UNIT III TUNED AMPLIFIERS

Coil losses, unloaded and loaded Q of tank circuits, small signal tuned amplifiers - Analysis of capacitor coupled single tuned amplifier - Double tuned amplifier - Effect of cascading single tuned and double tuned amplifiers on bandwidth - Stagger tuned amplifiers - Stability of tuned amplifiers - Neutralization - Hazeltine neutralization method.

3.4.Classification of Tuned Amplifier:

We know that, multistage amplifiers are used to obtain large overall gain. The cascadedstages of multistage tuned amplifiers can be categorized as given below:

1. Single Tuned Amplifiers
2. Double Tuned Amplifiers
3. Stagger Tuned Amplifiers

These amplifiers are further classified according to coupling used to cascade the stages ofmultistage amplifier. They are,

1. Capacitive Coupled
2. Inductive Coupled
3. Transformer Coupled

3.4.1Staggered Tuned Amplifier:

- Double tuned amplifiers give greater 3 dB bandwidth having steeper sides and flat top. But alignment of double tuned amplifier is difficult.
- To overcome this problem, two single tuned cascaded amplifiers having certain bandwidth are taken and their resonant frequencies are so that they are separated by an amount equal to the bandwidth of each stage.
- Since the resonant frequencies are displaced or staggered, they are known as stagger tuned amplifiers.
- The advantage of stagger tuned amplifier is to have better flat, wideband characteristics in contrast with a very sharp, narrow band characteristic of synchronously tuned circuits (tuned to same resonant frequencies).
- Fig shows the relation of amplification characteristics of individual stages in a staggered pair to the overall amplification of the two stages.

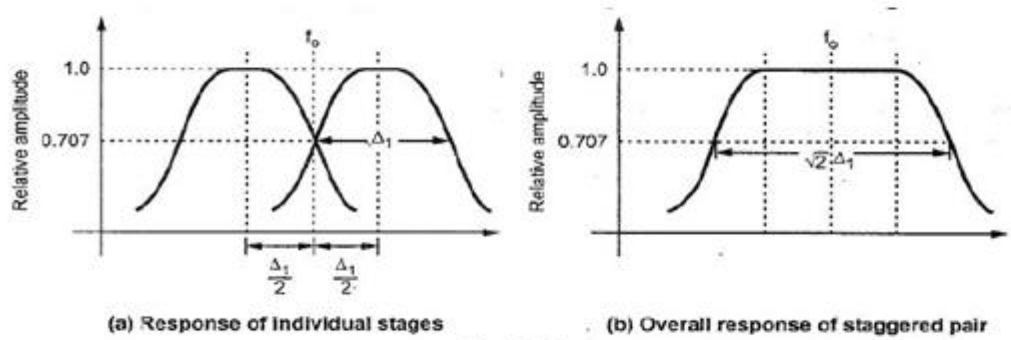

Fig 3.4.1. Staggered Tuned Amplifiers

- The overall response of the two stage stagger tuned pair is compared in the Fig. with the corresponding individual single tuned stages having same resonant circuits.
- Looking at Fig it can be seen that staggering reduces the total amplification of the centre frequency to 0.5 of the peak amplification of the individual stage and at the centre frequency each stage has amplification that is 0.707 of the peak amplification of the individual stage.
- Thus the equivalent voltage amplification per stage of the staggered pair is 0.707 times as great as when the same two stages are used without staggering.
- However, the half power (3 dB) bandwidth of the staggered pair is √2 times as great as the half power (3 dB) bandwidth of on individual single tuned stage.
- Hence the equivalent gain bandwidth product per stage of a stagger tuned pair is 0.707 x √2 = 1.00 times that of the individual single tuned stages.
- The stagger tuned idea can be easily extended to more stages. In case of three stages staggering, the first tuning circuit is tuned to a frequency lower than centre frequency while the third circuit is tuned to higher frequency than centre frequency. The middle tuned circuit is tuned at exact centre frequency.

$$f_{r1} = f_r + \delta \qquad \frac{A_v}{A_v \text{ (at resonance)}_2} = \frac{1}{1+j(X-1)}$$

$$f_{r2} = f_r - \delta$$

$$\left|\frac{A_v}{A_v \text{ (at resonance)}}\right|_{cascaded} = \frac{1}{\sqrt{(2-X^2)^2+(2X)^2}}$$

$$\frac{A_v}{A_v \text{ (at resonance)}_{cascaded}} = \frac{1}{2+2jX-X^2} = \frac{1}{(2-X^2)+(2jX)}$$

3.4.2.Large Signal Tuned Amplifiers:

- The output efficiency of an amplifier increases as the operation shifts from class A to class C through class AB and class B.
- As the output power of a radio transmitter is high and the efficiency is of prime concern, class B and class C amplifiers are used at the output stages in transmitters.
- The operation of class B and class C amplifiers are non-linear since the amplifying elements remain cut-off during a part of the input signal cycle. The non-linearity generates harmonics of the signal frequency at the output of the amplifier.
- In the push-pull arrangement where the bandwidth requirement is no limited, these harmonics can be eliminated or reduced. When a narrow bandwidth is desired, a resonant circuit is employed in class B and class Ctuned RF power amplifiers to eliminate the harmonics.

3.4.3.Class B Tuned Amplifier:

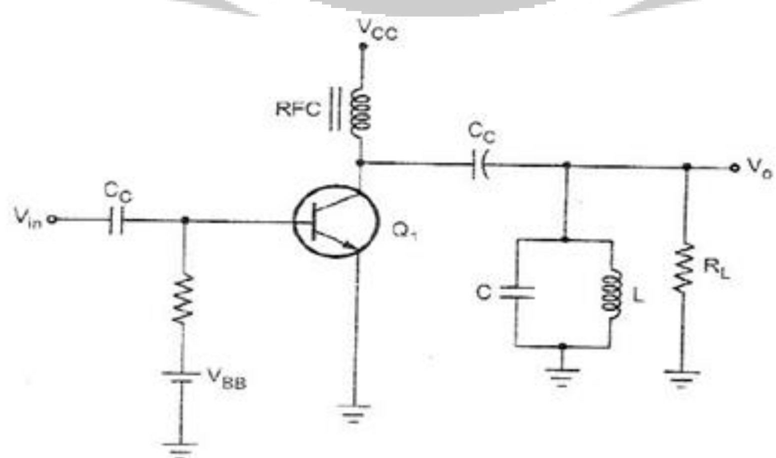

Fig 3.4.3.class B tuned amplifier

The Fig shows the class B tuned amplifier. It works with a single transistor by sending half sinusoidal current pulses to the load. The transistor is biased at the edge of the conduction.

- Even though the input is half sinusoidal, the load voltage is sinusoidal because a high Q RLC tank shunts harmonics to ground.
- The negative half is delivered by the RLC tank. The Q factor of the tank needs to be large enough to do this. This is analogous to pushing someone in swing. We only need to push in one direction, and the reactive energy stored will swing the person back in the reverse direction.

3.4.4.Class C Tuned Amplifier:

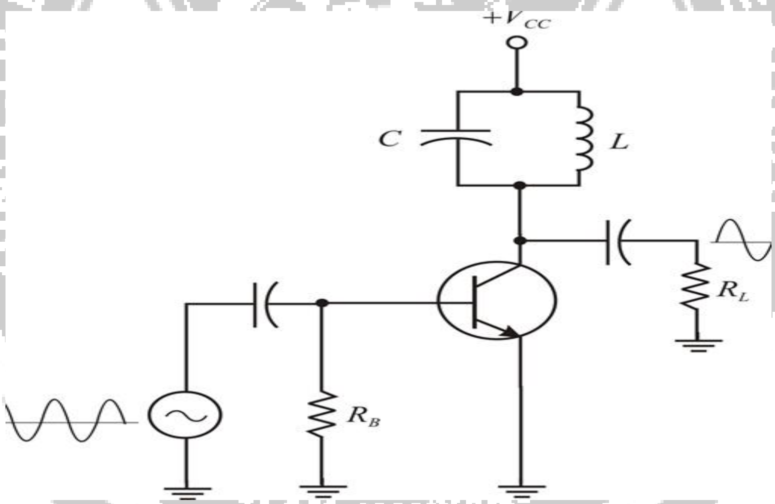

Fig 3.4.4.class C tuned amplifier

- The amplifier is said to be class C amplifier, if the Q point and the input signal are selected such the output signal is obtained for less than a half cycle, for a full cycle.
- Due to such a selection of the Q point, transistor remains active, for less than a half cycle. Hence only that part is reproduced at the output.
- For remaining cycle of the input cycle, the transistor remains cut-off and no signal is produced at the output.
- The current and voltage waveforms for a class C operation are shown in the Fig.

- Looking at Fig , it is apparent that the total angle during which current flows is less than 180^0. This angle is called the conduction angle, θ_C.
- Fig shows the class C tuned amplifier. Here a parallel resonant circuit as load impedance.
- As collector current flows for less than half a cycle, the collector current consists of a series of pulses with the harmonics of the input signal.
- A parallel tuned circuit acting as load impedance is tuned to the input frequency.
- Therefore, it filters the harmonic frequencies and produces a sine wave output voltage consisting of fundamental component of the input signal.

Output power

$$P_{out} = \frac{V_{rms}^2}{R_L}$$

$$V_{pp} = 2\sqrt{2}\,V_{rms}$$

$$P_{out} = \frac{\left(V_{PP}/2\sqrt{2}\right)^2}{R_L} = \frac{V_{PP}^2}{8R_L}$$