BVM Engineering College, VV Nagar

Gujarat Technological University

ANALOG CIRCUIT DESIGN

SEM 4
PRESENTATION

Barkhausen & Nyquist Criteria

Electronics & Communication Dept.

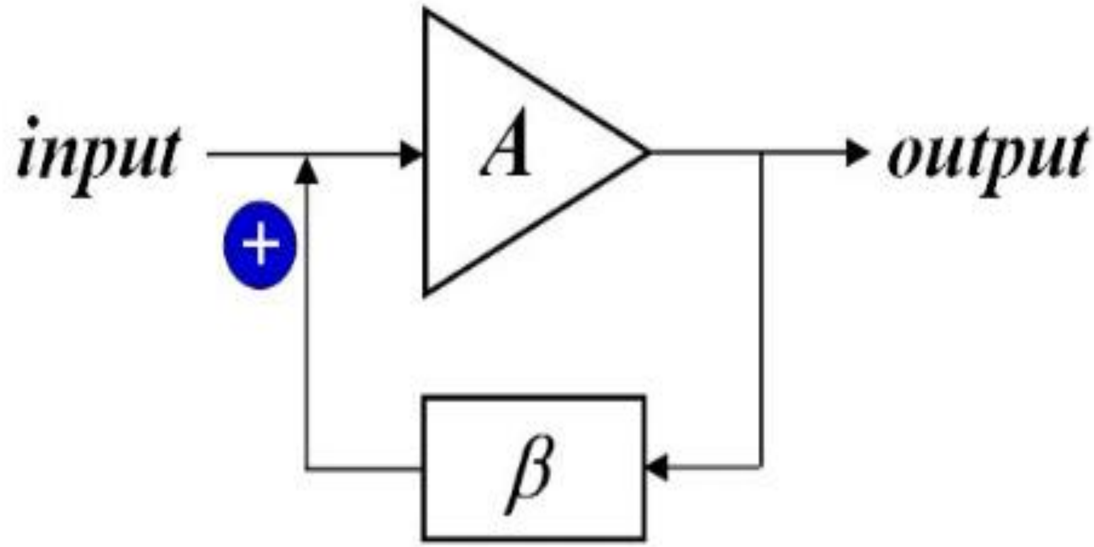
Presented By :

- Drupad Pandya (140080111021)
- Chaitanya Tejaswi (140080111013)

Barkhausen Stability Criterion

Positive Feedback

- Positive feedback is the process when the output is *added* to the input, amplified again, and this process continues.



- Positive feedback is used in the design of oscillator and other application.

POSITIVE FEEDBACK

There are two types of feedback namely positive and negative

An oscillator is an amplifier with positive feedback incorporated in it.

It can be proved that the amplifier gain with feedback(A_f) is given by

$A_f = A/(1- A\beta)$

$A\beta$ is positive quantity so $(1-A\beta) < 1$

Therefore $A_f > A$

Thus positive feedback increases amplifier gain

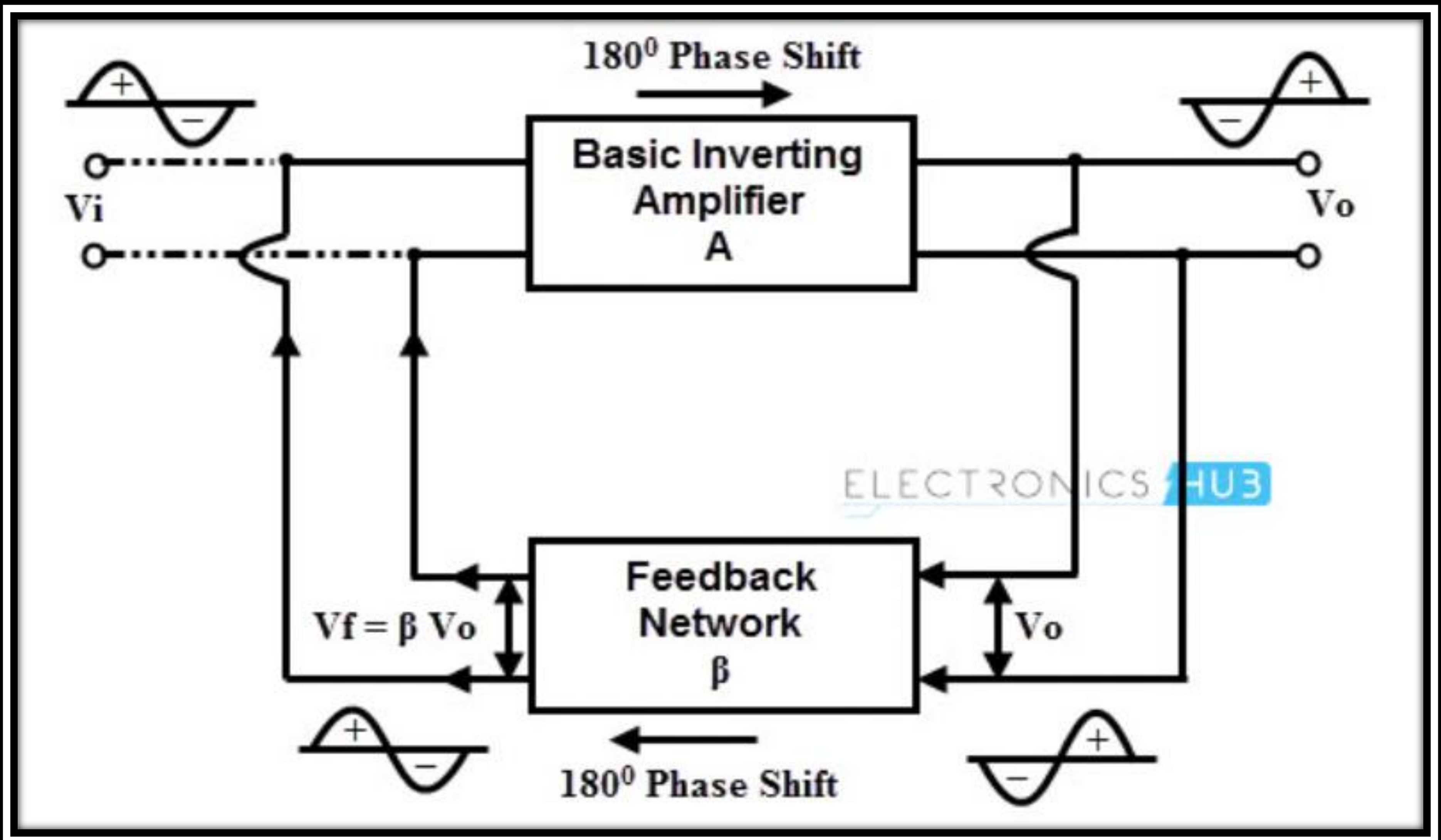
At particular value of β , A_f will become infinite and thus amplifier will start working as oscillator

BARKHAUSEN STABILITY CRITERIA

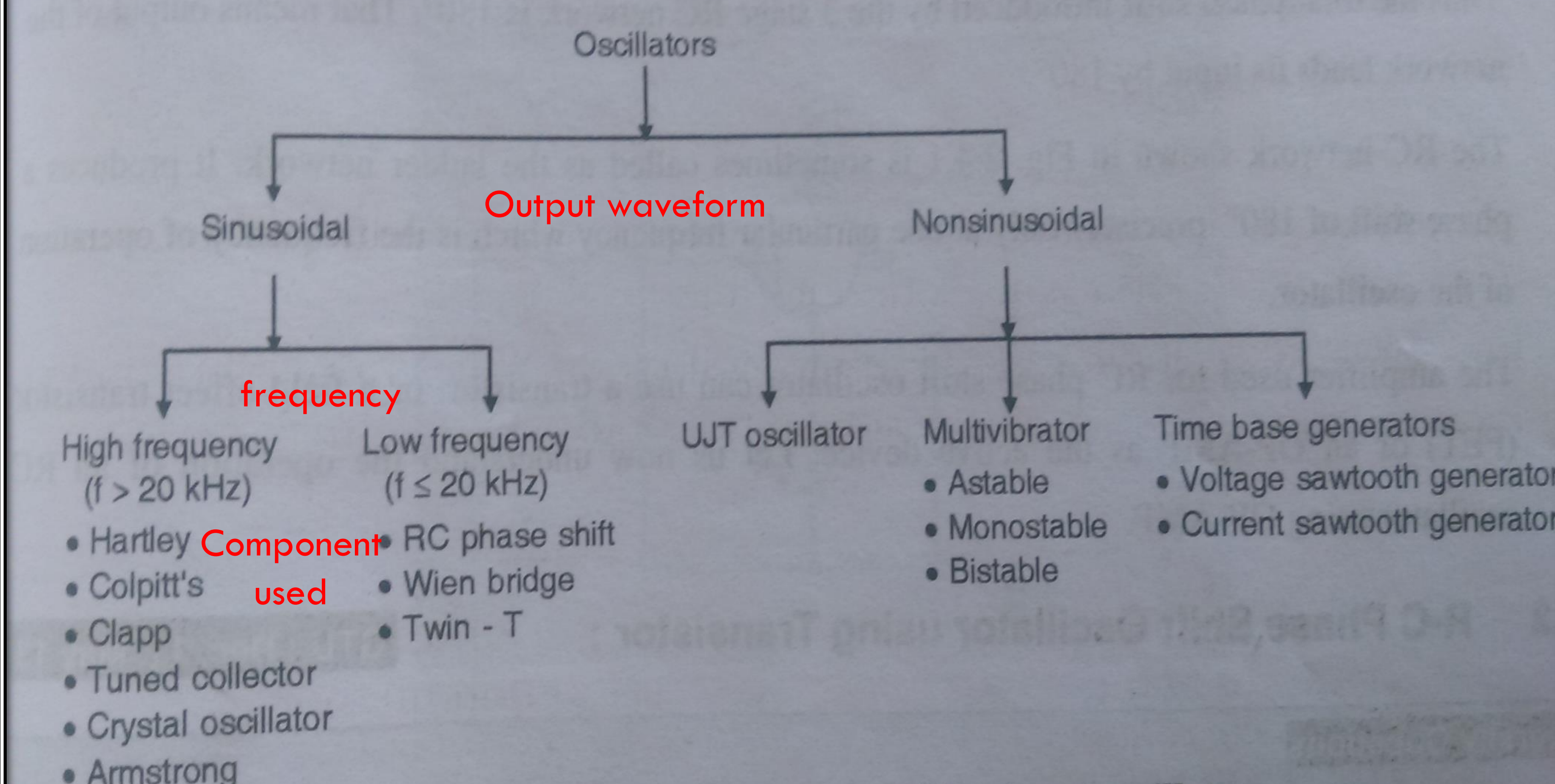
- 1.An oscillator will operate at frequency at which total phase shift introduced, as measured from the input terminals through amplifier and feedback network and back again to input terminals is precisely 0 or integral multiple of 360 degree.
- 2.At oscillator frequency the magnitude of product of open loop gain of amplifier A and feedback network β is equal or greater than unity i.e

$$|A\beta| \geq 1$$

BLOCK DIAGRAM OF OSCILLATOR FOLLOWING BARKHAUSEN CRITERIA



CLASSIFICATION OF OSCILLATOR



(F-790) **Fig. 2.3.4 : Complete classification of oscillators**

Nyquist Stability Criterion

General Equation

The transfer gain of an amplifier employing feedback is given by (13-4), namely,

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

If $|\beta A| \gg 1$, then

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

Frequency Domain

Single-pole Transfer Function The gain A of a single-pole amplifier is given by

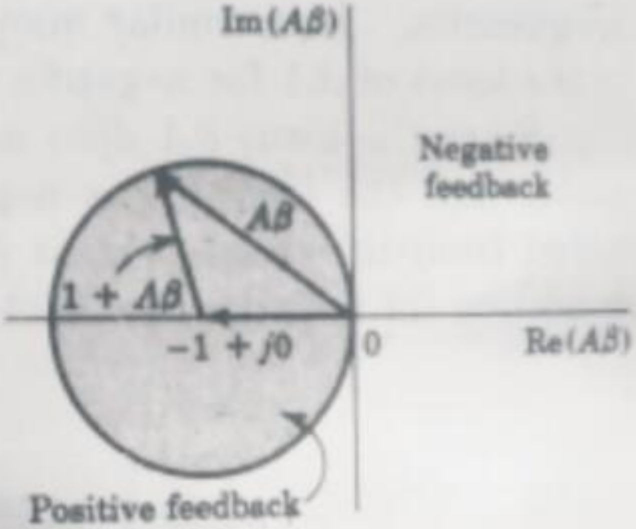
$$A = \frac{A_o}{1 + j(f/f_H)} \quad (14\text{-}2)$$

where A_o (real and negative) is the midband gain without feedback, and f_H is the high 3-dB frequency. The gain with feedback is given by Eq. (14-1), or using Eq. (14-2),

$$A_f = \frac{A_o/[1 + j(f/f_H)]}{1 + \beta A_o/[1 + j(f/f_H)]} = \frac{A_o}{1 + \beta A_o + j(f/f_H)}$$

Nyquist Criteria

Fig. 14-17 The locus of $|1 + A\beta| = 1$ is a circle of unit radius, with its center at $-1 + j0$. If the vector $A\beta$ ends in the shaded region, the feedback is positive.



The amplifier is unstable if the plot of $\boldsymbol{A\beta}$ in the **s-plane** encloses the point $\mathbf{-1 + j0}$

Illustration Consider an amplifier with an open-loop dominant pole so that the transfer-gain is represented by Eq. (14-2). Hence

$$\beta A = \frac{\beta A_o}{1 + j(f/f_H)} \tag{14-48}$$

$$\beta A + j\beta A \frac{f}{f_H} = \beta A_o \tag{14-49}$$

Example

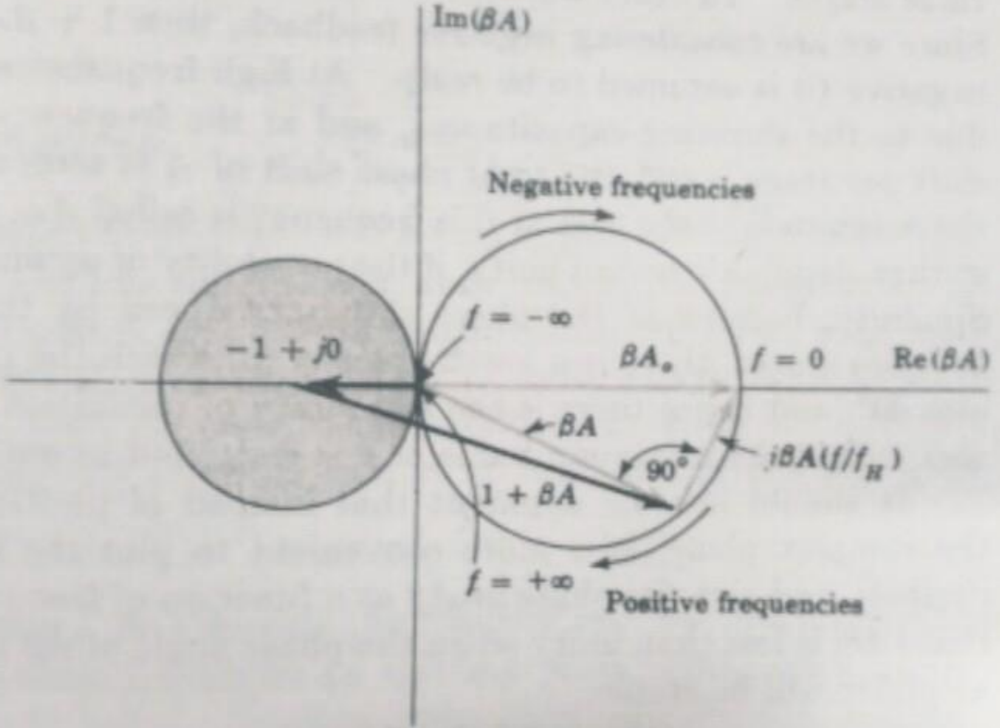
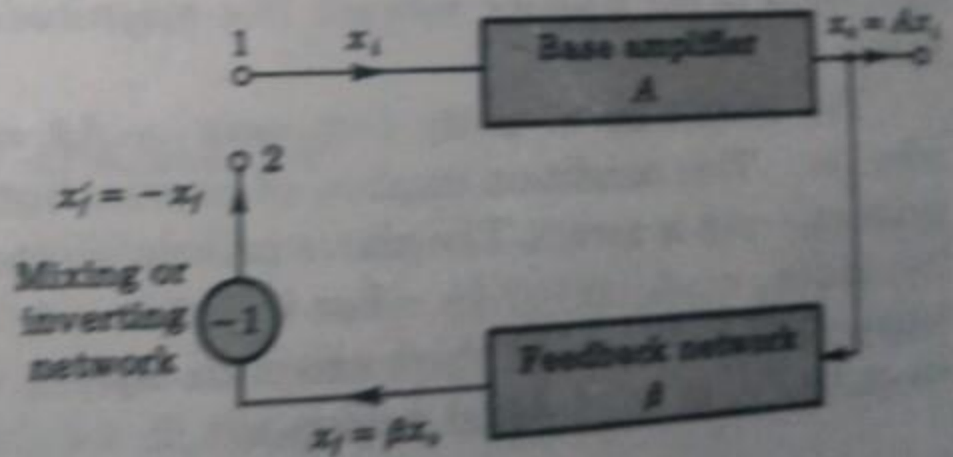


Fig. 14-18 For a dominant-pole amplifier, the locus (for all values of frequency) of βA in the complex βA plane is a circle in the right half plane.

Revisiting Barkhausen Criteria

Fig. 14-28 An amplifier with transfer gain A and feedback network β not yet connected to form a closed loop. (Compare with Fig. 13-8.)



$$x_f' = -x_f = -A\beta x_i$$

From Fig. 14-28 the loop gain is

$$\text{Loop gain} = \frac{x_f'}{x_i} = \frac{-x_f}{x_i} = -\beta A$$

THANK YOU !