**UNIT-IV – MULTISTAGE AMPLIFIER & DIFFERENTIAL AMPLIFIER**

1. **List the advantages of crystal oscillator**

The advantages of crystal oscillator are

a) Excellent frequency stability
b) High frequency of operation
c) Atomatic amplitude control

2. **What are the classifications of oscillators?**

According to the type of circuit used, sine wave oscillators may be classified as 1)RC oscillators
2)LC oscillators

3. **What is the difference between Amplifier and oscillator?**

> Amplifiers are circuits which transfer an input signal into an output signal.

> Oscillators produce a steady state signal e.g a square wave signal or a

sinusoidal signal.

4. **What are the advantages of differential Amplifier?**

A differential amplifier helps to increase the CMRR which in turn helps avoid unwanted signals that couple into the input to get propagated. It also helps to increase the signal to noise ratio.

**5. State Barkhausen criteria.**

The essential conditions for maintaining oscillators are AB=11 i.e the magnitude of loop gain
must be unity.

1. The total phase shift around the closed loop is zero or 360 degrees.

6. **Mention any two high frequency LC oscillators.**

1. Hartley oscillator

2. Colpitts oscillator

**7.Name the type of feedback amplifiers**

1. Voltage series feedback amplifier

2. Voltage series feedback amplifier

3. Voltage series feedback amplifier

4. Voltage series feedback amplifier

6. **Why LC oscillators are not preferred to generate low frequency signals even though they have higher frequency stability compared to RC Phase shift oscillator?**

   ➔ At the low frequency, the value of L required in the circuit for generating low frequency signals is very large as frequency is inversely proportional to the value of L.

# UNIT- IV

## MULTISTAGE AMPLIFIER AND DIFFERENTIAL AMPLIFIER.

1. How to eliminate the cross over distortion (16)

Cross over distortion - caused by non_linearity of i/p Characteristics of the transistor.

* In the region of small i/p currents, the o/p is such smaller that it would be if the response were linear.

Class AB Amplifier overcome the problem of Crossover distortion in class B amplifier, in which small current flows even at Zero i/p signal level. * diagram.

* $Q_1$, $Q_2$ → biased * Class AB b/w active region of class A & cutoff " " Class B.

* ↓ in output power due to negative feedback effect.

* Efficiency is greater than class A amplifier.

2. Explain neutralization techniques (16).

Neutralization - Reducing the feedback, provided interelectrode

* Capacitance to obtain better stability.

* elimination of potential oscillation.

* Neutralization in transistor amplifier: → $I_b = \frac{V_{b'e}}{V_{bb'}}$  $I_n = I_b$

→ $R_n = \frac{a\, r_{bb'}\, C_{b'e}}{C_{b'c}}$, $C_n = \frac{C_o}{a\left[1 + g_{b'e}\, r_{bb'}\right]}$

* Broadband technique (or) Hazeltine:

✓ o/p capacitance is neglected  $C_m = C_{b'e} + C_{b'c}(1 + g_m R_L)$

$V_o = g_m V_{b'e} \cdot R_L$

* Narrow band neutralization.

✓ Rice ✓ cross ✓ coil.

$B.W = \frac{r_{b'e} + R_s}{C_m + r_{b'e} R_s}$

$B.W \uparrow, \downarrow R_s$

9) Compare the characteristics of different configuration of BJT amplifiers:

* When transistor is to be connected in circuit, one terminal is used as an i/p terminal, other - o/p terminal, 3rd - common to i/p and o/p. Depends upon (i) CE (ii) CB (iii) CC configuration.

CB Configuration: Ground base configuration → i/p - emitter
$I_E$ $V_{EB}$ → o/p - collector
→ common - base.

CE Configuration: Ground emitter configuration → i/p - base
→ o/p - collector
→ common - emitter.

CC configuration: Ground collector configuration → i/p - base
→ o/p - emitter
→ common collector.

* Input & o/p characteristics of CE, CB & CC.
* Input & o/p resistance are compared.

Applications: CB - high freq. ckts  CC - for impedance matching.
CE - audio frequency ckts

10. Draw and explain the hybrid π model of CE configuration of transistor and derive the necessary expression. (16)

* Emitter junction capacitance is the diffusion capacitance and is proportional to emitter current. Independent of temperature.

* CE short circuit forward current transfer ratio (or) current gain is function of frequency.

→ Short circuit current gain $A_i = \frac{I_L}{I_i}$

→ Current gain $A_I = \frac{-h_{fe}}{1 + jf/f_\beta}$  * β cutoff frequency
* α cutoff frequency.

* $f_\beta = \frac{1}{2\pi r_{b'e}(C_{b'e} + C_{b'c})}$

3. Explain the working about differential amplifier & derive the expression for CMRR (16)

Differential Amplifier – to amplify the diff. b/w two signals

* Basic block diagram
* 2 i/p terminals
* 1 o/p terminal
* o/p s/l ∝ diff b/w
* two i/p s/l

* $V_0 = 0, V_1 = V_2$
* $V_0 \neq 0, V_1 \neq V_2$
* i/p voltage $V_{id} = (V_1 - V_2)$
* Common mode i/p voltage $V_{cm} = \frac{(V_1 + V_2)}{2}$

* Using operational Amplifiers, $V_0 = A V_{id} \frac{R_L}{R_o + R_L}$

$$A_V = \frac{V_o}{V_s} = \frac{A R_{id}}{R_{id} + R_s} \cdot \frac{R_L}{R_o + R_L}$$

* O/p depends on $V_{id}$. $V_0 = A V_{id}$. $V_c = \frac{V_1 + V_2}{2}$

* Total o/p $V_0 = A_d V_{id} + A_c V_c$

CMRR – Common mode Rejection Ratio

$$CMRR = 20 \log_{10} \left| \frac{A_d}{A_c} \right|$$

$V_0 = A_d V_{id}$

4. Explain transfer characteristics of differential amplifier and derive the expression for same. (16)

circuit diagram of differential amplifier with active loading.

* $V_{B1}$ is below the cutpoint of $Q_1$, ct $I_0$ flows thro $Q_2$.
* $V_{B1}$ " above " ct $Q_1 \uparrow$.
* I in $Q_2 \downarrow$, Sum of current remains Constant = 0.
* $I_{E1} + I_{E2} + I_0 = 0$  $I_{C1} = -I_{E1}$ ; $I_{C2} = -I_{E2}$.
* Normalized collector current $\frac{I_c}{I_0}$ with normalized differential i/p $(V_{B1} - V_{B2})/V_T$
* $$\frac{dI_{C1}}{d(V_{B1} - V_{B2})} = g_{md} = \frac{I_0}{4V_T}$$
* linear region → i/p varies by $\pm V_T$
room temperature ± 26mV.

5. Explain about single tuned amplifiers (16)

* Tuned circuit is capable of selecting a particular frequency and rejecting all other frequency.

* Single tuned amplifier (i) capacitance coupled (ii) Inductively "

Capacitance coupled Amplifier : o/p is coupled across next stage Cc

* circuit diagram * Equivalent circuit.

A - Voltage gain , $C_1, C_2$ — Stray wiring capacitance

* $C_S = C_{b'e} + C_1 + C_{b'c}(1-A)$

$$Y_1 = \frac{1}{R_p} + \frac{1}{j\omega L_p} \qquad Q = \frac{\omega_0 L}{R}$$

* Equivalent circuit of o/p part. * $Q_e = \frac{\text{Susceptance of } L \text{ (or) } C}{\text{Conductance of shunt resistance } R_t}$

$$V_o = -g_m V_{b'e} Z$$

* $\delta$ - fractional frequency variation $\delta = \frac{\omega}{\omega_0} - 1$

$$A = \frac{V_o}{V_i} = -g_m \left(\frac{r_{b'e}}{r_{bb'} + r_{b'e}}\right) Z \qquad \phi = -\tan^{-1}(2\delta Q_e)$$

* Response of tuned amplifier graph.

6. Explain the heat sink design.

* Junction temperature ↑ due to power dissipation Then the Collector power dissipation $P_d = V_{CE} \cdot I_C$

* To avoid damaging of transistor, a heat sink may be connected with transistor.

* Heat sink - mechanical device produce large surface area to dissipate the power in the form of heat.

* approach rated maximum value, temp ↓ * $q = \frac{(T_2 - T_1)}{P_d} \frac{°C}{mW}$

7. Draw a neat circuit diagram and explain the working of cascade amplifier and derive the expression for gain & frequency.

Cascade amplifier - Series connection with o/p of first stage is applied to i/p of second stage

* Larger overall gain achieved

* Voltage gain, $A_{V1} = \frac{V_2}{V_1} = \frac{\text{o/p voltage of 1st stage}}{\text{i/p voltage of 1st stage}}$

$A_V = A\angle\theta$

* magnitude of voltage gains = product of magnitude of voltage gain of each stage

* Current gain $A_{in} = \frac{-h_{fe}}{1 + h_{oe} R_n}$

* CC connection not used → voltage gain < unity

* CB stage, voltage gain = current gain

* CE stage, current gain > unity

* Change in overall frequency response - High frequency - Low frequency region

* $A_{V(lo\ overall)} = A_{V(lo)}n$ * $f_1' = \frac{f_1}{\sqrt{2^{1/n} - 1}}$ * $f_2' = (\sqrt{2^{1/n} - 1})f_2$

8. Describe the input stages of FET amplifiers.

* CS FET amplifier: $R_i = \frac{V_i}{I_i}$ $R_i \uparrow$,

* CD FET amplifier: → Source follower → Input impedance at → Input terminals $R_i = R_G$

* CD using potential divider method:

$$R_i = R_G = \frac{R_1 R_2}{R_1 + R_2}$$

* CG FET amplifier: produces variation in $V_{GS}$ ⇒ $V_{GS} \uparrow, I_D \uparrow$.

$$R_i = \frac{V_i}{I_i} = \frac{V_{GS}}{I_D} \therefore R_i = 1/g_m$$

* $R_i' = \frac{R_S}{1 + g_m R_S} \approx R_S$.