$$= \frac{h_{fe}\, k R^3 j \omega^3 C^3}{1 - \omega^2 C^2 R^2 (4k+6) + j\omega CR(5+k) - j\omega^3 C^3 R^3 (3k+1)}$$

$$= \frac{j\omega^3 k R^3 C^3 h_{fe}}{(1 - 4k\omega^2 C^2 R^2 - 6\omega^2 C^2 R^2) - j\omega\left[3k\omega^2 R^3 C^3 + \omega^2 R^3 C^3 - 5RC - kRC\right]}$$

Divide Nr & dr by $(-j\omega^3 R^3 C^3)$ we get:–

J.S. 18/07/11

$$= \frac{k h_{fe}}{\left(\frac{-1}{\omega^3 R^3 C^3} + \frac{4kj}{\omega RC} - \frac{6j}{\omega CR}\right)}$$

$$A\beta = \frac{k h_{fe}}{j\left(\frac{1}{\omega^3 R^3 C^3} - \frac{4k}{\omega RC} - \frac{6}{\omega RC}\right) + \left(3k + 1 - \frac{5}{\omega^2 R^2 C^2} - \frac{k}{\omega^2 C^2 R^2}\right)}$$

Condition:– (i) $A\beta = 1$ Barkhausen Criteria:

& (ii) $\angle A\beta = 0°$ or $180°$

$$\theta = -\tan^{-1}\left(\frac{\text{Imaginary part}}{\text{Real part}}\right)$$

$$= -\tan^{-1}\left(\frac{I.P}{R.P}\right) = 0$$

$\Rightarrow$ Imaginary part $= 0$

$$\Rightarrow \frac{1}{\omega^3R^3C^3} - \frac{4k}{\omega RC} - \frac{6}{\omega RC} = 0$$

Substitute, $\frac{1}{\omega RC} = \alpha$

$$\Rightarrow \cancel{\frac{\alpha^3}{\alpha^3} - \frac{4k}{\alpha}}$$

$$\Rightarrow \alpha^3 - 4\alpha k - 6\alpha = 0$$

$$\Rightarrow \alpha(\alpha^2 - 4k - 6) = 0$$

$\boxed{\alpha = 0}$ or, $\alpha^2 - 4k - 6 = 0$

$$\alpha = \pm\sqrt{4k+6}$$

$$\Rightarrow \frac{1}{\omega RC} = \sqrt{4k+6}$$

$$\Rightarrow \frac{1}{2\pi f RC} = \sqrt{4k+6}$$

$$\Rightarrow \boxed{f = \frac{1}{2\pi RC\sqrt{4k+6}}}$$

when $A\beta = 1$

$$\Rightarrow \frac{k h_{fe}}{3k+1-5\alpha^2-k\alpha^2} = 1$$

$$\Rightarrow k h_{fe} = 3k+1-5\alpha^2-k\alpha^2 \quad -①$$

Sub $\alpha = \sqrt{4k+6}$ in ②

$$k h_{fe} = 3k+1-5(4k+6)-k(4k+6)$$

$$= 3k+1-20k-30-4k^2-6k$$

$$k h_{fe} = -4k^2 - 23k - 29$$

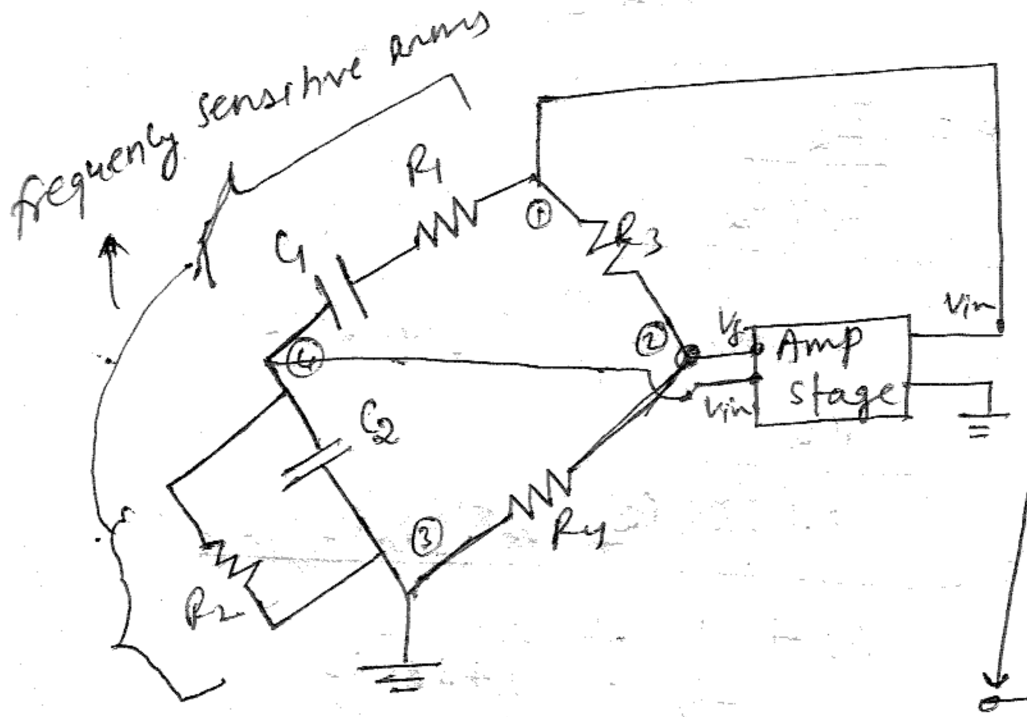
$$\boxed{k h_{fe} = -4k^2 - 23k - 29}$$

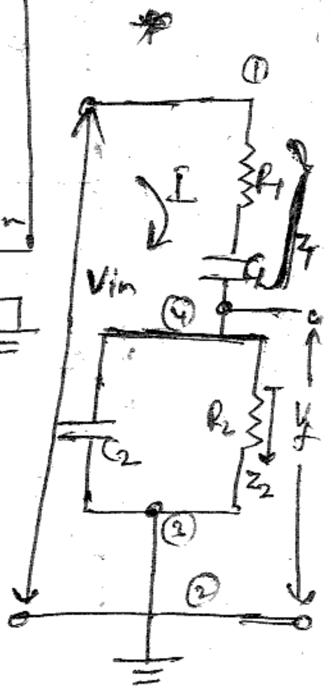
$$\because \left| \frac{k h_{fe}}{3k+1-5\alpha^2-k\alpha^2} \right| = 1$$

$$\Rightarrow \frac{k h_{fe}}{4k^2+23k+29} = 1$$

$$\Rightarrow \boxed{h_{fe} = \frac{4k^2+23k+29}{k}}$$

Wien Bridge Oscillator





*

$$Z_1 = R_1 + \frac{1}{j\omega C_1} = R_1 + \frac{1}{sC_1}$$

$$Z_2 = \frac{R_2 \times \frac{1}{j\omega C_2}}{R_2 + \frac{1}{j\omega C_2}} = \frac{\frac{R_2}{j\omega C_2}}{\frac{R_2 j\omega C_2 + 1}{j\omega C_2}} = \frac{R_2}{1 + R_2 j\omega C_2}$$

$$= \frac{R_2}{1 + R_2 s C_2}$$

$\because s = j\omega$.

$$I = \frac{V_{in}}{Z_1 + Z_2}$$

$$V_f = I Z_2 \quad \text{and} \quad \beta = \frac{V_f}{V_{in}}$$

$$\Rightarrow V_f = \left(\frac{V_{in}}{Z_1 + Z_2}\right) Z_2 \qquad \Rightarrow \frac{V_f}{V_{in}} = \frac{Z_2}{Z_1 + Z_2}$$

$$\beta = \frac{V_f}{v_{in}} = \frac{Z_2}{Z_1 + Z_2}$$

$$\boxed{\beta = \frac{Z_2}{Z_1 + Z_2}}$$

$$\beta = \frac{\dfrac{R_2}{1 + sR_2C_2}}{R_1 + \dfrac{1}{sC_1} + \dfrac{R_2}{1 + sR_2C_2}}$$

$$= \frac{\dfrac{R_2}{1 + sR_2C_2}}{\dfrac{(sC_1)(1 + sR_2C_2)R_1 + (1 + sR_2C_2) + R_2(sC_1)}{(sC_1)(1 + sR_2C_2)}}$$

$$= \frac{R_2}{\cancel{(1 + sR_2C_2)}} \times \frac{(sC_1)\cancel{(1 + sR_2C_2)}}{(sC_1)(1 + sR_2C_2)R_1 + (1 + sR_2C_2) + R_2 sC_1}$$

$$= \frac{R_2\, sC_1}{(sC_1)(1 + sR_2C_2)R_1 + (1 + sR_2C_2) + R_2 sC_1}$$

$$= \frac{R_2 S C_1}{S C_1 R_1 + s^2 R_2 R_1 C_1 C_2 + 1 + S R_2 C_2 + R_2 S C_1}$$

$$\boxed{\beta = \frac{R_2 s C_1}{s^2 [R_2 R_1 C_1 C_2] + s[R_2 C_2 + R_1 C_1 + R_2 C_1] + 1}}$$

$\cancel{+1}$

$s = j\omega$

$$\beta = \frac{R_2 j\omega C_1}{j^2 \omega^2 [R_1 R_2 C_1 C_2] + j\omega [R_2 C_2 + R_1 C_1 + R_2 C_1] + 1}$$

$$= \frac{\cancel{R_2 j\omega C_1}}{\cancel{1 + j\omega [j\omega (R_1 R_2 C_1 C_2)}}$$

$$= \frac{R_2 j\omega C_1}{-\omega^2 (R_1 R_2 C_1 C_2) + j\omega (R_2 C_2 + R_1 C_1 + R_2 C_1) + 1}$$

$$= \frac{R_2 j\omega C_1}{[1 - \omega^2 (R_1 R_2 C_1 C_2)] + j\omega (R_2 C_2 + R_1 C_1 + R_2 C_1)} \quad -①$$

$$= \frac{\cancel{R_2 j\omega C_1}}{\cancel{[1 - \omega^2 (R_1 R_2 C_1 C_2)] + j\omega (R_2 C_2 + R_1 C_1 + R_2 C_1)}} \times \frac{\cancel{1 - \omega^2 (R_1 R_2 C_1 C_2)}}{\cancel{j\omega (R_2 C_2 + R_1 C_1}}$$

$$= \frac{R_2 j\omega C_1}{[1-\omega^2(R_1R_2C_1C_2)] + j\omega(R_2C_2+R_1C_1+R_2C_1)} \times \frac{[1-\omega^2R_1R_2C_1C_2] - j\omega[R_2C_2+R_1C_1+R_2C_1]}{}$$

$$= \frac{R_2 j\omega C_1 \{[1-\omega^2R_1R_2C_1C_2] - j\omega[R_2C_2+R_1C_1+R_2C_1]\}}{(1-\omega^2R_1R_2C_1C_2) + \omega^2(R_2C_2+R_1C_1+R_2C_1)}$$

$$= \frac{R_2 j\omega C_1 \{(1-\omega^2R_1R_2C_1C_2) - j\omega(R_2C_2+R_1C_1+R_2C_1)\}}{1-\omega^2R_1R_2C_1C_2 + \omega^2R_2C_2 + \omega^2R_1C_1 + \omega^2R_2C_1}$$

$$= \frac{R_2 j\omega C_1(1-\omega^2R_1R_2C_1C_2) + R_2\omega^2C_1(R_2C_2+R_1C_1+R_2C_1)}{(1-\omega^2R_1R_2C_1C_2) + \omega^2(R_2C_2+R_1C_1+R_2C_1)^2} \quad \text{--- (2)}$$

$\because$ Imaginary part $= 0$

$$\Rightarrow \frac{\cancel{R_2 j\omega C_1}(1-\omega^2R_1R_2C_1C_2)}{} = 0$$

$$\Rightarrow \cancel{R_2 j\omega C_1}(1-\omega^2R_1R_2C_1C_2) = 0$$

$$\Rightarrow \quad 1 = \omega^2 R_1 R_2 C_1 C_2$$

$$\boxed{\omega = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}}}$$

$$\boxed{f = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}}$$

When, $R_1 = R_2 = R$ & $C_1 = C_2 = C$

$$\therefore \boxed{f = \frac{1}{2\pi\sqrt{R^2C^2}} = \frac{1}{2\pi RC}}$$

Sub $f = \frac{1}{2\pi RC}$, $\omega = \frac{1}{RC}$, $R_1 = R_2 = R$, $C_1 = C_2 = C$

in (2).

$$\beta = \frac{R\left(j\frac{1}{\cancel{RC}}C\left(1-\frac{1}{\cancel{R^2C^2}}\cdot \cancel{R^2C^2}\right)\right) + RC\frac{1}{R^2C^2}\cdot(RC+RC+RC)}{\left(1-\frac{1}{\cancel{R^2C^2}}\cancel{R^2C^2}\right) + \frac{1}{R^2C^2}(RC+RC+RC)}$$

$$= \frac{\frac{1}{RC}(3RC)}{\frac{1}{R^2C^2}(3RC)} = \frac{3}{\frac{3}{RC}} = \frac{3\times RC}{3} = RC$$

$$\beta = \frac{Rj\frac{1}{RC}\cdot C\left(1-\frac{1}{R^2C^2}R^2C^2\right)+RC\frac{1}{R^2C^2}(3RC)}{\left(1-\frac{1}{R^2C^2}\cdot R^2C^2\right)^2+\frac{1}{R^2C^2}(3RC)^2}$$

$$= \frac{3}{9R^2C^2} = \frac{1}{3}$$

$$= \frac{3}{9} = \frac{1}{3}$$

$$\boxed{\beta = 1/3}$$

$$|A\beta| = 1$$

$$A\left(\frac{1}{3}\right) = 1$$

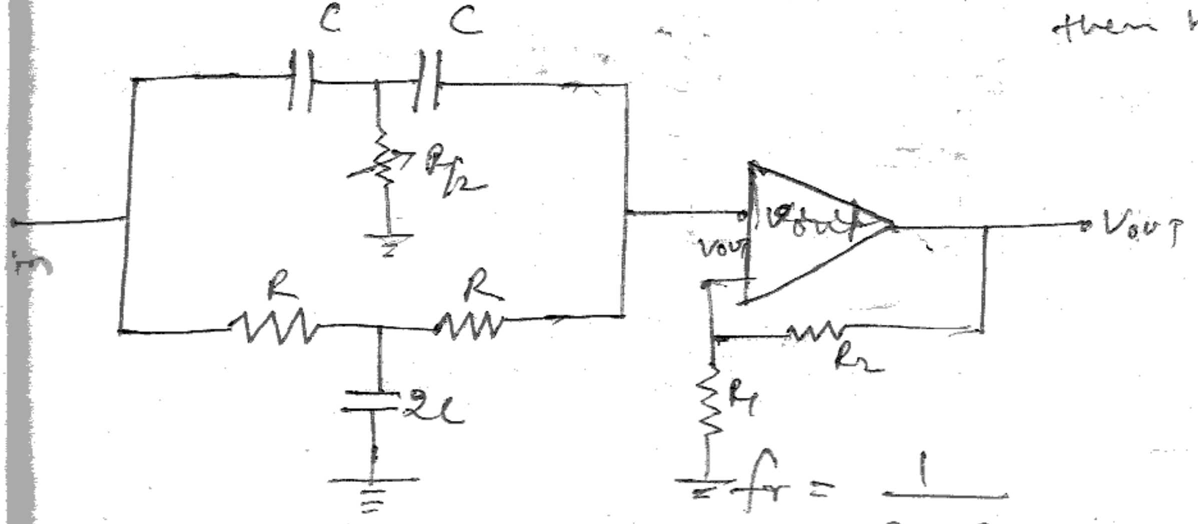
$$\Rightarrow \boxed{A = 3}$$

RC)

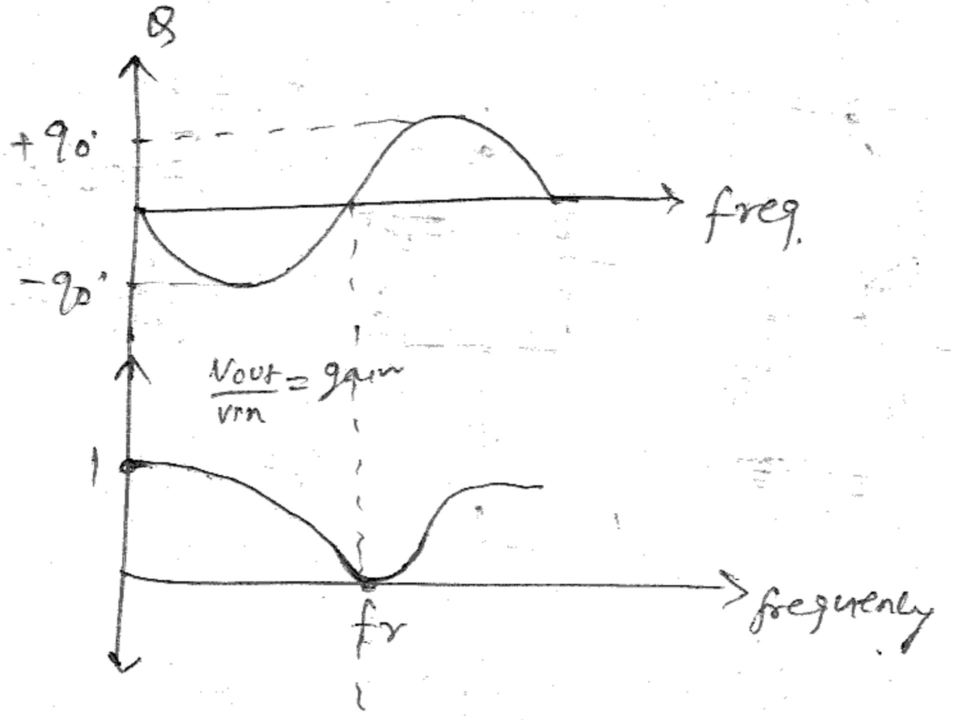
21/7/4.

Twin- T oscillator

If first capacitor & then resistor is connected then HPF.



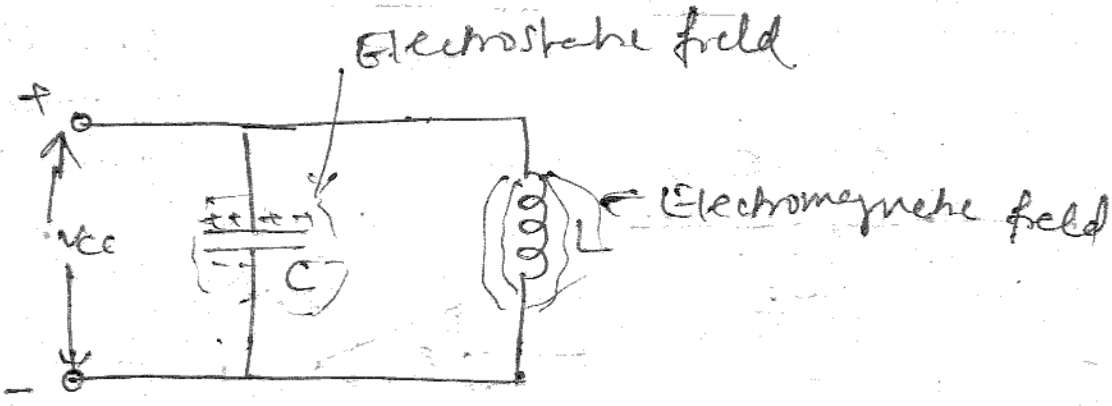
$$f_r = \frac{1}{2\pi RC}.$$



Band stop filter or Band elimin" filter.

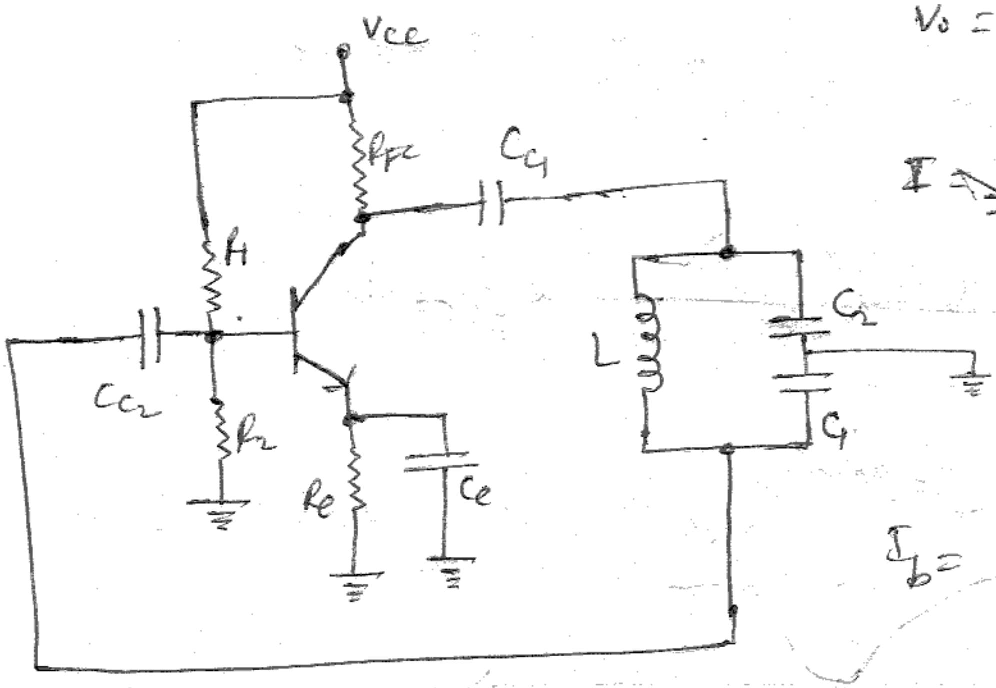
Notch filter.

LC-oscillator



26/7/11

Colpitts oscillator



$V_o = h_{fe} I_b \cdot \frac{1}{j\omega C_2}$

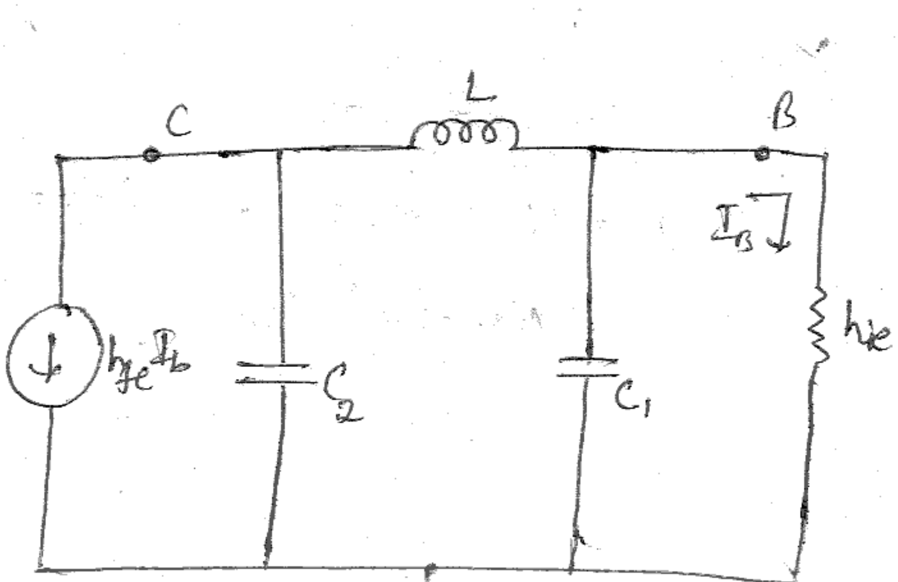
$\cancel{I = \frac{V_o}{R}}$

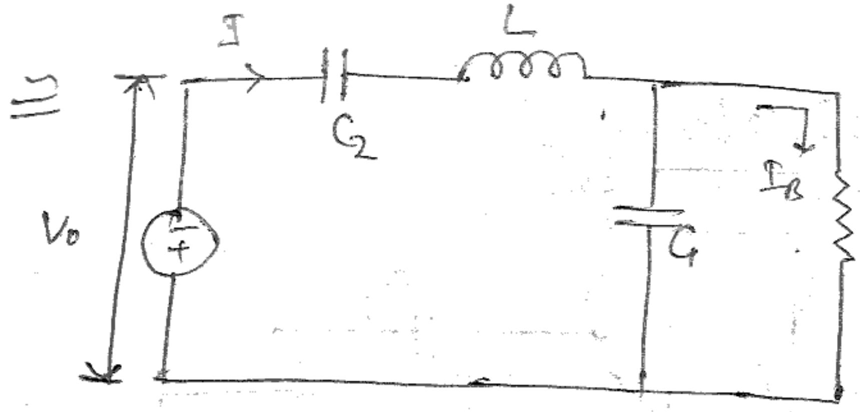
$\cancel{= -h_{fe} I_b \cdot \frac{1}{j\omega}}$

$\frac{1}{j\omega C_2} + j\omega L$

$I_b =$

C
C
L





$$I = \frac{V_o}{R} = \frac{-h_{fe} I_b \cdot \frac{1}{j\omega C_2}}{\left(\frac{1}{j\omega C_2} + j\omega L\right) + \left(\frac{\frac{1}{j\omega C_1}\cdot h_{ie}}{\frac{1}{j\omega C_1} + h_{ie}}\right)}$$

Substitute $s = j\omega$.

$$\boxed{I = \frac{-h_{fe} I_b \left(1 + s C_1 h_{ie}\right)}{s^3 L C_1 C_2 h_{ie} + s^2 L C_2 + s h_{ie}(C_1 + C_2) + 1}}$$

$$I_b = I \, \frac{\frac{1}{j\omega C_1}}{\frac{1}{j\omega C_1} + h_{ie}}$$

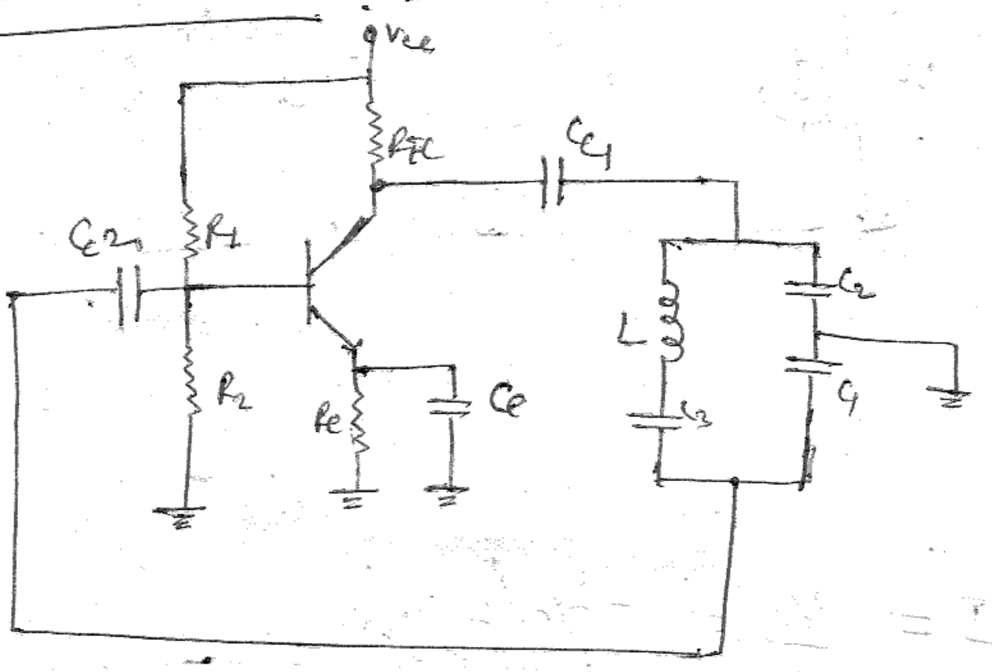
sub $j\omega = s$, and simplifying we get

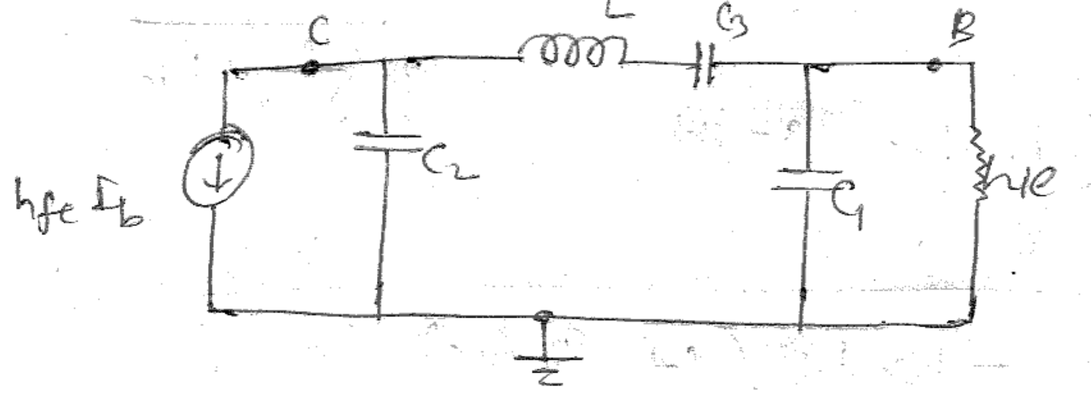
$$\boxed{I_b = \frac{I}{1 + s h_{ie} C_1}}$$

then sub I in I_b.

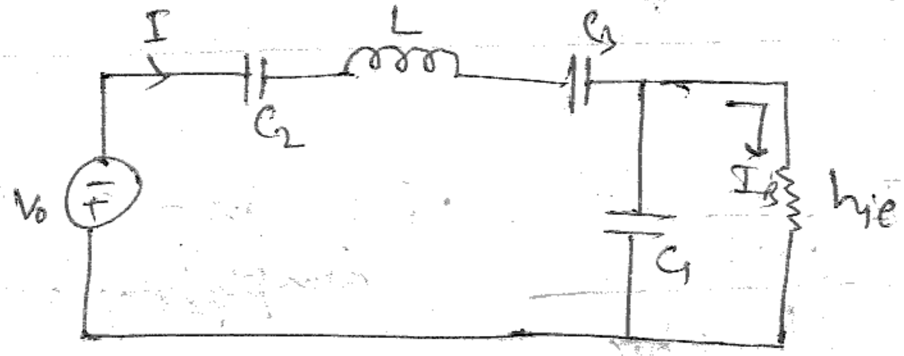
**

Clapp's oscillator :-





$\cong$



$$V_0 = h_{fe} I_b \cdot \frac{1}{j\omega C_2}$$

$$I = \frac{V_0}{R} = \frac{h_{fe} I_b \cdot \frac{1}{j\omega C_2}}{\left(\frac{1}{j\omega C_2} + j\omega L + \frac{1}{j\omega C_3}\right) + \frac{\frac{1}{j\omega C_1} h_{ie}}{\frac{1}{j\omega C_1} + h_{ie}}}$$

Sub $j\omega = s$, in above eq^n,

$$I = \frac{-h_{fe} I_b C_3 (1 + sC_1 h_{ie})}{s^3 L C_1 C_2 C_3 h_{ie} + s^2 L C_2 C_3 + s h_{ie}(C_2 C_3 + C_1 C_2 + C_1 C_3) + C_2 + C_3}$$

~~Sub I in I_b~~

$$I_b = \frac{I \times \frac{1}{j\omega C_1}}{\frac{1}{j\omega C_1} + h_{ie}} = \frac{I}{1 + s h_{ie} C_1}$$

Sub I in I_b, we get,

$$\Rightarrow \frac{I}{1 + s h_{ie} C_1} = -h_{fe} I$$

$$1 = \frac{-h_{fe} C_3}{C_2 + C_3 - \omega^2 L C_2 C_3 + j\omega h_{ie}(C_1 C_2 + C_2 C_3 + C_3 C_1) - \omega^2 L C_1 C_2 C_3}$$

$I.P = 0$

$$C_1C_2 + C_2C_3 + C_3C_1 - \omega^2 L C_1C_2C_3 = 0$$

$$\omega = \sqrt{\frac{C_1C_2 + C_2C_3 + C_3C_1}{LC_1C_2C_3}}$$

$$\omega = \frac{1}{\sqrt{LC_{equiv}}}$$

$$\boxed{f = \frac{1}{2\pi\sqrt{LC_{equiv}}}}$$

Sub I_b in I, we get.

$$I_b = \frac{I}{1 + s h_{ie} C_1}$$

$$\frac{\cancel{I_b}}{\cancel{(1+s h_{ie} C_1)}} = \frac{-h_{fe}\cancel{I_b}\,\cancel{(1+s C_1 h_{ie})}}{s^3 L C_1 C_2 h_{ie} + s^2 L C_2 + s h_{ie}(C_1+C_2)+1}$$

$$\Rightarrow 1 = \frac{-h_{fe}}{s^3 L C_1 C_2 h_{ie} + s^2 L C_2 + s h_{ie}(C_1+C_2)+1}$$

Sub $s = j\omega$,

$$1 = \frac{-h_{fe}}{1-\omega^2 L C_2 + j\omega h_{ie}\left[C_1+C_2-\omega^2 L C_1 C_2\right]}$$

$\therefore \tan^{-1}\theta = \infty$ Imaginary part $= -\tan^{-1}\dfrac{\text{img part}}{\text{real part}}$

$\Rightarrow \theta = \frac{\pi}{2}$.

$\Rightarrow$ Imaginary part $= 0$

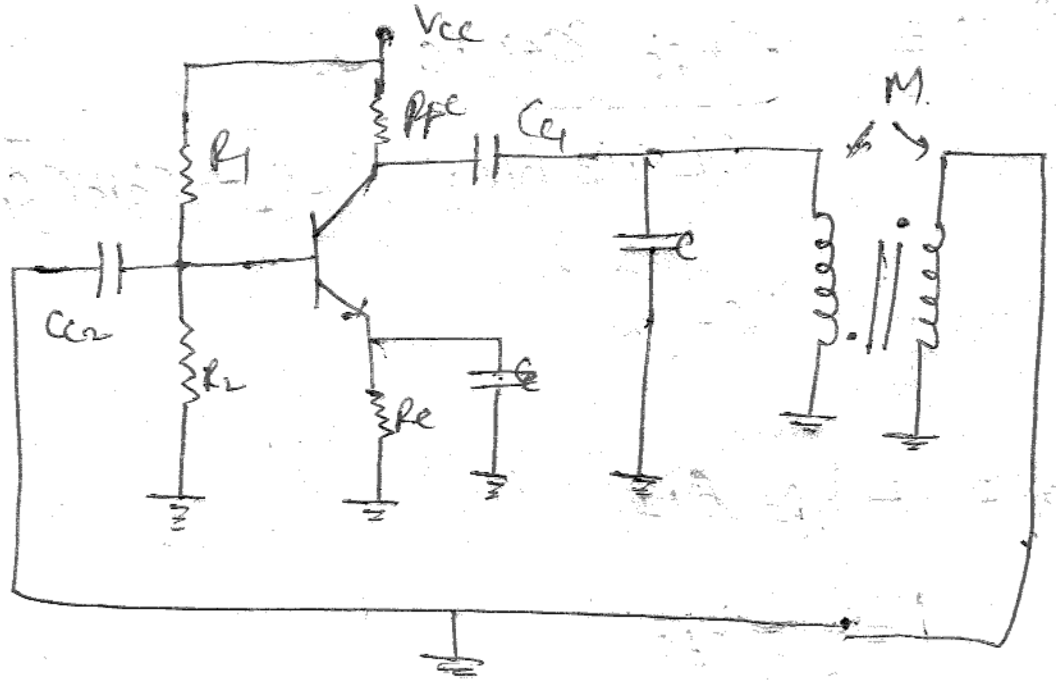
$$\left[C_1+C_2-\omega^2 L C_1 C_2\right] = 0$$

$$\omega = \sqrt{\frac{C_1+C_2}{L C_1 C_2}} = \sqrt{\frac{1}{L C_{equ}}} \qquad \because \frac{C_1 C_2}{C_1+C_2} = C_{eq}.$$

∴ frequency for Colpitts oscillator

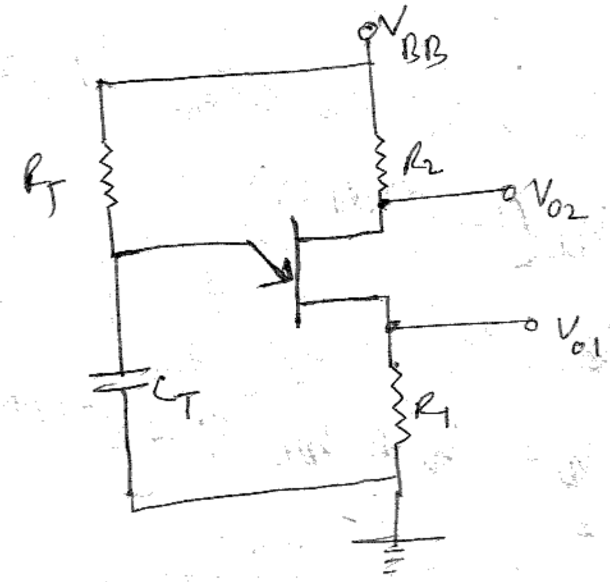
$$\boxed{f = \frac{1}{2\pi\sqrt{L C_{equiv}}}}$$

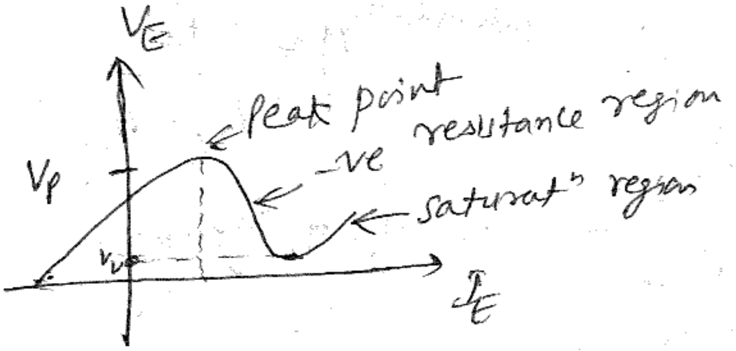
Armstrong oscillator

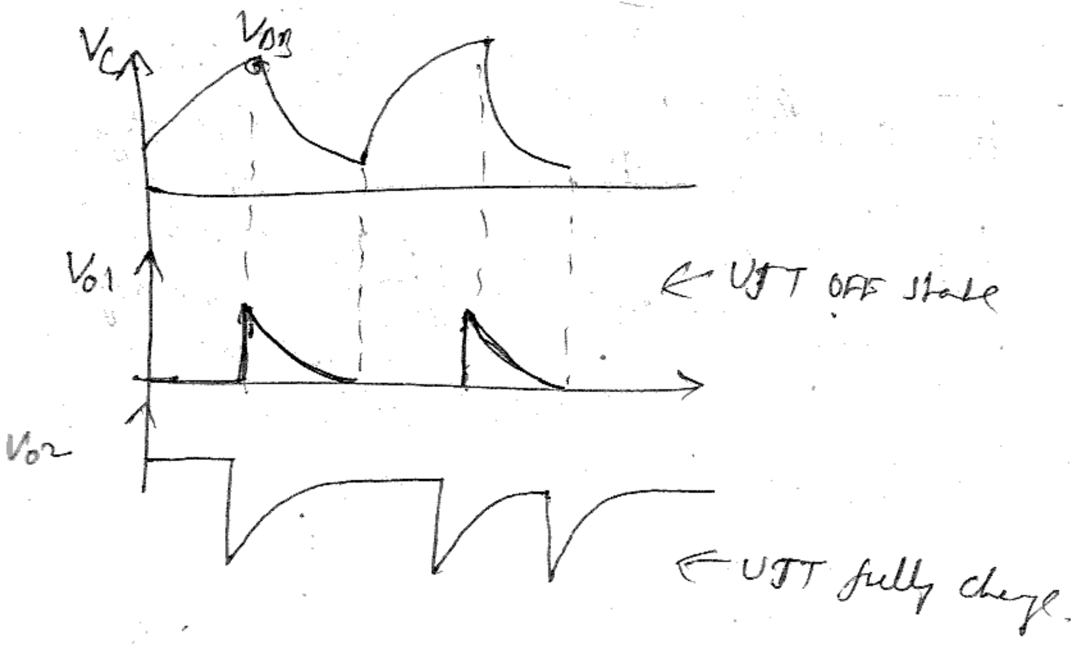


4/8/11

Negative Resistance Oscillator using UJT







$V_p = \eta V_{BB} + V_D$

$V_D \leftarrow$ Diode Cut in Voltage.

~~intrinsti~~
intrinsic stand of ratio

Capacitor voltage, $\cancel{V_C = V_V + V_{BB}(1-e^{-t})}$

$V_C = V_V + V_{BB}(1 - e^{-t/R_T C_T})$

when, $V_C = V_p$, at $t = T$

$\eta V_{BB} + V_D = V_V + V_{BB}(1 - e^{-T/R_T C_T})$

V_D & $V_V \rightarrow$ small

$\eta = 1 - e^{-T/R_T C_T}$

$\Rightarrow e^{-T/R_T C_T} = 1 - \eta$ where $\eta = \dfrac{R_{B_1}}{R_{B_1} + R_{B_2}}$.

$\Rightarrow \dfrac{-T}{R_T C_T} = \ln \dfrac{1}{1-\eta}$

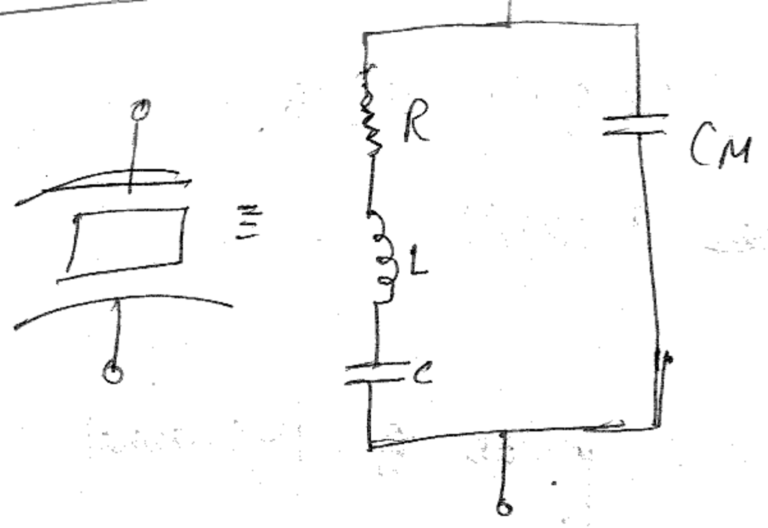
R_{B_1} = Base resistance of UJT.

$\Rightarrow \boxed{T = R_T C_T \ln \dfrac{1}{1-\eta}}$

V_V = Valley voltage or minimum voltage.

$T = R_T \cdot C_T \ln\left(\dfrac{1}{1-\eta}\right)$

$$\boxed{f = \frac{1}{T} = \frac{1}{R_T C_T \ln\left(\frac{1}{1-\eta}\right)}}$$



$$f_r = \frac{1}{2\pi\sqrt{LC}}$$ ⇒ frequency stability

$$f \propto \frac{1}{\text{thickness}}$$

Rochelle Crystal :-

→ Piezoelectric prop ↑
mechanical strength ↓.

Pierson oscillator
Miller oscillator.

Tormaline Crystal

→ Piezo ↓
mechanical ↑.

Quartz Crystal

Piezoelectric
mechanical strength

RC-Phase
Wein
Hartly.
~~Coul~~ Collpits.

Analysis

i/p resistance
↓
o/p

$\boxed{\text{Voltage Series} \quad \text{Current Series}}$

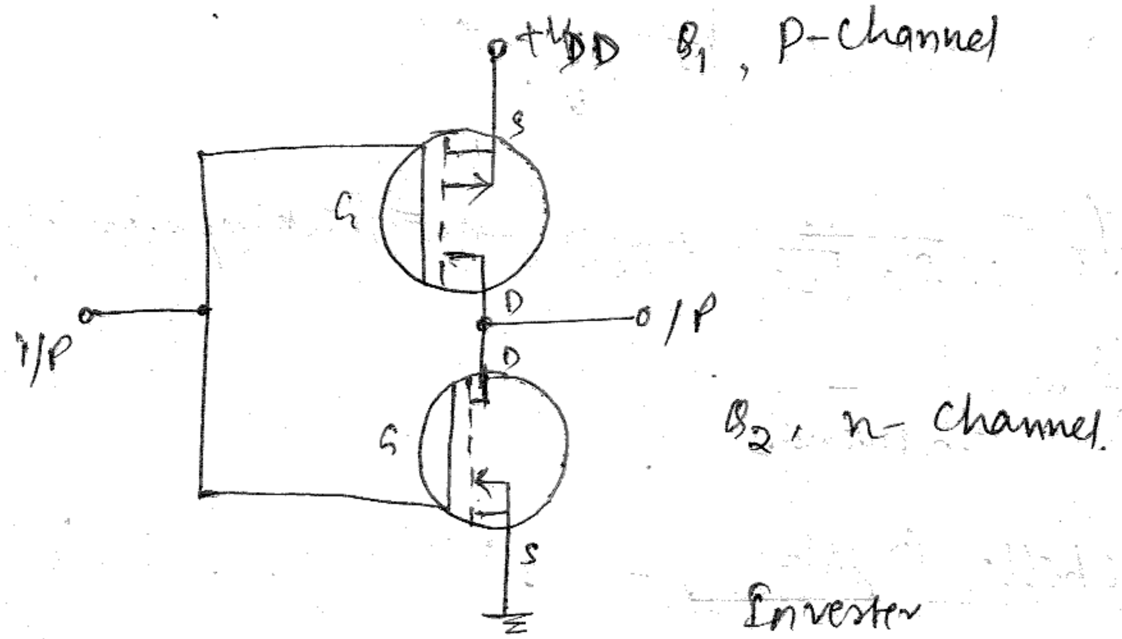
I/P & O/P

$\boxed{\text{f Analysis}}$ + $\boxed{\text{Steps of Analysis}}$

11/8/4

USE OF LOGIC GATE

→ as linear amplifier

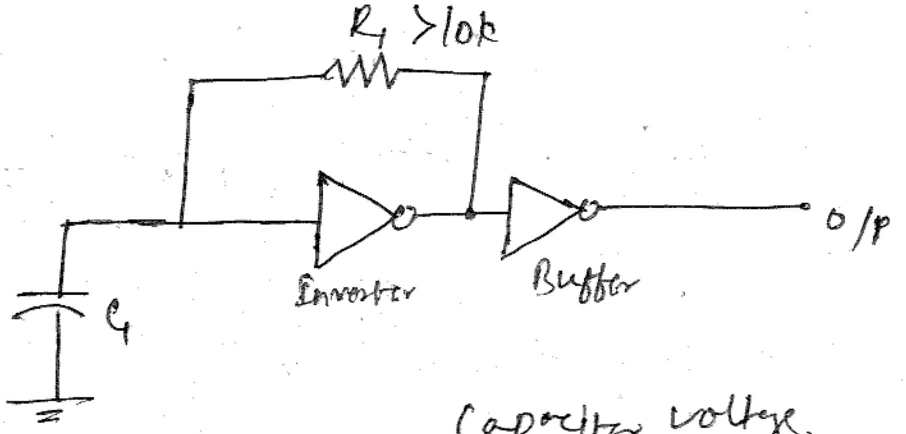


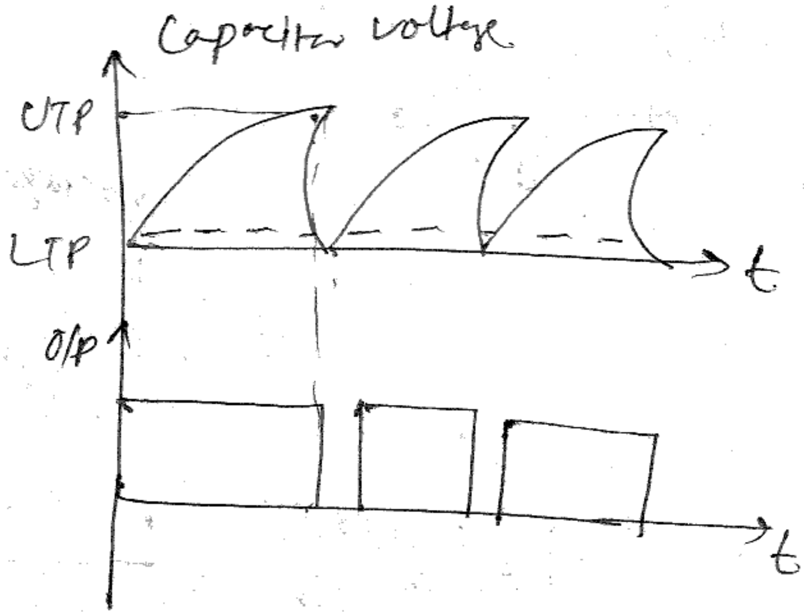
Inverter

~~Oscillator & Clock Gen~~

eg { P channel ON when O/P=0
N ,, ON when I/P=1.

Oscillator & Clock generator Circuits using logic gates :-



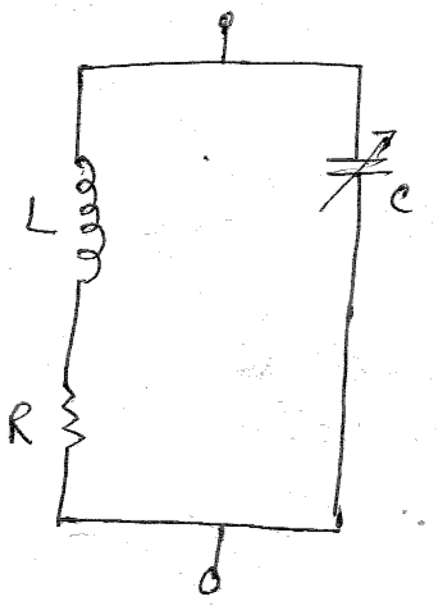


en O/P=0
en I/P=1.

12/8/11

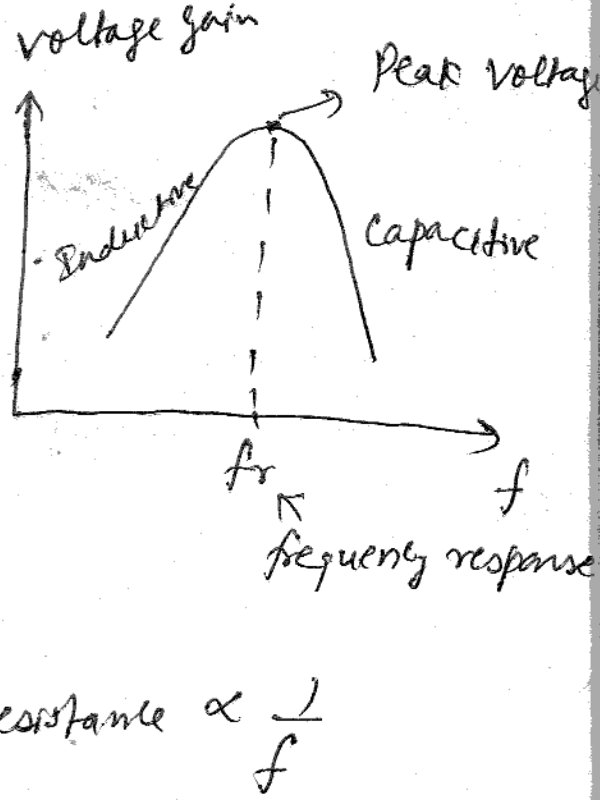
UNIT 3
TUNNED AMPLIFIER

Tunned circuit:- or Tanked circuit



frequency, $f_r = \frac{1}{2\pi\sqrt{LC}}$

$X_C = X_L$, at resonance



f_r = tunned freq or resonant freq.

frequency response

Coil losses:-

① Copper loss ⇒ DC Resistance $\propto \frac{1}{f}$

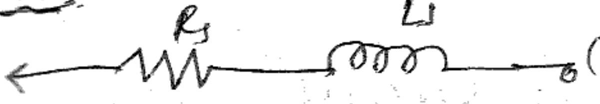
② Eddy current loss ⇒ due to current flow within the core caused by induct^n $\propto$ frequency

③ Hysteresis loss $\propto$ area enclosed by the hysteresis loop $\propto$ frequency

$$\text{Quality factor} = \frac{\text{Reactance}}{\text{Resistance}} = Q$$

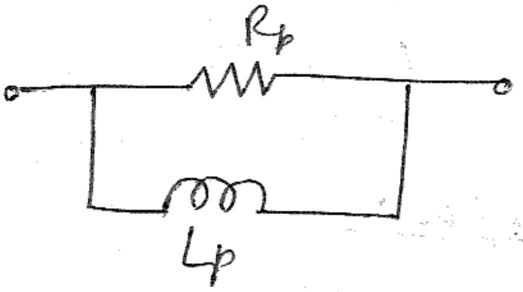
Dissipation factor, $D = \frac{1}{Q}$ ⇒ Dissipation within the Component

Series :-



(i) $\boxed{\text{Inductive impulse} = \frac{\omega L_s}{R_s}}$

(ii) $\boxed{\text{inductive admittance} = \frac{R_p}{\omega L_p}}$



← Parallel

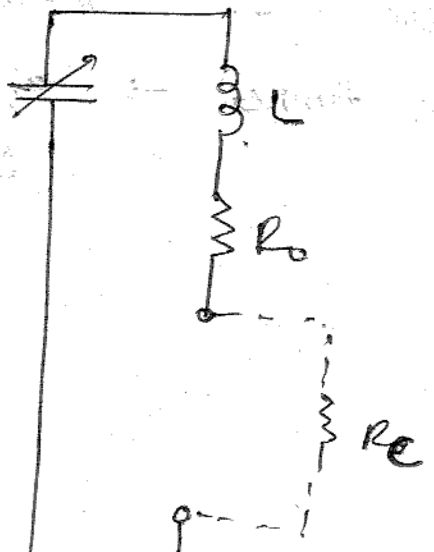
$$\boxed{\text{Quality factor, } Q = \frac{1}{D} = \frac{\omega L_s}{R_s} = \frac{R_p}{\omega L_p}}$$

Loaded Q

& unloaded Q.

$$\boxed{Q_U = \frac{\omega L}{R_o}}$$

$$\boxed{Q_L = \frac{\omega L}{R_L}}$$



Effiecieny for the tanked circuit :

$\eta = \cancel{Q_u + Q_L}$

$$\boxed{\eta = \frac{Q_u}{Q_u + Q_L}}$$

Bandwidth for Resonance Circuit,

$$\boxed{B.W = \frac{f_r}{Q_L}}$$

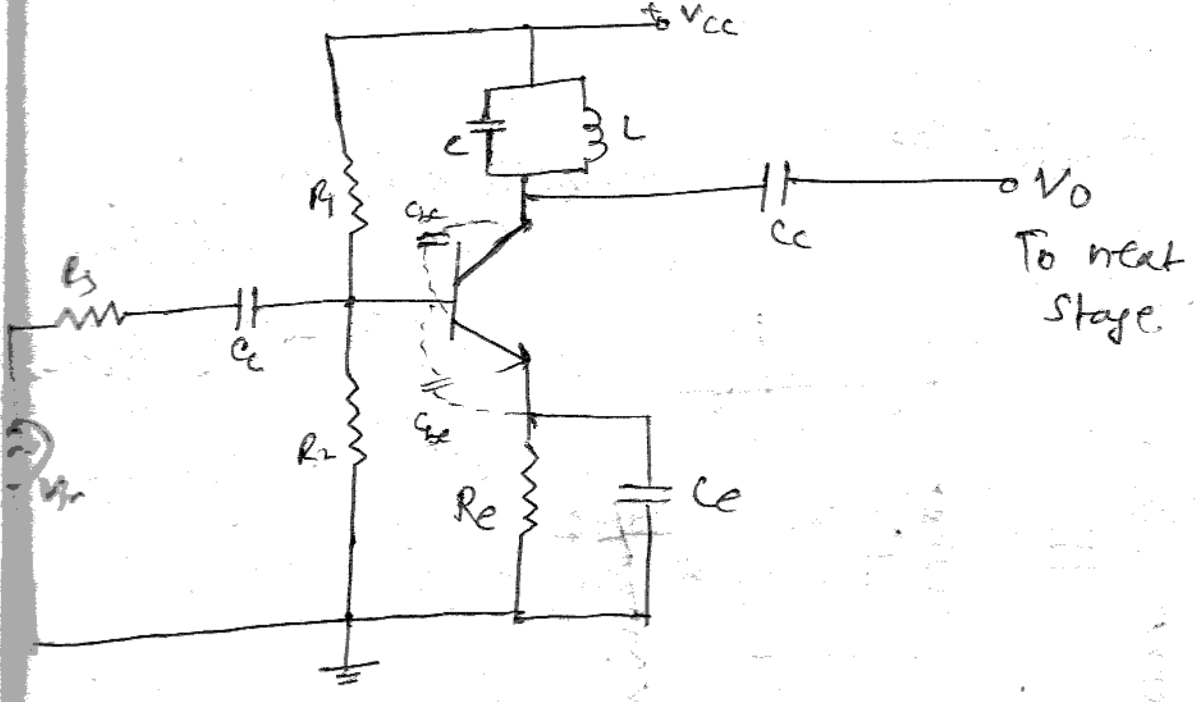
16/8/14.

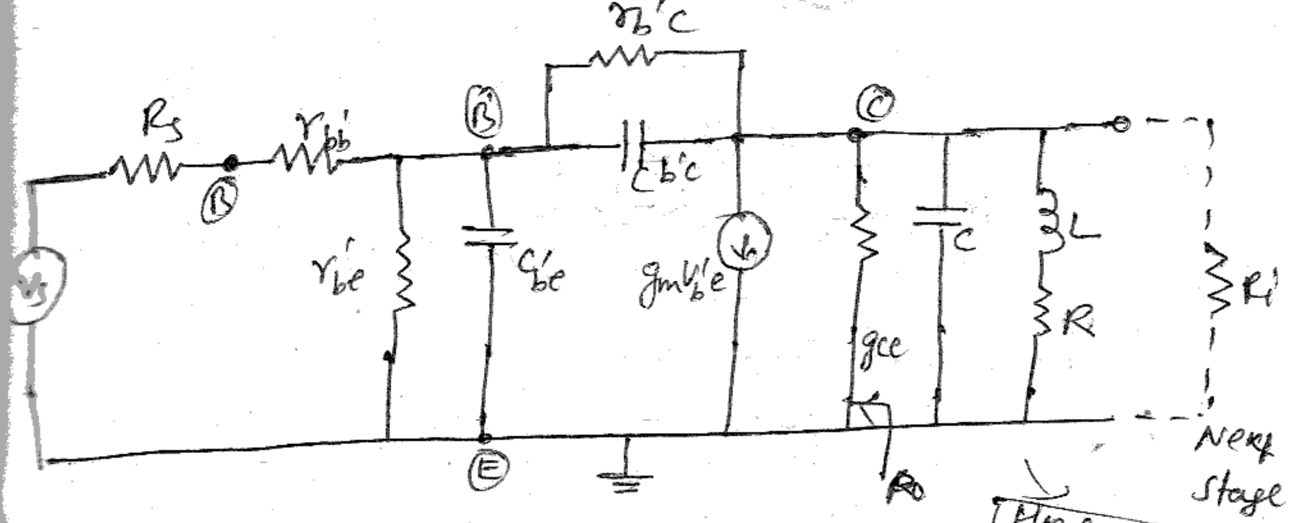
Types of Tunned Amplifier :-

(i) Single Tunned
(ii) Double tunned
(iii) Stagger tunned amplifier

Single Tunned → 1 tanked ckt
Double " → 2 tanked ckt
Stagger tunned → Two single tunned ckt are connected together.

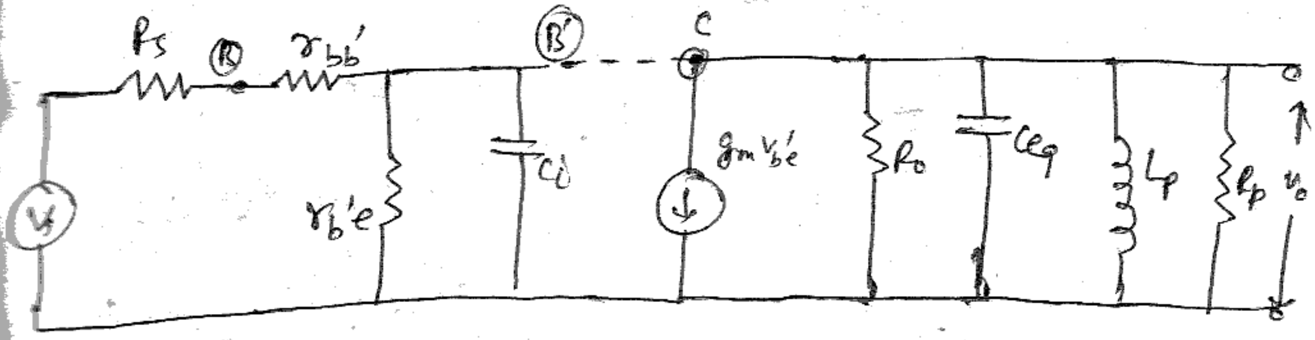
Single Tunned Amplifier :-





Simplified Ckt using Millers theorem,

ckt are

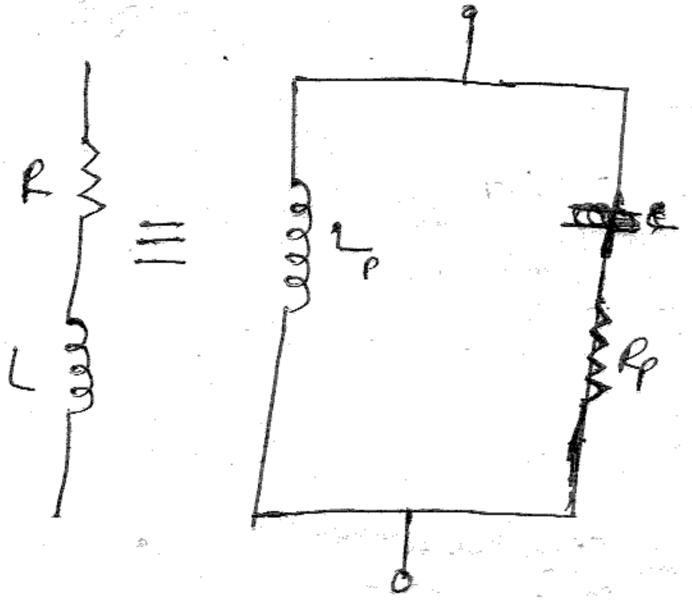


$C_i = C_{b'e} + C_{b'c}(1-A)$ & $C_{eq} = C_{b'c}\left(\frac{A'}{A}\right) + C$

& $g_{ce} = R_o$.

Admittance, $Y = \frac{1}{R + j\omega L}$

$\div$ & $\times$ by $(R - j\omega L)$



$$Y = \frac{1}{R + j\omega L} \times \frac{R - j\omega L}{R - j\omega L}$$

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

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

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

[$\times$ & $\div$ by ω in 2nd term]

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

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

where, $R_p = \frac{R^2+\omega^2L^2}{R}$

& $L_p = \frac{R^2+\omega^2L^2}{\omega^2L}$

Resonanty freq, $f_r = \frac{1}{2\pi\sqrt{L_{p}C_{equiv}}}$

$$\boxed{\text{Quality factor, } Q = \frac{\text{Reactance}}{\text{resistance}} = \frac{\omega L}{R}}$$

At resonance,

$$\boxed{Q_r = \frac{\omega_r L}{R}}$$

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

Here neglecting R $\because$ $R <<< \frac{\omega^2L^2}{R}$

$$\boxed{R_p = \frac{\omega^2L^2}{R}}$$

Ily $\boxed{L_p = \frac{R^2+\omega^2L^2}{\omega^2L} = \frac{R^2}{\omega^2L} + L}$ —2

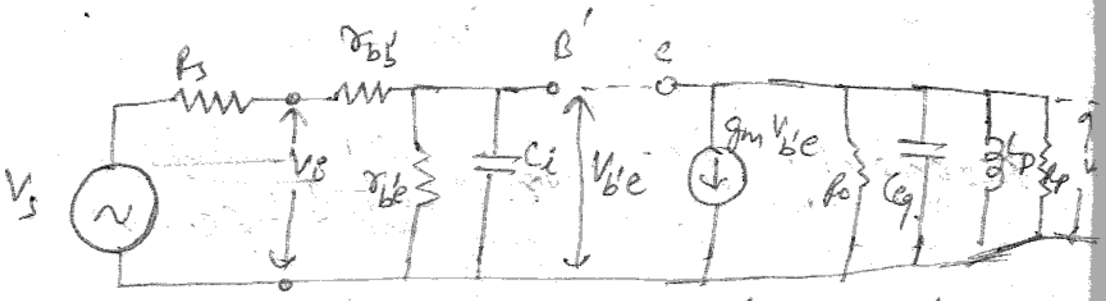
Since ω^2L is higher, and in denomr.

So, neglecting, $\frac{R^2}{\omega^2L}$ in above eqn

$\boxed{L_p \cong L}$

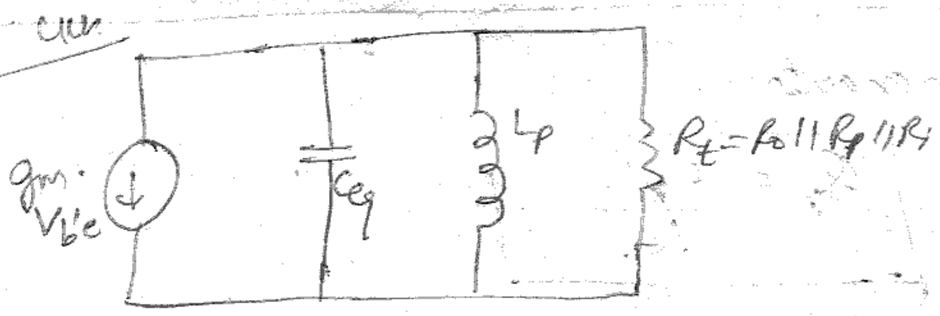
$R_p =$

18/8/11



Hybrid model of single tuned amplifier

O/P equi ckt



Effective Q-factor, $Q_{eff} = \dfrac{\text{Susceptance of } L \text{ or } C}{\text{Conductance of Shunt resistance } R_t}$

~~voltage gain~~,

$$Q_{eff} = \frac{\frac{1}{\omega L}}{\frac{1}{R_t}}$$

for Inductance

$$\boxed{Q_{eff} = \frac{R_t}{\omega L}}$$

at resonance freq, $Q_{eff} = \dfrac{R_t}{\omega_0 L}$

for Capacitance,

$$\cancel{Q_{eff} = \frac{\omega_r c}{R_t}}$$

$$\boxed{Q_{eff} = \frac{1/\frac{1}{\omega_r c}}{1/R_t} = \frac{\omega_r c}{1/R_t} = \omega_r c R_t}$$

Voltage gain:-

$$A_v = \frac{V_o}{V_i}$$

$$\Rightarrow V_o = g_m V_{b'e} \times R_t$$

~~Adm~~

$$\boxed{V_o = g_m V_{b'e} Z}$$

$$\boxed{\text{Admittance } Y = \frac{1}{Z} = \frac{1}{C_{eq}} + \frac{1}{L_p} + \frac{1}{R_t}}$$

$$Y = \frac{1}{\cancel{1/}j\omega C_{eq}} + \frac{1}{j\omega L_p} + \frac{1}{R_t}$$

$$\boxed{Y = j\omega C_{eq} + \frac{1}{j\omega L_p} + \frac{1}{R_t}}$$

$$Y = \frac{1}{R_t}\left[j R_t \cdot \omega C_{eq} + \frac{R_t}{j\omega L_p} + 1\right]$$

$$= \frac{1}{R_t}\left[\frac{j\omega \cdot \omega_r R_t C_{eq}}{\omega_r} + \frac{\omega_r R_t}{j\omega_r \omega L_p} + \frac{\omega_r}{\omega_r}\right]$$

$$= \frac{1}{R_t}\left[1 + j\frac{\omega_r}{\omega} \cdot Q_{eff} + j\frac{\omega}{\omega_r} \cdot Q_{eff}\right]$$

$$= \cancel{\frac{1}{R_t}\left[1 + Q_{eff}\left(\frac{j\omega_r}{\omega} + j\frac{\omega}{\omega_r}\right)\right]}$$

$$= \cancel{\frac{1}{R_t}\left[1 + Q_{eff}\left(\frac{\omega_r^2 + \omega^2}{\omega \cdot \omega_r}\right)\right]}$$

$$= \cancel{\frac{1}{R_t}\left[1 + Q_{eff}\, j\left(\frac{\omega_r}{\omega} - \frac{\omega}{\omega_r}\right)\right]}$$

$$= \frac{1}{R_t}\left[1 + jQ_{eff}\left(\frac{\omega}{\omega_r} - \frac{\omega_r}{\omega}\right)\right] \leftarrow (1)$$

variation in resonant freq,

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

$$\delta = \frac{\omega}{\omega_r} - 1$$

$$\Rightarrow \boxed{\frac{\omega}{\omega_r} = \delta + 1} \quad \text{sub in (1)}$$

$\Rightarrow$

$$Y = \frac{1}{R_t}\left[1 + jQ_{eff}\left((\delta+1) - \frac{1}{\delta+1}\right)\right]$$

$$= \frac{1}{R_t}\left[1 + jQ_{eff}\left(\frac{(\delta+1)^2 - 1}{(\delta+1)}\right)\right]$$

$$= \frac{1}{R_t}\left[1 + jQ_{eff}\left(\frac{\delta^2 + \cancel{1} + 2\delta - \cancel{1}}{\delta+1}\right)\right]$$

$$= \frac{1}{R_t}\left[1 + jQ_{eff}\left(\frac{\delta^2+2\delta}{(\delta+1)}\right)\right]$$

$$Y = \frac{1}{R_t}\left[1 + jQ_{eff}\,\frac{\delta(\delta+2)}{(\delta+1)}\right]$$

$$Y = \frac{1}{R_t}\left[1 + jQ_{eff}\,\frac{(\delta^2+2\delta)}{(\delta+1)}\right]$$

$$\boxed{Z = \frac{R_t}{1 + jQ_{eff}\left(\frac{\delta^2+2\delta}{\delta+1}\right)}}$$

$$Z = \frac{R_t}{1 + jQ_{eff}\,\frac{2\delta\left(\frac{\delta}{2}+1\right)}{\delta+1}}$$

assuming variation is very less

so neglecting $\left(\frac{\delta}{2}+1\right)$ & $(\delta+1)$

So, $$\boxed{Z = \frac{R_t}{1 + jQ_{eff}\,2\delta}}$$

So, at resonanting freq. $X_L = X_C$

$\Rightarrow$ so eq. of δ is cancelled

$$\Rightarrow \boxed{Z = R_t}$$

$V_0 = g_m V_{b'e} Z$

$$\boxed{V_0 = g_m V_{b'e} R_t}$$ at resonant.
$Z = R_t$

$$\boxed{V_{b'e} = \frac{V_i \, r_{b'e}}{r_{bb'} + r_{b'e}}}$$ By voltage divider rule

$\therefore V_0 = g_m V_{b'e} Z$

$$= g_m \frac{V_i \cdot r_{b'e}}{r_{bb'} + r_{b'e}} \cdot Z$$

$$\boxed{V_0 = \frac{g_m V_i r_{b'e}}{r_{bb'} + r_{b'e}} \cdot \frac{R_t}{1 + j\,2\delta Q_{eff}}}$$

$$\boxed{A_V = \frac{V_0}{V_i} = \frac{-g_m r_{b'e} \times R_t}{(r_{b'e} + r_{bb'})(1 + j\,2\delta Q_{eff})}}$$

At resonant freq,

$$\boxed{(A_V)_{\text{at reson}} = \frac{V_0}{V_i} = \frac{-g_m r_{b'e}}{(r_{b'e} + r_{bb'})} \cdot R_t}$$

$\because$ at res $Z = R_t$

$$\boxed{\frac{A_v}{(A_v)_{reson}} = \frac{1}{1 + j2\delta\theta_{eff}}}$$

$$\left|\frac{A_v}{(A_v)_{reson}}\right| = \frac{1}{\sqrt{1^2 + (2\delta\theta_{eff})^2}}$$

$$\boxed{\left|\frac{A_v}{(A_v)_{res}}\right| = \frac{1}{\sqrt{1 + 4\delta^2\theta_{eff}^2}}}$$

$$\angle \frac{A_v}{(A_v)_{res}} = -\tan^{-1}\frac{2\delta\theta_{eff}}{1}$$

$$\boxed{\phi = -\tan^{-1}(2\delta\theta_{eff})}$$

At f_L, freq drops by 3dB, so

$$\left.\frac{A_v}{(A_v)_{reson}}\right| = \frac{1}{\sqrt{1 + (2\delta\theta_{eff})^2}} = \frac{1}{\sqrt{2}}$$

$3dB = 0.707 = \frac{1}{\sqrt{2}}$

Squaring both sides.

$$1 + (2\delta\theta_{eff})^2 = 2$$

$$\cancel{2\delta\theta_{eff}}\ (2\delta\theta_{eff})^2 = 1$$

$$\Rightarrow \delta = \frac{1}{\sqrt{2\theta_{eff}}}$$

$$\Rightarrow 2\delta\theta_{eff} = 1$$

t.
R_f

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le.

$\theta_{eff})$

res
$Z = R_t$

$$\Rightarrow \boxed{\delta = \frac{1}{2 Q_{eff}}}$$

$B.W = \omega_2 - \omega_1$

$\Delta\omega = (\omega_2 - \omega_r) + (\omega_r - \omega_1)$

Multiply & div by ω_r

$$\Delta\omega = \left(\frac{\omega_2 - \omega_r}{\omega_r} + \frac{\omega_r - \omega_1}{\omega_r}\right)\omega_r$$

$$\Rightarrow \Delta\omega = (\delta + \delta)\omega_r$$

$$\Delta\omega = 2\delta\omega_r$$

Sub $\delta = \dfrac{1}{2 Q_{eff}}$

$$\Delta\omega = 2 \times \frac{1}{2 Q_{eff}} \times \omega_r = \frac{\omega_r}{Q_{eff}} \Rightarrow$$

$$\Delta\omega = \frac{\omega_r}{\omega_r C_{eq} R_t} = \frac{1}{R_t C_{eq}}$$

$$\boxed{\Delta f = \frac{1}{2\pi C_{eq} \cdot R_t}}$$

$$\Delta\omega = \frac{\omega_r}{R_t / \omega_r L} = \frac{\omega_r^2 L}{R_t}$$

$$\boxed{\Delta f = \frac{\omega^2 L}{2\pi R_t}}$$

$$\boxed{\Delta f = \frac{f_r}{Q_{eff}}}$$ ← Bandwidth $= \frac{f_r}{Q_{eff}}$

9/8/11

Effect of Cascading Single tunned Amplifier on B.W :-

→ to have high overall gain

$$\left| \frac{A_v}{A_{v(resonance)}} \right| = \frac{1}{\sqrt{1+(2\delta Q_{eff})^2}}$$

Relative gain for n-stage cascaded amplifier,

$$\left| \frac{A_v}{A_{v(resonance)}} \right|^n = \left[\frac{1}{\sqrt{1+(2\delta Q_{eff})^2}} \right]^n = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \frac{1}{\left[1+(2\delta Q_{eff})^2\right]^{n/2}} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \left[1+(2\delta Q_{eff})^2\right]^{n/2} = (2)^{1/2}$$

$$\Rightarrow \left[1+(2\delta Q_{eff})^2\right]^{\frac{n}{n}} = (2)^{1/n}$$

$$\Rightarrow \cancel{1+(2\delta Q_{eff})}$$

$$\cancel{1+2f\delta}$$

$$\Rightarrow 1+(2\delta Q_{eff})^2 = 2^{1/n}$$

$$\left(2\delta\, Q_{eff}\right)^2 = 2^{1/n}-1$$

$$\Rightarrow 2\delta\, Q_{eff} = \pm\sqrt{2^{1/n}-1}$$

$$\Rightarrow 2\delta\, Q_{eff} = \pm\sqrt{2^{1/n}-1}$$

Sub, $\delta = \dfrac{\omega-\omega_r}{\omega_r} = \dfrac{f-f_r}{f_r}$

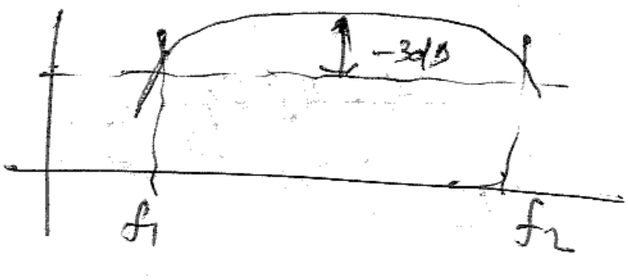
$$\Rightarrow 2\,\frac{\omega-\omega_r}{\omega_r}\, Q_{eff} = \pm\sqrt{2^{1/n}-1}$$

$$\Rightarrow 2\,\frac{f-f_r}{f_r}\cdot Q_{eff} = \pm\sqrt{2^{1/n}-1}$$

$$\Rightarrow f-f_r = \frac{\pm f_r\sqrt{2^{1/n}-1}}{2\,Q_{eff}} \quad -(3)$$

$f_1 \to$ lower cut off frequency

$f_2 \to$ higher cut off freq.



at lower cut off freq. eqn ③ becomes

$$\boxed{f_r - f_1 = \pm \frac{f_r \sqrt{2^{1/n} - 1}}{2 Q_{eff}}}$$

at higher cut off freq.

$$\boxed{f_2 - f_r = \pm \frac{f_r \sqrt{2^{1/n} - 1}}{2 Q_{eff}}}$$

$$\text{Bandwidth} = f_2 - f_1$$

$$= (f_2 - f_r) \pm (f_r - f_1)$$

$$= \pm \frac{f_r \sqrt{2^{1/n} - 1}}{2 Q_{eff}} + \pm \frac{f_r \sqrt{2^{1/n} - 1}}{2 Q_{eff}}$$

$$= \frac{\pm 2 f_r \sqrt{2^{1/n} - 1}}{2 Q_{eff}}$$

$$= \pm \frac{f_r \sqrt{2^{1/n} - 1}}{Q_{eff}}$$

③

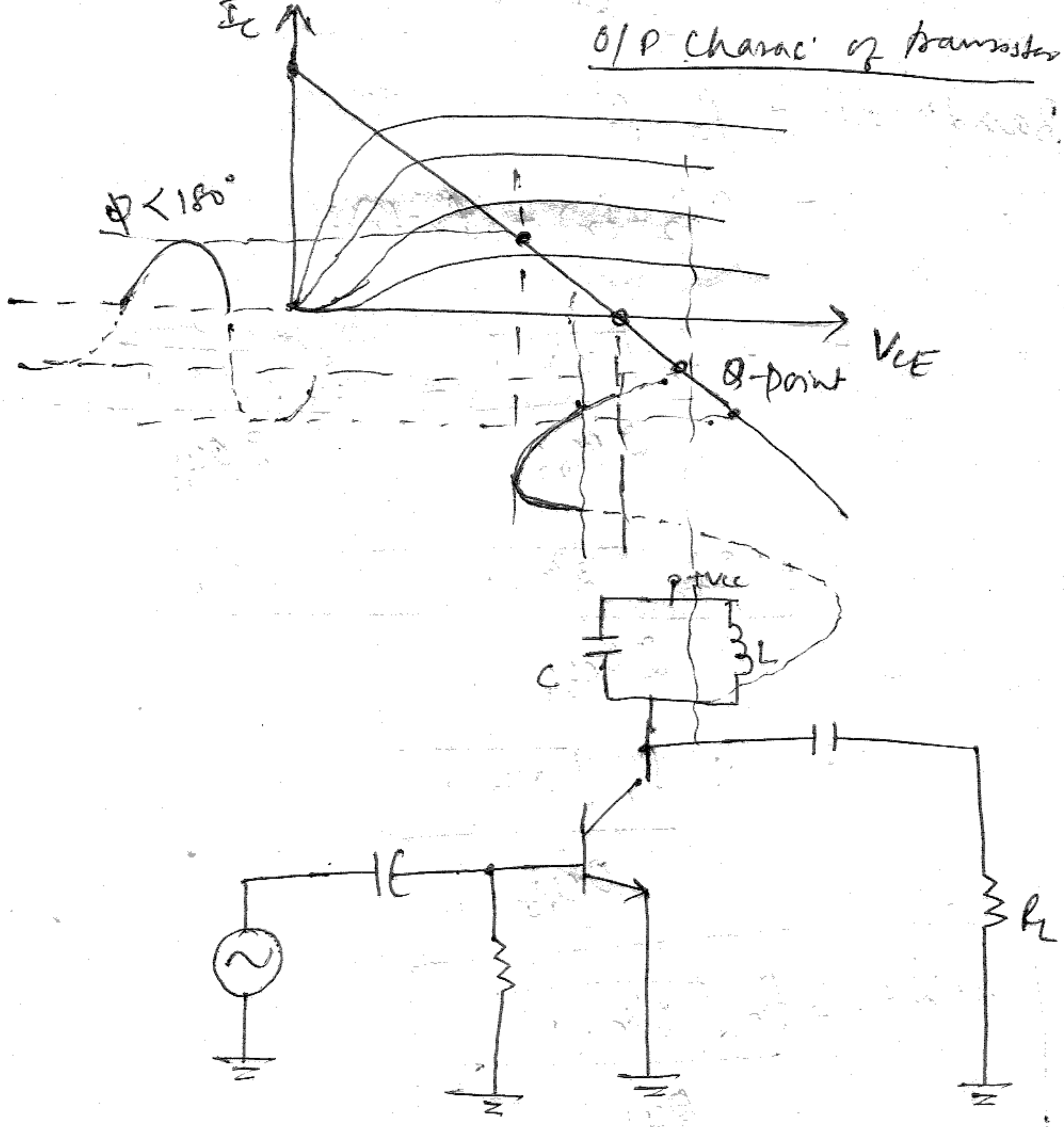
$$\boxed{B.W = \pm \frac{f_r \sqrt{2^{1/n} - 1}}{Q_{eff}}}$$

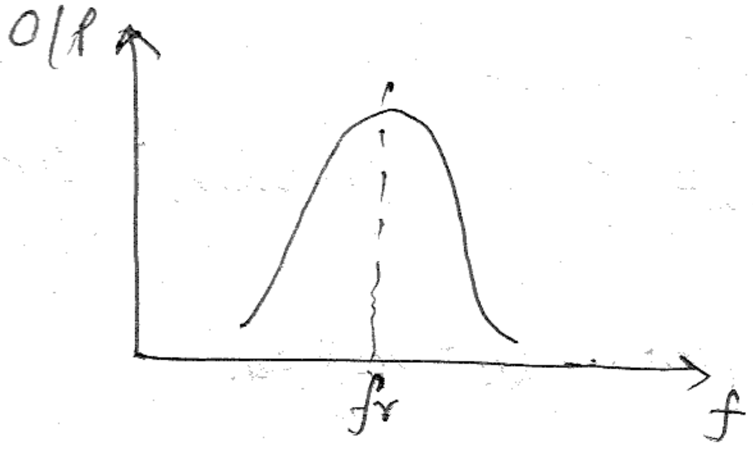
$\therefore \dfrac{f_r}{Q_{eff}}$ = Bandwidth of Single tuned amplifier

$$\boxed{BW_n = BW_1 \sqrt{2^{1/n} - 1}}$$

CLASS C Tuned Amplifier

O/P Charac' of transistor





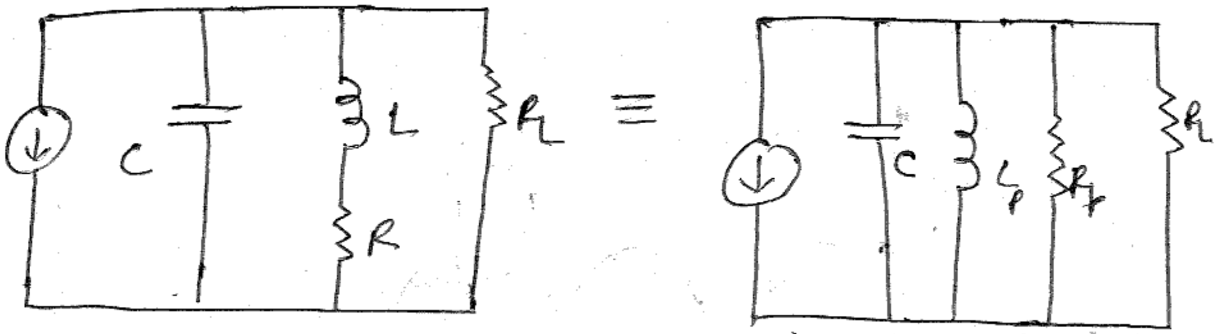
$$f = \frac{1}{2\pi\sqrt{LC}} \quad , \text{Power gain} = \frac{P_{out}}{P_{in}}$$

$$P_{out} = \frac{V_{rms}^2}{R_L} \quad ; \quad V_{rms} = \frac{V_{pp}}{2\sqrt{2}}$$

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

ac Collector Resistance

$$Q = \frac{X_L}{R} = \frac{\omega_r L}{R}$$



$$R_p = Q_L \, \omega_r L$$

$r_c = R_p \| R_L \Rightarrow$ ac Collector Resist.

$$Q = \frac{r_c}{\omega_r L}$$

Power dissipation :-

$(V_{pp})_{max} = 2V_{cc}$, $P_{o(max)} = \frac{V_{pp\,max}^2}{40 R_c}$

DC i/p power, $P_{dc} = V_{cc} \times I_{dc}$

$$\Rightarrow \boxed{\eta = \frac{P_{ou}}{P_{dc}} = \frac{P_{out}}{V_{cc} \times I_{dc}}}$$

22/8/11

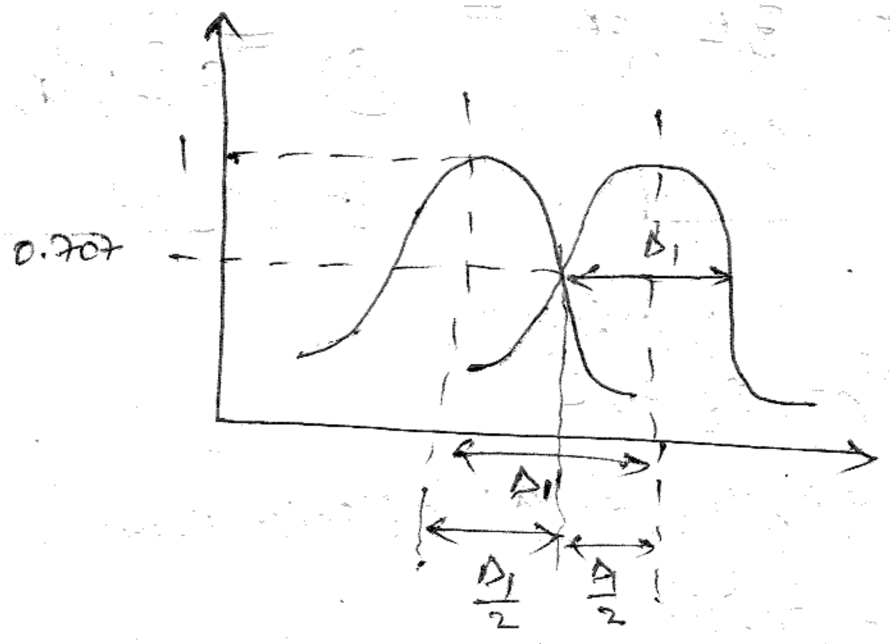
→ Double tunned Amplifier

$$\boxed{B \cdot W = f_2 - f_1 = \frac{f_r}{Q}}$$

23/8/11.

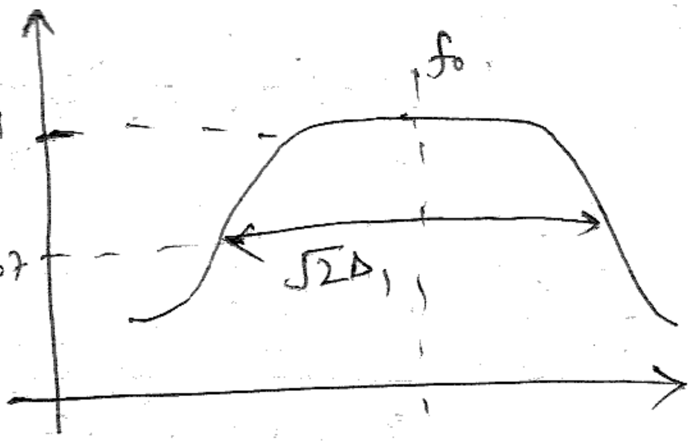
Stagger tunned Amplifier

→ Resonant frequency are ~~spent~~ Separated equal to Bandwidth.



Response of individual stages

2
p max
40 %

$\equiv$ 

Overall response of staggered paird.

ly
le
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lifier

Analysis:-

$$\frac{A_v}{A_{v(\text{resonance})}} = \frac{1}{1+2j\,\delta Q_{eff}} = \frac{1}{1+jX}$$

$$f_{r1} = f_r + \delta \;\&\; f_{r2} = f_r - \delta$$

$$\frac{A_v}{A_{v(\text{reso})_1}} = \frac{1}{1+j(X+1)} \quad \& \quad \frac{A_v}{A_{v(\text{reson})_2}} = \frac{1}{1+j(X-1)}$$

$$\frac{A_v}{A_{v(\text{cascaded})}} = \frac{A_v}{A_{v(\text{reso})_1}} \times \frac{A_v}{A_{v(\text{reso})_2}}$$

$$= \frac{1}{1+j(X+1)} \times \frac{1}{1+j(X-1)}$$

$$= \frac{1}{[1+j(X+1)][1+j(X-1)]}$$

$$= \frac{1}{[1+jX+j][1+jX-j]}$$

$$= \frac{1}{1+jx-\cancel{j}+jx-x^2+\cancel{x}+\cancel{j}-\cancel{x}+1}$$

$$\boxed{\frac{A_v}{A_{v(\text{cascaded})}} = \frac{1}{2+2jx-x^2}}$$

~~Instability of tunned Amplifier & Neutral~~

Seperaly real & img parts, we get.

$$\frac{A_v}{A_{v(\text{cascaded})}} = \frac{1}{(2-x^2)+2jx}$$

$$\left|\frac{A_v}{A_{v(\text{cascaded})}}\right| = \frac{1}{\sqrt{(2-x^2)^2+4x^2}}$$

$$= \frac{1}{\sqrt{4+x^4-\cancel{4x^2}+\cancel{4x^2}}}$$

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

$$\left|\frac{A_v}{A_v(\text{cascaded})}\right| = \frac{1}{\sqrt{X^4+4}}$$

$x+1$

$$\because \quad X = 2\delta Q_{eff}$$

$$\left|\frac{A_v}{A_v(\text{cascaded})}\right| = \frac{1}{\sqrt{(2\delta Q_{eff})^4+4}}$$

$$= \frac{1}{\sqrt{16\delta^4 Q_{eff}^4+4}}$$

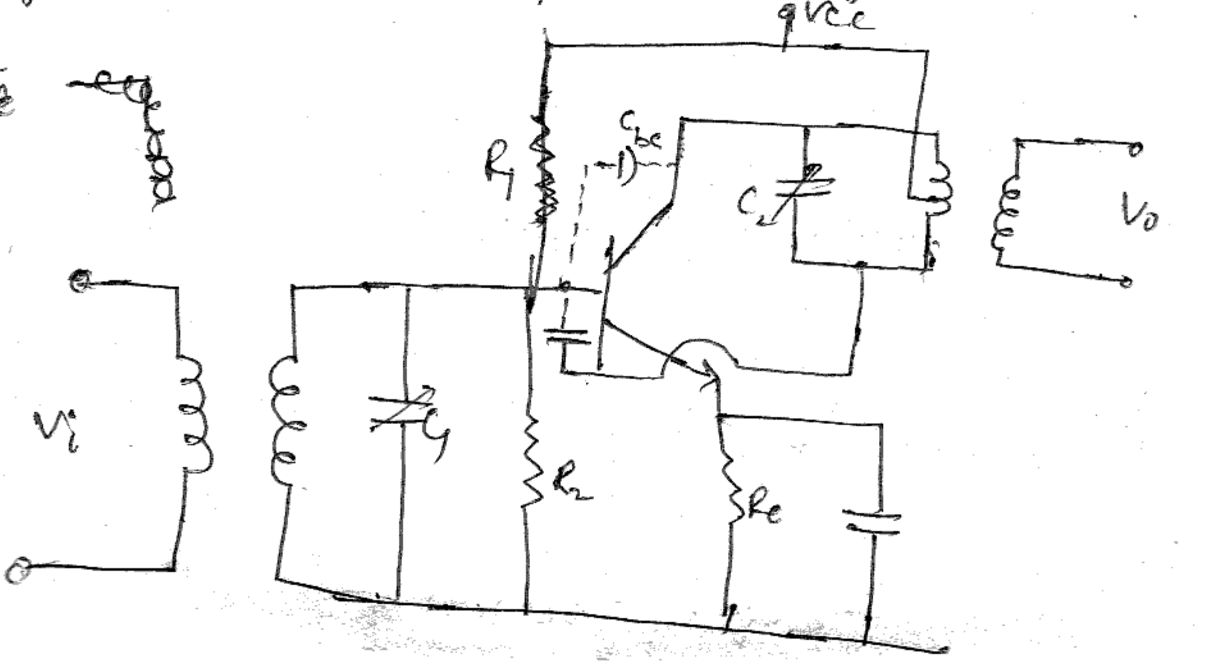
$$= \frac{1}{2\sqrt{(4\delta^4 Q_{eff}^4+1)}}$$

Instability of tuned Amplifier & Neutralization techniques

$= \frac{1}{j2\pi fc}$

$\Rightarrow$ resonant freq & o/p voltage is not stable.

$= \frac{1}{j\omega c}$



Neutralization technique

(i)

(ii) Neutrodyne