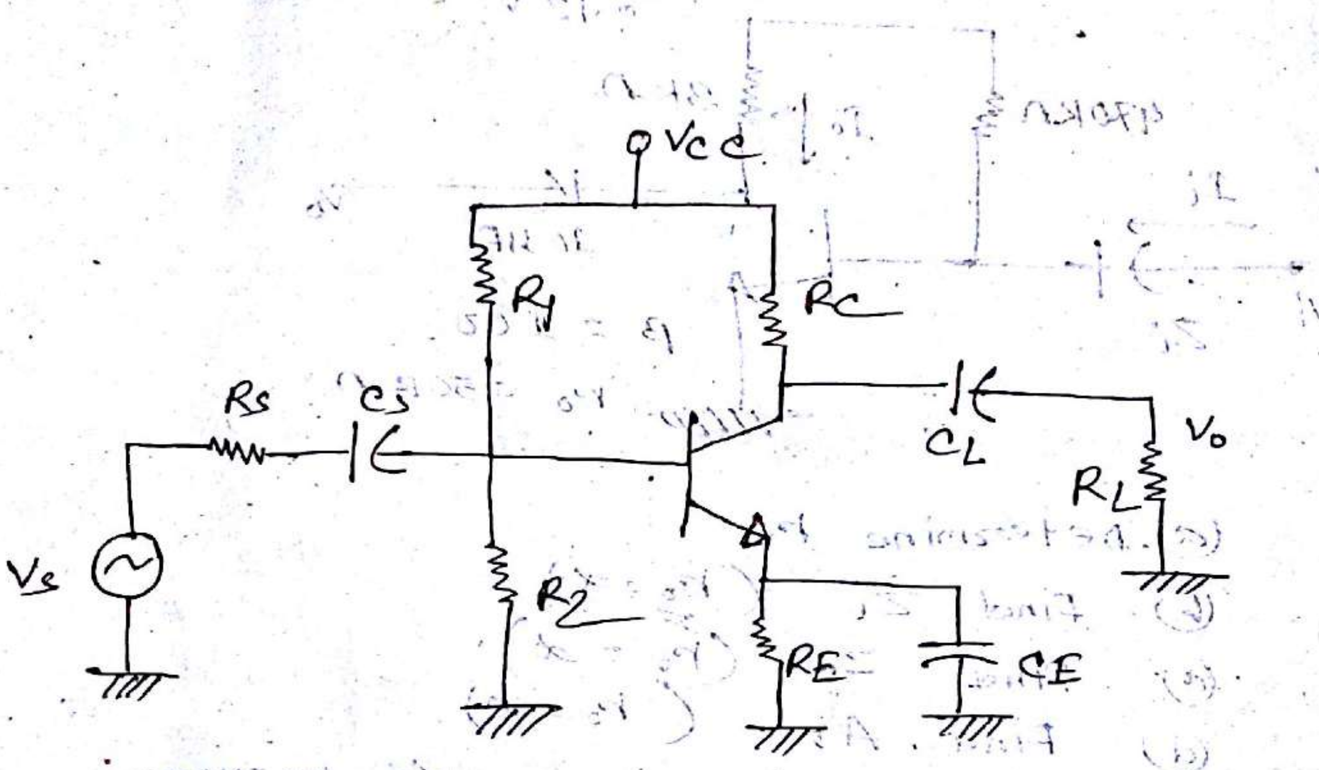
এবার, বাকি সব calculation Fixed bias configur-

এর মতই

Frequency Response of BJT

Low Frequency:-





C_s = source/Input capacitor

C_c = coupling/output "

C_E = Bypass capacitor

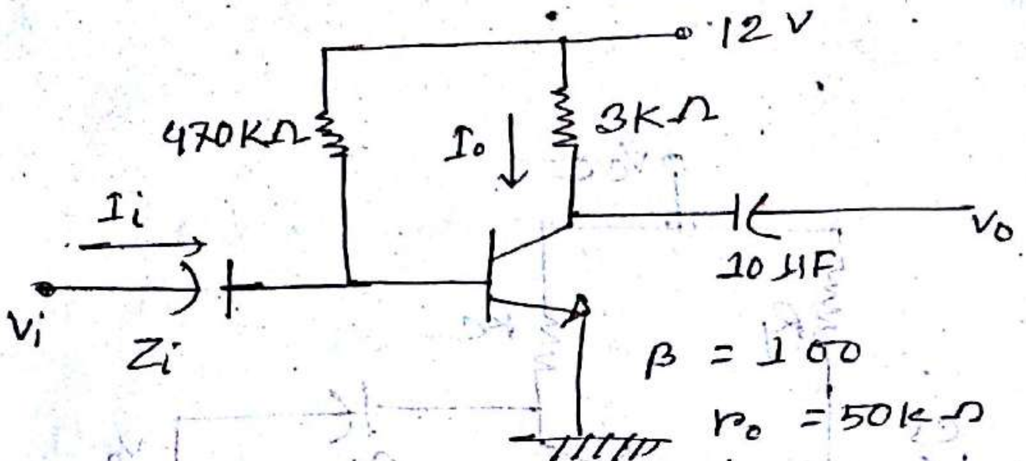
Voltage divider এর ক্ষেত্রে,

$Z_i = R_1 \| R_2 \| \beta r_e$

Just এই জায়গাতে change, বাকি সব আগের মত।

=0=

Math:-



(a) Determine r_e

(b) Find Z_i $(r_o = \infty)$

(c) Find Z_o $(r_o = \infty)$

(d) Find A_v $(r_o = \infty)$

প্রথমে equivalent circuit টা draw করব—

(a) $r_e = \dfrac{26mV}{I_E}$

যদি I_E এর মান দেওয়া না থাকে তবে Dc bias Analysis করে বের করতে হবে।

$I_E = 2.428\ mA$

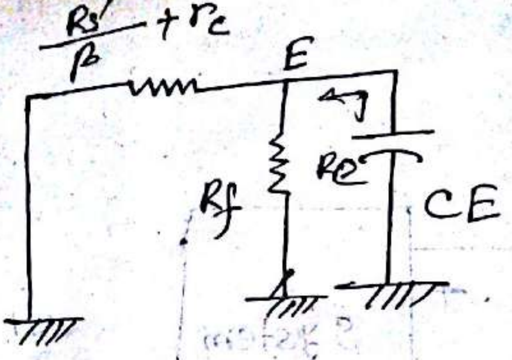
(c) (b) $r_o \geq 10R_C$

$Z_o = R_C$

(d) $Z_i = R_B \| \beta r_e$

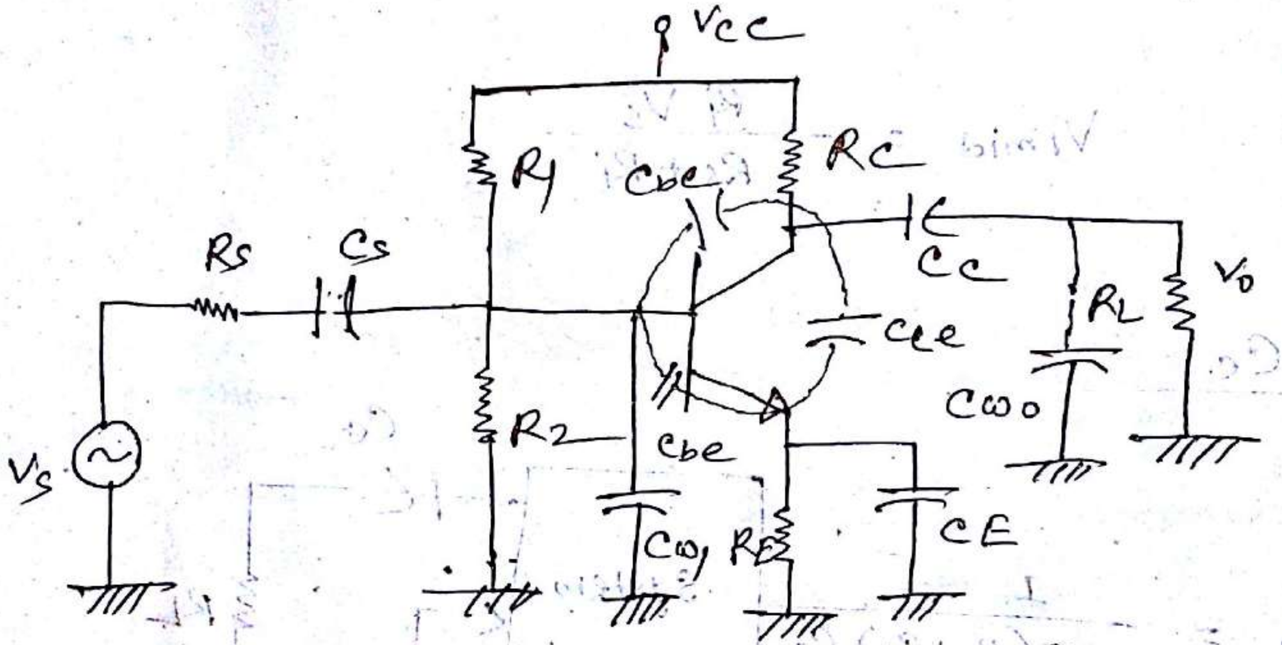
(e) $A_v = -\dfrac{R_C \| r_o}{r_e}$

$= -\dfrac{R_C}{r_e}$ (r_o ≥ [illegible]



** math গুলা করবে উদাহরণ → Example গুলা

High frequency



$$f_{Hi} = \frac{1}{2\pi R_{th} C_i}$$

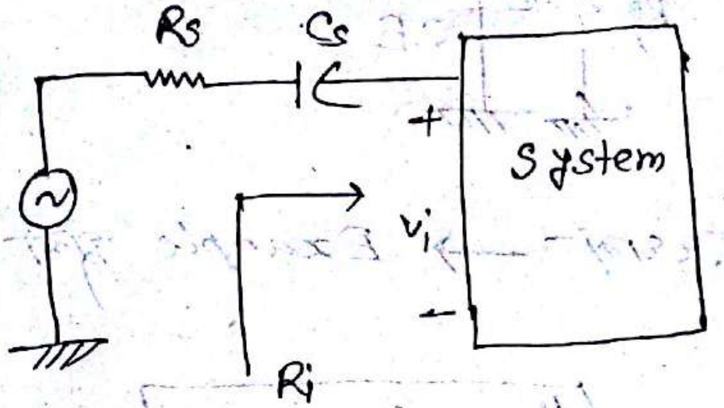
$C_{bc} = C_{ce} = C_{be} =$ interelectrode capacitor

$$R_{th} = R_s \parallel R_1 \parallel R_2 \parallel R_i'$$

$$C_i = C_{\omega i} + C_{be} + C_{Mi}$$

$$= C_{\omega i} + C_{be} + (1 - A_v) C_{bc}$$

C_S

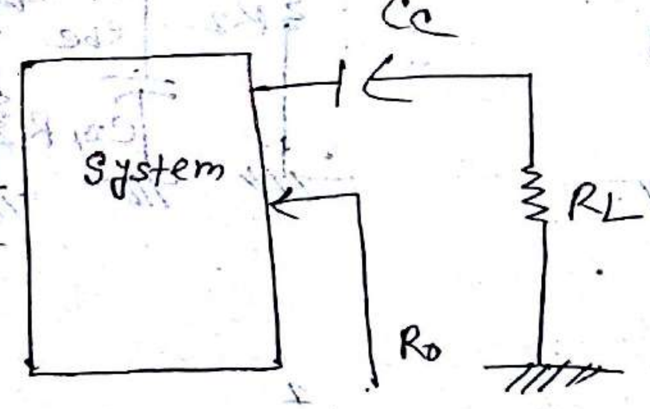


$$f_1 = \frac{1}{2\pi RC} = \frac{1}{2\pi(R_S + R_i')C_S}$$

$$R_i' = R_1 \parallel R_2 \parallel \beta r_e$$

$$V_{i\,mid} = \frac{R_i V_s}{R_S + R_i}$$

C_C



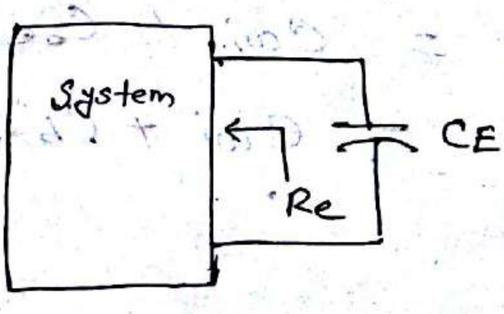
$$f_1 = \frac{1}{2\pi(R_o + R_L)\,C_C}$$

$$R_o = r_o \parallel R_C$$

C_E

$$f_{1E} = \frac{1}{2\pi R_e C_E}$$

$$R_e = R_E \parallel \frac{R_S'}{\beta} + r_e$$



$$f_H = \frac{1}{2\pi R_{th} C_o}$$

$$R_{th} = R_C \parallel r_o \parallel R_L$$

$$C_o = C_{wo} + C_{ce} + C_{Mo}.$$

Example টা অভ্যাস কর।