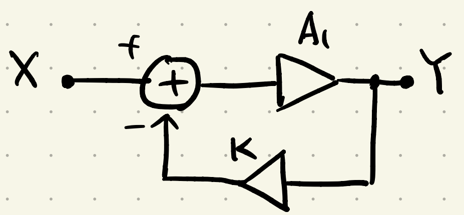
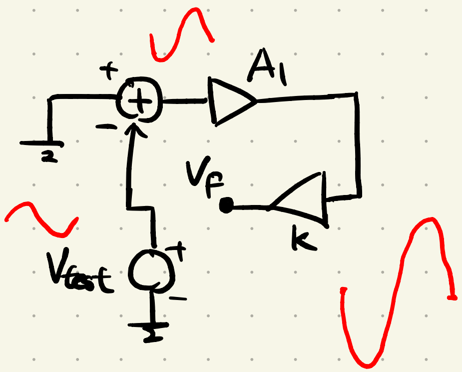
Lec 43

- Instability in Negative Feedback Analysis

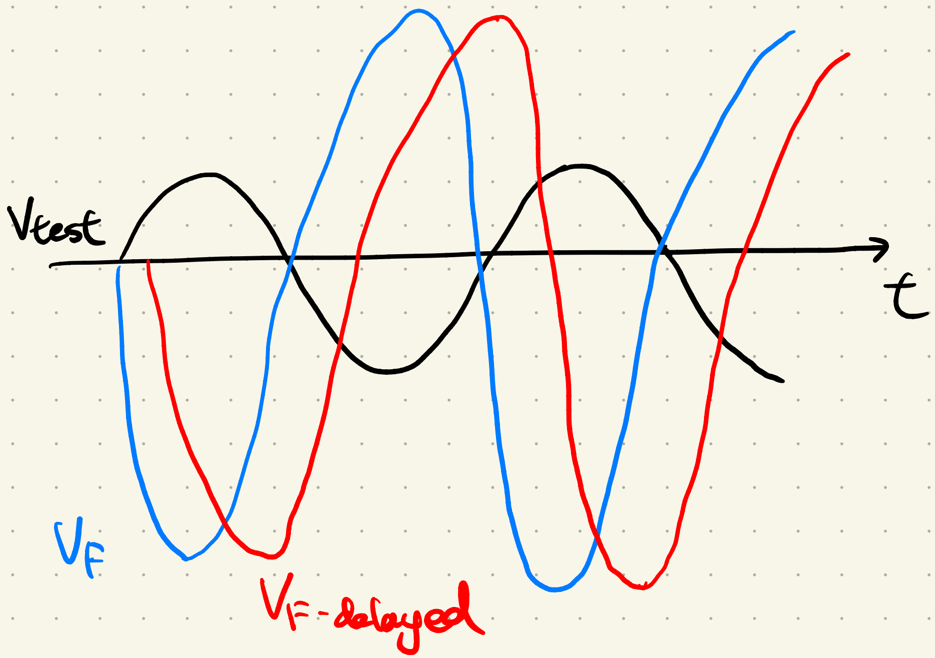
Observations

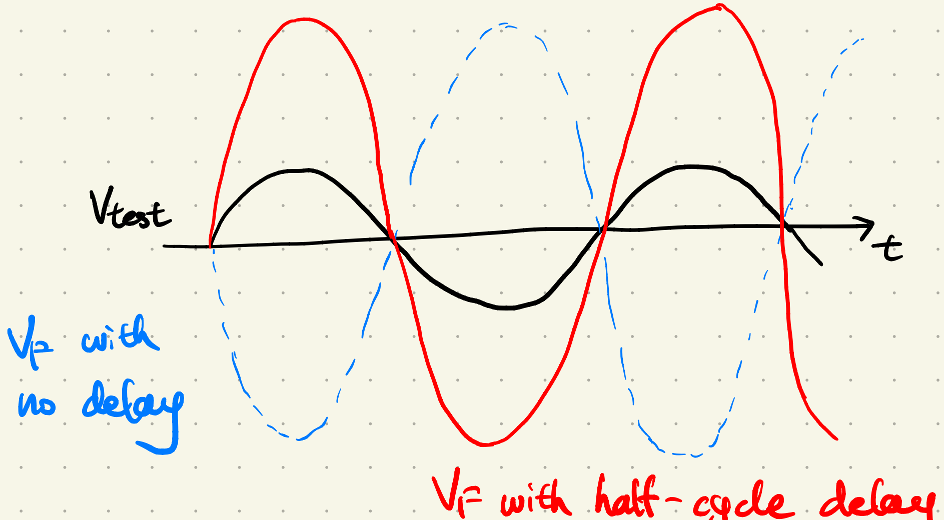




$$\text{Loop Gain} = -\frac{V_F}{V_{test}} = KA_1$$

V_F opposes V_{test}



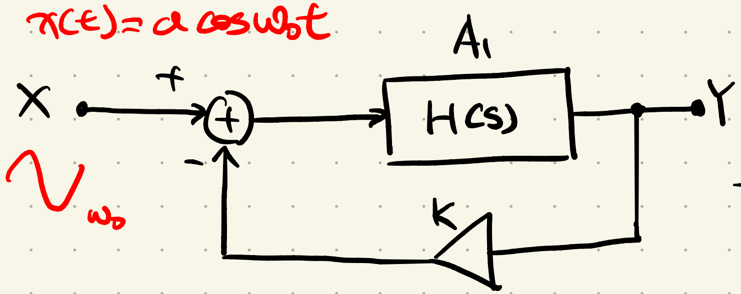


V_F enhances V_{test}

→ feedback is positive!

Analysis of Instability

$x(t) = a\cos\omega_0 t$



$$\frac{Y}{X} = \frac{H(s)}{1+KH(s)}$$

$$\Rightarrow \frac{Y}{X} = \frac{H(s=j\omega_0)}{1+\underbrace{KH(s=j\omega_0)}_{\to -1}} = \infty$$

$\to -1 \Rightarrow$ unstable loop

$\Rightarrow$ { Good for building Oscillators
Bad for building amps.

A Closer Look

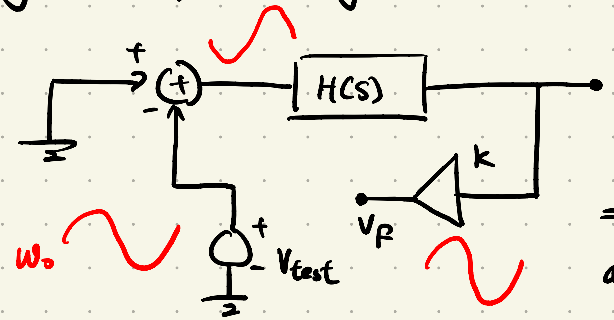
If $KH(j\omega_0) = -1 \Rightarrow$ loop is unstable

To avoid instability, we need to ensure the

$$KH(j\omega) \neq -1 \quad \text{for any } \omega$$

$$KH(j\omega) = -1 \Rightarrow \begin{cases} |KH(j\omega)| = 1 \\ \angle KH(j\omega) = 180^\circ \end{cases}$$

Try the loop test again:

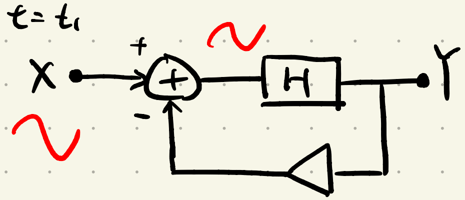


V_F enhances V_{test}

$\Rightarrow$ feedback is positive at a frequency of ω_0

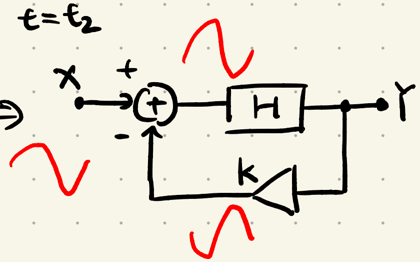
Examine the close-loop system in the time domain

$t = t_1$



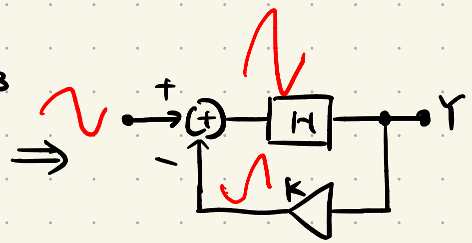
$t = t_2$

$\Rightarrow$

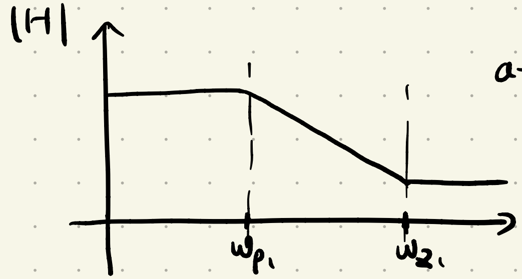


$t = t_3$

$\Rightarrow$



Review of Bode's Rules



$a+jb \to |a+jb| = \sqrt{a^2+b^2}$

$a+jb \to \angle(a+jb) = \arctan\frac{b}{a}$