UNIT - V TUNED AMPLIFIERS

Topics to be covered:

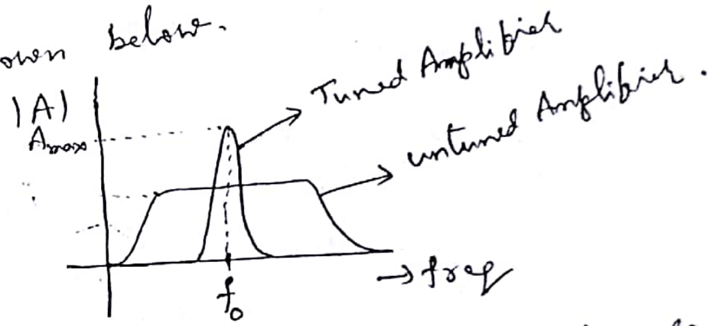
1. Tuned Amplifier definition.
2. classification of Tuned Amplifiers
3. Basics required for the Analysis of tuned Amplifier.
   - a) Tank circuit
   - b) Resistance of inductor
   - c) Q - Factor
   - d) Relation between B.W. and Q.
4. Analysis of single tuned ~~Am~~ Amplifier
   - a) Capacitive coupled ..
   - b) inductive (xmer) coupled.
5. Effect of cascading on BW, for single tuned amplifiers.
6. Double tuned amplifier Analysis &
7. Effect of cascading double tuned amp. on B.W.
8. stagger tuned amplifier.
9. stability considerations in tuned amplifiers.
10. Problems.

A.

(P.T.O.)..2

1 Tuned Amplifier:

An electronic circuit which amplifies maximally a desired frequency (f_0) is called as a tuned amplifier. The gain of this amplifier is maximum at f_0 and the gain rapidly decreases for those frequencies away from f_0. The frequency response of a tuned amplifier is as shown below.



Note: 1 A tuned circuit (Tank circuit) is used as a load in tuned amplifiers for frequency selection.

2 At resonant frequency the impedance of the tank ckt is maximum (ideally infinite), hence the voltage gain is also maximum. At other frequencies the tank ckt impedance rapidly decreases and hence voltage also decreases.

3 The Band width of a tuned amplifier is very small. So, these amplifiers are also called as Narrow Band amplifiers.

4 The resonant frequency (f_0) of the tank ckt is given by

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{LC}}}$$

5 The B.W. of tuned amplifiers is inversely proportional to Q, quality Factor.

$$\boxed{B.W = \frac{f_0}{Q}}$$

(P.T.O.)

② Classification of tuned Amplifiers:

Tuned amplifiers are classified, based on the number tuned ckts used and method of tuning, as follows:

① Single tuned Amplifier

② Double tuned Amplifier

③ Stagger tuned Amplifier.

Single tuned amplifier is again two types

a) Capacitive Coupled

b) inductively Coupled.

③ Basic information

a) Tank Circuit

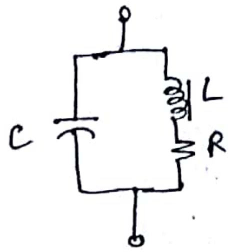
b) Resistance of an inductor

c) Q - Factor

d) Relation between B.W and Q.

ⓐ Tank Circuit

① A parallel LC circuit is called as tuned circuit or tank circuit. The circuit is as shown in figure.



② The resistance R is internal resistance of the inductor.

③ The resonant frequency is given by

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{LC}}}$$

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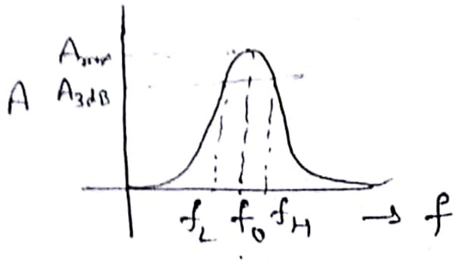
(4) The frequency response of the tuned amplifier is as shown below.



(*)(5) The impedance of the tank circuit is maximum at resonant frequency (f_0) and it is pure resistive

(*)(6) For the frequencies above f_0 tank circuit exhibits capacitive reactance

(*)(7) For frequencies below f_0 tank circuit exhibits inductive reactance.

(8) In tuned amplifiers the tank circuit is used as the load. The gain (A_V) of an amplifier is proportional to Load R_L. Therefore the voltage gain at resonant ~~at~~ frequency is maximum and gain rapidly decreases on either side of f_0.

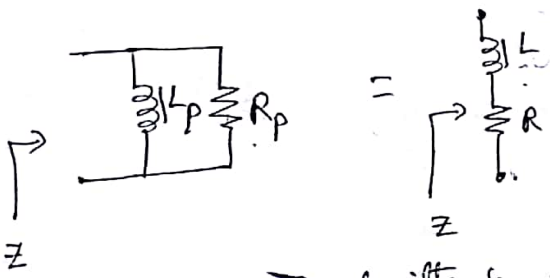
(9) Tuned amplifiers are called as frequency selective amplifiers, because they amplify only selected frequency signal f_0.

(10) Tuned circuits are used to select a small range of frequencies and to reject all other frequencies.

(P.T.O.)..

(b) Resistance of an inductor :

An inductor exhibits some resistance in series with it and behaves as a series RL circuit. In the analysis of tuned amplifiers most of the components appear parallel to each other, hence it is convinient to represent the series of the inductance in parallel to it. The equivalent parallel circuit can be represented as below.



The impedance or admittance on both sides should be same.

$$\therefore \frac{1}{R_p} + \frac{1}{j\omega L_p} = \frac{1}{R+j\omega L}$$

$$= \frac{R - j\omega L}{R^2 + \omega^2 L^2} \quad \text{(Rationalization)}$$

$$= \frac{R}{R^2+\omega^2 L^2} - j\frac{\omega L}{R^2+\omega^2 L^2}$$

In a practical tuned circuit ω is very large (radio frequency)

$$\therefore \omega^2 L^2 >> R^2$$

$$\therefore \frac{1}{R_p} + \frac{1}{j\omega L_p} = \frac{1}{\left(\frac{\omega^2 L^2}{R}\right)} + \frac{1}{j\omega L}$$

$$\therefore \boxed{R_p = \frac{\omega^2 L^2}{R}} \quad \text{and} \quad \boxed{L_p = L}$$

So, a series RL circuit can be converted into parallel RL with values as obtained above. The $L_p = L$ is now behaves as an ideal inductance.

(c) Q-factor:

* definition: The Q-factor is defined as 2π times the ratio of maximum energy stored per cycle to the energy dissipated per cycle in a reactive element.

$$\therefore \boxed{Q = 2\pi \times \frac{\text{Maximum energy stored per Cycle}}{\text{Energy dissipated per Cycle}}}$$

For inductor:

The maximum energy stored per cycle $= \frac{1}{2} L I_m^2$

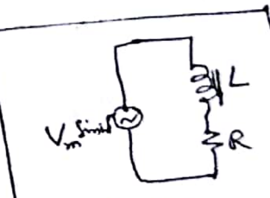
The average power dissipated per cycle $= \left(\frac{I_m}{\sqrt{2}}\right)^2 R$

(∵ sine wave is assumed) $= \frac{1}{2} I_m^2 R$

$\therefore$ Energy dissipated per cycle $=$ Power $\times$ Time of one cycle

$$= \frac{1}{2} I_m^2 R \times T$$

$$= \frac{I_m^2 R}{2f} \qquad \left[\because T = \frac{1}{f}\right]$$



Figure

$$\therefore Q = 2\pi \times \frac{\cancel{\frac{1}{2}} \cancel{I_m^2} RL}{\cancel{\frac{1}{2}} \times \frac{\cancel{I_m^2} R}{f}}$$

$$= \frac{2\pi f L}{R} = \frac{\omega L}{R} = \frac{X_L}{R}$$

$$\boxed{\therefore Q = \frac{\omega L}{R}}$$

Note: ① For a series RL circuit the $\boxed{Q = \frac{\omega L}{R}}$ and for a parallel RL circuit the $\boxed{Q = \frac{R}{\omega L}}$

(P.T.O.)

~~For a Capacitor:~~

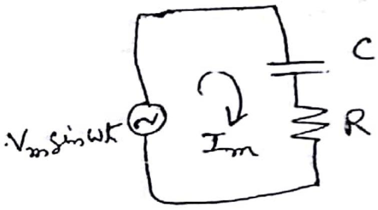
~~The maximum energy stored per cycle $= \frac{1}{2} C V_{max}^2$~~

~~The average power dissipated per cycle $= \left(\frac{V_m}{\sqrt{2}}\right)^2 \times \frac{1}{R}$~~

~~$= \frac{V_m^2}{2R}$~~

~~$\therefore$ Energy~~

For capacitor:



The maximum energy stored per cycle $= \frac{1}{2} C V_{max}^2$

where V_{max} is the maximum voltage across capacitor given by

$$V_{max} = I_m X_C = \frac{I_m}{\omega C} \quad \left(\because R << \frac{1}{\omega C}\right)$$

$\therefore$ The maximum energy stored per cycle $= \frac{1}{2} C \left(\frac{I_m}{\omega C}\right)^2$

$$= \frac{1}{2} \frac{I_m^2}{\omega^2 C}$$

The average power dissipated per cycle $= \left(\frac{I_m}{\sqrt{2}}\right)^2 \times R$
($\because$ sine wave is assumed)

$\therefore$ The energy dissipated per cycle $=$ Power $\times T$

$$= \frac{I_m^2 R}{2f}$$

$$\therefore \quad Q = 2\pi \times \frac{\frac{I_m^2}{2\omega^2 C}}{\frac{I_m^2 R}{2f}} = \frac{2\pi f}{\omega^2 CR} = \frac{1}{\omega CR}$$

$$\therefore \boxed{Q = \frac{1}{\omega CR}}$$

Note: For series RC circuit $\boxed{Q = \frac{1}{\omega CR}}$ and for parallel RC ckt $\boxed{Q = \omega CR}$

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(d) Relation between Bandwidth and Quality factor :

The quality factor determines the 3 dB bandwidth for the resonant circuit and is given by

$$\boxed{BW = \frac{\omega_0}{2\pi Q}}$$

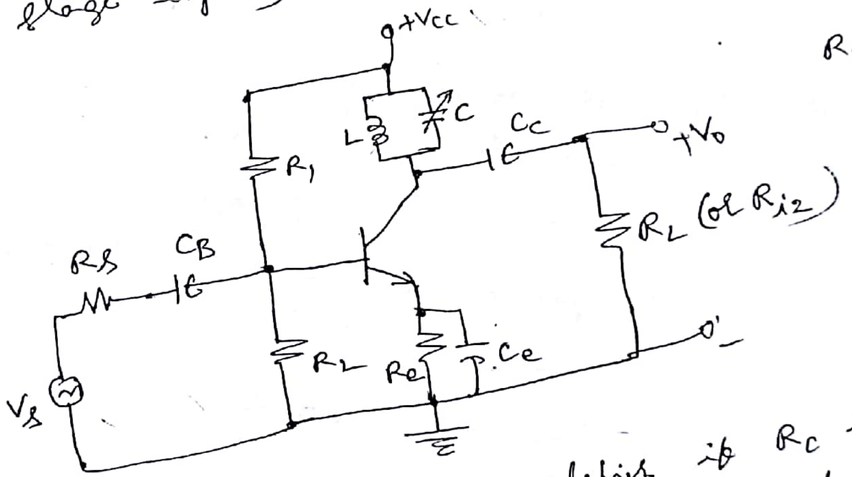
$$\boxed{BW = \frac{f_0}{Q}}$$

where BW → Bandwidth
ω_0 → Resonant frequency
Q → quality factor.

(4) Analysis of single tuned amplifier :

(a) Capacitive coupled single tuned amplifier :

The circuit of a single tuned amplifier coupled through a capacitor to load R_L (or to the next stage input) is as shown below.



R_{i2} → input impedance of 2nd stage in a Multi-stage amplifier.

In a normal CE amplifier if R_C is replaced with a tank circuit then it is called as a tuned amplifier. Any tank circuit has its natural frequency (f_0) of resonance. In practical applications this frequency will be very very large in comparission with audio frequencies. Hence ~~dun~~ during analysis the Transistor is to be replaced with Hybrid-π model.

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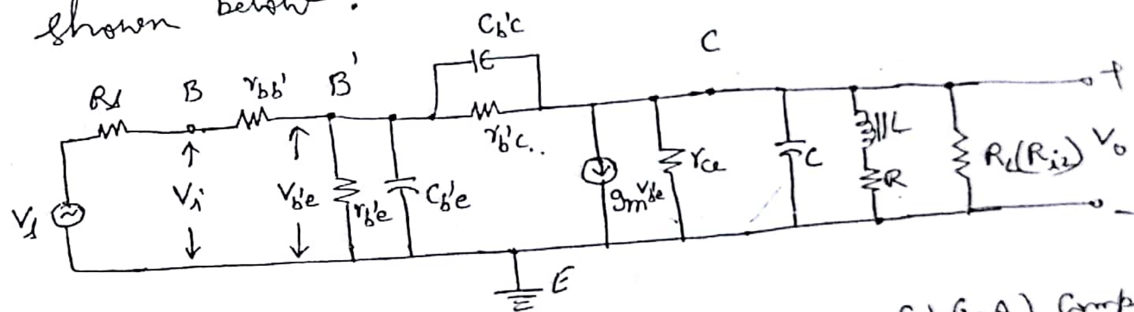
During Analysis we derive the expression for voltage gain and obtain a relation between BW and Q-factor. While performing analysis neglect the effect of biasing circuit R_1, R_2, or R_e and capacitors C_B, C_e, C_c. Donot neglect the capacitor tuned circuit because plays critical role in frequency selection.

The ac equivalent of the amplifier is as shown below.



① Apply Miller's theorem to $r_{b'c}$ and $C_{b'c}$, then $C_{b'c}(1-A)$ component falls in parallel to C, hence the total capacitance is

$$C_T = C + C_{b'c}\left(1-\frac{1}{A}\right) = C$$

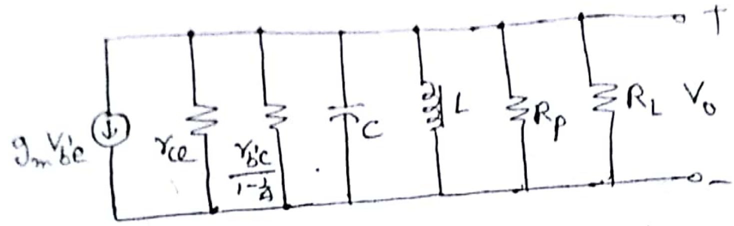
but the capacitance C will be much larger than $C_{b'c}(1-A)$

hence $C_T \simeq C$.

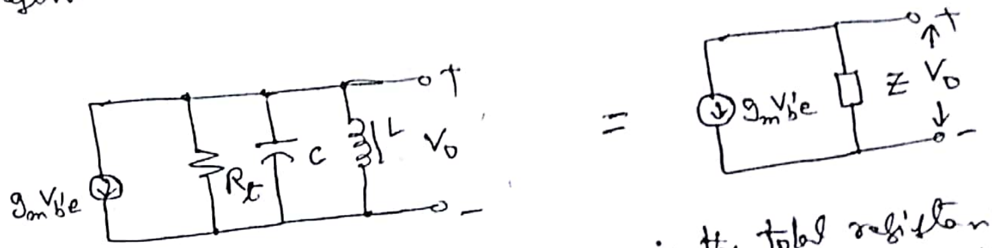
② The series resistance, R of inductance can be represented in parallel to inductance L.

③ The resonance frequency f_o is mainly decided by L and C of the tuned circuit only, hence it is sufficient to analyse the output circuit only.

④ The equivalent circuit on output side is as shown below.



The above circuit can be further simplified and represented as below.



where $R_t = r_{ce} \parallel \left(\frac{r_{b'c}}{1-\frac{1}{A}}\right) \parallel R_p \parallel R_L$ is the total resistance (effective resistance)

and $Z = (R_t) \parallel \left(\frac{1}{j\omega C}\right) \parallel (j\omega L)$

The effective quality factor Q_e can be written as

$$\boxed{Q_e = \omega_o C R_t = \frac{R_t}{\omega_o L}}$$

where $\omega_o = 2\pi f_o$ the resonant frequency.

Therefore the voltage gain of the tuned amplifier can be defined as

$$A_V = \frac{V_o}{V_i} = \frac{V_o}{V_{b'e}}$$

$$= -\frac{g_m V_{b'e} Z}{V_{b'e}}$$

$$\boxed{A_V = -g_m Z.}$$

where Z is given by

$$Y = \frac{1}{Z} = \frac{1}{R_t} + \frac{1}{j\omega L} + j\omega C$$

$$= \frac{1}{R_t}\left[1 + j\omega C R_t - j\frac{R_t}{\omega L}\right]$$

$$= \frac{1}{R_t}\left[1 + j\frac{\omega\omega_0 C R_t}{\omega_0} - j\frac{\omega_0 R_t}{\omega\omega_0 L}\right]$$ [Multiply and devide reactances with the ω_0 to introduce Q term]

but we know $Q_e = \omega_0 C R_t$ &

$$Q_e = \frac{R_t}{\omega_0 L}$$

$$\therefore \frac{1}{Z} = \frac{1}{R_t}\left[1 + jQ_e\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)\right]$$

Let δ is the fractional change in the resonant frequency and defined as

$$\delta = \frac{\omega - \omega_0}{\omega_0}$$

$$= \frac{\omega}{\omega_0} - 1$$

$$\therefore \boxed{\frac{\omega}{\omega_0} = 1 + \delta}$$

$$\therefore \frac{\omega_0}{\omega} = \frac{1}{1+\delta} = (1+\delta)^{-1} = 1 - \delta + \delta^2 - \delta^3 + \cdots$$

$$= 1 - \delta$$ [$\because$ δ is very small hence $\delta^2, \delta^3 \ldots$ will be negligibly small hence neglected.]

$$\therefore \boxed{\frac{\omega_0}{\omega} = 1 - \delta}$$

$$\therefore \cancel{\frac{1}{Z} = \frac{1}{R_t}\left[1 +\right.}$$

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$$\therefore \left(\frac{W}{W_0} - \frac{W_0}{W}\right) = 1+\delta - (1-\delta)$$
$$= 1+\delta-1+\delta$$
$$= 2\delta$$

$$\therefore \frac{1}{Z} = \frac{1}{R_t}\left[1+jQ_e 2\delta\right]$$

$$\boxed{\therefore Z = \frac{R_t}{1+j2\delta Q_e}}$$

$$\boxed{\therefore A_V = -\frac{g_m R_t}{1+j2\delta Q_e}}$$

at resonant frequency $\delta = 0$, the gain at resonance A_{res} is given by

[this is the maximum gain]

$$A_{vres} = -g_m R_t$$

$$\boxed{\therefore \left|\frac{A_V}{A_{vres}}\right| = \left|\frac{1}{1+j2\delta Q_e}\right|}$$ → This is the normalized gain.

(or)

important ⟷

$$\boxed{\frac{A_V}{A_{vres}} = \frac{1}{1+j2\delta Q_e}}$$

At 3 dB frequencies the magnitude of this normalized gain should be equal to $\frac{1}{\sqrt{2}}$

$$\therefore \frac{1}{\sqrt{1+(2\delta Q_e)^2}} = \frac{1}{\sqrt{2}}$$

$$\therefore 1+(2\delta Q_e)^2 = 2$$

$$\therefore 2\delta Q_e = 1$$

important →

$$\boxed{\therefore 2\delta = \frac{1}{Q_e}}$$

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Band width Consideration:

The bandwidth of the amplifier is defined as

Where $W_2 = 2\pi f_2 = 2\pi$
$W_1 = 2\pi f_1 = 2\pi f$

$$BW = W_2 - W_1$$

$$= (W_2 - W_0) + (W_0 - W_1)$$

$W_2 > W_0$ and
$W_1 < W_0$

but $(W_2 - W_0)$ and $(W_0 - W_1)$ are the deviations from the resonant frequency W_0 and we know

$$\delta = \frac{W_2 - W_0}{W_0} \quad \text{or} \quad \delta = \frac{W_0 - W_1}{W_0}$$

$$\therefore (W_2 - W_0) = \delta W_0 \quad \text{or} \quad (W_0 - W_1) = \delta W_0$$

$$\therefore BW = \delta W_0 + \delta W_0$$

$$= 2\delta W_0$$

but $2\delta = \frac{1}{Q_e}$

$$\boxed{\therefore BW = \frac{W_0}{Q_e}}$$

~~The same expression in terms of the~~

but $Q_e = W_0 C R_t = \frac{R_t}{W_0 L}$

$$\therefore BW = \frac{W_0}{W_0 C R_t} \quad \text{or} \quad BW = \frac{W_0^2 L}{R_t}$$

$$\boxed{BW = \frac{1}{CR_t} \text{ rad/sec}} \quad \text{or} \quad \boxed{BW = \frac{W_0^2 L}{R_t} \text{ rad/sec}}$$

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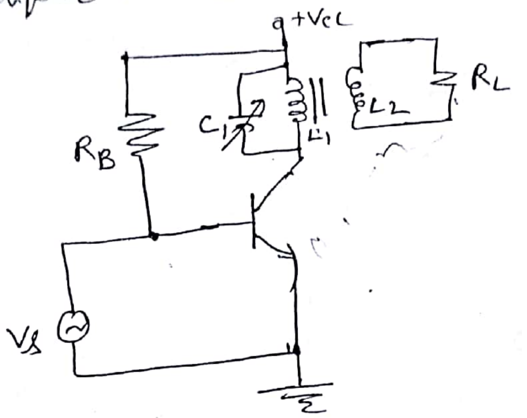
Inductively Coupled Single tuned Amplifier:

When the load is coupled through a transformer to the output of single tuned amplifier then it is said to inductively coupled single tuned amplifier. The circuit is as shown below



The resonant frequency of this circuit is given by

$$f_0 = \frac{1}{2\pi\sqrt{L_{eq}C_1}} \quad \text{where } L_{eq} = L_1 + M$$

The capacitor C_1 can be connected on either side of the transformer. By changing the value of capacitor resonant frequency can be changed. This process is called as "tuning".

When another capacitor C_2 connected across secondary winding then the circuit is called as double tuned amplifier. If the two tank circuits are tuned to same frequency then it is called as double tuned amplifier, if they are tuned to slightly different frequencies then it is called as stagger tuned amplifier.

(P.T.O.)..

(5) Effect of cascading on Bandwidth :

We know the normalized voltage gain of single tuned amplifier is given by

$$\frac{A_v}{A_{vres}} = \frac{1}{1+j2\delta Q_e}$$

when n - such amplifiers are cascaded together then the overall voltage gain is given by

$$\left(\frac{A_v}{A_{vres}}\right)^n = \left[\frac{1}{1+j2\delta Q_e}\right]^n$$

at 3dB frequencies the gain magnitude of this should be equal to $\frac{1}{\sqrt{2}}$

$$\therefore \left[\frac{1}{\sqrt{1+(2\delta Q_e)^2}}\right]^n = \frac{1}{\sqrt{2}}$$

$$\therefore 1+(2\delta Q_e)^2 = 2^{1/n}$$

$$\therefore 2\delta Q_e = \pm\sqrt{2^{1/n}-1}$$

but we know $\delta = \frac{\omega-\omega_0}{\omega_0} = \frac{f-f_0}{f_0}$

$$\therefore 2\left(\frac{f-f_0}{f_0}\right)Q_e = \pm\sqrt{2^{1/n}-1}$$

Therefore when $f > f_0$ then

$$2\left(\frac{f_2-f_0}{f_0}\right)Q_e = +\sqrt{2^{1/n}-1}$$

$$\therefore (f_2 - f_0) = +\frac{f_0}{2Q_e}\sqrt{2^{1/n}-1} \quad \text{— (I)}$$

and

when $f < f_0$ then

$$\frac{2(f_1 - f_0)}{f_0} Q_e = -\sqrt{2^{1/n}-1}$$

$$\therefore (f_1 - f_0) = -\frac{f_0}{2Q_e}\sqrt{2^{1/n}-1} \quad \text{— (II)}$$

$\therefore$ I − II gives

$$(f_2 - f_0) - (f_1 - f_0) = \frac{f_0}{2Q_e}\sqrt{2^{1/n}-1} + \frac{f_0}{2Q_e}\sqrt{2^{1/n}-1}$$

$$= \frac{f_0}{2Q_e}\sqrt{2^{1/n}-1}$$

$$\therefore (f_2 - f_1) = \frac{f_0}{Q_e}\sqrt{2^{1/n}-1}$$

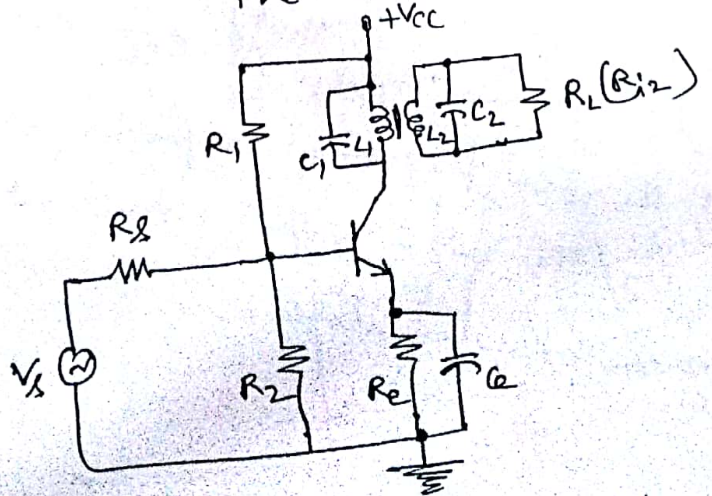
but $BW = (f_2 - f_1)$

$$\boxed{\therefore BW_n = BW\sqrt{2^{1/n}-1}}$$

where BW is the Bandwidth of single tuned amplifier.

(6) Double Tuned Amplifier :

The circuit of a double tuned amplifier is as shown.



In this circuit $L_1 = L_2 = L$ and $C_1 = C_2 = C$ hence the resonant frequency is given by

$$\boxed{f_0 = \frac{1}{2\pi\sqrt{LC}}}$$

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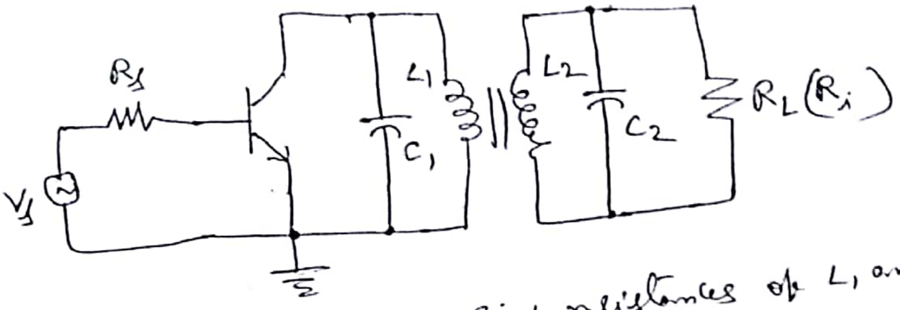
The ac equivalent circuit is given as below, biasing circuit is neglected.



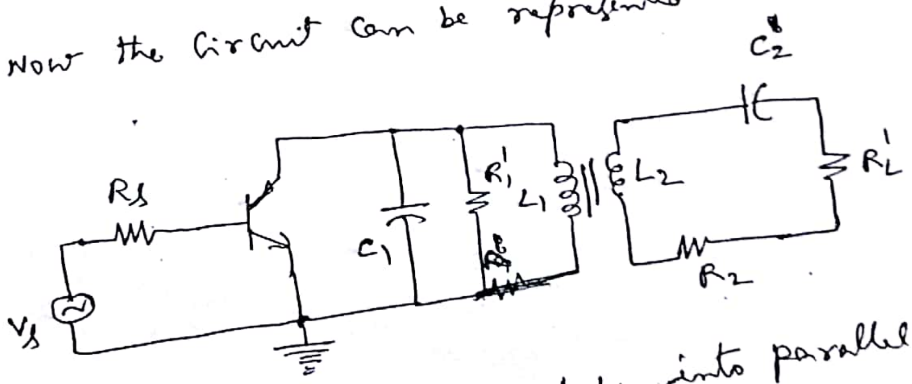
① Let R_1 and R_2 are the series resistances of L_1 and L_2

② C_2 and R_L are parallel to ~~at~~ each other, this can be represented as a series combination of C_2' and R_L'

where $\boxed{C_2' \simeq C_2}$ and $\boxed{R_L' = \frac{R_L}{1+Q^2} \simeq \frac{R_L}{Q^2}}$ $[\because Q>1]$

where $\boxed{Q = WC_2R_L}$

③ Now the circuit can be represented as below



④ Convert ~~Replace~~ series resistance R_1 of L_1 into parallel as shown above where $R_1' = \frac{(WL_1)^2}{R_1}$.

⑤ Replace BJT with Hybrid-π model and apply Millers theorem to $C_{b'c}$ and $r_{b'c}$. As $C_{b'e} << C_1$, neglect $C_{b'c}$ and the final frequency response is decided by the output ~~output~~ circuit only which is as shown below.

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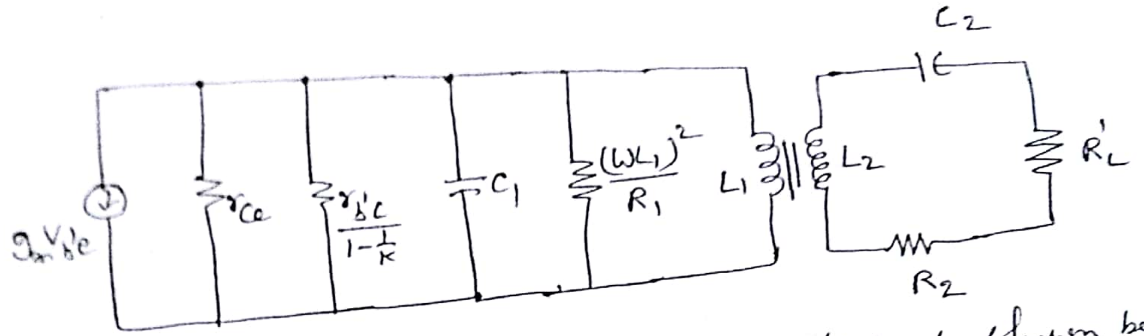
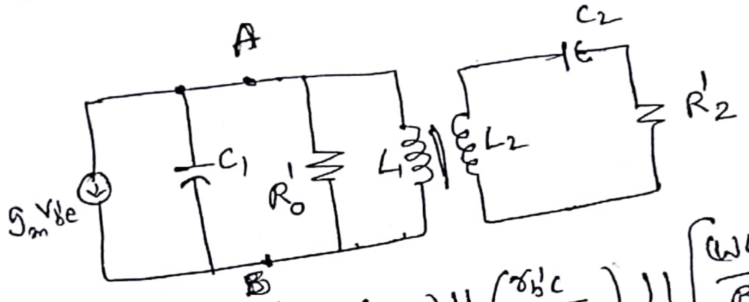


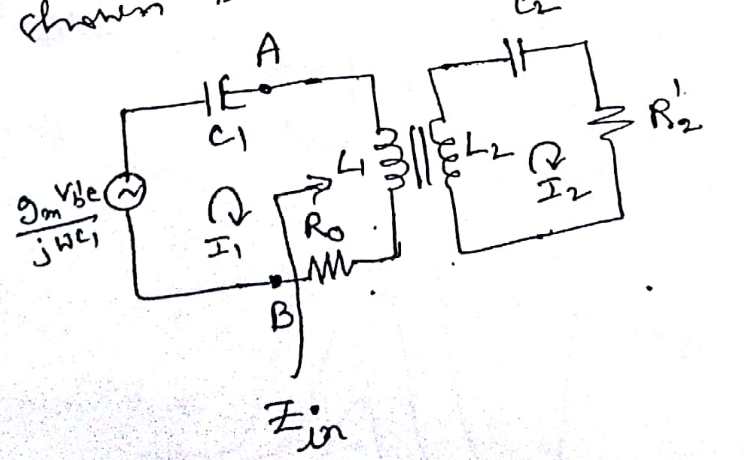
This circuit can be further simplified as shown below.



where $R_0' = (r_{ce}) \,\|\, \left(\frac{r_{b'c}}{1-\frac{1}{K}}\right) \,\|\, \left[\frac{(\omega L_1)^2}{R_1}\right]$

and $R_2' = R_2 + R_L'$

It is convinient to represent R_0' in series with L_1 and ~~current~~ ~~and~~ on right side of points A, B Nortons source ~~is~~ as representing ~~&~~ $g_m V_{b'e}$, C_1 Thevenins source, for writing loop equations. Hence the final circuit will be looking as shown below.



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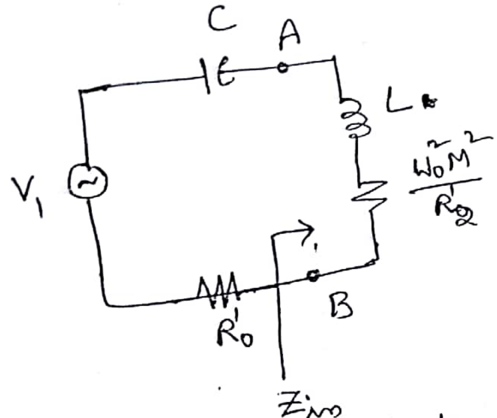
writing loop equations to right side of points A,B and replacing the circuit with its equivalent impedance Z_{in} further simplifies the circuit as given below.

here it is assumed

$C_1 = C_2 = C$ and

$L_1 = L_2 = L$



$$\boxed{W = \pm W_0 \cdot \sqrt{1 \pm \frac{\sqrt{b^2-1}}{Q}}}$$

Resonant frequency of double tuned amp.

It is not difficult to obtain voltage gain of this double tuned amplifier and w is given by above expression. Under maximum power transfer conditions the Band width of the double tuned amplifier is given by

$$BW_2 = \boxed{(W_2 - W_1) = \frac{W_0}{Q}\sqrt{(b^2-1) \pm 2b}}$$

Band width of double tuned amplifier.

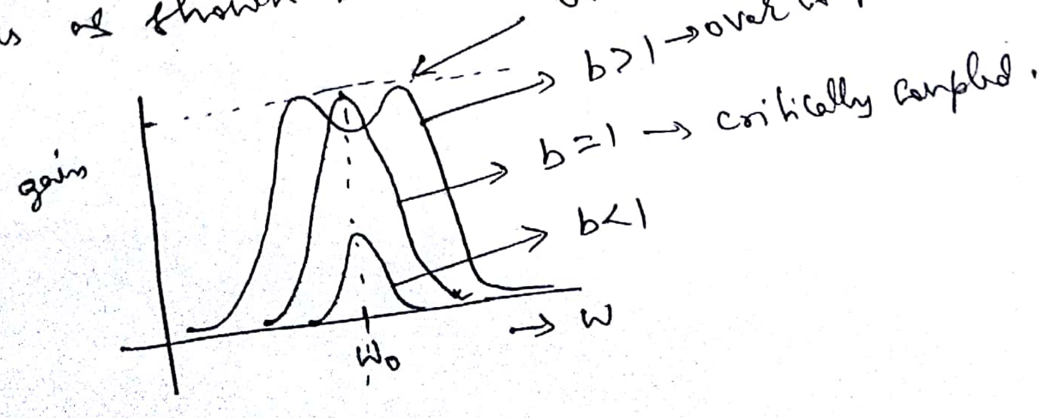
where b is coefficient of coupling.

when $b<1$ then it is said to be under coupled.

when $b=1$ then it is said to be critically coupled.

when $b>1$ then it is said to be over coupled.

The frequency response for different values of b is as shown below.



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In a practical circuit the optimum value of b is selected between 1 and 1.7.

Advantages of double tuned Amplifier:

① The gain of amp is almost equal to that of single tuned amplifier.

② The bandwidth is larger than single tuned amp.

③ The gain-bandwidth product is large.

④ The gain vs frequency response has steeper sides and flatter top.

⑦ Effect of cascading double tuned amplifier on BW:

When double tuned amplifiers are cascaded the 3dB bandwidth becomes more narrower and the steepness of the frequency response increases. The n-stage amplifier Bandwidth is given by

$$\boxed{B_{2n} = B_2\left[2^{1/n} - 1\right]^{1/4}}$$

Note: ① Alignment of double tuned amplifier is difficult. So stagger tuned amplifier is used.

(P.T.O.)

(8) stagger tuned Amplifier :

In a multi-stage (2 stage) single single-tuned amplifier, if all tuned circuits are tuned to the same frequency then it is said to be Synchronously tuned amplifier. When they are tuned to slightly different frequencies then it is said to be stagger tuned amplifier.

We know the gain of a single tuned amplifier is given by

$$\frac{A}{A_{res}} = \frac{1}{1+j2\delta Q_e}$$

$$= \frac{1}{1+jx} \qquad \text{where } x = 2\delta Q_e$$

When two such amplifiers are cascaded together and tuned to slightly different frequencies then the overall gain can be obtained as

$$\left(\frac{A}{A_{res}}\right)_{2\text{-stage}} = \left(\frac{A_1}{A_{res}}\right)_{1\text{-stage}} \times \left(\frac{A_2}{A_{res}}\right)_{2\text{-stage}}$$

$$= \left[\frac{1}{1+j(x-1)}\right] \times \left[\frac{1}{1+j(x+1)}\right]$$

$$\left(\frac{A}{A_{res}}\right)_{2\text{-stage}} = \frac{1}{(2-x^2)+j2x}$$

$$\therefore \left|\frac{A}{A_{res}}\right|_{2\text{-stage}} = \frac{1}{\sqrt{(2-x^2)^2+(2x)^2}}$$

$$= \frac{1}{\sqrt{4+x^4}}$$

(P.T.O.)

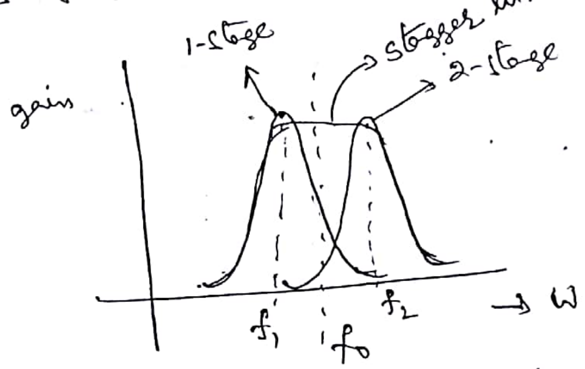
but $x = 2\delta Q_e$

$$\therefore \left|\frac{A}{A_{res}}\right|_{2\,stage} = \frac{1}{\sqrt{4+(2\delta Q_e)^4}}$$

$$= \frac{1}{2}\frac{1}{\sqrt{1+4\delta^4 Q_e^4}}$$

where δ is the small deviation from resonant frequency ω_0.

The frequency response of stagger tuned amp. is as shown below.



$f_0 \to$ the ~~definite~~ desired resonant frequency

$\left.\begin{array}{l} f_1 < f_0 \\ f_2 > f_0 \end{array}\right\}$ by small amount

Advantages of stagger tuned amplifiers:

(1) The Bandwidth is $\sqrt{2}$ times larger than double tuned amplifiers.

(2) The steepness of sides is high

(3) The frequency response is flat.

(4) Good selectivity.

(5) Alignment is easy.

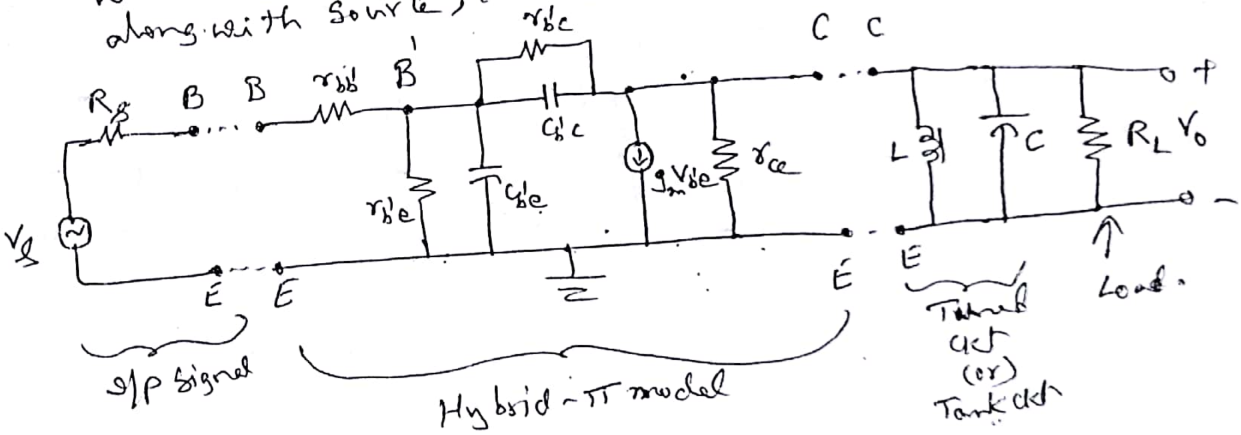
disadvantage:

(1) Gain reduces by a factor of $\sqrt{2}$.

(P.T.O.)

(9) Stability Considerations:

The main purpose of tuned amplifiers is to amplify the selected frequency and rejecting all other frequencies. These amplifiers are used at high frequencies in Communication Circuits. The active devices like BJT & FET are used for amplification in these circuits. At high frequencies the internal (Junction) capacitances show their effect on gain. During analysis of a tuned amplifier the BJT (FET) is to be replaced with Hybrid-π (High frequency) model as shown below, along with source, tank circuit and load R_L.



In the above circuit the internal parameters $r_{b'c}$ and $C_{b'c}$ are connected between output and input terminals of the active device, which provide internal feedback. If this feedback is negative the amplifier stability improves, but if this feed back component is in phase with external signal at Base terminal (B'), at any frequency within the desired bandwidth of the tuned amplifier, then the circuit starts oscillating for that frequency and the action of amplification is seized.

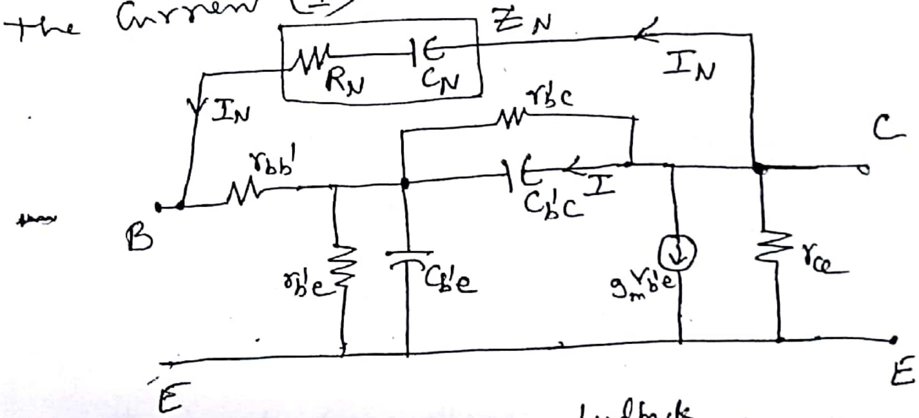
(P.T.O.).. (13)

This creates instability in tuned amplifiers. For preventing oscillations three methods are used in practice.

1. Neutralization
2. Unilateralization
3. Mis match technique

① Neutralization

In this method an external impedance Z_n is connected between collector and Base terminals of BJT. and this impedance consists of a resistance R_N in series with a capacitor C_N. The values of R_N and C_N are to be selected such that the current (I_N) flowing through Z_N is exactly equal in magnitude to the current (I) through $C_{b'c}$ as shown in figure.



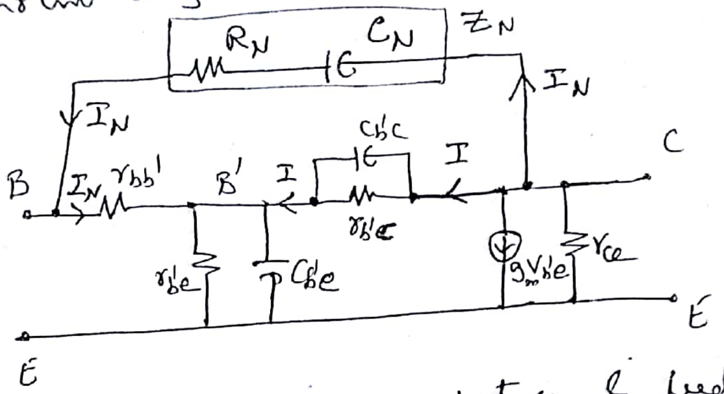
In the case of Neutralization the feedback current through $r_{b'c}$ is ignored, hence there will be feedback but that does lead to any oscillations. The current through Z_N and the current through $C_{b'c}$ are equal in magnitude and opposite in direction hence they cancel each other. This type of cancelling internal feed back is called as Neutralization.

(P.T.O.)

~~(2) UNILATERAL~~

(2) UNILATERALIZATION:

In Unilateralization the feedback current through both $r_{b'c}$ and $C_{b'c}$ is considered. The external feedback impedance Z_N is selected such that I_N is equal in magnitude to the total current through $r_{b'c}$ and $C_{b'c}$.
The circuit diagram is as shown below.



In this method the internal feedback signal is completely eliminated through the external feedback circuit Z_N, hence the signal in the entire circuit is flowing from input to output only and no signal appears from output to input, so the circuit is behaving as a unilateral circuit. Hence this method is called as <u>Unilateralization</u>.

END OF UNIT – V.

UNIT - V. TUNED AMPLIFIERS

① Define Q-factor and derive an expression for Q-factor of a) RL circuit and b) RC circuit.

*② Draw the equivalent circuit of capacitive coupled single tuned amplifier and derive the equation for its ~~at~~ voltage gain.

③ Derive the Band width equation for a capacitive coupled single tuned amplifier.

*④ Discuss the effect of cascading single tuned amplifiers on Band width.

*⑤ what is the principle of stagger tuned amplifier? Derive the expression for its voltage gain and explain its frequency response and advantages.

⑥ Discuss the instability in tuned amplifiers.

*⑦ write short notes on
a) Neutralization
b) Unilateralization.

⑧ Draw the circuit of a double tuned amplifier and derive the expression for voltage gain.

*⑨ A single tuned amplifier has a BW of 100 KHz. Calculate the BW when 3 such stages are cascaded.

*⑩ A tank circuit has a capacitor of 100 pF and inductor of 100 μH, the resistance of the inductor is 5 Ω. Determine ⓐ Resonant frequency ⓑ Q-factor ⓒ Band width.

END