Note starts

Oscillators

circuit which generate o/p without giving any i/p.

Positive feedback is applying here.

An amplifier and feedback circuit is used in circuits.

Types of oscillators:

1. Sinusoidal or harmonic → produce sine wave as o/p
2. Non-sinusoidal or relaxation → other wave as o/p

① RC oscillator → eg: RC phase shift oscillator
↓ works in low freq or audio freq regions

② LC oscillator → High frequency oscillator &, in feedback circuit capacitor or Inductance is used.

③ Crystal oscillator → (quartz made of crystal) is used to produce oscillation. [made up of piezoelectric material]

It is most common used oscillator i.e it is stable and frequency of operation is high

4) -ve resistance

- oscillator used ~~for~~ as tunnel diode

Factors affecting frequency stability

① Operating point or Q-point :

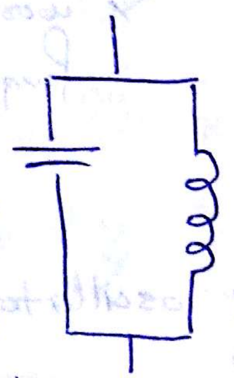
② circuit component

③ Supply voltage

④ o/p load

⑤ Inter element or stray capacitance

Tank circuit



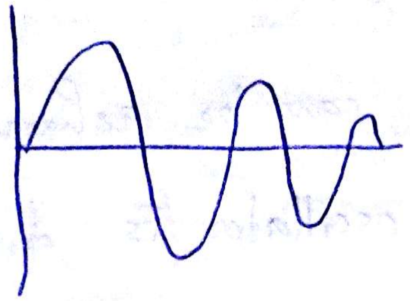
charge is stored as electric field

charge is stored as magnetic ~~fiel~~ ~~fiel~~ feild

Both capacitor & inductive are passive.

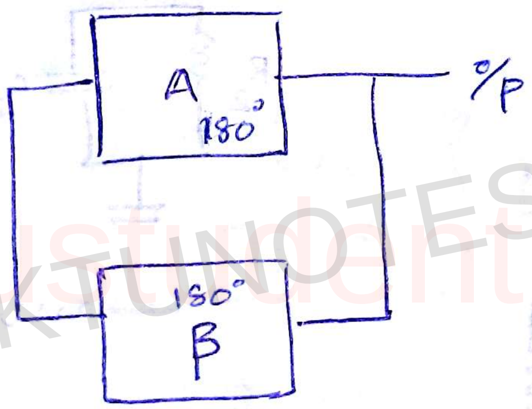
amplifier is used to sustain the oscillation so an amplifier is needed for oscillation.

Normal damped waveform of tank circuit



$A\beta \phi < 1$

Inorder to prevent this damping we use amplifier in oscillator

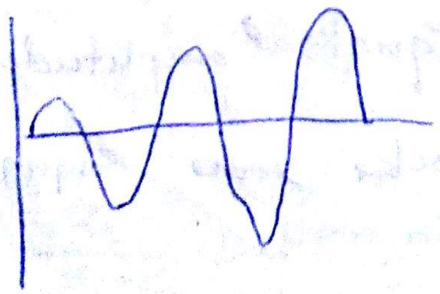


* Barkehauen criteria for sustained oscillation: condition:

① $A\beta = 1$ we get constant waveform (condtn for sustained wavefm)

② total phase shift circuit is either 360° or 0°.

$A\beta > 1$

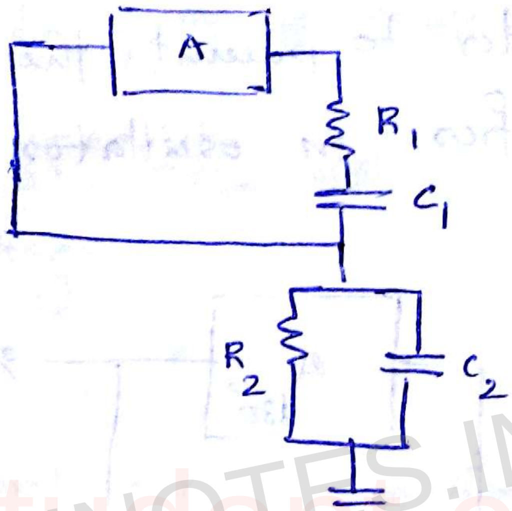


we will not get sustained oscillation

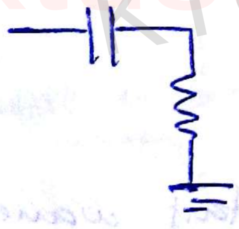
over damp.

Wein bridge Oscillator

Any phase shift can be achieved by using RC network. This oscillator is a combination lead & lag network.



→ This circuit is both lead and lag phase shift.

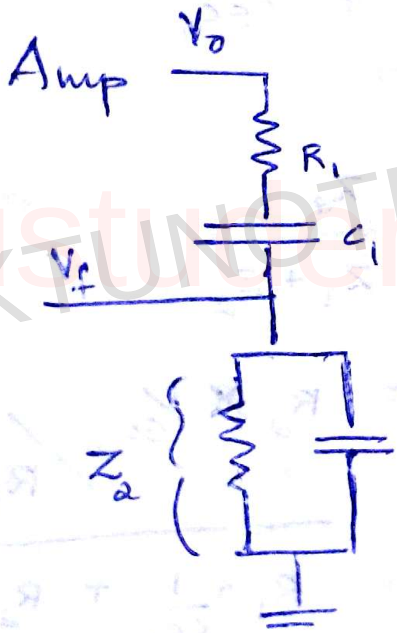


This is lead network
phase shift leads

This is a lag network
phase shift lags

low frequency signal's amplitude reduce becoz of c_1 as it blocks some signal & high frequency signal's amplitude decreases bcz of capacitor C_2 as it has low impedance some current flows through C_2 and get grounded

feedback components determine the frequency of o/p signal.



$$\beta = \frac{V_f}{V_o}$$

$$\therefore V_f = \frac{V_o}{Z_1 + Z_2} \times Z_2$$

$$\therefore \beta = \frac{Z_2}{Z_1 + Z_2}$$ from above by substitution.

Hartley oscillator

$$f = \frac{1}{2\pi\sqrt{C(L_1+L_2)}}$$

h_{fe} - gain

Real part = 0

$$-\omega^2 (L_2+M)\left[(1+h_{fe})(L_1+M) - \frac{1}{\omega^2 C}\right] = 0$$

$$(1+h_{fe})(L_1+M) - \frac{1}{\omega^2 C} = 0$$

$$\frac{1}{\omega^2 C} = L_1+L_2+2M$$

$$(1+h_{fe})(L_1+M) - \frac{\cancel{L_1+L_2+2M}}{\cancel{L_1+L_2+2M}} = 0$$

$$\cancel{h_{fe}}\ \cancel{L_1}+M+L_1 h_{fe}+M h_{fe} - \cancel{L_1} \mp L_2 \mp 2M = 0$$

$$-2M + h_{fe}(L_1+M) \mp L_2 = 0$$

$$\text{gain}(A) = h_{fe} = \frac{M+L_2}{L_1+M}$$

we know

$$A\beta = 1$$

$$\therefore \beta = 1/A = \boxed{\frac{L_1+M}{L_2+M}}$$

Crystal Oscillator

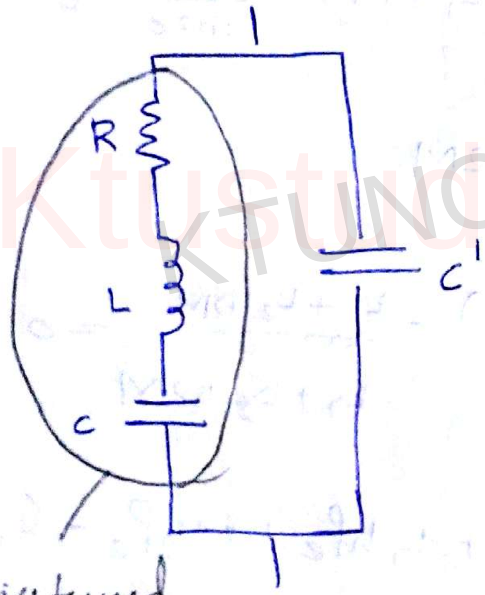
Quality factor

$$Q\text{-factor} = \frac{L\omega}{R}$$

Q. factor of crystal oscillator is very high.

feedback element is piezoelectric crystal (Quartz)

when voltage applies, a mechanical deformation occurs.



Series tuned circuit

C' is mounting capacitance or capacitance of entire crystal

for a crystal oscillator, there are:

⇒ series tuned frequency

→ parallel tuned frequency

ω_s and f_{p_s} are angular frequency and series frequency

$$f_s \text{ (series resonance frequency)} = \frac{1}{2\pi\sqrt{LC}}$$

$$f_p = \frac{1}{2\pi\sqrt{LC}}$$

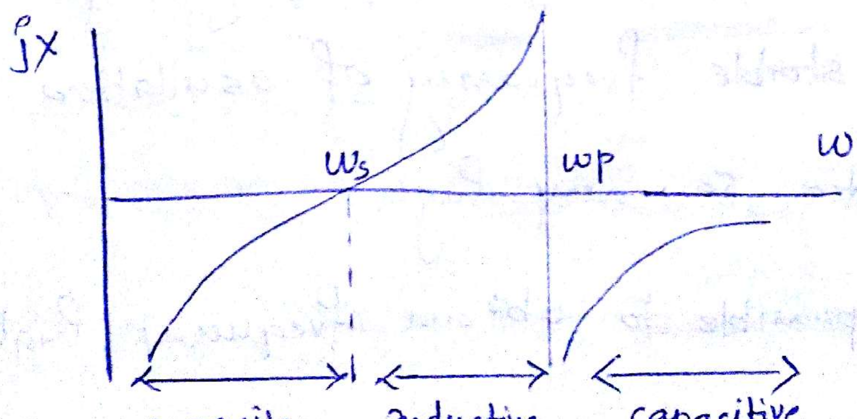
$$C_{equi} = \frac{CC'}{C+C'}$$

$$\text{Net impedence } jX = \left(j\omega L + \frac{1}{j\omega C}\right) \,//\, \frac{1}{j\omega C'}$$

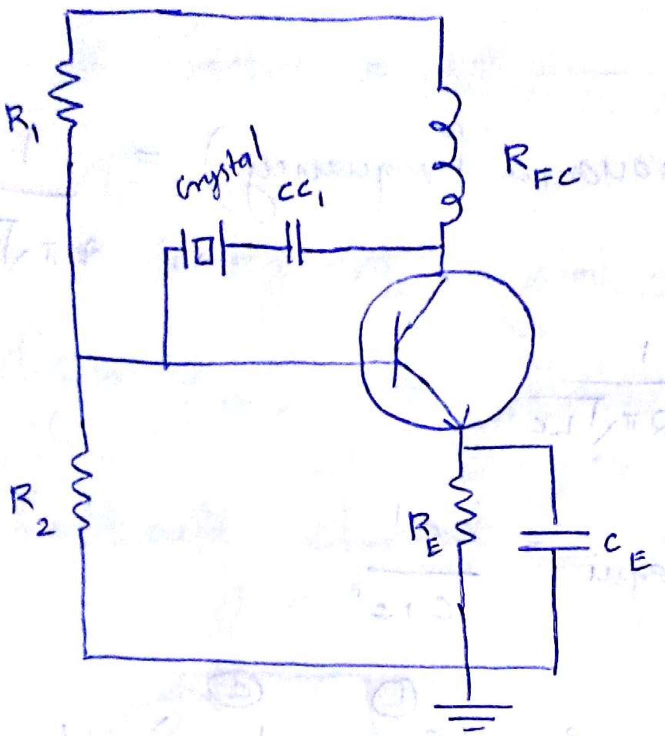
$$= \frac{\left(j\omega L + \frac{1}{j\omega C}\right)\frac{1}{j\omega C'}}{j\omega L + \frac{1}{j\omega C} + \frac{1}{j\omega C'}}$$

on simplifying:

$$= \frac{-j}{\omega C'}\left(\frac{\omega^2 - \omega_s^2}{\omega^2 - \omega_p^2}\right)$$



circuit



Advantage

Very high frequency stability

Very low frequency drift due to change in temp & other parameter

It is possible to obtain very high precise and stable frequency of oscillation

Q-factor is very high

It is possible to obtain frequency higher than fundamental frequency by operating crystal in overtone mode.

Drawbacks

⇒ These are suitable only for high frequency application

⇒ Crystals of low fundamental frequencies are not easily available.

Applications

As a crystal clock in microprocessors.

In the frequency synthesis

In the radio and TV transmitter

In special type of receivers

Advantages of hartley oscillators

Easy to tune

Can operate a wide frequency range

Easy to change freq by a variable capacitor

Application of Hartley

⇒ Used as local oscillator in radio & TV receivers

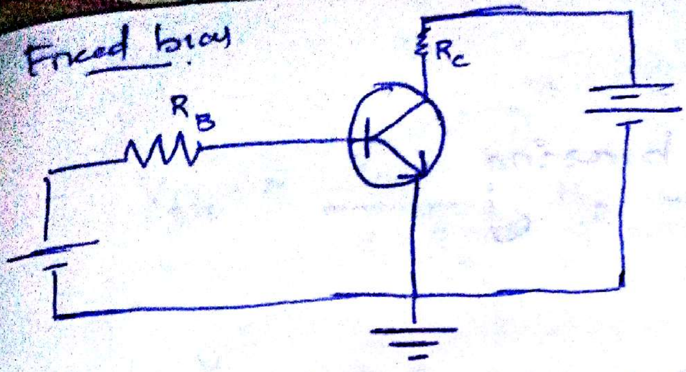
⇒ In functional generator

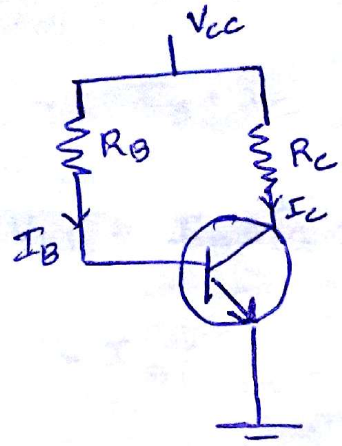
⇒ In radio frequency sources.

Disadvantages of Hartley Oscillator

Poor frequency stability

Fixed bias





consider the input loop:

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

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

$$I_c = \beta I_B$$

$$= \beta \frac{V_{cc}}{R_B}$$

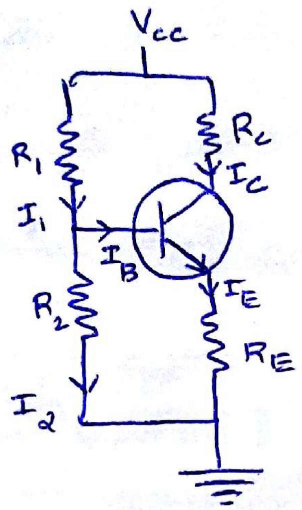
$$V_{cc} = I_c R_c + V_{CE}$$

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

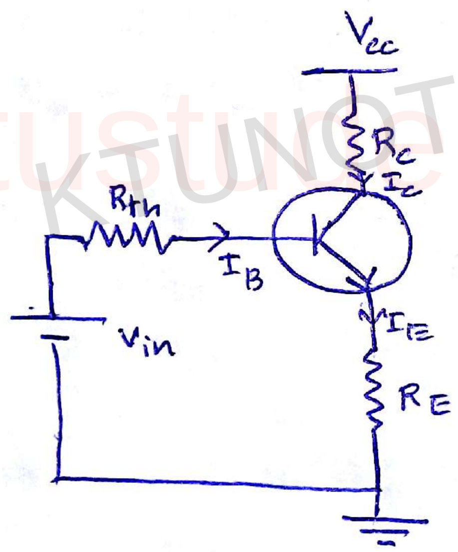
$$S = \frac{\beta + 1}{1}$$

$$S = \underline{\beta + 1}$$

Voltage divider biasing



Using thevenins theorem



R_{th} - equivalent i/p resistance of voltage divider circuit

V_{th} - equivalent i/p DC voltage to the base.

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

$$V_{th} = I_B R_{th} + V_{BE} + I_E R_E$$

$$I_E = I_B + I_C$$

$$\therefore V_{th} = I_B R_{th} + V_{BE} + I_B R_E + I_C R_E$$

$$= I_B (R_{th} + R_E) + V_{BE} + I_C R_E$$

constant

$$I_B = \frac{V_{th} - V_{BE} - I_C R_E}{R_{th} + R_E}$$

$$\frac{dI_B}{dI_C} = 0 - \frac{d}{dI_C}\left(\frac{I_C R_E}{R_{th} + R_E}\right)$$

$$= \frac{-R_E}{R_{th} + R_E}$$

$$S = \frac{\beta + 1}{1 + \beta \frac{R_E}{R_{th} + R_E}}$$

~~V_E~~ Operating point

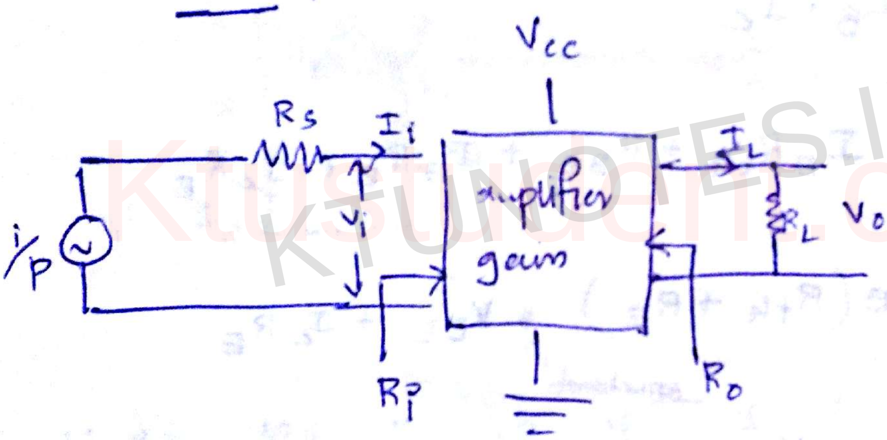
$$V_E = V_B - V_{BE}$$

$$I_E = \frac{V_B - V_{BE}}{R_E} \approx I_C$$

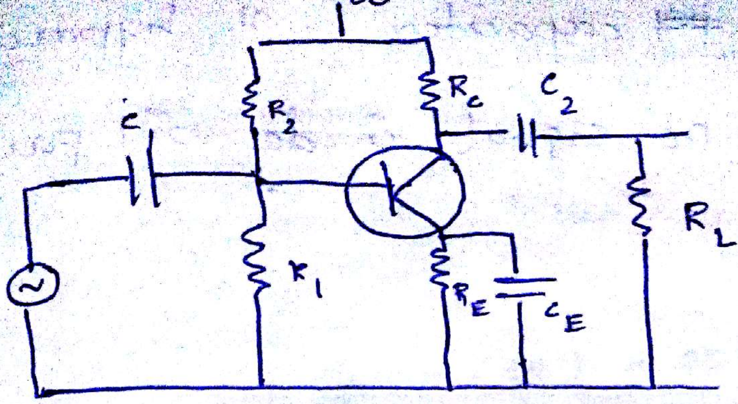
$$V_{cc} - I_C R_C + V_{CE} + I_E R_E$$

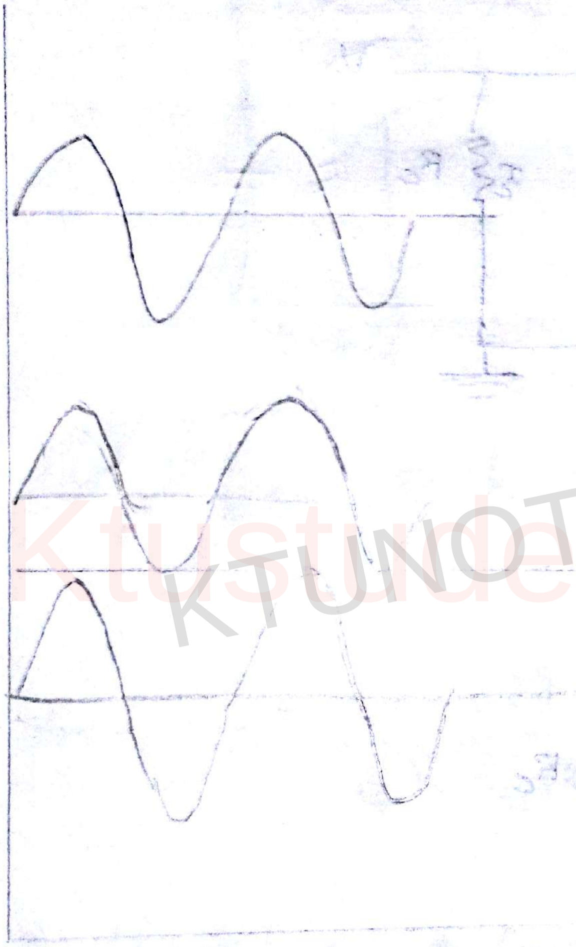
$$V_{CE} = V_{cc} - I_C R_C - I_E R_E$$

BJT amplifier



V_{cc} - amplification biasing



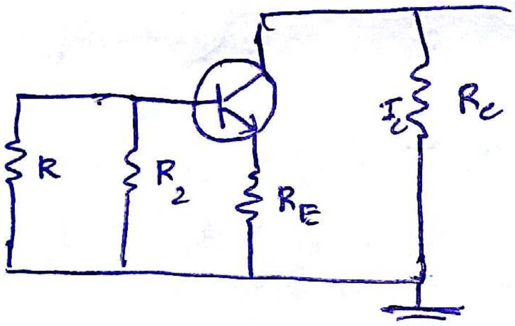


C_1 an C_2 are coupling capacitor. This will block DC components. C_1 block DC components from i/p ac signal.

C_E is bypass ~~for~~ capacitor. It bypasses ac signal block DC signal i.e. dc will pass through R_E.

$V_{R_1} = V_{BE} + V_{RE}$

internal circuit :



$$A_v = \frac{V_o}{V_{in}}$$

$$= -I_c R_c$$

$$V_{in} = V_B + V_E$$

$$= I_e r_e' + I_E R_E$$

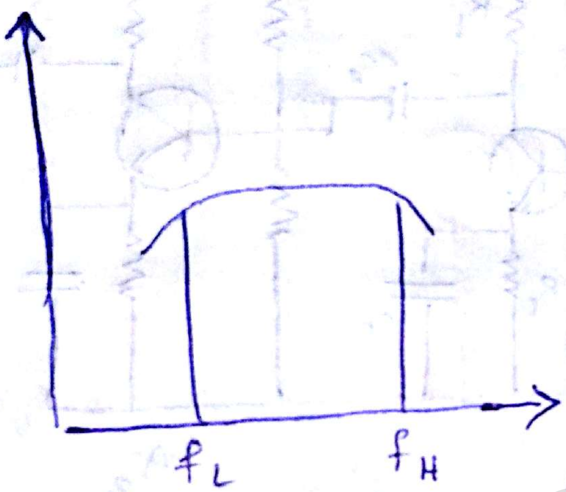
$$I_E = I_B + I_C$$

$$A_v = \frac{V_o}{V_{in}} = \frac{-I_c R_c}{I_e (R_e + r_e')}$$

$$\frac{R_C}{R_E + r_e'} \qquad \left(r_e' = \frac{25\,mV}{I_C} \right)$$

$$= R_C / r_e' \quad \text{(No bypass capacitor)}$$

$$\text{gain (dB)} = 20 \log \frac{V_o}{V_{in}}$$



$$BW = f_H - f_L$$

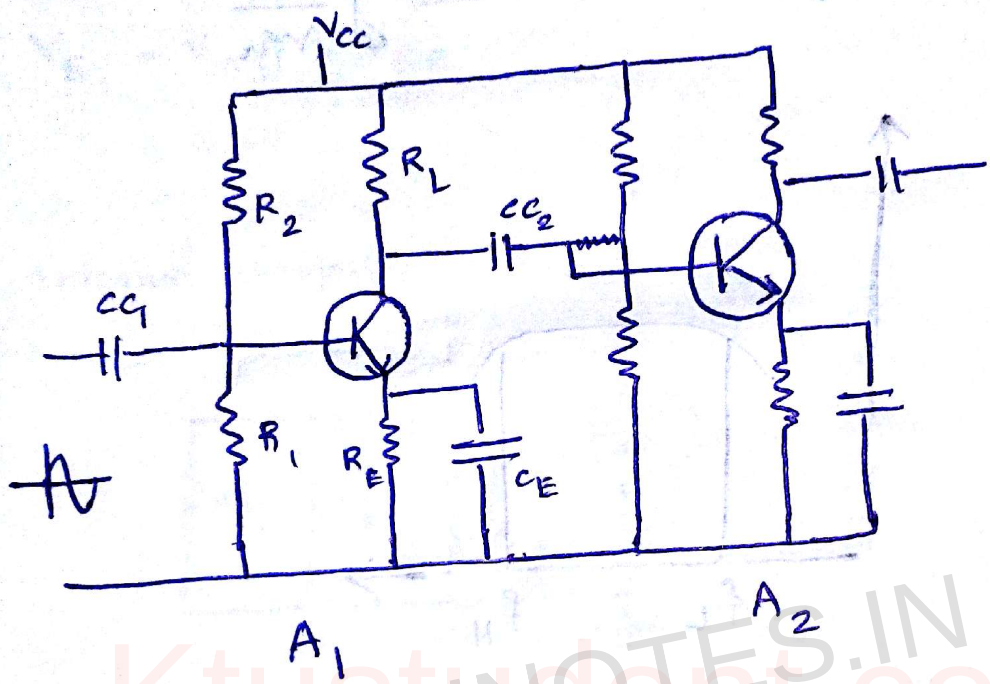
$$A_v(\text{low}) = \frac{A_v(\text{mid})}{\sqrt{1 + (f_L/f)^2}}$$

$$A_v(\text{high}) = \frac{A_v(\text{mid})}{\sqrt{1 + (f/f_H)^2}}$$

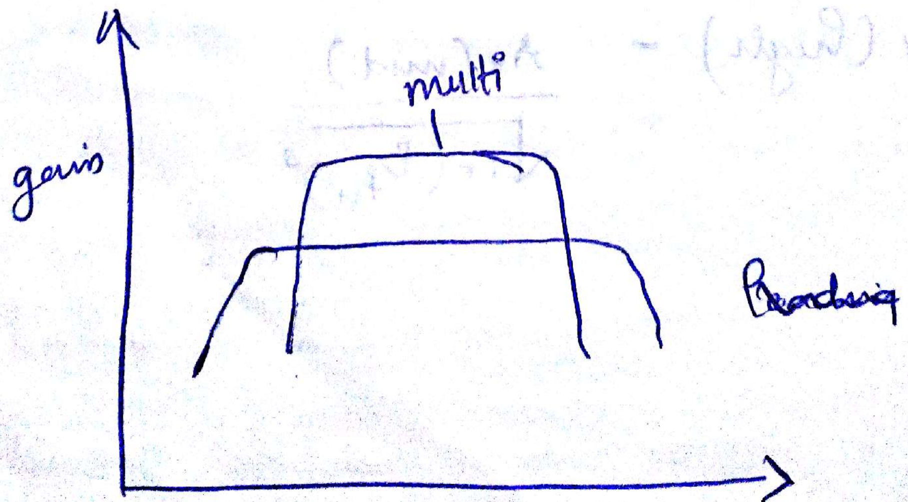
Multistage Amplifier

1. Cascade amplifier CE, CE

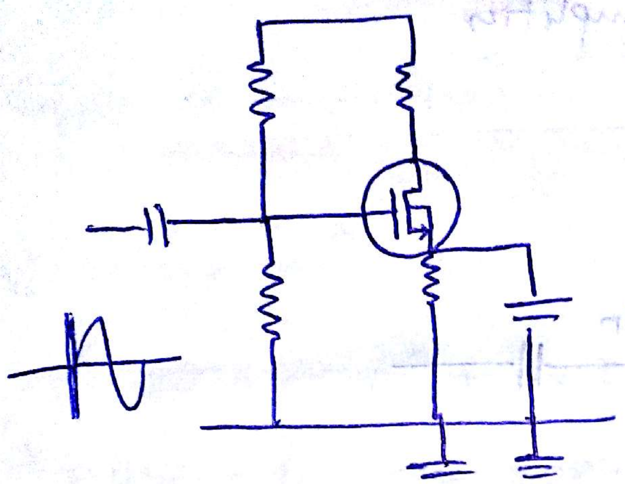
2. cascode CE, CB

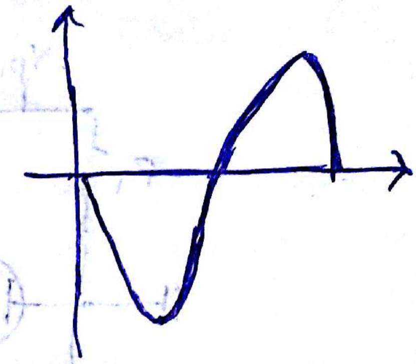


1) Rc coupling
2) transformer
3) Direct



Common Source MOSFET (with R_s)





$$A_V = \frac{-g_m R_D}{1 + g_m R_S}$$

$$= \frac{-g_m R_D}{g_m R_S}$$

$$\approx -R_D / R_S$$

I/p impedance $\approx R_1 \| R_2$

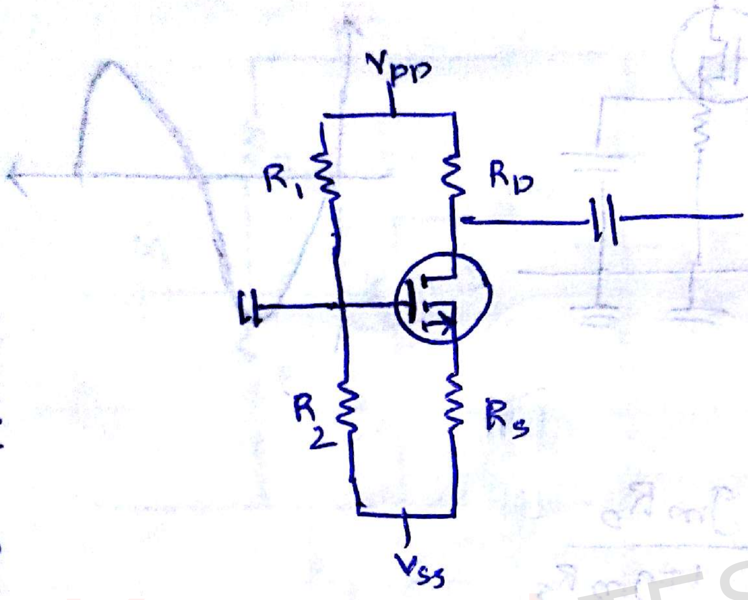
O/p impedance $\approx R_D // R_S$

$A_V = -g_m (r_o // R_o)$

I/p impedance $= R_1 // R_2$

O/p Impedance $= r_o \,//\, R_D$

CS MOSFET amplifier



Feedback circuits

=) Amplifier gain is unstable due to change in the supply voltage

=) change in the parameter of active base

=) Ageing

=) V_p Due to rise in leakage current

To TI AMMA2220. 20 YOU CHE 10
20 FACUA.

Positive feed back :

i/p & o/p are in same phase

Types of amplifiers

① voltage amplifier :

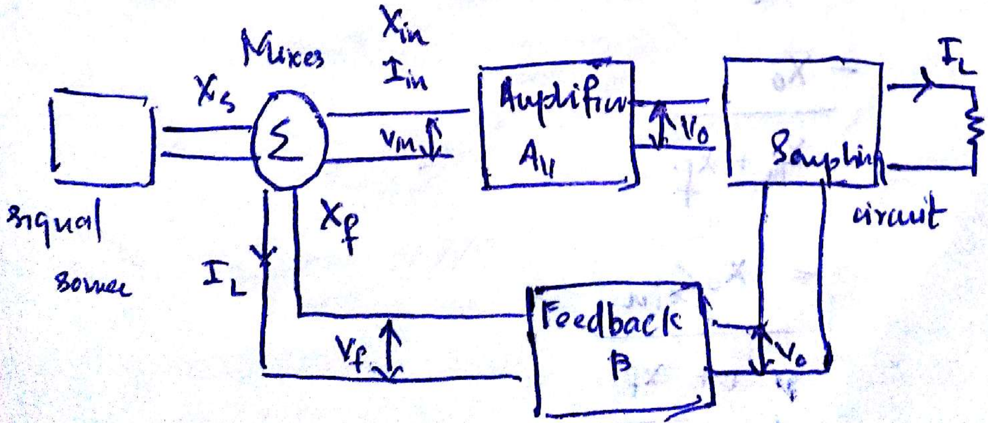
② current amplifier :

③ transconductance amplifier :

④ transresistance amplifier :

	i/p	o/p	R_{in}	R_{out}	transfer fn
① Voltage amplifier :	V	V	∞	0	$A_V = V_o/V_s$
② current amplifier :	I	I	0	∞	$A_I = \frac{I_L}{I_s}$
③ transconductance amplifier :	V	I	∞	∞	$G_m = \frac{I_L}{V_s}$
④ transresistance amplifier :	I	V	0	0	$R_m = V_o/I_s$

Feedback block



$$X_{in} = X_s - X_f$$

$$X_s = X_{in} + X_f$$

Gain Stability : Reduced non-linear distortion

Reduced by $\frac{1}{1+A\beta}$

Reduced Noise by a factor $\frac{1}{1+A\beta}$

Increased bandwidth by " $1+A\beta$

Increased i/p impedance by a factor $1+A\beta$

Reduced o/p impedance by a factor $\frac{1}{1+A\beta}$

Reduced gain by a factor $\frac{1}{1+A\beta}$

Negative feedback

$$A = \frac{X_o}{X_{in}}$$

$$= \frac{X_o}{X_{in} + X_f}$$

$$= \frac{X_o / X_{in}}{1 + \frac{X_f}{X_{in}}}$$

$$A_f = \frac{A}{1 + \frac{X_f}{X_o} \cdot \frac{X_o}{X_{in}}}$$

$$= \frac{A}{1+A\beta}$$

$$\beta = \frac{X_f}{X_o}$$

Positive feedback

$$A_f = \frac{A}{1-A\beta}$$

4 types of feedback amplifier

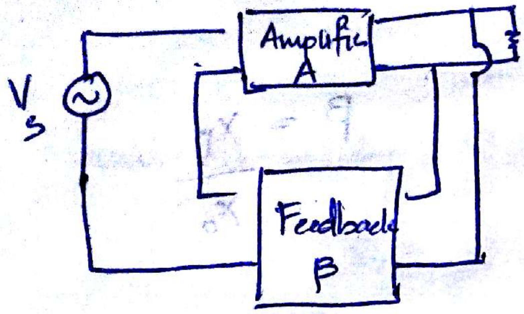
Voltage series feedback amplifier

Voltage shunt "

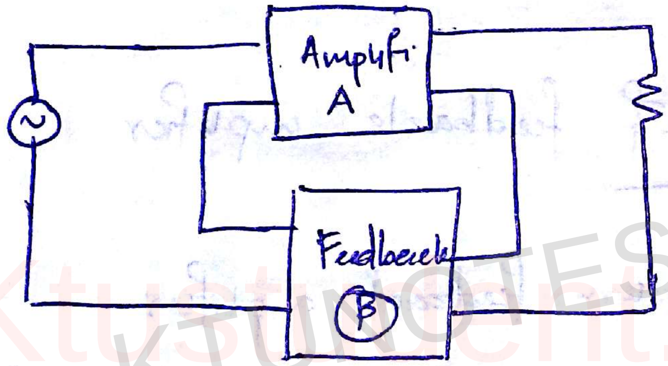
Current series "

current shunt "

Voltage Source



current source



eg: CE amplifier without bypass capacitor

amplifier	o/p	i/p	gain A	feedback β
Voltage series ~~gain~~	V	V	$A_v = \frac{V_o}{V_{in}}$	$\beta = \frac{V_f}{V_{out}}$
Voltage shunt	V	I	$R_{in} = \frac{V_{out}}{I_{in}}$	$\frac{I_f}{V_{out}}$
current series ~~gain~~	I	V	$G_m = \frac{I_{out}}{V_{in}}$	V_f/I_{out}
current shunt	I	I	$A_i = \frac{I_{out}}{I_{in}}$	I_f/I_{out}