11-11-19

AMPLIFIERS.

1. Defination of amplifiers.
2. Gain of the amplifier.
3. Classification of the amplifiers.

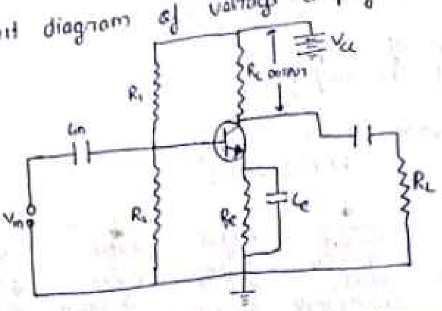
AMPLIFIERS.

- INPUT SIGNAL
  - (a) Small signal
  - (b) Large Signal
- USUAGE
  - (a) Voltage
  - (b) Power
  - (c) Current
  - → 3 definations
- Frequency handling capablities
  - (a) Radio
  - (b) Intermediate
  - (c) Audio
  - → 3 definations
- Method of coupling
  - (a) R-C
  - (b) Transformer
  - (c) Direct.
  - * Why coupling is done
  - * On the Basis of device used for coupling
- Method of Biasing
  - (a) Class A
  - (b) Class B
  - (c) Class C
  - (d) Class A-B
  - → 4 definations
    - (a) Full input → Forward Biased: Full
    - (b) Half input: Half
    - (c) Less then half: Less then half.
    - (d) More then 180° but less the 360°
- Configuration
  - (a) CE.
  - (b) C-B.
  - (c) C-C.

4. On the Basis of Usuage.

A. Valtage amplifiers.
- Defination
- Relation of valtage gain G_v or $A_v = \beta \frac{R_c}{R_{in}}$.

• Circuit diagram of voltage amplifiers.



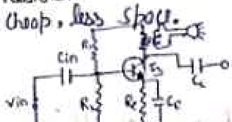
$$\boxed{V_0 = \beta \frac{R_c}{R_{in}}}$$

ⓐ High value of β. → Base made thinner.

ⓑ High value of collector Resistance (R_L) → For this low value of collector current, Because of low collector current no heat sink.

ⓒ Less value of input Resistance (R_{in}) →

ⓓ R-C coupling :→ Light, Cheap, less space.



Ⓑ POWER AMPLIFIERS.

• Definations.

• Law of conservation of energy. → DC → Input converts AC signal ↓ Amplified Power ← Amplified at output.

ⓐ Low value of β → Base should be made thicker because withstand max current.

ⓑ Low value of collector resistance :- If Rc is high more voltage drop the more power loss.

ⓒ Size of transistor → Larger, withstand high amount of current, heat sinks are also Provided to reduce the heat.

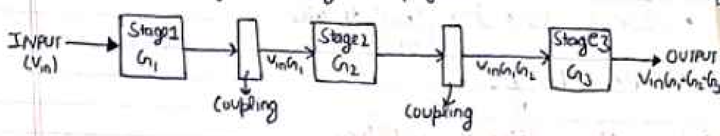
ⓓ Transformer coupling :- Input impedance = Output impedance.

5. Comparison of Voltage and power amplifier.

	Property	Voltage	Power.
ⓐ	Current amplification(β)	High	Low
ⓑ	Input Voltage	Low	High.
ⓒ	Output Power	Low	V·High
ⓓ	Output impedance	High	Low
ⓔ	Output resistance	High	Low
ⓕ	Collector current	Low	High
g.	Coupling.	R-C	Transformer.

6. MULTISTAGE AMPLIFIERS.

* Definination.
* Why amplifiers are coupled?
* Output of one stage → input for other stage.
* Block diagram of 3 Stage Amplifier.



* Types of coupling.
  • RC
  • Transformer
  • Direct.

Named as

- Impartant terms

ⓐ Gain.
- Defination.
- Denoted by

ⓑ Decibel.
- No unit for Gain
- Telephone industry → 'Bel'.
- $1 Bel = \log_{10} G_P = \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$.
- Decibel is more convinient.
  $1 deci Bel = 10^{-1} \times 1 Bel$
  $\Rightarrow 1 Bel = 10$ decibel.

$G_P = 10 \times \log_{10}\left(\frac{P_{out}}{P_{in}}\right)$ decibel.
$G_I = 20 \times \log_{10}\left(\frac{I_{out}}{I_{in}}\right)$ decibel.
$G_V = 20 \times \log_{10}\left(\frac{V_{out}}{V_{in}}\right)$ decibel.

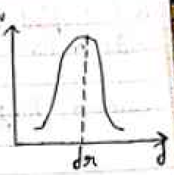
- $P \propto I^2 R \propto \frac{V^2}{R}$.

ⓒ Gain of multistage amplifier.
absolute gain :- $G = G_1 \times G_2 \times G_3 \times --- G_n$
Total gain $(G) = G_1 + G_2 + G_3 + --- + G_n$ decibel.

* Why the gain always less then $G_1 \times G_2 \times G_3 \times --- \times G_n$

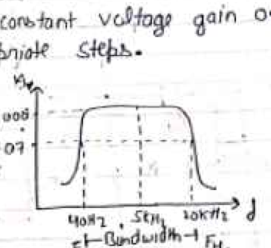
ⓓ Reasons for expressing gain in decibels.
(i) More convinient P.G → 12000 ⇒ 40.79 dB
(ii) Overall Gain → Adding
Absalute Gain → Multipleying.

Frequency response curve.



* Defination.
* As the f increases → $V_g \uparrow$ → becomes max → fr → f increased beyond fr → $V_g \downarrow$.
* Because f changes → reactance changes due to this ...
* Not desirable F-R curve, constant voltage gain over specific range of f, appropriate steps.

BANDWIDTH.



* Defination
* Range F_L to F_H Bandwidth
* why Range greater then or equal to 70.7 is chosen.
* Distortionless sound f must lie in between Bandwidth.

Lower cutoff frequency (F_L):- Defination.
Higher cutoff frequency (F_H):- Defination.

* Voltage gain in decibel. = 3dB.
- Defination.

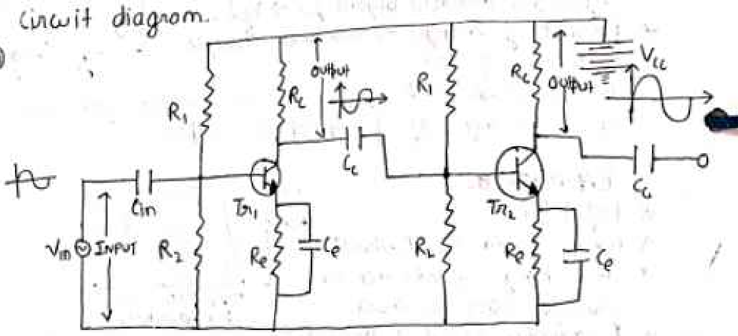
* Why the F_L or F_H are termed as half Power frequency? [$P \propto V^2 \propto (0.707)^2 = 0.499$].

I. R-C coupled amplifiers.

ⓐ • Defination.

Circuit diagram.

ⓑ



COMPONENTS.

(i) C_{in} :- Input capacitor → Work (passing AC only)

(ii) C_C :- Coupling capacitor → Work (Pass AC only, blocks DC, Coupling)

(iii) C_e :- Emitter capacitor → Low reactance path, C_e absent voltage gain is lost.

*where the output of first stage appears?

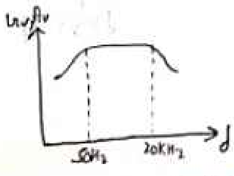
* First Stage → Phase reversed (180°), second stage → Phase retrieved (0° or 360°).

Working procedure. [Tr_1 and Tr_2].

Frequency Response Curve. → Defination.

ⓐ frequency less than the 50 Hz. Gain less

- Reactance of C_C increased
- Reactance of C_e increased not able to shunt Re hence gain Reduced.



b. Mid frequency Range (50Hz < f < 20KHz). [Audio frequency].
Gain remains Constant.

* f↑ Reactance↓ gain↑
* f↑ Reactance↓ loading effect gain↓.

Net effect constant.

ⓒ Higher frequency Range. [f > 20kHz]

* Reactance C_C↓ loading effect gain↓.

ADVANTAGES OF RC COUPLED AMPLIFIER.

* Cheap * Less space * less weight * Constant V_g over specific Range of f.

Disadvantages of RC coupled amplifier.

* With time becomes noisy.
* Output impedance > impedance of speaker less power is supplied.
* Comparatively lesser gain due to Loading effect.

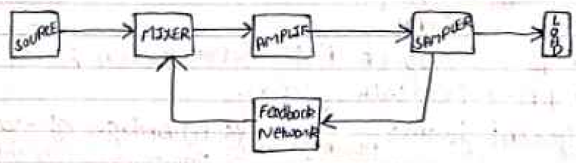
FEEDBACK AMPLIFIER.

CONTENTS.

1. Defination of feedback.
2. Types of feedback.
   (A) Positive
   - * Defination
   - * Overall Gain $[A_{vori} = \frac{A}{1-\beta A}]$.
   - * Increases noise, distortion and instablity.
   - * Regenrative or Direct

   (B) Negative feedback
   - * Defination.
   - * Overall Gain $[A = \frac{A}{1+\beta A}]$.
   - * Decreases noise, distortion and instablity.
   - * Degenrative or reverse.

3. Block Diagram of Feedback amplifier.



(A) SAMPLER:- Work of Sampler.

(i) ~~Series~~ ~~So~~ Current Sampler.
- * Represent Series network
- * Output resistance ↑
- * Output signal → Source or emitter.

I
ⓐ
(ii) Voltage Sampler. [V C].
* Represent parallel network
* Output resistance ↓
* Output signal → Collector or Drain

ⓑ

[B] MIXER.
(i) Current mixer
Input impedance ↑

(ii) Voltage mixer
Input impedance ↓.

(C) Feed Back Network
• Passive Components
• Comprises of :-

④ Negative feedback amplifier.
Ⓐ Gain
• Derivation
• $A_{vsi} = \frac{A}{1+\beta A}$.
• $\beta \rightarrow$ Feedback Ratio/Retransmission factor/ Return Ratio
• $\beta A \rightarrow$ Feedback factor.

⑤ Different forms. BLOCK DIAGRAM
ⓐ Series-Voltage feedback
ⓑ Series-Current feedback
ⓒ Shunt -Voltage feedback
ⓓ Shunt -Current feedback.
I/O impedance in each case

⑦ Disadvantage of -ve feedb
ⓐ Decreases the Gain.

⑥ Advantages of -ve feedback
ⓐ Increases Stability.
Concept explanation $A_{iov} = \frac{1}{\beta}$.
ⓑ Increases Bandwidth
Concept explanation.
ⓒ Decrease noise or distortion
• Block diagram • Derivation • explanation.
ⓓ I/O impedance can be modified easily
ⓔ Reduces FAHP distortion.
[Frequency, Amplitude, Harmonic, Phase].

9-11-19

AMPLIFIERS

* Amplifiers are the electronic device which amplify (increase the amplitude) of input signal.

* The Ratio of output signal to the input signal is known as Gain of amplifier.

CLASSIFICATION OF AMPLIFERS.

INPUT SIGNAL	USAGE	Frequency Handling capablities	Coupling methods	Biasing methods	Transistor Configuration
(a) Small signal amplifier	(a) Voltage gain amplifier	(a) Audio frequency amplifier	(a) RC coupled	(a) Class A	(a) CE.
(b) Large Signal amplifier.	(b) Power gain amplifier	(b) Radio frequency amplifier	(b) Transistor coupled	(b) Class B	(b) CB.
			(c) Direct coupled	(c) Class C	(c) CC.
				(d) Class AB	

(A) On the Basis of input signal.
(i) Small signal amplifier.
(ii) Large signal amplifier.

(B) On the Basis of USAGE.
(i) Voltage gain amplifier:- Amplifiers which increases the output voltage.

(ii) Power gain amplifier:- Amplifier which increases the output power.

③ On the Basis of ~~Usage~~ Frequency Handling Capablities.

(i) Audio frequency amplifiers

Audio frequency amplifiers are the amplifiers which increases the audio frequency (20Hz to 20KHz).

(ii) Intermediate frequency amplifiers.

(iii) Radio frequency amplifier.

Radio frequency amplifier are the amplifier which increases the Radio frequency (>20KHz).

④ On the Basis of Coupling methods.

To increase the overall gain several stages of amplifier are coupled together. On the basis of device used for coupling amplifier can be classified as.

(i) R-C coupled amplifier.

(ii) transistor coupled amplifier

(iii) Direct coupled amplifier.

⑤ On the Basis of method of Biasing.

(i) Class - A amplifiers.

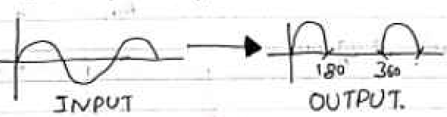
Class A amplifiers are the amplifires in which biasing is done in such a manner that output current flows for full input cycle (i.e 360°)

* Hence the transistor remains forward biased for whole of the input cycle

(ii) Class B amplifier.

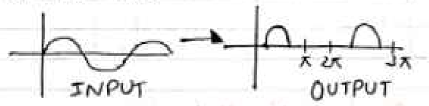
Class B amplifier are the amplifier in which biasing is done in such a manner that output current flows for only half cycle of input (ie 180°)

* Hence the transistor remains forward biased for half on input cycle.



(iii) Class C amplifier.

Class C amplifier are the amplifier in which biasing is done in such a manner that the output current flows for less then Half Cycle of input (ie 120- 150°)



(iv) Class A-B amplifier.

Class AB amplifier are the amplifier in which biasing is done in such a manner that output current flows for more then 180° but less then 360° of input signal.

① On the Basis of Usuage.

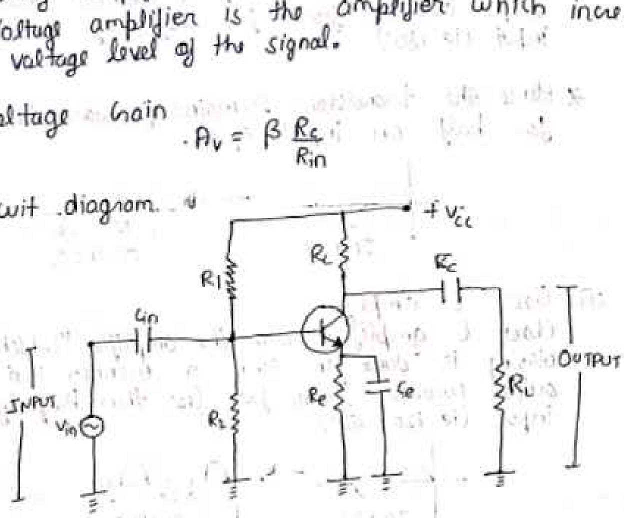
Ⓐ Voltage amplifier.

Voltage amplifier is the amplifier which increase the voltage level of the signal.

* Voltage Gain

$$A_v = \beta \frac{R_c}{R_{in}}$$

Circuit diagram.



Properties of Voltage amplifiers.

ⓐ Higher value of β. (β>100)

Value of β for Voltage amplifier should be higher to achieve maximum gain voltage.

For this Base should be made thinner.

ⓑ High collector OR Load Resistance (R_c).

The collector ~~current~~ resistance should be relatively high to increase the overall gain. The to achieve this condition Low value of the collector current is maintained. Since the collector carries only small amount of current, no heat sink is required.

ⓒ Low input Resistance (Rin).

To obtain maximum gain the Value of input resistance should be relatively low.

ⓓ R-C coupling is done.

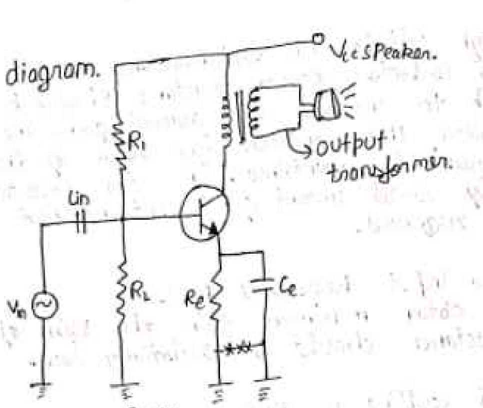
As the RC coupling is cheap, smaller weight, smaller size and ocupy less space therefore this type of coupling is preffered to couple various stages of voltage amplifiers.

B. POWER AMPLIFIER.

Power amplifier are the amplifier which increases the power level of the signal.

* So power amplifier does'nt obey Law of conservation of energy it is false because actually a power amplifier takes dc power as input converts it to the useful AC signal amplifies it and we get the amplified signal at the output.

Circuit diagram.



Properties of ~~Voltage~~ Power amplifiers.

ⓐ Thicker Base.
Since Power amplifier have to withstand high current base should be made thicker and it have less value of β.

ⓑ Low output Resistance.
The output resistance should be low because if it is high then more power loss i.e. heat should take place at the resistance and high voltage drop across load Resistance.

ⓒ Larger size of transistor.
Transistor should be of higher size because the Power amplifier conducts high current due to which high amount of heat will be discipated and heat sinks are required to reduce heat.

d. Transformer Coupling.
To get the maximum amplified power output we know the input impedance should be equal to the output resistance/impedence so transformer coupling is used.

Comparison of Voltage and power Amplifiers.

SR	PROPERTY	VOLTAGE	POWER.
1	Current amplification (β)	High (>100)	Low (25 to 50)
2	Input Voltage.	Low (2 to 5mV)	High (2 to 5)
3	Output Power	Low	Very high
4	Output impedence	High (10kΩ)	Low (100 to 200Ω)
5	Output resistance	High (5 to 10kΩ)	low (5 to 25Ω)
6	Collector Current	low (≃1mA)	Very high (>100mA)
7	Coupling	RC coupled	Transformer Coupled.

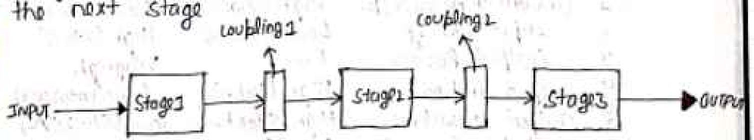
10-11-19

MULTISTAGE AMPLIFIERS.

These amplifiers in which several stages of the amplifier are coupled together are called multistage amplifier or Cascaded amplifier.

* To increase the overall gain of the amplifier several stages are coupled together.

* Infact the output of one stage acts as input for the next stage



* Various types of coupling are used named as.
  - RC coupling → RC coupled amplifier
  - Transformer coupling → Transformer coupled amplifier
  - Direct Coupling → Direct coupled amplifier.

IMPORTANT TERMS.

① Gain of amplifier.
The Ratio of output (current, Power, Voltage) to the input is known as gain of amplifier.

* It is denoted by G or A.
  - Current gain – G_i, A_i
  - Voltage gain – G_v, A_v
  - Power gain – G_p, A_p

② DECIBEL(dB).
The Gain has no unit as It is the Ratio of two same type quantity.

* But the telephone industry introduced unit known as 'BEL' named after Alexander Graham Bell.

* Defination of BEL
The common logarithm (log to base 10) of the power gain is known as 1 Bel.

$$1\,Bel = \log_{10} G_p$$

$$1\,Bel = \log_{10} \frac{P_{out}}{P_{in}}$$

- Moreover the 1/10th of Bel is considered to be more convinient unit for denoting the gain Hence new unit known as "deci-Bel" is considered to be more convinient.

$$1\ decibel = \frac{1}{10} \times 1\,Bel.$$

(i) POWER GAIN. in decibel

$$G_p = \log_{10} \frac{P_{out}}{P_{in}}\ Bel.$$

$$\boxed{G_p = 10 \times \log_{10} \frac{P_{out}}{P_{in}}\ decibel}$$

$P = I^2R$ or $\frac{V^2}{R}$.

(ii) Voltage gain in decibel.

$$\boxed{G_V = \log_{10}\left(\frac{V_{out}}{V_{in}}\right)^2 \text{ Bel.}}$$

$$G_V = 10 \times 2 \times \log_{10}\left(\frac{V_{out}}{V_{in}}\right). \text{ decibel}$$

$$\boxed{G_V = 20 \times \log_{10}\left(\frac{V_{out}}{V_{in}}\right). \text{ dB}}$$

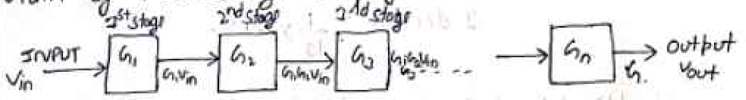
(iii) Current Gain in decibel.

$$\boxed{G_i = \log_{10}\left(\frac{I_{out}}{I_{in}}\right)^2 \text{ Bel.}}$$

$$G_i = 2 \times 10 \log_{10}\left(\frac{I_{out}}{I_{in}}\right) \text{ deciBel.}$$

$$\boxed{G_i = 20 \log_{10}\left(\frac{I_{out}}{I_{in}}\right) \text{ dB.}}$$

Gain of multistage amplifiers.



Input of 1st Stage = V_{in}
Output of 1st = Input of 2nd = G_1V_{in}
output of 2nd = Input of 3rd = $G_1G_2V_{in}$
output of nth = ~~output~~ $= (G_1G_2G_3 \ldots G_n) \times V_{in} = V_{out}$

Actual value of gain is always less then $G_1 \times G_2 \times G_3 \times \ldots \times G_n$.

$V_{out} = (G_1 \times G_2 \times G_3 \times \ldots \times G_n) \times V_{in}$.

* This is valid for power and Current relation also.

$P_{out} = (G_1 \times G_2 \times G_3 \times \ldots \times G_n) \times P_{in}$
$I_{out} = (G_1 \times G_2 \times G_3 \times \ldots \times G_n) \times I_{in}$.

Gain in Bel.

$$\frac{P_{out}}{P_{in}} = G_1 \times G_2 \times G_3 \times \ldots \times G_n$$

$$\log_{10} G_P = \log_{10}(G_1 \times G_2 \times \ldots \times G_n).$$

$$\log_{10} G_P = \log_{10} G_1 + \log_{10} G_2 + \ldots + \log_{10} G_n.$$

$$\boxed{G_P = G_1 + G_2 + G_3 + \ldots + G_n.} \text{ dB.}$$

- This Gain is also true for Current gain and Voltage gain.

Resons for expressing gain in decibels.

(i) Decibel is more convinient unit for expressing gain rather then no unit. Because Power gain of 12000 is Just 40.79 dB.

$$G_p = 12000$$
$$G_p = 10 \times (\log_{10} (12 \times 10^3) \text{ dB}$$
$$= 10 \times (\log_{10} 12 + 3) \text{ dB}$$
$$G_p = 40.79 \text{ dB}$$

(ii) Overall gain of the multistage amplifier can be obtained Just by adding decibel gain of each stages. Absolute gain can be obtained by multiplying gain of each stages.

QUESTION.

① An input of 1mV is applied to the Voltage amplifier. The output of amplifier is 10mV. Calculate its voltage gain in decibels.

Sol) $\frac{V_{out}}{V_{in}} = 10.$

$$G_v = 10 \times 2 \times \log_{10}\left(\frac{V_{out}}{V_{in}}\right) \cdot dB.$$

$$G_v = 20 \log_{10} 10 = 20 dB.$$

② A multistage amplifier consist of three stages. The voltage gain of three stages are 40, 60 and 80 respectively. Calculate the overall voltage gain in dB.

Sol) $G_v = 40, 60, 80.$

$$G_v = 20 \log_{10} 40 = 20 \times 1.602 = 32.04\ dB$$
$$G_v = 20 \log_{10} 60 = 20 \times 1.778 = 35.56\ dB$$
$$G_v = 20 \log_{10} 80 = 20 \times 1.903 = 38.06\ dB.$$

Net Gain = 105.66 dB.

③ If the power gain of the three stages are 100, 400 and 800 respectively, what will be the overall power gain in dB.

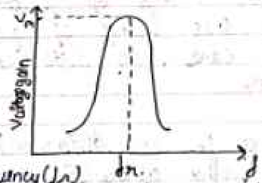
Sol) $G_p = 100, 400, 800$

$$G_p = 10 \log_{10} 10^2 = 20 dB$$
$$G_p = 10 \log_{10} (4 \times 10^2) = 26.02 dB$$
$$G_p = 10 \log_{10} (8 \times 10^2) = 29.03$$

$$G_p = 75.05\ dB\ (Ans).$$

Frequency response curve.

The graph between the voltage gain (A_v, G_v) and the signal frequency is known as the frequency response curve.



* As the signal frequency increases the voltage gain increases rapidly, voltage gain achieves its maximum value at the resonant frequency (f_r). As the frequency is increased beyond resonant frequency the voltage gain decreases rapidly.

* The value of voltage gain does'nt remain constant with frequency this is because the reactance of the capacitor changes with change in frequency hence it affects the output overall gain of voltage.

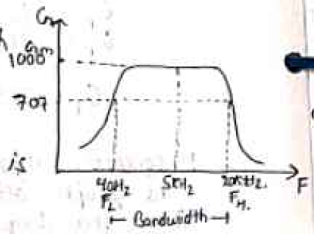
Reactance of capacitor = $X_L = \frac{1}{2\pi f C}$

* However this type (B_v) of the frequency response curve
(ii) isn't desirable because it contains a lot of distortion in it therefore appropriate steps are taken in order to obtain constant voltage gain over fixed range of frequency.

6 BANDWIDTH.

The range of frequency over which gain of the amplifier is greater than or equal to 70.7% of its max value is known as Bandwidth.

* This range of frequency F_L to F_H is known as Bandwidth.



* This range of greater than 70.7% is chosen because over this range of gain the change is not audible to our ears, so distortion can't be heard over this Range of Gain.

* Hence for the distortionless amplification the frequency must lie within bandwidth of amplifier.

Lower cutoff frequency. (F_L)

The lower value of frequency at which the gain of the amplifier is 70.7% (0.707 G_m) of its maximum value is called Lower Cutoff frequency.

Higher Cutoff frequency. (F_H)

The higher value of frequency at which gain of amplifier is 70.7% (0.707 G_m) of the maximum value is called Higher cut off frequency.

Voltage gain in decibel.

$$G_v = 20 \log_{10} \frac{\cancel{1000}\, G_m}{0.707\, G_m} \text{ dB.}$$

$$G_v = 20 \log_{10} 1.41$$
$$G_v = 3\text{dB.}$$

Hence, the range of frequency within which the voltage gain of an amplifier falls by 3dB from its max gain is known as the bandwidth

* When the frequency is equal to F_L or F_H

* The frequency F_L or F_H sometimes also termed as the Half power frequency because when the voltage is 70.7% of it maximum value then power is 50% of its max value.

$$P \propto V^2 \propto (0.707)^2 = 0.499$$

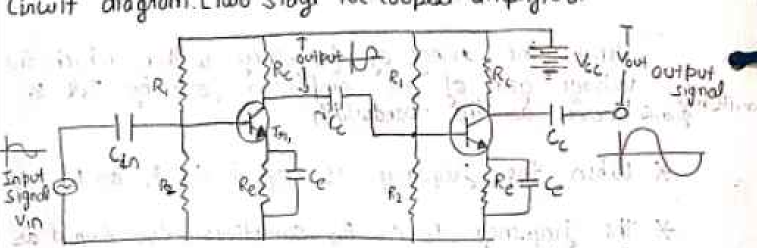
Mid Band gain.

When the gain is maximum it is obtained at mid of the Bandwidth, This maximum gain is also termed as mid band gain.

(i) RC coupled amplifiers.

* Coupling from one stage to other is achieved by coupling capacitor followed by the resistance hence this is named as R-C coupled amplifiers.

Circuit diagram. [Two stage RC coupled amplifier].



COMPONENTS.

(i) C_c:- It is known as the coupling capacitor it is used to couple two stages of a multistage amplifier. It allows AC signal to pass through it and blocks the DC current.

(ii) Emitter capacitor [C_e] Bypass capacitor:- The emitter capacitor provides low reactance path to the signal. If there is no C_e then voltage gain of previous stage would be lost.

(iii) Input capacitor [C_{in}]:- It blocks the DC signal and allows the AC signal to pass through it.

* The output of first stage amplification appears across the collector resistance (R_c). It phase is reversed.

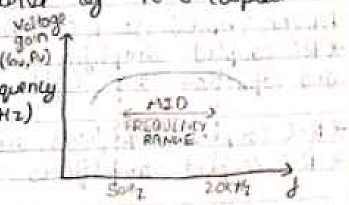
* A single stage R-C coupled amplifier introduce the phase shift of 180° whereas two stage R-C coupled amplifier introduce phase shift of 360° or 0°.

Operation of R-C coupled amplifier

* Input voltage V_{in} is applied to the base of the transistor Tr_1 and then its amplified form appears across the collector Resistance R_c. Its phase is Reversed.

* Then the single stage amplified output of first stage is applied across the base of the transistor Tr_2 and then its amplified form appears across the collector Resistance R_c. Its phase is reversed again.

Frequency response curve of R-C coupled amplifier.



Case 1. When $f < 50Hz$ Low frequency
At the low frequency ($f < 50Hz$) gain is small because.

① At the low frequency the reactance of coupling capacitor is high ($X_c = \frac{1}{2\pi f c}$) due to which the gain of the capacitor is reduced.

⊙ At low frequency C_E also offers the high reactance due to which it doesn't able to shunt the emitter resistance effectively due to, which gain decreases.

Case 2] Mid frequency Range (50Hz < f < 20KHz). [Audio frequency]
Then the gain of the amplifier remains almost constant because.
⊙ As the frequency increases the reactance of C_C decreases due to which the gain increases whereas the decrease in reactance produces higher loading effect due to which gain decreases. Hence due to this increment decrement gain remains almost constant.

Case 3] Higher frequency [f > 20 KHz].
* Gain is decreased because.
⊙ At the higher frequency the reactance of C_C decreases due to which it produces higher loading effect and hence the gain is decreased.

ADVANTAGES OF RC COUPLED AMPLIFIER.
* RC coupled amplifier are of less weight as resistance, and capacitor are light in weight.

* R-C coupled amplifiers are cheap.
* R-C coupled amplifiers occupies less space.

* They have better frequency response curve as the voltage gain in mid frequency region is almost constant.

DISADVANTAGE OF RC coupled amplifiers.
* Comparatively R-C coupled amplifier have lesser gain due to loading effect.

* Poor impedance matching, Actually the final output impedance of R-C coupled amplifier is several hundred ohms but that of the speaker is few ohms. Due to this mismatch very little power is transferred.

* With time these amplifiers becomes noisy.

14-11-19.

11

FEEDBACK AMPLIFIER

1. FEEDBACK.

A small fraction of output (Voltage, Current) is taken and injected back to the input this is known as Feedback.

a. Positive feedback

- When the feedback signal is in the phase with the input signal then it is known as Positive feedback.

- It increases the gain of amplifier.

$$A_{f} = \frac{A}{1-\beta A}.$$

- It also increases noise, distortion and the instability of the gain.

- It also called regenerative or Direct feedba[ck]

(b) Negative feedback.

- When the feedback signal is out of phase of the input signal then it is known as Negative feedback.

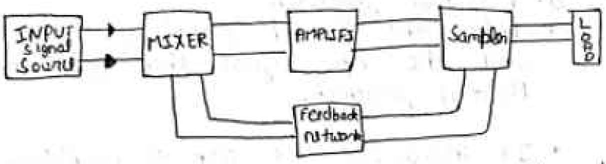
- It decreases the gain of the amplifier

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

• It is also called degenerative or Reverse feedback.

• It decreases noise, distortion, increases the stablity of gain and also improves input and output impedance

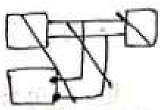
Block diagram of feedback amplifiers.



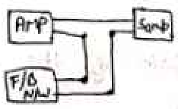
Sampler :- Sampler fed back to the mixer with a fraction of output signal.

Sampler are of two types.
- Current Sampler
- Voltage sampler.

(a) Current Sampler.



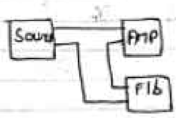
- It represents series network.
- Output resistance increases.
- If the output signal is taken from emitter or source it refers to current sampler.



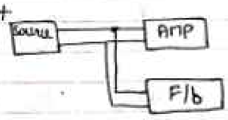
(b) Voltage Sampler.
* It represents a parallel network.
* It decreases output resistance.
* When the output signal is drawn from collector or drain terminal it is called voltage sampler.

MIXER.

(a) Series mixer.
* It increases the input resistance.
*



(b) Shunt mixer.
* It decreases the input resistance.



Feedback network :- It is made up of Passive component
It comprises. mixer, Amplifier, Sampler.
"βA" is known as the feedback factor.

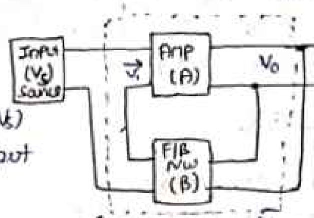
① Negative feedback amplifier.

Ⓐ Gain of amplifier with negative feedback.

$V_i = V_s + x$

as, it is negative feedback.

* Feedback Voltage signal (V_f) should be opposite of input Source signal (V_s).



$\beta = \frac{x}{V_0}$

$x = \beta V_0$

Series Voltage Feedback.

$V_i = V_s - \beta V_0$

$$\text{Gain } (A) = \frac{V_0}{V_i}$$

$$A = \frac{V_0}{V_s - \beta V_0}$$

$$\cancel{A = \frac{1}{\frac{V_s}{V_0} - \beta}}$$

$$AV_s - \beta V_0 A = V_0$$

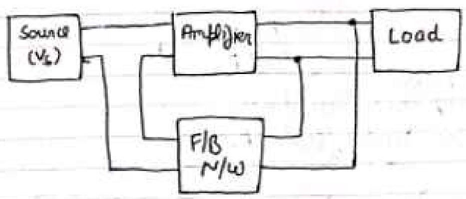
$$V_0 = \frac{AV_s}{1+\beta A}.$$

$$\boxed{\frac{V_0}{V_s} = A_{fb} = \frac{A}{1+\beta A}}$$

* Here β is known as the feed back Ratio which will decide howmuch amount of output is fed Back to the input.
* Sometimes β is also represented as m.
* β is also called Return Ratio, retransmission factor, inverse feedback Ratio.

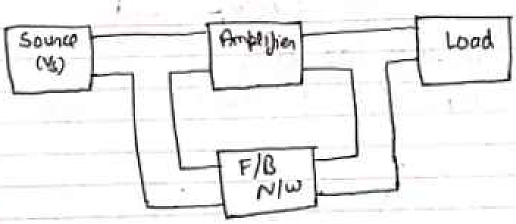
Different Configuration of negative feedback amplifier.

a. Series Voltage feedback.



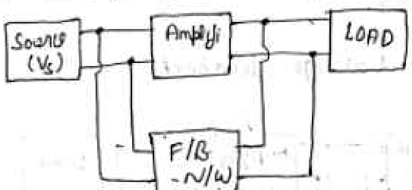
* Input impedence increases.
* Output impedence decreass.

b. Series current feedback.



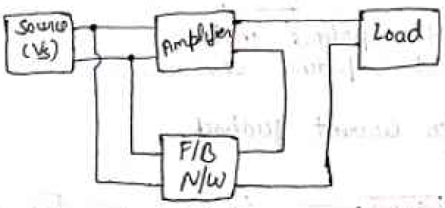
* Input impedence increases
* Output impedence also increass.

© Shunt Voltage feedback



* Input impedance decreases
* Output impedance decreases.

ⓓ Shunt Current feedback.



* Input imedince decreases
* Output impedance increases.

Advantages of amplifier with negative feedback.

① Provides stablity of Gain.
Gain of the amplifier may change if the input signal [current, voltage] is changed. But if we want to get a constant gain then we have to make feedback gain (A_{FB}) independent of overall gain of amplifier

$$A_{fB} = \frac{A}{1+\beta A}.$$

* If we considered $\beta A >>> 1$ then we can neglect 1 as compared to βA
hence $A_{fB} = \frac{A}{\beta A} = \frac{1}{\beta}$.

* Hence in this case gain of feedback only depends upon β, feedback ratio which in turn depends upon the value of resistances and value of Resistance remains constant forever.
Hence A_{FB} [Gain of feedback] is constant always.

② Reduces the distortion or noise.

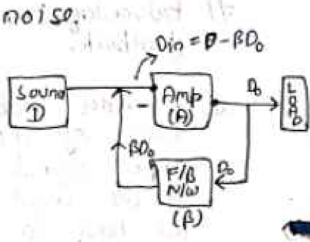
$$A = \frac{D_o}{D - \beta D_o}$$

$$AD - A\beta D_o = D_o$$

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

$$D_o = D - \beta A D_o$$

$$\boxed{D_o = \frac{D}{1+\beta A}}$$



Negative feedback

* Here note that the output distortion is reduced by the factor of $1+\beta A$.

* When source with distortion is applied across the feedback (negative) network then due to negative feedback gain of distortion is reduced.

③ Increases bandwidth or improves frequency Response
As in negative feed back the gain is reduced in the same way negative feedback decreases the lower cutoff frequency by factor of $1+\beta A$ and increases the higher by same factor of $1+\beta A$
Hence finally we get Increased Bandwidth.
Band width of negative feedback is given by.

* $(BW)_{FB} = BW(1+\beta A)$

④ Input and output impedance can be modified as desired

⑤ Reduces frequency, Amplitude, Harmonic, Phase distortion.

Disadvantage of Negative feedback.

① It reduces gain of the amplifier.