# B.Tech.4th Semester (common for EE and EX)
# ANALOG ELECTRONICS
Solution(SET-A)

Q1.

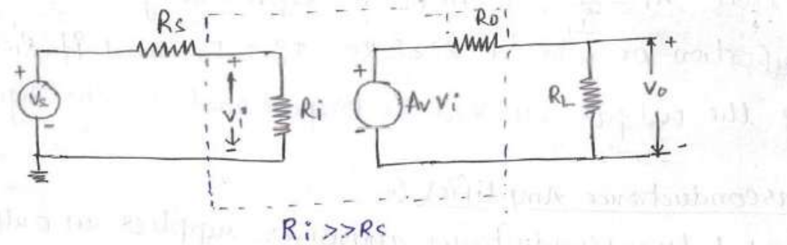
UNIT-1 Analog electronics

Classification of Amplifiers — Green Maraiya.

1) Voltage Amplifier
2) Current Amplifier
3) Transconductance Amplifier
4) Transresistance Amplifier

Voltage Amplifier

fig show a Thevenin's Equivalent Circuit of a two port network which represents an amplifier. If the amplifier input resistance R_i is large compared with the source resistance R_s then $V_i \approx V_s$. If the External load resistance R_L is large compared with the output resistance R_o of the amplifier, then $V_o \approx A_v V_i \approx A_v V_s$



$R_i >> R_s$
$R_o << R_L$

Thevenin's equivalent circuits of a voltage amplifier

This amplifier provide voltage input and the proportionality factor is independent of the magnitudes of the source and load resistance such a circuit is called voltage amplifier

An ideal voltage amplifier must have

$R_i = \infty$
$R_o = 0$
$R_L = \infty$

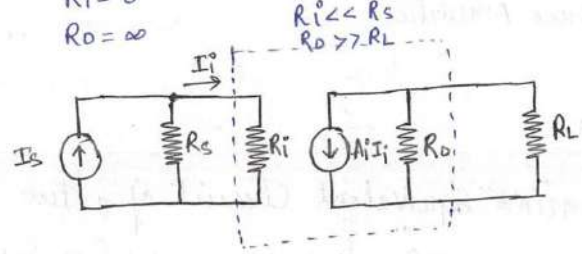
Current Amplifier :-

An ideal current amplifier is defined as an amplifier which provide an output current proportional to the signal current, and the proportionality factor is independent of R_s and R_L

An ideal current amplifier must have

$R_i = 0$

$R_o = \infty$



Norton's Equivalent Circuit of a current amplifier

In practical the amplifier has low input resistance and high output resistance. It drives a low resistance load ($R_o >> R_L$) and its driven by high resistance to source ($R_i << R_s$)

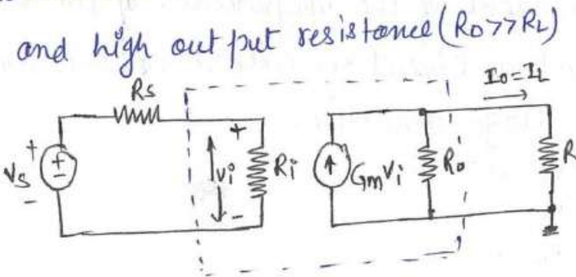
Note that $A_i = \frac{I_L}{I_i}$, with $R_L = 0$ representing the s.c current amplification or gain if $R_i << R_s$, $I_i \approx I_s$ and if $R_o \approx R_L$, $I_L = A_i I_i = A_i I_s$

Hence the output current is proportional to the signal current.

Transconductance Amplifier :-

The ided transconductance amplifier supplies an output current which is proportional to the signal voltage independently of the magnitude of R_s and R_L. This amplifier must have an $R_i = \infty$ and $R_o = \infty$

A practical transconductance amplifier has a large input resistance ($R_i >> R_s$) and high output resistance ($R_o >> R_L$)



Transresistance Amplifier

An amplifier which ideally supplies an output Voltage V_o in proportional to the signal current I_s independently of R_s and R_L. This amplifier is Called a transresistance amplifier.

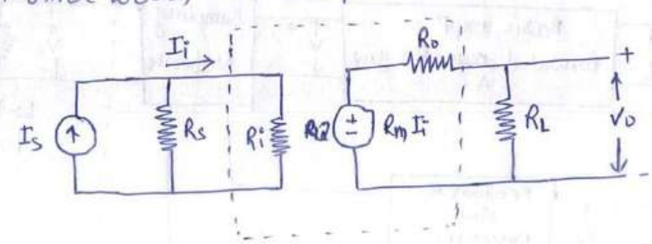
For practice $R_i << R_s$ and $R_o << R_L$

Hence the input and output resistance are low relative to the source and load resistance

we see that if $R_s >> R_i$, $I_i \approx I_s$ and if $R_o << R_L$, $V_o \approx R_m I_i \approx R_m I_s$

$R_m = \frac{V_o}{I_i}$ with $R_L = \infty$

In other word, R_m is open circuit mutual or transfer resistance.



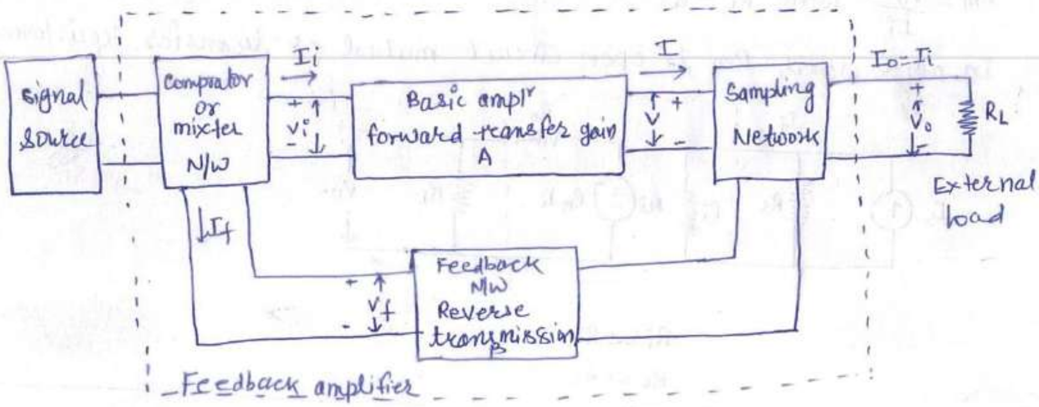
$R_i << R_s$
$R_o << R_L$

Parameter	Amplifier type: Voltage	Current	Transconductance	Transresistance
R_i	∞	0	∞	0
R_o	0	∞	∞	0
Transfer Charq.	$V_o = A_V V_s$	$I_L = A_i I_s$	$I_L = G_m V_s$	$V_o = R_m I_s$

Q1.

The feedback concept

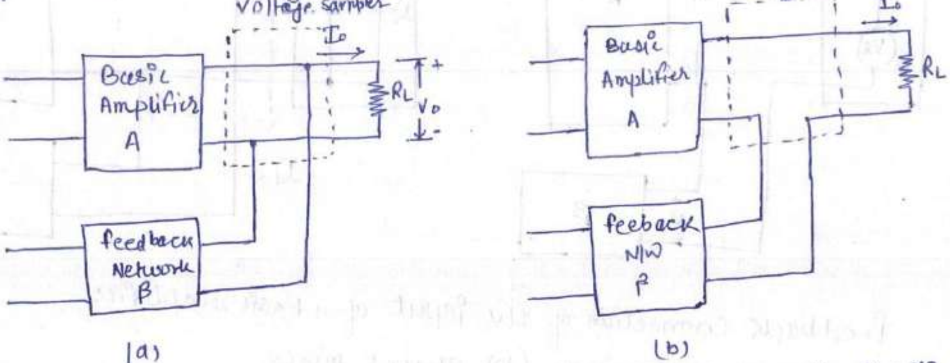
In basic amplifier type in each on of these circuits we may sample the output voltage or current by means of a suitable sampling network and apply this signal to the input through feedback two-port network. At the input the feedback signal is combined with external (source) signal through a mixer network and is fed into the amplifier proper.



Representation of any single loop feedback connection around a basic amplifier. The transfer gain A may represent A_v, A_I, G_m or R_M

Signal source In this block is either a signal voltage V_s in series with resistance R_s (Thevenin representation) or a signal current I_s in parallel with a resistor R_s (a Norton representation)

Feedback Network This block is usually a passive two port Network which may contain resistors, capacitor and inductors. Most often it is simply a resistive configuration.



(a) (b)

feedback connections at the output of a basic amplifier, sampling the o/p (a) voltage (b) current.

Sampling Network In fig(a) the output voltage is sampled by connecting the feedback network in shunt across the output. This type of connection is referred as voltage, or node, sampling. Another feedback connection which samples the output current in fig(b) where feedback network is connected in series with the output. This type of connection is referred to as current, or loop, sampling.

Comparator, or Mixer, Network Two mixing block as shown below fig(a) and fig(b) show the simple and very common series loop input and shunt (node) input connection respectively

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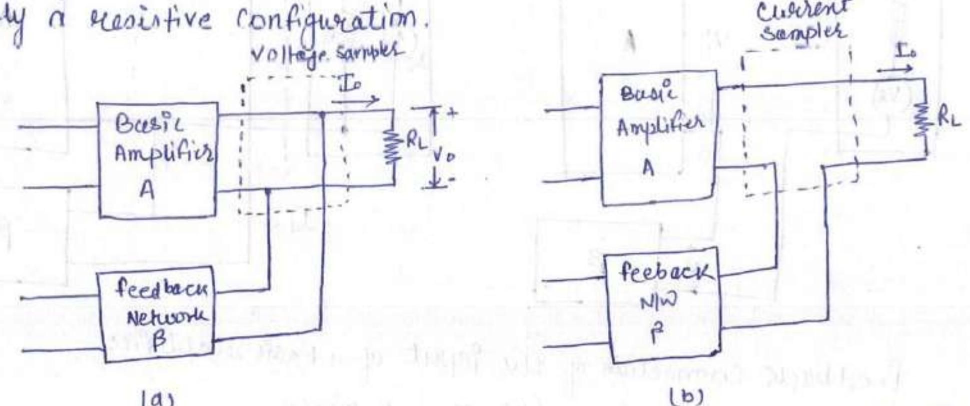

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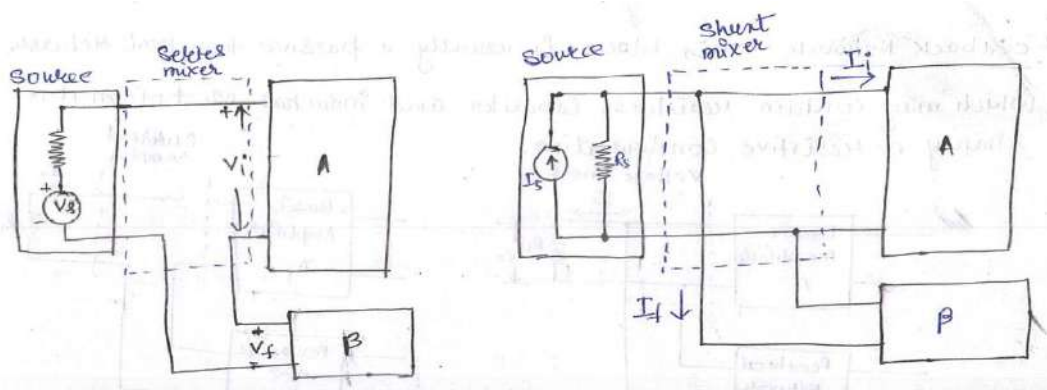


feed back connection of the input of a basic amplifier (a) series comparision (b) shunt mixer

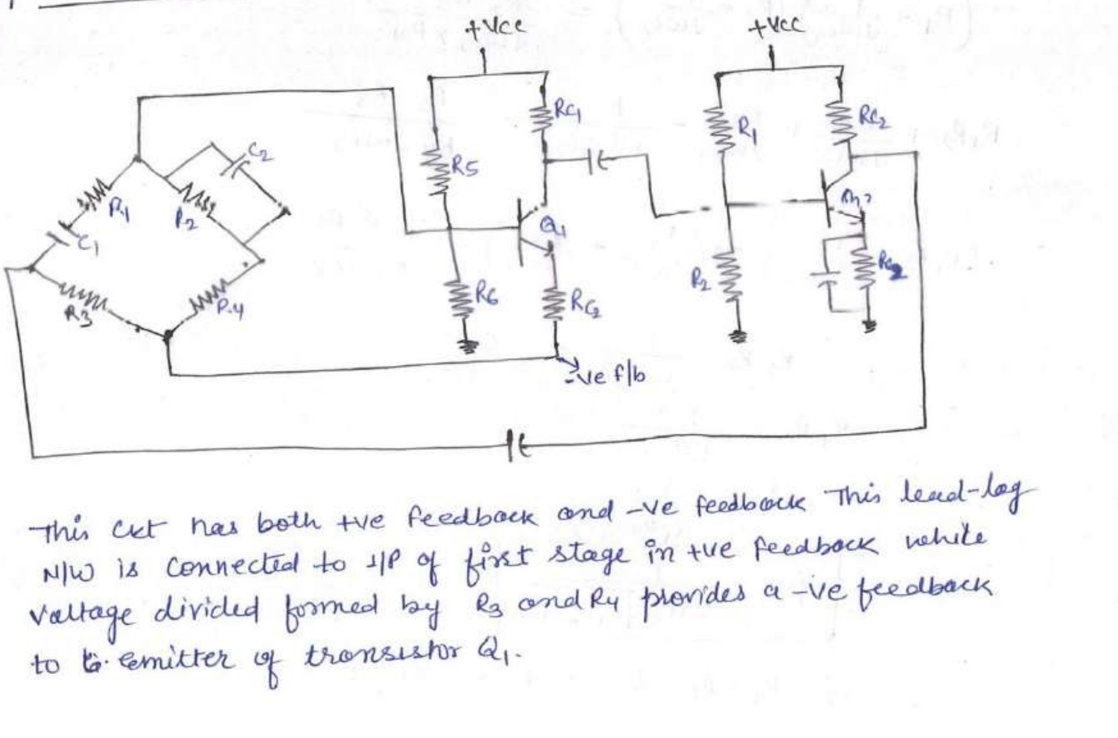
Q2.Solution

wein bridge oscillator

It is audio frequency RC oscillation which has frequency in range of 20Hz - 20KHz But in case of RC oscillation there was no variation in frequency.

Here feedback doesnot provide any type of phase-shift By using particular this f/b n/w oscillation become senstive only to a particular frequency so that good frequency stability is obtained to maintain 360 phase shift b/w i/p and o/p two inverting ampl^r are used each providing 180° phase shift By changing R & C values frequency oscillation can be varied.

practical circuit using BJT



This ckt has both +ve feedback and -ve feedback This lead-lag N/W is connected to i/p of first stage in +ve feedback while voltage divided formed by R3 and R4 provides a -ve feedback to emitter of transistor Q1.

This N/W doesnot provide any phase shift and for zero phase shift this bridge should be balanced.

$$Z_1 = R_1 + \frac{1}{JW_1} \qquad Z_2 = R_2 \parallel \frac{1}{JWC_2}$$

$$Z_3 = R_3 \qquad R_4 = Z_4$$

$$Z_1 Z_4 = Z_2 Z_3$$

$$\frac{Z_1}{Z_3} = \frac{Z_2}{Z_4}$$

$$\frac{R_1 + \frac{1}{JWC_1}}{R_3} = \frac{R_2 \times \frac{1}{JWC_2}}{\left(R_2 + \frac{1}{JWC_2}\right) R_4}$$

$$\left(R_1 + \frac{1}{JWC_1}\right)\left(R_2 + \frac{1}{JWC_2}\right) = \frac{R_2 R_3}{JWC_2 \times R_4}$$

$$R_1 R_2 + \frac{R_1}{JWC_2} + \frac{R_2}{JWC_1} - \frac{1}{W^2 C_1 C_2} = \frac{R_2 R_3}{R_4 JWC_2}$$

$$\left(R_1 R_2 - \frac{1}{W^2 C_1 C_2}\right) - J\left(\frac{R_1}{WC_2} + \frac{R_2}{WC_1}\right) = \frac{-J R_2 R_3}{R_4 W C_2}$$

$$R_1 R_2 - \frac{1}{W^2 C_1 C_2} = 0$$

$$R_1 R_2 = \frac{1}{W^2 C_1 C_2}$$

$$W^2 = \frac{1}{R_1 R_2 C_1 C_2}$$

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

if $R_1 = R_2 = R$ and $C_1 = C_2 = C$

$$\boxed{f = \frac{1}{2\pi RC}}$$

$$-\left(\frac{R_1}{j\omega C_2} + \frac{R_2}{j\omega C_1}\right) = \frac{-R_2 R_3}{j\omega R_4 C_2}$$

$$\frac{R_1 C_1 + R_2 C_2}{C_1 C_2} = \frac{R_2 R_3}{R_4 C_2}$$

$$R_1 C_1 + R_2 C_2 = \frac{R_2 R_3 C_1}{R_4}$$

$$RC + RC = \frac{R R_3 C}{R_4}$$

$$2RC = \frac{R_3 RC}{R_4}$$

$$\boxed{\frac{R_3}{R_4} = 2}$$

so, by varying the value of R and C, one can change the frequency of oscillation.

Advantages:

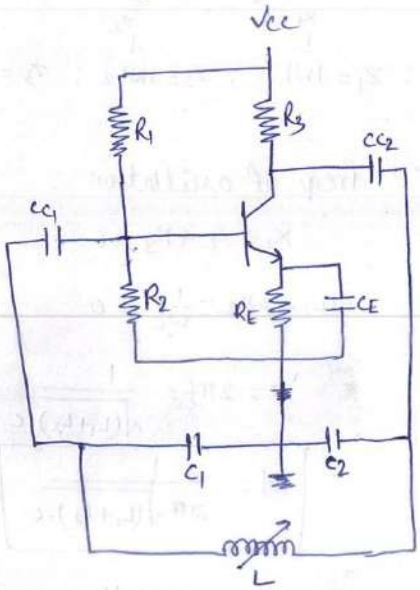
1) since it has two stage amplification, so oreall gain will be high.
2) It is variable frequency generated and frequency may be in range of 20Hz – 20kHz.
3) It generates extreemly part sine wave, has good frequency stability and highly stained amplitude.
4) freq can be changed by changing either R and C.

Q2.Solution

Colpitt oscillator

→ It has better frequency stability and it is obtained by reducing net capacitance of modified tank ckt.

$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$; $Q = \frac{1}{WRC}$; C↓ Q↑ stability↑



$Z_1 = \frac{-J}{WC_1}$; $Z_2 = \frac{-J}{WC_2}$; $Z_3 = JWL$

freq of oscillation

$X_1 + X_2 + X_3 = 0$

$\frac{-J}{WC_1} - \frac{J}{WC_2} + JWL = 0$

$W = \frac{1}{\sqrt{L \cdot \frac{C_1 C_2}{C_1 + C_2}}}$

$$f = \frac{1}{2\pi \sqrt{L \cdot \frac{C_1 C_2}{C_1 + C_2}}}$$

Condition for oscillation

$A_v \geq \frac{X_1}{X_2} \Rightarrow A_v \geq \frac{C_1}{C_2}$

Advantage It is smaller in size and economical

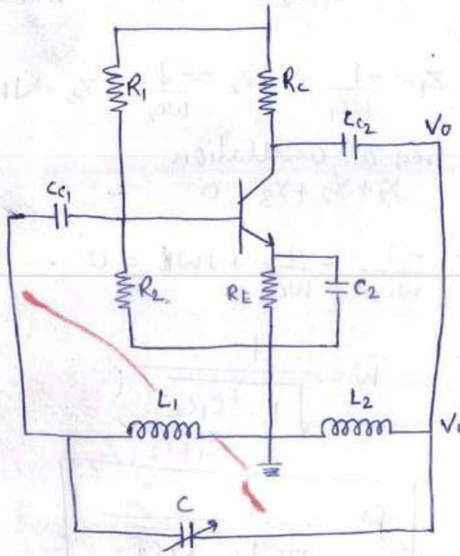
Disadvantage :- Inductive tuning wear & tear problem.

Application :- As a local oscillator in reciever.

Q3.Solution

Hartley oscillator

- It is also called tapped inductor type oscillator
- → They are variable freq type RF oscillator
- → working principle is parallel resonance



$Z_1 = jwL_1$; $Z_2 = jwL_2$; $Z_3 = \frac{-j}{wC}$

(X_1, X_2, X_3)

freq of oscillation

$$X_1 + X_2 + X_3 = 0$$

$$wL_1 + wL_2 - \frac{1}{wC} = 0$$

$$w = 2\pi f = \frac{1}{\sqrt{(L_1+L_2).C}}$$

$$f = \frac{1}{2\pi\sqrt{(L_1+L_2).C}}$$

condition for oscillation

$$A_v \geq \frac{X_2}{X_1} \Rightarrow A_v \geq \frac{L_2}{L_1}$$

Advantage :- capacitive tuning i.e. No wear and tear problem

Disadvantage :- Bulky and expensive because of two inductor.

Application :- In designing local oscillator ckt in reciever.

Q3

Solution

$L_1 = 20\mu H \quad L_2 = 2mH$

$$L_{eq} = L_1 + L_2 = 20\times10^{-6} + 20\times10^{-3} = 2.002\times10^{-3} H$$

for $f = f_{max} = 2.5 MHz$

$$f = \frac{1}{2\pi\sqrt{C \times L_{eq}}}$$

$$2.5\times10^{6} = \frac{1}{2\pi\sqrt{C\times 2.002\times10^{-3}}}$$

$$\boxed{C = 2.0244 PF}$$

for $f = f_{min} = 1MHz$

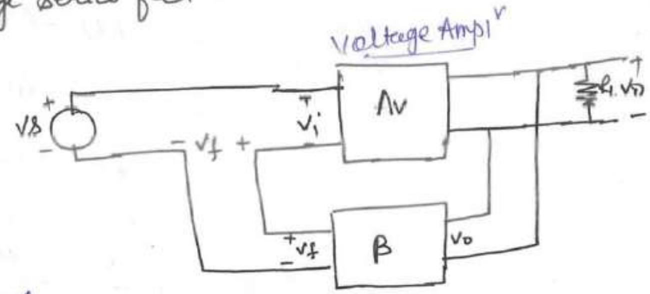
$$1\times10^{6} = \frac{1}{2\pi\sqrt{C\times 2.002\times10^{-3}}}$$

$$\boxed{C = 12.6525 PF}$$

Thus c must be varied from 2.0244PF to 12.6525 PF

Q4.Solution

Derivation of R_{if} (input resistance with feedback) and R_{of} (O/P resistance with FB) for voltage series feedback.

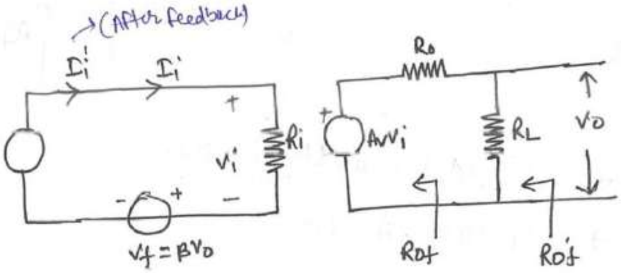


$\Rightarrow V_f = \beta V_o$

$\beta = \frac{V_f}{V_o}$ (unitless)

$A_{if} = \frac{A_v}{1 + A_v\beta} = \frac{1}{\beta}$ $\quad A_v\beta >> 1$

$\Rightarrow R_{of} < R_o$ & $R_{if} > R_i$



Calculation of R_{if}

Before feedback

$V_i = V_s$

After feedback

$V_s = V_i + V_f$

$V_i = V_s - V_f$ (There is -ve feedback)

Applying KVL

$R_i I_i' + V_f - V_s$

$I_i' R_i + \beta V_0 - V_s$

but $V_0 = \frac{A_V V_i R_L}{R_0 + R_L}$ $\quad R_0 << R_L$

$V_0 = A_V V_i$

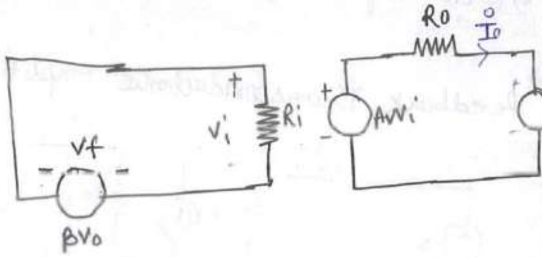
$I_i' R_i + \beta A_V V_i = V_s$.

$V_s = I_i' R_i + \beta A_V R_i I_i'$

$\frac{V_s}{I_i'} = R_i + \beta A_V \cdot R_i$

$$\boxed{\frac{V_s}{I_i'} = R_{if}} \qquad R_{if} = R_i(1 + A_V\beta)$$

Calculation of Rof :-



~~RoI + AvViRL~~

$R_0 I + A_V V_i = V$

$V_i + V_f = 0$

$V_i + \beta V = 0$

$V_i = -\beta V$

$V = R_0 I - \beta A_V V$

$I \cdot R_0 = (1 + \beta A_V) \cdot V$

$$\boxed{R_{of} = \frac{V}{I} = \frac{R_0}{1 + \beta A_V}}$$

$R_0 I_0 + V - A_V V_i = 0$

$R_0 I_0 - A_V V_i = V$

$R_0 I_0 + A_V V_i - V = 0$

$I_0 = V + A_V V_i$

$R_0 I_0 + V - A_V V_i = 0$

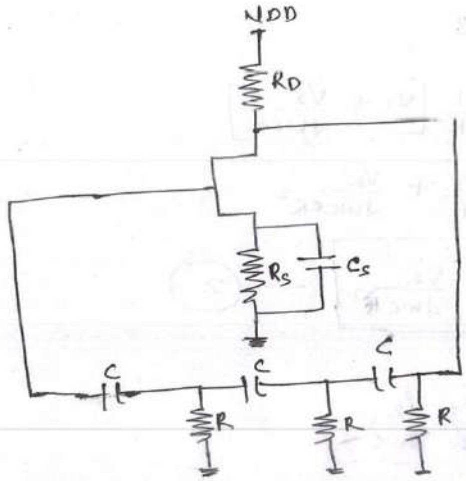
~~$R_0 I_0$~~

$V = -R_0 I_0 + A_V V_i$

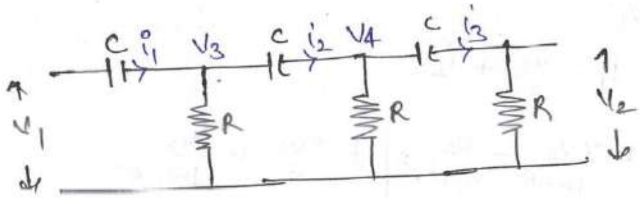
$V = -R_0 I_0$

Q4.Solution

Rc phase shift oscillation using FET



since this feedback is voltage series +ve feedback and due to high value of i/p impedance, there is no effect on the resistance R. In this case maximum phase shift provided by one Network is 90° but we will use only 60° phase shift from each RC N/W so that there will be no distortion in the o/p.



$$V_4 = V_2 + \frac{i_3}{jwC} \qquad \therefore \; i_3 = \frac{V_2}{R}$$

$$V_4 = V_2 + \frac{V_2}{jwCR} \qquad \text{--- (1)}$$

KCL at node 'V_4'

$$i_2 = \frac{V_4}{R} + i_3$$

$$i_2 = \frac{V_2}{R} + \frac{1}{R}\left[V_2 + \frac{V_2}{JWCR}\right]$$

$$i_2 = \frac{V_2}{R} + \frac{V_2}{R} + \frac{V_2}{JWCR^2}$$

$$\boxed{i_2 = \frac{2V_2}{R} + \frac{V_2}{JWCR^2}} \quad \text{---} (2)$$

$$\therefore \quad V_3 = V_4 + \frac{i_2}{JWC}$$

$$V_3 = V_2 + \frac{V_2}{JWCR} + \frac{1}{JWC}\left[\frac{2V_2}{R} + \frac{V_2}{JWCR^2}\right]$$

$$V_3 = V_2 + \frac{V_2}{JWCR} + \frac{2V_2}{JWCR} - \frac{V_2}{\omega^2 C^2 R^2}$$

$$\boxed{V_3 = V_2 + \frac{3V_2}{JWCR} - \frac{V_2}{\omega^2 C^2 R^2}} \quad \text{---} (3)$$

KCL at node 'V_3'

$$i_1 = \frac{V_3}{R} + i_2$$

$$i_1 = \frac{1}{R}\left[V_2 + \frac{3V_2}{JWCR} - \frac{V_2}{\omega^2 C^2 R^2}\right] + \frac{2V_2}{R} + \frac{V_2}{JWCR^2}$$

$$i_1 = \frac{V_2}{R} + \frac{3V_2}{JWCR^2} - \frac{V_2}{\omega^2 C^2 R^2} + \frac{2V_2}{R} + \frac{V_2}{JWCR^2}$$

$$\boxed{i_1 = \frac{3V_2}{R} + \frac{4V_2}{JWCR^2} - \frac{V_2}{\omega^2 C^2 R^2}} \quad \text{---} (4)$$

$$\therefore \quad V_1 = \frac{V_3}{R} + \frac{i_1}{jwC}$$

$$V_1 = V_2 + \frac{3V_2}{jwCR} - \frac{V_2}{w^2C^2R^2} + \frac{1}{jwC}\left[\frac{3V_2}{R} + \frac{4V_2}{jwCR^2} - \frac{V_2}{w^2C^2R^3}\right]$$

$$V_1 = V_2 + \frac{3V_2}{jwCR} - \frac{V_2}{w^2C^2R^2} + \frac{3V_2}{jwCR} - \frac{4V_2}{w^2C^2R^2} - \frac{V_2}{jw^3C^3R^3}$$

$$V_1 = V_2 + \frac{6V_2}{jwCR} - \frac{5V_2}{w^2C^2R^2} - \frac{V_2}{jw^3C^3R^3} \quad — (5)$$

The o/p voltage is real at frequency making factor.

$$\frac{6V_2}{jwCR} - \frac{1}{jw^3C^3R^3} = 0$$

$$\frac{6V_2}{jwCR} = \frac{1}{jw^3C^3R^3}$$

$$\boxed{w = \frac{1}{\sqrt{6}\,RC}} \quad — (6) \qquad \therefore \; 6 = \frac{1}{w^2R^2C^2}$$

At this frequency taking real part is.

$$V_1 = V_2 - \frac{5V_2}{w^2C^2R^2}$$

$$V_1 = V_2\left[1 - \frac{5}{w^2C^2R^2}\right]$$

$$V_1 = V_2\,[1 - 30]$$

$$V_1 = -29V_2$$

The o/p voltage is $\frac{1}{29}$ (β) times the input and 180° out of phase with the input at this frequency.

Hence the gain of the amplifier much greater than 29

since $A\beta = 1$

$$A\beta = 29 \times \frac{1}{29} = 1 \qquad \boxed{A = 29}$$

# B.Tech.4th Semester (common for EE and EX)
# ANALOG ELECTRONICS
Solution(SET-B)

Q1.

Effects of Negative feedback

1. Increased stability
2. Decrease BW
3. Less distortion
4. Decreased Noise
5. i/p & o/p Impedance can be modified.

1. Increased stability:

Feedback gain $A_{vf} = \frac{A_v}{1 + A_v \beta}$.

$$\frac{dA_{vf}}{dA_v} = \frac{(1+A_v\beta)\cdot 1 - A_v(0+\beta)}{(1+A_v\beta)^2}$$

$$\frac{dA_{vf}}{dA_{vf}} = \frac{1}{(1+A_v\beta)^2}$$

$$dA_{vf} = \frac{dA_v}{(1+A_v\beta)^2}$$

Divided A_{vf} on both side

$$\frac{dA_{vf}}{A_{vf}} = \frac{dA_v}{A_{vf}} \times \frac{1}{(1+A_v\beta)^2}$$

$$\frac{dA_f}{A_{vf}} = \frac{dA_{vf}}{\frac{A_v}{(1+A_v\beta)}} \times \frac{1}{(1+A_v\beta)^2}$$

$$\frac{dA_{vf}}{A_{vf}} = \frac{dA_{vf}}{A_v} \times \frac{1}{(1+A_v\beta)}$$

$$\frac{1}{1+A_v\beta} = \frac{\frac{dA_{vf}}{A_{vf}}}{\frac{dA_v}{A_v}}$$

Sensitivity $S = \dfrac{\frac{dA_{vf}}{A_{vf}}}{\frac{dA_V}{A_V}}$

$\frac{dA_V}{A_V}$ = fraction change in A w/o f/b.

$\frac{dA_f}{A_f}$ = fraction variation in feedback.

$$\boxed{S = \frac{1}{1+A_V\beta}}$$

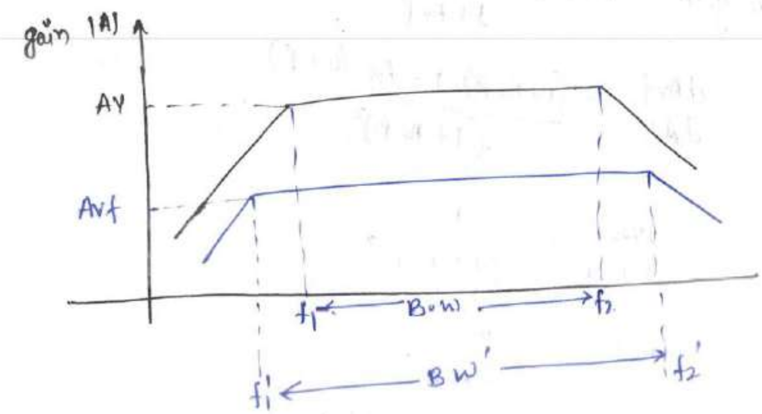
Desensitivity $\boxed{D = \frac{1}{S}}$

For stability $S<1$

$D>1$ for stability after f/b.

2. Increased BW

$$BW = f_H - f_L$$



$$B.W = f_2 - f_1$$

$$B.W' = f_2' - f_1'$$

$$\boxed{f_2' = f_2(1+A_V\beta)}$$

$$\boxed{f_1' = \frac{f_1}{(1+A_V\beta)}}$$

Effect of Negative feedback

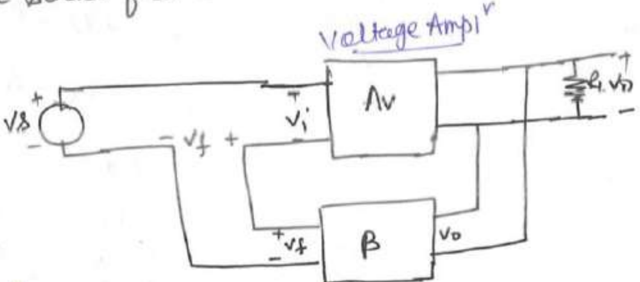
Parameter	Voltage series	Current series	Current shunt	Voltage shunt
Gain with feedback	$A_{vf} = \frac{A_v}{1+A_v\beta}$ ↓es	$G_{mf} = \frac{G_m}{1+\beta G_m}$ ↓es	$A_{if} = \frac{A_i}{1+\beta A_i}$ ↓es	$R_f = \frac{R_m}{1+\beta R_m}$ ↓es
input resistance	$R_{if} = R_i[1+A_v\beta]$ ↑es	$R_{if} = R_i[1+\beta G_m]$ ↑es	$R_{if} = \frac{R_i}{[1+\beta A_i]}$ ↓es	$R_{if} = \frac{R_i}{1+\beta R_m}$ ↓es
output resistance	$R_{of} = \frac{R_o}{1+\beta A_v}$ ↓es	$R_{of} = R_o[1+\beta G_m]$ ↑es	$R_{of} = R_o[1+A_i\beta]$ ↑es	$R_{of} = \frac{R_o}{1+\beta R_m}$ ↓es
stability	↑es	↑es	↑es	↑es
Noise	↓es	↓es	↓es	↓es.

Q1.Solution

Feedback topology :-

1) Voltage series feeback (~~series series~~) series - shunt
2) current series "
3) Voltage shunt "
3) current shunt "

Derivation of Rif (input resistance with feedback) and Rof (O/P resistance with FB) for voltage series feedback.

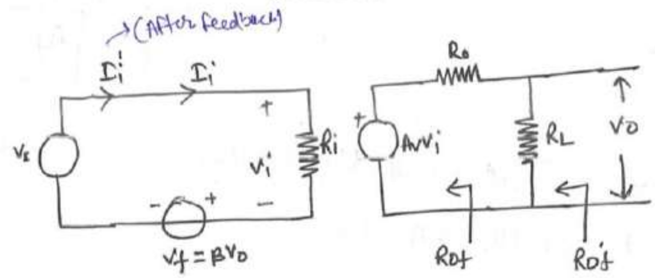


$\Rightarrow V_f = \beta V_o$

$\beta = \frac{V_f}{V_o}$ (unitless)

$A_{if} = \frac{A_V}{1+A_V\beta} = \frac{1}{\beta}$ $\quad A_V\beta >> 1$

$\Rightarrow R_{of} < R_o$ & $R_{if} > R_i$



Calculation of Rif

Before feedback

$V_i = V_s$

After feedback

$V_s = V_i + V_f$

$V_i = V_s - V_f$ (There is -ve feedback)

Applying KVL

$R_i I_i' + V_f - V_s$

$I_i' R_i + \beta V_0 - V_s$

but $V_0 = \frac{A_V V_i R_L}{R_0 + R_L}$ $R_0 << R_L$

$V_0 = A_V V_i$

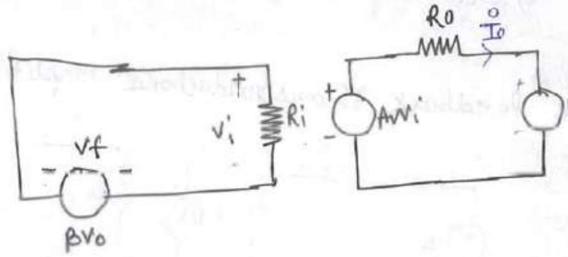
$I_i' R_i + \beta A_V V_i = V_s$.

$V_s = I_i' R_i + \beta A_V R_i I_i'$

$\frac{V_s}{I_i'} = R_i + \beta A_V \cdot R_i$

$\boxed{\frac{V_s}{I_i'} = R_{if}}$ $R_{if} = R_i(1 + A_V\beta)$

Calculation of R_{of} :-



~~RoI + AvViRLoR~~

$R_0 I + A_V V_i = V$

$V_i + V_f = 0$

$V_i + \beta V = 0$

$V_i = -\beta V$

$V = R_0 I - \beta A_V V$

$I \cdot R_0 = (1 + \beta A_V) \cdot V$

$\boxed{R_{of} = \frac{V}{I} = \frac{R_0}{1 + \beta A_V}}$

$R_0 I_0 + V - A_V V_i' = 0$

$R_0 I_0 - A_V V_i' = V$

$R_0 I_0 + A_V V_i - V = 0$

$I_0 = V + A_V V_i'$

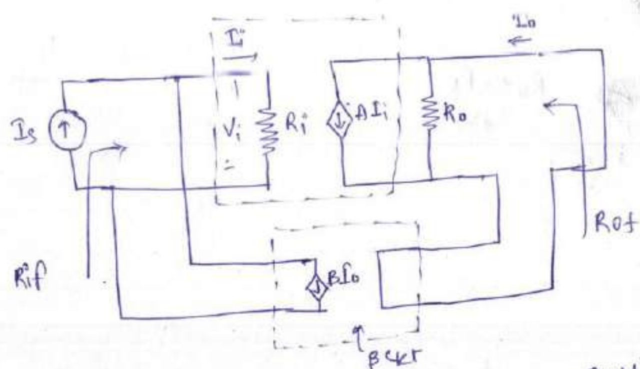
$R_0 I_0 + V - A_V V_i = 0$

$R_0 I_0$

$V = -R_0 I_0 + A_V V_i'$

$V = -R_0 I_0$

The feedback current amplifier (~~series~~ shunt-series)
current shunt

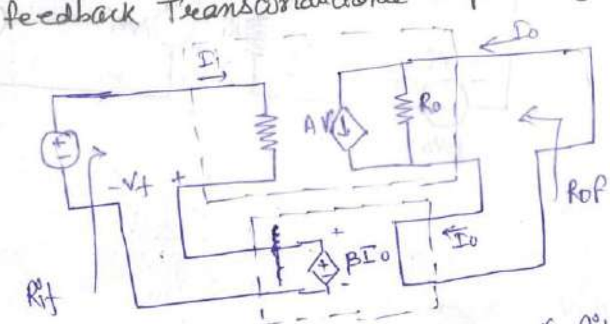


⇒ Input resistance of the feedback Ampl^r $R_{if} = \frac{R_i}{1+A\beta}$

⇒ output resistance " " " $R_{of} = (1+A\beta) R_o$

⇒ Gain of the feedback Ampl^r $A_f = \frac{A}{1+A\beta}$

The feedback Transconductance Amplifier (series-series) - current series



→ i/p resistance of the feedback Ampl^r $R_{if} = (1+A\beta) R_i$

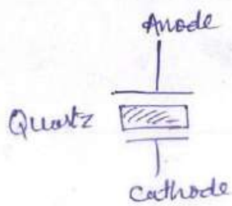
⇒ o/p " " $R_{of} = (1+A\beta) R_o$

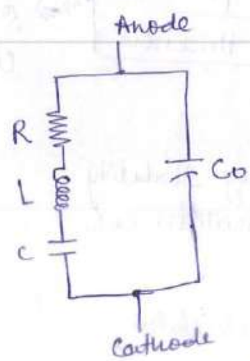
⇒ Gain of the feedback Ampl^r $A_f = \frac{A}{1+A\beta}$

Q2.Solution

Crystal oscillator

- It is a fixed frequency RF oscillator
- It works on principle of piezoelectric effect.
- It has two resonating freq f_s & f_p oscillating frequencies lies b/w f_s and f_p
- Due to high quality factor Q of a resonance ckt, it provides very good frequency stability
- frequency of oscillation generated by crystal depends on its physical dimensions but mainly on thickness.
- On high freq, t should be small it makes crystal mechanically weak.





Ac Equivalent ckt

Co → capacitance b/w cathode and anode ckt.

Series resonance due to RLC in series

- Impedence - minimum

$$f_s = \frac{1}{2\pi\sqrt{LC}}$$

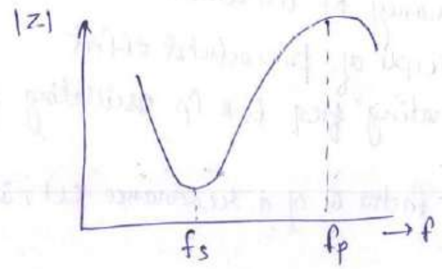
parallel resonance

Impedence maximum

$$f_p = \frac{1}{2\pi\sqrt{L C_{eq}}} \quad C_{eq} = \frac{C C_0}{C + C_0}$$

3

$f_p > f_s$ and freq of oscillator varies b/w f_s and f_p



frequency of oscillation

→ f depends of l, b & t - the physical dimension

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

⇒ on higher frequencies crystal becomes weak.

Advantages

→ Excellent frequency stability
→ Simplest RF oscillator ckt.

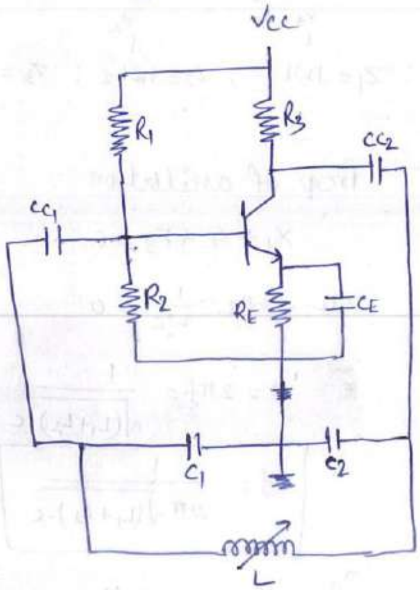
→ Disadvantage
→ fixed freq type oscillator.

Application. To generate carrier in AM & FM transmission
⇒ In designing of liner circuit.

Q2.Solution

Colpitt oscillator

→ It has better frequency stability and it is obtained by reducing net capacitance of modified tank ckt.



$C_{eq} = \frac{C_1 C_2}{C_1+C_2}$; $Q = \frac{1}{WRC}$; C↓ Q↑ stability↑

$Z_1 = \frac{-J}{WC_1}$; $Z_2 = \frac{-J}{WC_2}$; $Z_3 = JWL$

freq of oscillation

$X_1 + X_2 + X_3 = 0$

$\frac{-J}{WC_1} - \frac{J}{WC_2} + JWL = 0$

$W = \frac{1}{\sqrt{L \cdot \frac{C_1 C_2}{C_1+C_2}}}$

$$f = \frac{1}{2\pi\sqrt{L \cdot \frac{C_1 C_2}{C_1+C_2}}}$$

Condition for oscillation

$A_v \geq \frac{X_1}{X_2} \Rightarrow A_v \geq \frac{C_1}{C_2}$

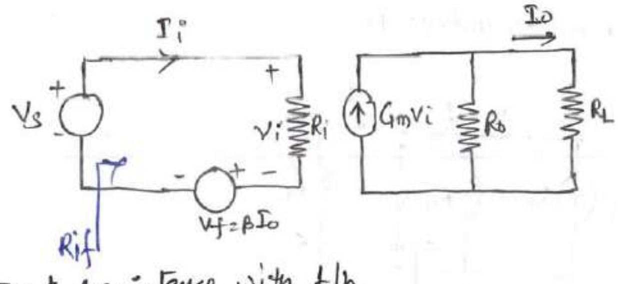
Advantage It is smaller in size and economical

Disadvantage :- Inductive tuning wear & tear problem.

Application :- As a local oscillator in reciever.

Q3.Solution

current-series feedback



Input resistance with f/b

Applying KVL at input side

$$R_i I_i + V_f - V_s = 0$$

$$R_i I_i + \beta I_o = V_s \quad \text{—} (1)$$

The output current I_o is given as

$$I_o = \frac{G_m V_i \times R_o}{R_o + R_L} \qquad \therefore G_M = \frac{G_m R_o}{R_o + R_L}$$

$$I_o = G_M \cdot V_i$$

from eq (1)

$$R_i I_i + G_m \beta V_i = V_s$$

$$R_i I_i + \beta G_m \cdot R_i I_i = V_s$$

$$R_i I_i [1 + \beta G_m] = V_s$$

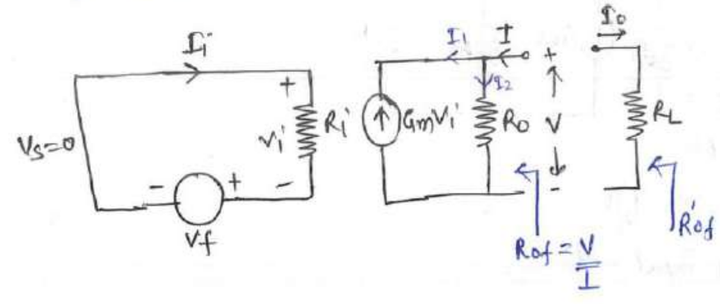
$$R_{if} = \boxed{\frac{V_s}{I_i} = R_i [1 + \beta G_m]}$$

Gm is respresent the transconductance without feedback and Gm " " " with feedback taking the load resistance R_L into account.

Output resistance

i) $V_s = 0$ short ckt.

ii) Disconnect the load resistance R_L



KCL at output side

$$I = I_1 + I_2$$

$$I = -G_m V_i + \frac{V-0}{R_o}$$

$$I = \frac{V}{R_o} - G_m V_i \quad \text{— (1)}$$

KVL at input side.

$$V_i + V_f = 0 \qquad I_o = I$$

$$V_i = -\beta I_o$$

$$V_i = \beta I$$

from eq -(1)

$$I = \frac{V}{R_o} - G_m \cdot \beta I$$

$$I + G_m \beta I = \frac{V}{R_o}$$

$$I\left[1 + G_m \beta\right] = \frac{V}{R_o}$$

$$R_{of} = \frac{V}{I} = R_o\left[1 + G_m \beta\right]$$

$$\boxed{R_{of} = R_o\left[1 + G_m \beta\right]}$$

Q3.Solution

Que Voltage gain of an ampl. without f/b is 400 If the f/b ratio is 0.1 find voltage of an ampl with -ve feedback.

Sol' $A_V = 400$

$\beta = 0.1$ or 10%

$$A_{vf} = \frac{A_V}{1 + A_V\beta}$$

$$A_{vf} = \frac{400}{1 + 400 \times 0.1}$$

$$\boxed{A_{vf} = \frac{400}{41} = 9.76}$$

Q4.Solution

Barkhausen Criterion

It is state that :-

1) Total phase shift around a loop as signal proceeds from i/p through amplifier, feedback N/W and back to i/p again, completing a loop is multiple integral of 2π i.e

$$\boxed{\phi = 2n\pi} \quad n = 1, 2, 3 \ldots$$

2) The magnitute of product of open loop gain,

Q4.Solution

Ques If an ampl. has voltage gain 1000 with -ve f/b the voltage gain reduce to 10 calculate the % of feedback to be applied.

Sol^n

$A_V = 1000$

$A_{Vf} = 10.$

$$A_{Vf} = \frac{A_V}{1+A_V \beta}$$

$$10 = \frac{1000}{1+1000\beta}$$

$$1+1000\beta = 100$$

$$1000\beta = 99$$

$$\beta = \frac{99}{1000} = 0.099 \text{ or } 9.9\%$$