LTIC system combinations - Example # 22

- Consider the system below

$\hat{F_1} = \hat{F} \cdot \hat{H}^*$

basic feedback

$\hat{F_1}$ $\hat{H_a}$ $\hat{Y}(s) = \hat{H} \cdot \hat{F}$

$\hat{H}^*$ $\hat{H_b}$

$\hat{H_1}$
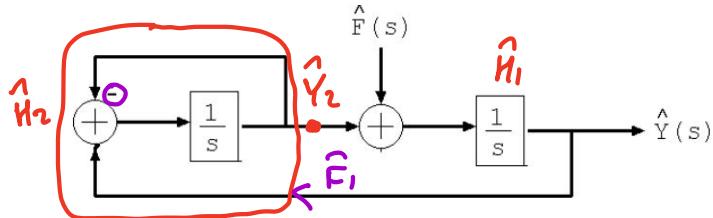
- Determine the overall system's transfer function.

$$\hat{Y} = \hat{F_1} \cdot \hat{H_1} = \hat{F_1}\left(\frac{\hat{H_a}}{1 - \hat{H_b}\hat{H_a}}\right) = \hat{F} \cdot \hat{H}^*\left(\frac{\hat{H_a}}{1 - \hat{H_b}\hat{H_a}}\right) = \hat{F} \cdot \frac{1}{s+1}\left(\frac{\frac{1}{s+1}}{1 - \frac{1}{s+1}\cdot\frac{2}{s}}\right) =$$

$$= \hat{F}\left(\frac{s}{(s+1)(s+2)(s-1)}\right)$$

$\underbrace{\qquad\qquad\qquad}_{\hat{H}}$
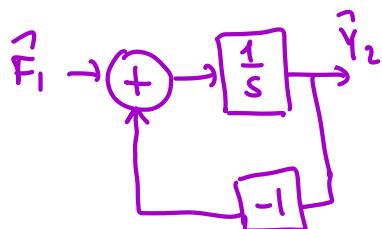
poles @ $s = -1, -2, 1$ ← RHP

not BIBO stable!

LTIC system combinations - Example # 23
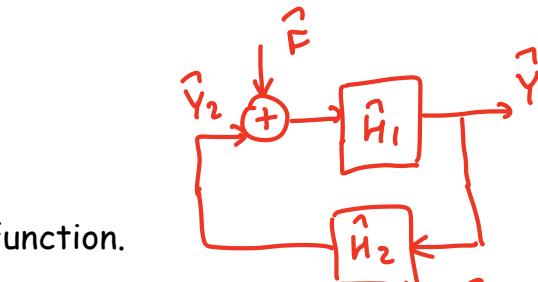
- Consider the system below

$\hat{F}(s)$

$\hat{H_2}$ $\oplus$ → $\boxed{\dfrac{1}{s}}$ $\hat{Y_2}$ ● $\oplus$ → $\boxed{\dfrac{1}{s}}$ $\hat{H_1}$ → $\hat{Y}(s)$

$\hat{F_1}$

- Determine the overall system's transfer function.

$\hat{F}$

$\hat{Y_2}$ $\oplus$ → $\boxed{\hat{H_1}}$ → $\hat{Y}$

$\boxed{\hat{H_2}}$

$\hat{F_1}$ → $\oplus$ → $\boxed{\dfrac{1}{s}}$ → $\hat{Y_2}$

$\boxed{-1}$

$\hat{Y_2} = \hat{F_1} \left(\dfrac{1/s}{1 - \frac{1}{s}(-1)} \right) = \hat{F_1} \cdot \left(\dfrac{1}{s+1} \right)$

$\underbrace{\qquad}_{\hat{H_2}}$

$\hat{Y} = \hat{F} \left(\dfrac{\hat{H_1}}{1 - \hat{H_2}\hat{H_1}} \right) =$

$\overset{\hat{H_1}}{\frown}$

$= \hat{F} \left(\dfrac{1/s}{1 - \frac{1}{s+1} \cdot \frac{1}{s}} \right) =$

$= \hat{F} \left(\dfrac{s+1}{s^2 + s - 1} \right)$

$\underbrace{\qquad}_{\hat{H}}$

not BIBO stable!   RHD! $= \hat{F} \left(\dfrac{s+1}{s^2+s-1} \right)$

poles @ 0.618
          -1.618

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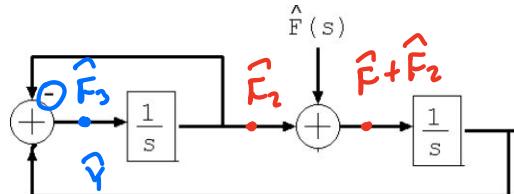
- ## LTIC system combinations - Example # 23-cont
  - Consider the system below

$\hat{F}(s)$

Redo from scratch

$\hat{Y}(s) = (\hat{F} + \hat{F}_2) \cdot \frac{1}{s} = \left(\hat{F} + \hat{Y}\frac{1}{s+1}\right) \cdot \frac{1}{s} = \hat{Y}$

  - Determine the overall system's transfer function.

$\hat{F}_2 = \hat{F}_3 \cdot \frac{1}{s} = \left(\hat{Y} - \hat{F}_2\right) \cdot \frac{1}{s} \Rightarrow \hat{F}_2 = \frac{\hat{Y} \cdot \frac{1}{s}}{1 + \frac{1}{s}} = \hat{Y}\frac{1}{s+1}$

$\hat{Y} = \frac{\hat{F}\frac{1}{s}}{1 - \frac{1}{s} \cdot \frac{1}{s+1}} =$

$= \hat{F}\left(\frac{s+1}{s^2 + s + 1}\right)$

$\underbrace{\qquad}_{\hat{H}}$

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Chapter objectives

- Perform Laplace transforms
- Understand the region of convergence of Laplace transform and its relation to BIBO stability
- Understand the relation between Laplace transform and Fourier transform
- Understand and apply properties of Laplace transform
- Perform inverse Laplace transform of rational functions using partial fraction expansion
- Perform s-domain system analysis
- Obtain the general response of LTIC circuits and systems
- Perform analysis of LTIC system combinations

Good luck on the final exam! ☺