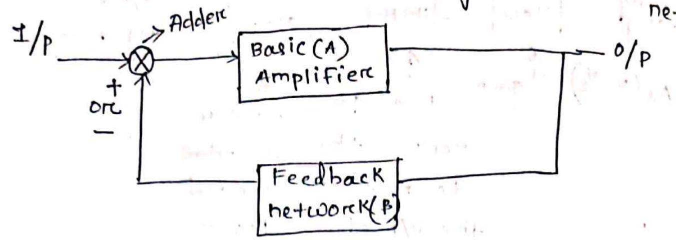
25/11/19

Feedback Amplifier :-

(Block diagram of feedback network)



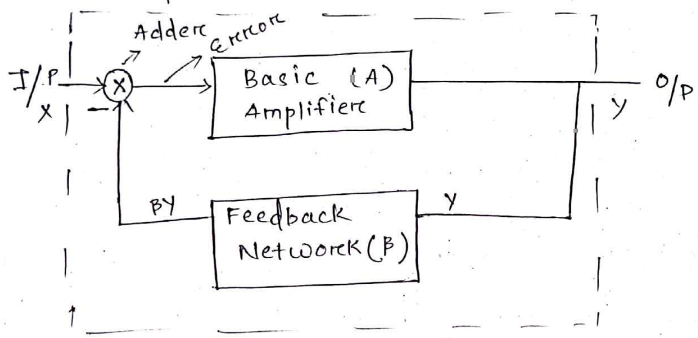
→ Feedback network is used to ~~feedback circuit~~ control the O/P of the system by adding or substracting some part of O/P in the i/p

Types of feedback :-

(1) Negative Feedback :-

→ It is also known as degenerative circuit.

Ex:- All amplifiers.



$\boxed{\text{error} = x - \beta y}$

$\boxed{y = A \cdot \text{error}}$

$\Rightarrow y = A(x - \beta y)$

$\Rightarrow y = Ax - A\beta y$

$\Rightarrow y + A\beta y = Ax$

$\Rightarrow y(1 + A\beta) = Ax \Rightarrow \boxed{\frac{y}{x} = \frac{A}{1 + A\beta}}$ = Gain of a −ve feedback ~~network~~ amplifier

Concept of -ve feedback:-

→ All the O/P should be reached at the i/p of the feed back (β) network, if the O/P is voltage the connection ~~of~~ β betⁿ i/p & β network and O/P ~~connection~~ must be in shunt / parallel.

→ If the O/P is current, then the connection betⁿ i/p of β network and o/p must be in series.

→ Input & output of β network are connected in such a manner that, both will have significance.

→ If the i/p is current, i/p & O/P of an β network must be connected in parallel.

→ If the i/p is voltage i/p & O/P of β network must be in series.

27/11

-Ve feedback connection types (types of -Ve feedback amplifiers) :- OR (Topology)

→ There are 4 types of feedback amplifier

(i) Voltage amplier

(ii) Current amplier

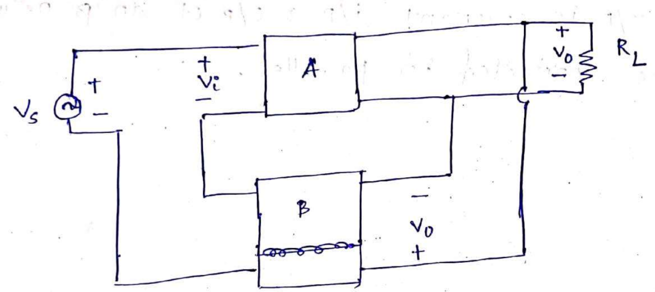
(iii) Trans impedance

(iv) Trans conductance.

Voltage Amplier :-

OR voltage-series or series-shunt.

→



$V_f = BV_o$

Gain with feedback = $A_f \triangleq \frac{V_o}{V_s}$

$A_f = \frac{V_o}{V_s}$

Applying KVL at I/P,

$V_s - V_i - V_f = 0$

$\Rightarrow V_s = V_i + V_f$

$$\boxed{A = \frac{V_o}{V_i}}$$

$$A_f = \frac{V_o}{V_s}$$

$$= \frac{V_o}{V_i + V_f} = \frac{\frac{V_o}{V_i}}{\frac{V_i + V_f}{V_i}}$$

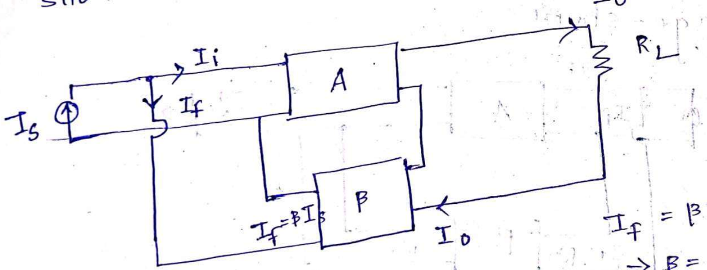
$$= \frac{A}{1 + \frac{V_f}{V_i}} = \frac{A}{1 + \frac{V_f}{V_o} \times \frac{V_o}{V_i}}$$

$$\boxed{A_f = \frac{A}{1 + A\beta}}$$

Current Amplifier:-

OR shunt-series OR current shunt

I/P	O/P
I	I
shunt	series



$I_f = \beta I_s$

$\Rightarrow \beta = \frac{I_f}{I_s}$

$$A_f = \frac{I_o}{I_s}$$

Applying KCL at input

$$I_s = I_i + I_f$$

$$A_f = \frac{I_o}{I_i + I_f}$$

$$A = \frac{I_o}{I_i}$$

$$A_f = \frac{\frac{I_o}{I_i}}{\frac{I_i + I_f}{I_i}}$$

$$= \frac{A}{1 + \frac{I_f}{I_i}}$$

$$= \frac{A}{1 + \frac{I_f}{I_o} \times \frac{I_o}{I_i}} = \frac{A}{1 + \beta A}$$

$$\boxed{A_f = \frac{A}{1 + A\beta}}$$

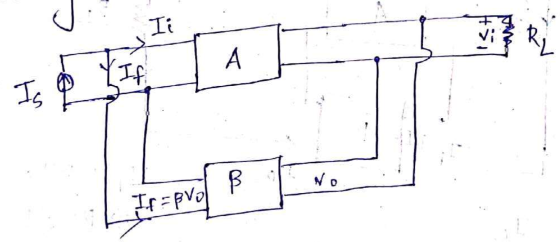
Trans-impedance :-

$\frac{I/P}{I}$ $\frac{O/P}{V}$

shunt   shunt

Name :- shunt-shunt

Voltage-shunt



$$I_f = \beta V_o \Rightarrow \beta = \frac{I_f}{V_o}$$

Here, $A_f = \frac{V_o}{I_S}$

Applying KCL at I/P

$$I_s = I_i + I_f$$

$$A_f = \frac{V_o}{I_i + I_f}$$

$$= \frac{\frac{V_o}{I_i}}{\frac{I_i + I_f}{I_i}}$$

$$= \frac{A}{1 + \frac{I_f}{I_i}}$$

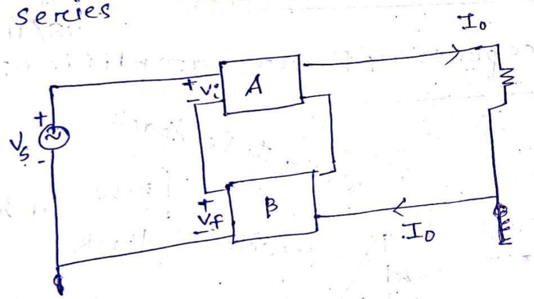
$$= \frac{A}{1 + \frac{I_f}{V_o} \cdot \frac{V_o}{I_i}}$$

$$\Rightarrow \boxed{A_f = \frac{A}{1 + A\beta}}$$

Trans-conductance :-

(series - series or Current series)

$\frac{I/P}{V}$	$\frac{O/P}{I}$
series	series



$$A_f = \frac{I_o}{V_s}$$

Applying KVL at I/P ;

$$V_s = V_i + V_f$$

$$A_f = \frac{\frac{I_o}{V_i}}{\frac{V_s}{V_i}} = \frac{\frac{I_o}{V_i}}{\frac{V_i + V_f}{V_i}}$$

$$\Rightarrow A_f = \frac{A}{1+\frac{V_f}{V_i}}$$

$$= \frac{A}{1+\frac{V_f}{I_0}\cdot\frac{I_0}{V_i}}$$

$$= \frac{A}{1+\beta A}$$

$$\Rightarrow \boxed{A_f = \frac{A}{1+\beta A}}.$$

I/p imp.

★. Voltage Amplifier $\longrightarrow A_{V_f} = \frac{A_V}{1+A_V\beta}$ $\uparrow Z_{if} = Z_i(1+A\beta)$

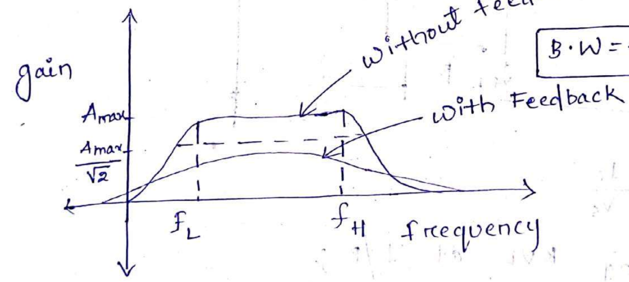
★. Current Amplifier $\longrightarrow A_{I_f} = \frac{A_I}{1+A_I\beta}$ $\downarrow Z_{if} = \frac{Z_i}{1+A\beta}$

★. Trans ~~Amplifiers~~ impedance $\longrightarrow A_{Z_f} = \frac{A_Z}{1+A_Z\beta}$ $\downarrow Z_{if} = \frac{Z_i}{1+A\beta}$

★. Trans conductance $\rightarrow A_{gf} = \frac{A_g}{1+A_g\beta}$ $\uparrow Z_{if} = Z_i(1+A\beta)$

28/11/19

Frequency response of an amplifier :—



$\boxed{B\cdot W = f_H - f_L}$

★ Note :-

$\boxed{\text{Gain}\downarrow \times B\cdot W\uparrow = \text{constant}}$

$$B\cdot W|_f = (1+A\beta)\,B\cdot W.$$

The B.W of amplifier will increase the

amplifier with -ve feedback by factor of $(1+A\beta)$ term.

Distortion (Noise) :- ↓

$$\boxed{D_f = \frac{D}{1+A\beta}}$$

Advantages :- Negative feedback produces the stable output by reducing the gain.

$$\boxed{A_f = \frac{A}{1+A\beta}}$$

$A_f \rightarrow$ Gain with feedback

$A \rightarrow$ Gain without feedback (openloop gain)

$\beta \rightarrow$ Feedback factor

$A\beta \rightarrow$ Closed loop gain.

→ Negative feedback enhances the i/p impedance of voltage amplifier.

O/P imp.

↓ $Z_{of} = \frac{Z_o}{1+A\beta}$

↑ $Z_{of} = Z_o(1+A\beta)$

↓ $Z_{of} = \frac{Z_o}{1+A\beta}$

↑ $Z_{of} = Z_o(1+A\beta)$

→ -ve feedback reduces the o/p impedance of voltage amplifier.

$Z_{if} = Z_i(1+A\beta)$

$$Z_{of} = \frac{Z_o}{1+A\beta}$$

→ -ve feedback enhances the $B\cdot W|_f = (1+A\beta)\, B\cdot W$

→ -ve feedback reduces the noise (distortion).

$$D_f = \frac{D}{1+A\beta}$$

Q:- When -ve voltage feedback is applied to an amplifier with gain $(A) = 1000$. Overall gain false to $A_f = 6$. Calculate the feedback factor (β)?

Ans :-

$A = 1000$

$A_f = 6$

Here, $A_f = \dfrac{A}{1 + A\beta}$

$\Rightarrow 6 = \dfrac{1000}{1 + 1000\beta}$

$\Rightarrow 6 + 6000\beta = 1000$

$\Rightarrow 6000\beta = 1000 - 6$

$\Rightarrow \beta = \dfrac{1000 - 6}{6000} = \dfrac{994}{6000} = 0.16$

Q:- The gain & distortion of an amplifier are 150 & 5% respectively without feedback. If the stage has 10% of its o/p voltage apply as -ve feedback, Find the distortion of amplifier with -ve feedback.

Ans :- $A = 150$

$D = 5\%$

$\beta = 10\% = \dfrac{1}{10}$

$D_f = \dfrac{D}{1 + A\beta} = \dfrac{5\%}{1 + 15\cancel{0} \times \frac{1}{1\cancel{0}}} = \dfrac{5\%}{16} = 0.003.$

Q:- Determine the voltage gain, i/p & o/p impedance with feedback for a voltage series feedback having $A = -100$, $R_i = 10 K\Omega$, $R_o = 20 K\Omega$. (a) $\beta = -0.1$

(b) $\beta = -0.5$

(a) $A_f = \dfrac{A}{1 + A\beta} = \dfrac{-100}{1 + (-100)(-0.1)} = \dfrac{-100}{101} = -0.9$

$Z_{if} = Z_i(1+A\beta) =$

$$Z_{of} = \frac{Z_o}{1+A\beta} =$$

Q:- If an amplifier with gain $A = -1000$, with $\beta = -0.1$ has a gain change of 20% due to temperature. Calculate the change in gain of calculate feedback.

Ans:- $A = -1000$ $\qquad 100\cancel{0} \times \frac{1}{1\cancel{0}}$

$\beta = -0.1$

$$A_f = \frac{A}{1+A\beta}$$

$$\frac{dA_f}{dA} = \frac{(1+A\beta)1 - A(\beta)}{(1+A\beta)^2} = \frac{1}{(1+A\beta)^2}$$

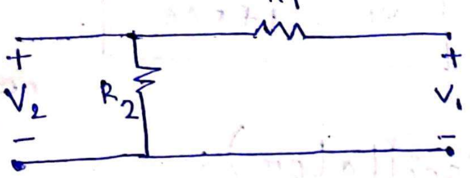
$$dA_f = \frac{dA}{(1+A\beta)^2} = \frac{20\%}{1+(-1000)(-0.1)} = \frac{20\%}{1+100}$$

$$= \frac{\frac{\cancel{20}^{1}}{\cancel{100}_{5}}}{101} = \frac{1}{505} = 0.0019.$$

Wednesday.

02/12/19

(1)



$\frac{V_2}{V_1} = ?$

$\frac{R_2}{R_1+R_2}$

In series, voltage division occurs.

$$V_2 = \frac{V_1 R_2}{R_1 + R_2}$$

$$\Rightarrow \frac{V_2}{V_1} = \frac{R_2}{R_1+R_2}.$$

★ Impedance offered by capacitor, $\frac{1}{j} \frac{1}{\Omega C} = \frac{1}{2\pi f C}$

inductor, $= j\omega L$ = ohm

resistor, $= R$.

↓

Unit = ohm

L = 1 Henry.

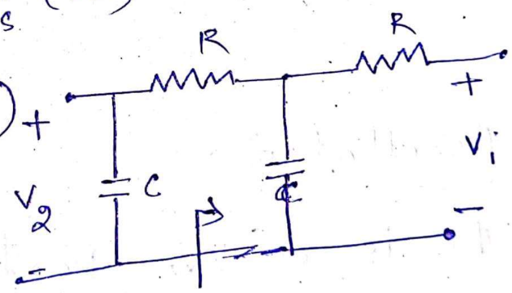
$i, j = \sqrt{-1}$

★ $Z_C = \frac{1}{j\omega C} = \frac{-1}{\omega C} = \frac{1}{CS}$ (Ω)

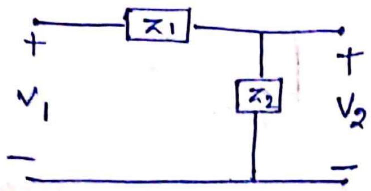
★ $Z_L = j\omega L = LS$ (Ω)

★ $\boxed{Z = R + jX}$

★ $S = \cancel{\sigma}^{0} + j\omega$



★. NOTE :-



$$\boxed{V_2 = \frac{V_1 \times Z_2}{Z_1 + Z_2}}$$

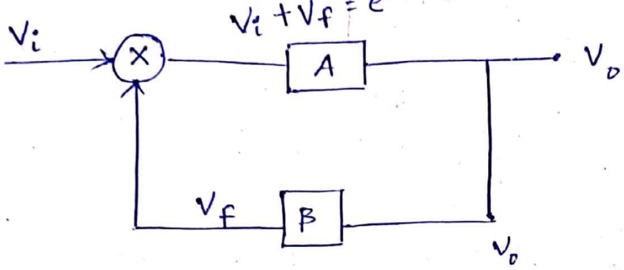
Z = Impedance

$$\Rightarrow V_2 = \frac{V_1 \times \frac{1}{CS}}{R + \frac{1}{CS}} = \frac{V_1}{RCS + 1}$$

$$\boxed{\frac{V_2}{V_1} = \frac{1}{1 + RCS}}$$

05/12/2019

Positive Feedback (Oscillator) :-



$$\boxed{\beta = \frac{V_f}{V_o}}$$

e → error.

$$\frac{V_o}{e} = A$$

$$\boxed{V_f = \beta V_o}$$

$$\Rightarrow V_o = eA = (V_i + V_f)A$$

$$= V_i A + \beta V_o A$$

$V_o = \sin\omega_o t$.

$$V_o(1 - A\beta) = V_i A$$

$$\boxed{A_f = \frac{V_o}{V_i} = \frac{A}{1 - A\beta}}$$

Oscillator :-

It is a +ve feedback circuit in which there is no external input is applied and its generate and produces a sino-sodial signal (single frequency component).

Sustain Oscillator :-

When the O/P signal is a sinosodial with one frequency and the peak amplitudes are fixed that signal is known as sustain oscillated signal.

Condition for sustain oscillation :-
(Bark hansen's critarion of principle)

$$A_f = \frac{A}{1 - A\beta}$$

$$1 - A\beta = 0$$

$$A\beta = 1 = 1 + j0 = 1 \angle 0^\circ \text{ or } 360^\circ$$

$$|A\beta| = 1 \quad , \quad \angle AB = 360^\circ$$

$$i = j = \sqrt{-1}$$

$$|z| = \sqrt{x^2 + y^2} \qquad \theta = \tan^{-1}\left|\frac{y}{x}\right|$$

$$z = x + iy$$
$$= |z| e^{j\theta}$$
$$= |z| \angle \theta$$

$\beta \rightarrow$ May be real or may be complex.

gain = Real number
i.e A = real.

$$z = 1 + j1$$
$$= \sqrt{2} \angle 45^\circ$$

$$z = j = 0 + j1$$
$$= 1 \angle 90^\circ$$

$$z = 1 + j0$$
$$= 1 \angle 0^\circ \text{ or } 360^\circ$$

$\beta \rightarrow$ Feedback factor / Gain of β network.

$A \rightarrow$ Gain of basic amplifier / Gain without feedback

$A\beta \rightarrow$ Loop gain.

Principles :-

1. Magnetude of loop gain = 1

$|A\beta| = 1$ (magnitude condⁿ)

2. Phase of loop gain = 360°.

$\angle A\beta = 360°$. (Phase condⁿ)

3. $\beta = \beta_r + j\beta_i$

For sustain oscillator,

$A\beta = 1$

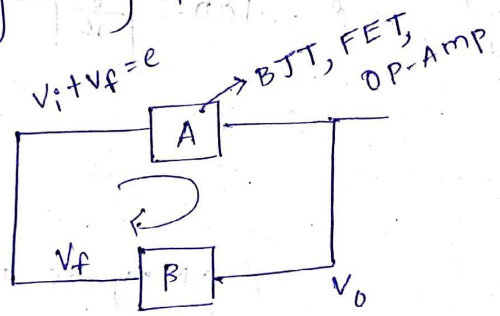
$A(\beta_r + \cancel{j\beta_i}^{0}) = 1$

$Im(\beta) = \beta_i = 0$ (It must be 0).

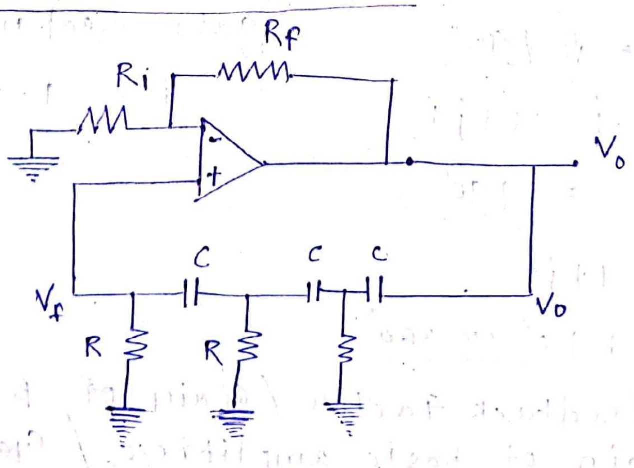
Procedure to calculate frequency of Oscillat? (ω_0, F_0)

→ calculate β.

→ Put imaginary part of β to calculate F_0.



RC phase shift oscillator :-



Note :-

$$Z_C = \frac{1}{j\omega C} = \frac{1}{sC}$$

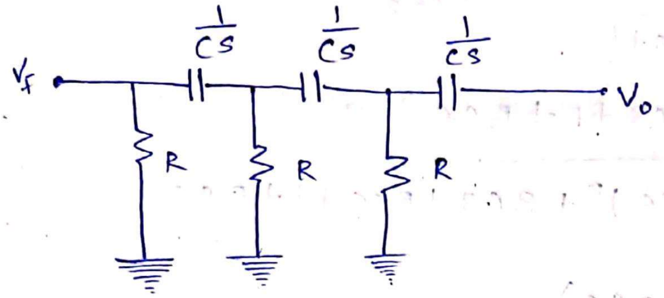
$$Z_L = j\omega L = sL$$

$$Z_R = R$$

Q.1 ← 1 mark. compulsory.

2, 3, 4, 5, 6 } 2 mark

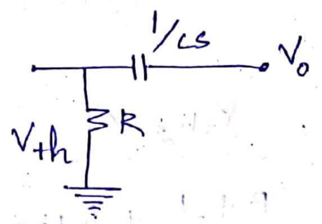
7, 8, 9, 10, 11 } Lq.



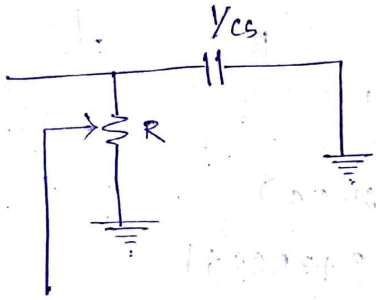
Derivation of frequency of oscillator:-

$$V_{th_1} = \frac{V_o \times R}{R + \frac{1}{Cs}}$$

$$= \frac{V_o RCs}{RCs + 1}$$

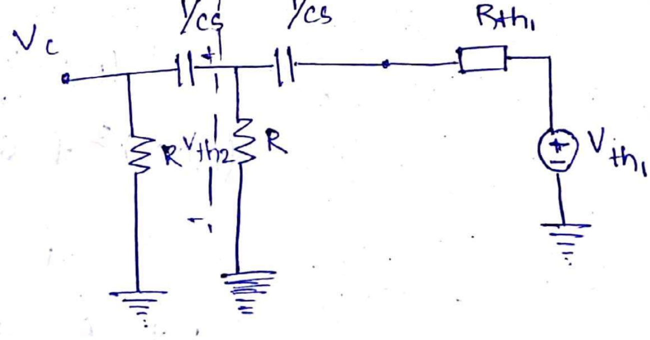


R_{th_1}



R_{th_1}

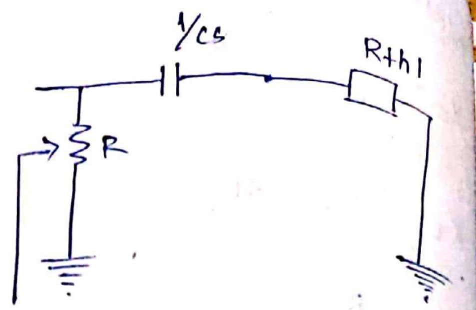
$$R_{th_1} = \frac{R \times \frac{1}{Cs}}{R + \frac{1}{Cs}}$$



$$V_{th_2} = \frac{V_{th_1} R}{\frac{1}{Cs} + \frac{R}{RCs+1} + R}$$

$$= \frac{\frac{V_o RCs}{\cancel{1+RCs}} \cdot R}{\frac{1 + RCs + RCs + (RCs)^2 + RCs}{Cs(\cancel{1+RCs})}}$$

$$= \frac{V_0 (RCs)^2}{(RCs)^2 + 3RCs + 1}$$

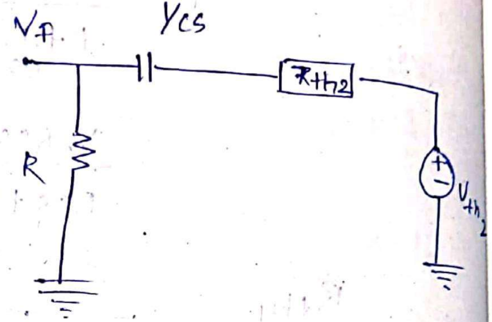


Rth2

$$R_{th2} = \frac{R\left(\frac{1}{Cs} + \frac{R}{RCs+1}\right)}{R + \frac{1}{Cs} + \frac{R}{RCs+1}}$$

$$R_{th2} = \frac{R(RCs + 1 + RCs)}{(RCs)^2 + RCs + RCs + 1 + RCs}$$

$$= \frac{R(1 + 2RCs)}{(RCs)^2 + 3RCs + 1}$$



$$V_f = \frac{V_{th_2} \times R}{R + \frac{1}{Cs} + R_{th_2}}$$

$$= \frac{\frac{V_0 (RCs)^2}{(RCs)^2 + 3RCs + 1} R}{R + \frac{1}{Cs} + \frac{R(1+2RCs)}{(RCs)^2 + 3RCs + 1}}$$

$$\boxed{\begin{aligned} s &= j\omega \\ s^2 &= -\omega^2 \\ s^3 &= -j\omega^3 \end{aligned}}$$

$$\beta = \frac{V_f}{V_0} = \frac{(RCs)^3}{(RCs)^3 + 3(RCs)^2 + RCs + (RCs)^2 + 3RCs + 1 + RCs + 2(RCs)^2}$$

$$= \frac{(RCs)^2}{(RCs)^3 + 6(RCs)^2 + 5RCs + 1}$$

$$= \frac{1}{1 + \frac{6}{RCs} + \frac{5}{(RCs)^2} + \frac{1}{(RCs)^3}}$$

$$= \frac{1}{1 - \frac{j6}{RC\omega} - \frac{5}{R^2C^2\omega^2} + j\frac{1}{R^3C^3\omega^3}}$$

$$\Rightarrow \beta = \frac{1}{1 - \frac{5}{R^2c^2\omega^2} - j\left(\frac{6}{RC\omega} - \frac{1}{R^3c^3\omega^3}\right)}$$

For sustain oscillation,

$$\frac{6}{RC\omega} - \frac{1}{R^3c^3\omega^3} = 0$$

$$\Rightarrow \frac{6}{\cancel{R}\cancel{C}\cancel{\omega}} = \frac{1}{R^{\cancel{3}2}c^{\cancel{3}2}\omega^{\cancel{3}2}}$$

$$\Rightarrow 6R^2c^2\omega^2 = 1$$

$$\Rightarrow \omega^2 = \frac{1}{6R^2c^2}$$

$$\Rightarrow \omega = \frac{1}{\sqrt{6}\,RC}$$

$$\Rightarrow F_0 = \frac{1}{2\pi\sqrt{6}\,RC}$$

$$A\beta_R = 1$$

$$\Rightarrow A \frac{1}{1 - \frac{5}{R^2c^2\omega^2}} = 1$$

$$\Rightarrow A = 1 - \frac{5}{R^2c^2\omega^2}$$

$$\Rightarrow A = 1 - \frac{5}{\cancel{R^2}\cancel{c^2} \times \frac{1}{6\cancel{R^2}\cancel{c^2}}} = 1 - 30 = -29$$

$$\Rightarrow A = -29$$