

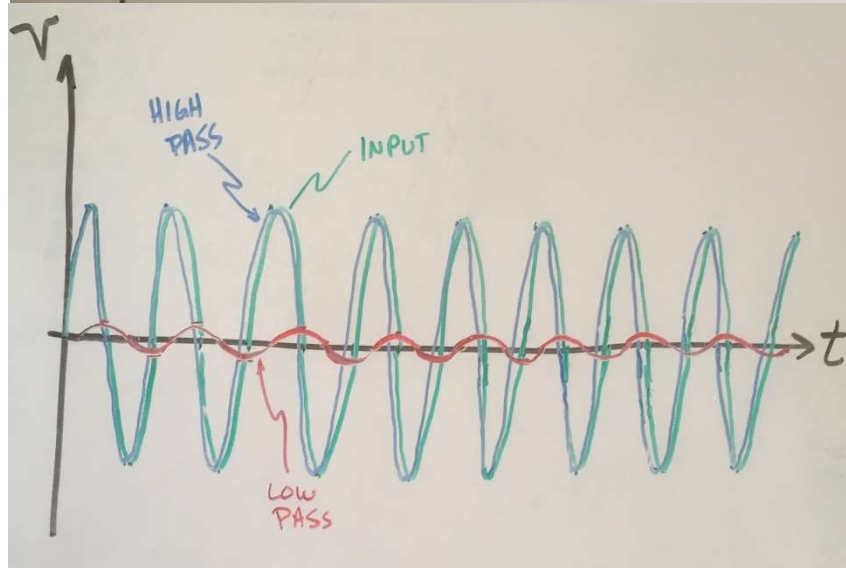
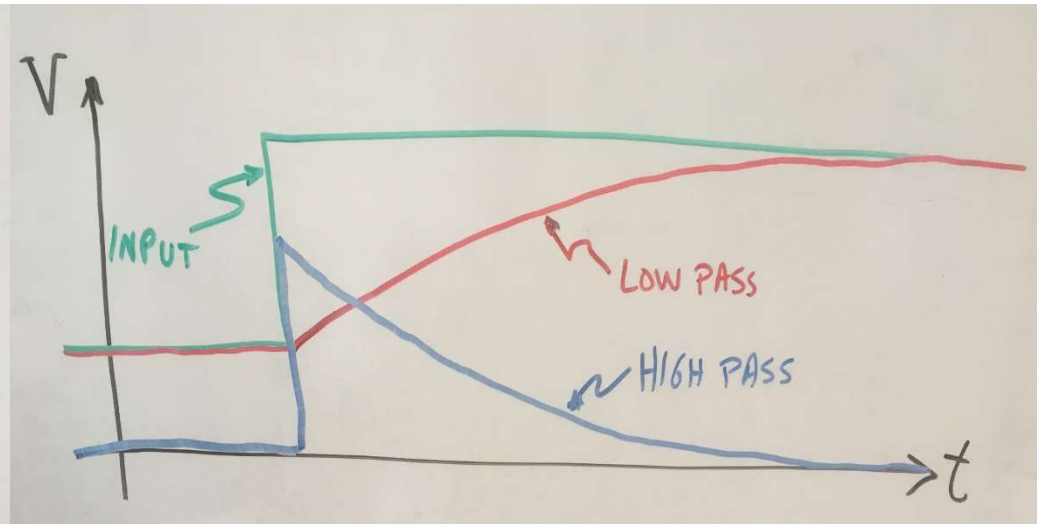
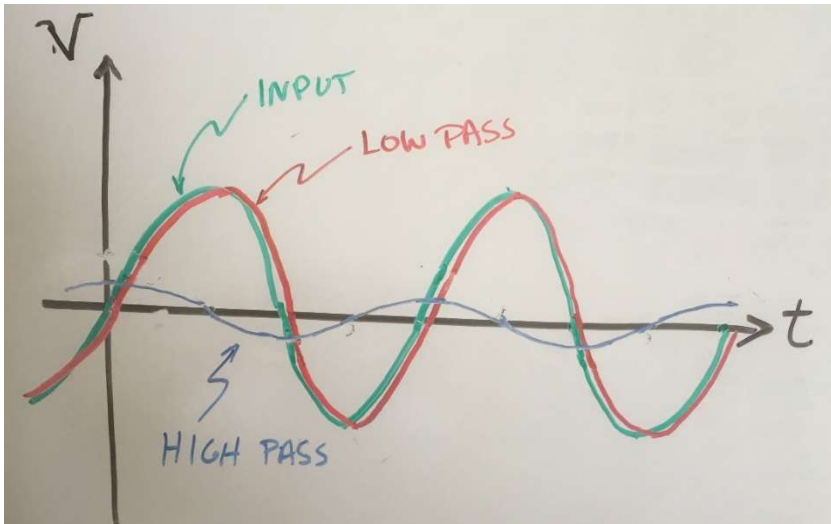
# Filter Implementation

ESE 421

2018-09-24

Bruce D. Kothmann

# Recall Filter Responses



**Low Pass**

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

**High Pass**

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

# Let's Practice Reading "s" on YF-16 CLAWS

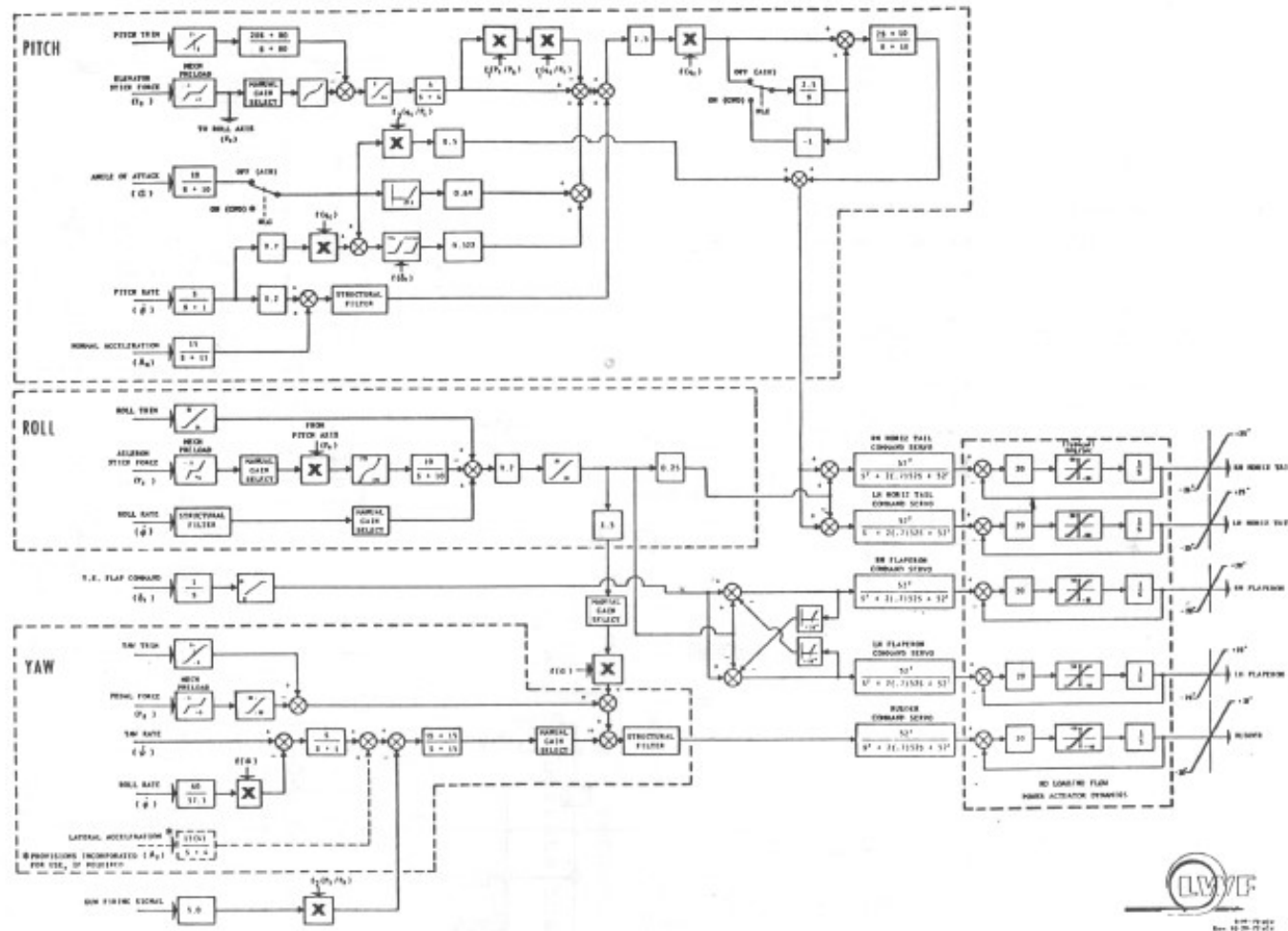


Figure 3.1-3 Original YF-16 Flight Control System Block Diagram

# Let's Practice Reading "s" on YF-16 CLAWS

Pilot Stick

Loadfactor  
(g's)

What & Why ?

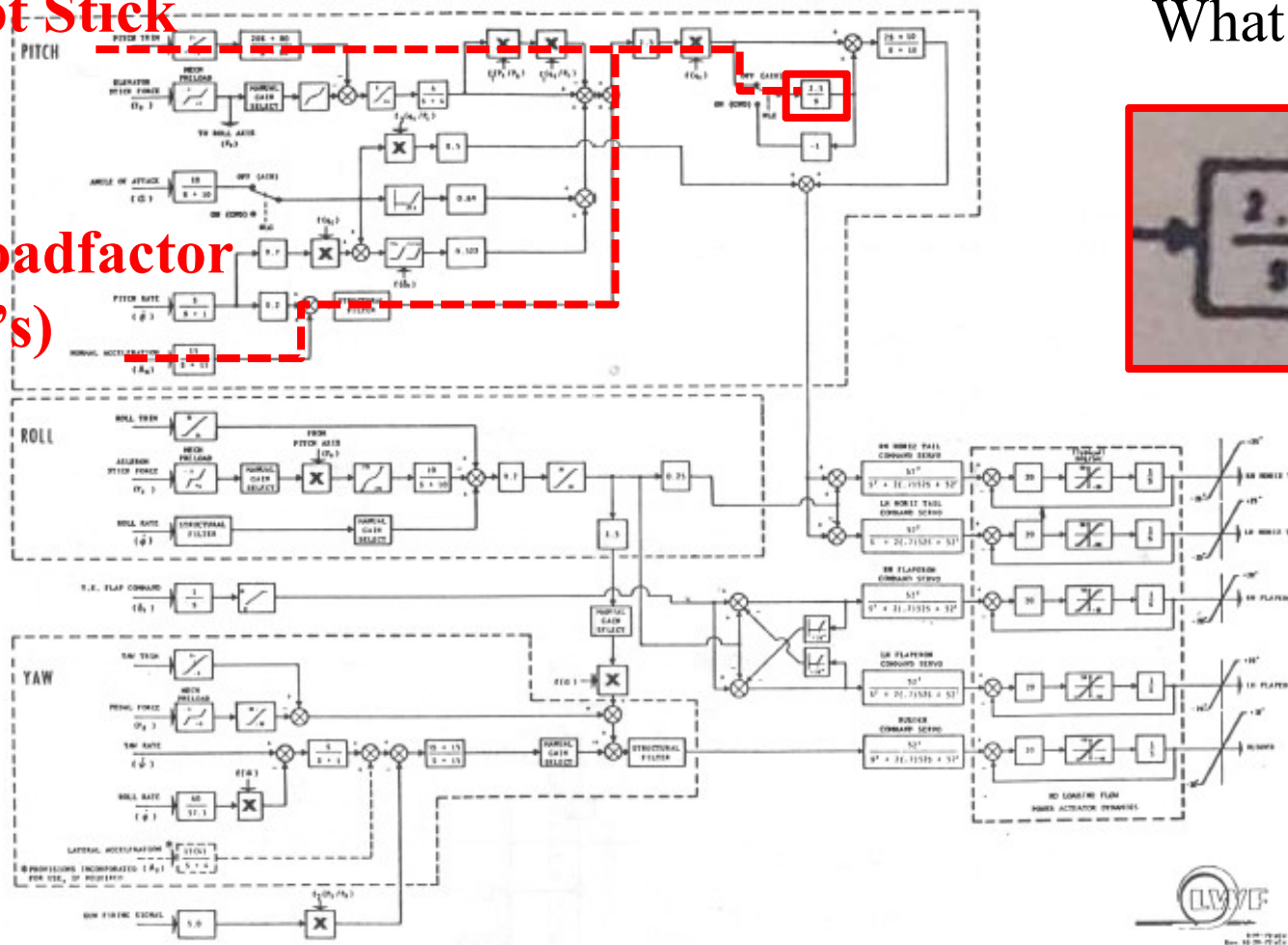
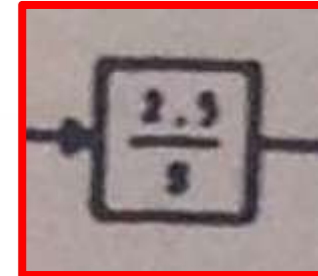


Figure 3.1-3 Original YF-16 Flight Control System Block Diagram

# Let's Practice Reading "s" on YF-16 CLAWS

What & Why ?

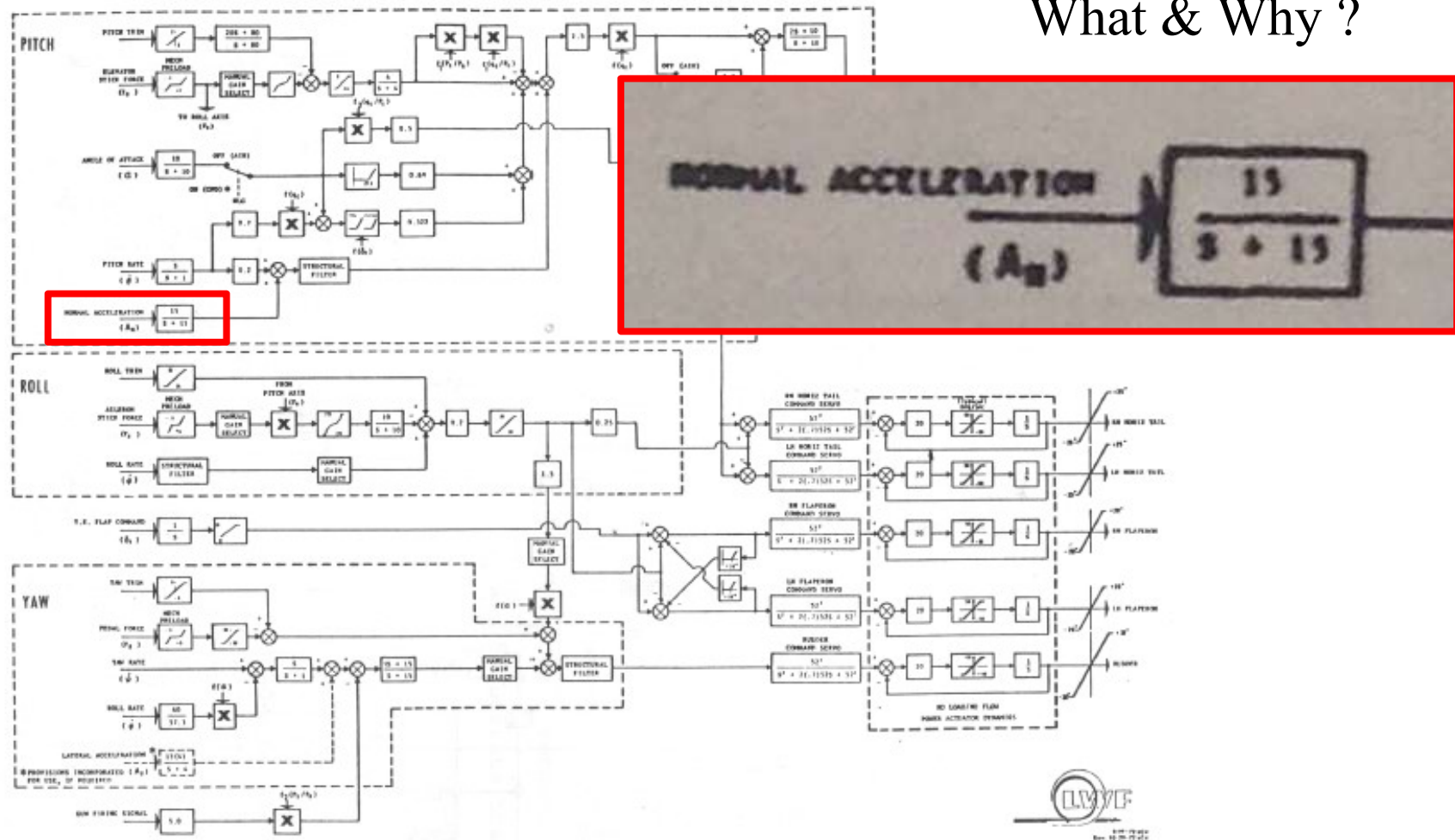


Figure 3.1-3 Original YF-16 Flight Control System Block Diagram



# Let's Practice Reading "s" on YF-16 CLAWS

What & Why ?

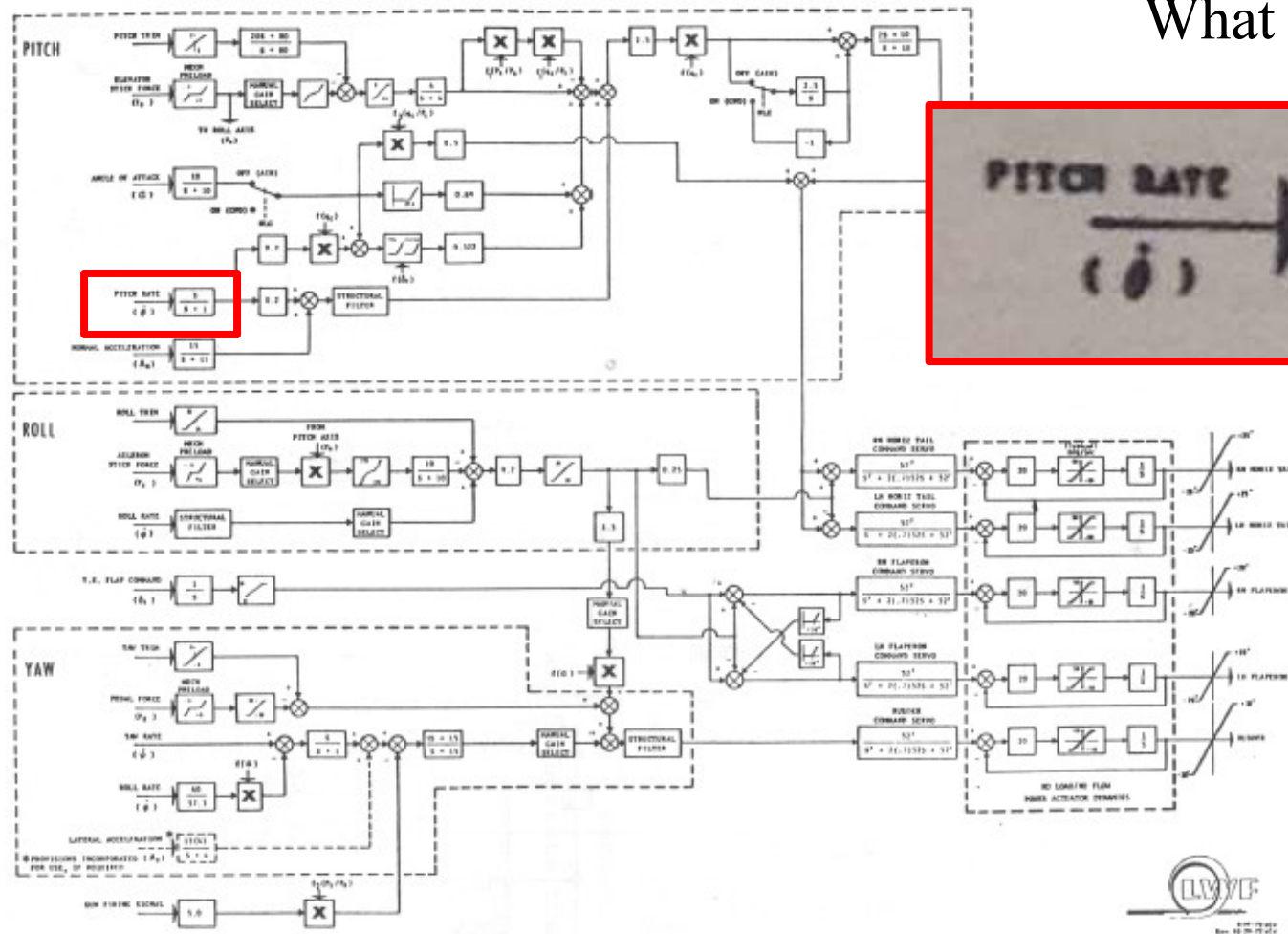
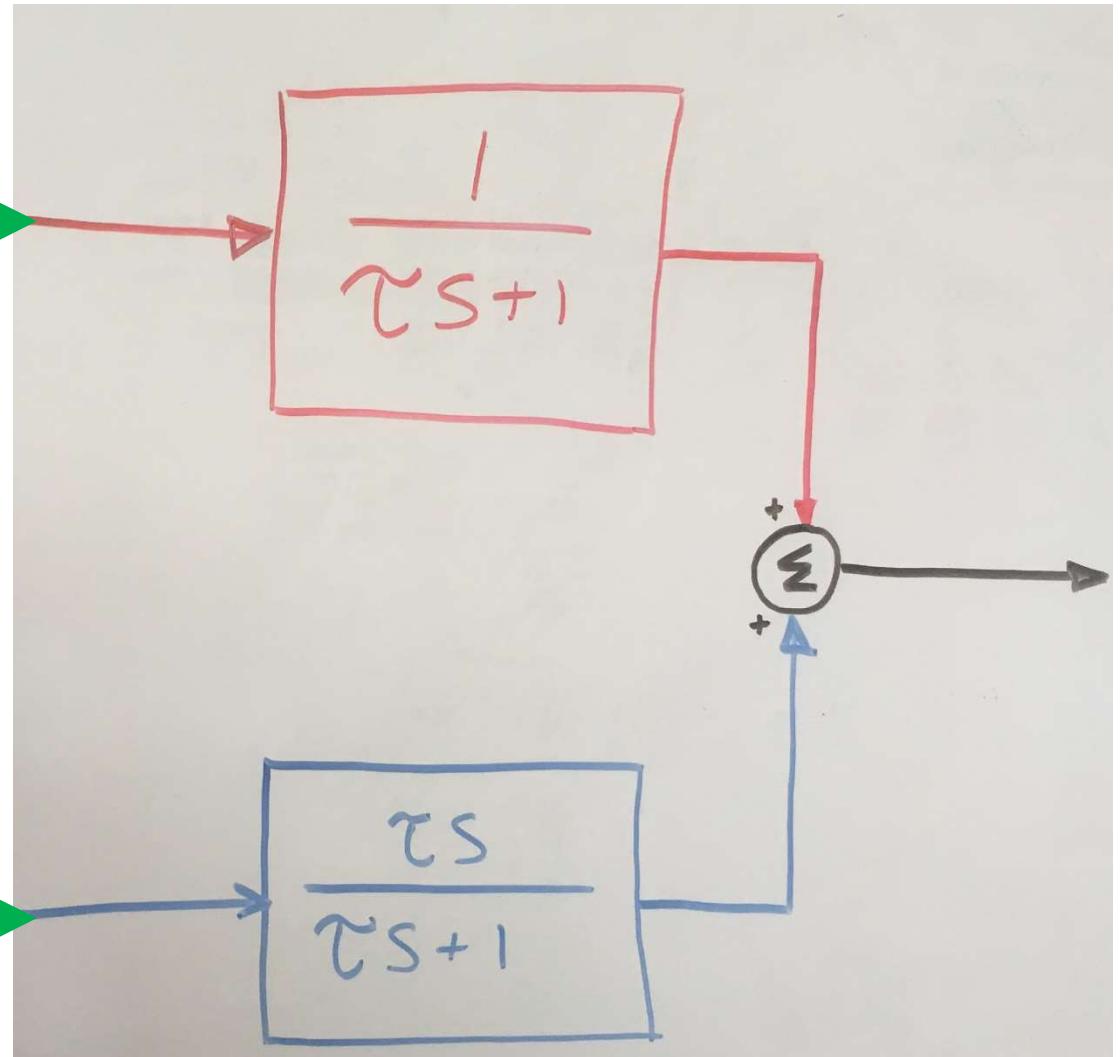


Figure 3.1-3 Original YF-16 Flight Control System Block Diagram

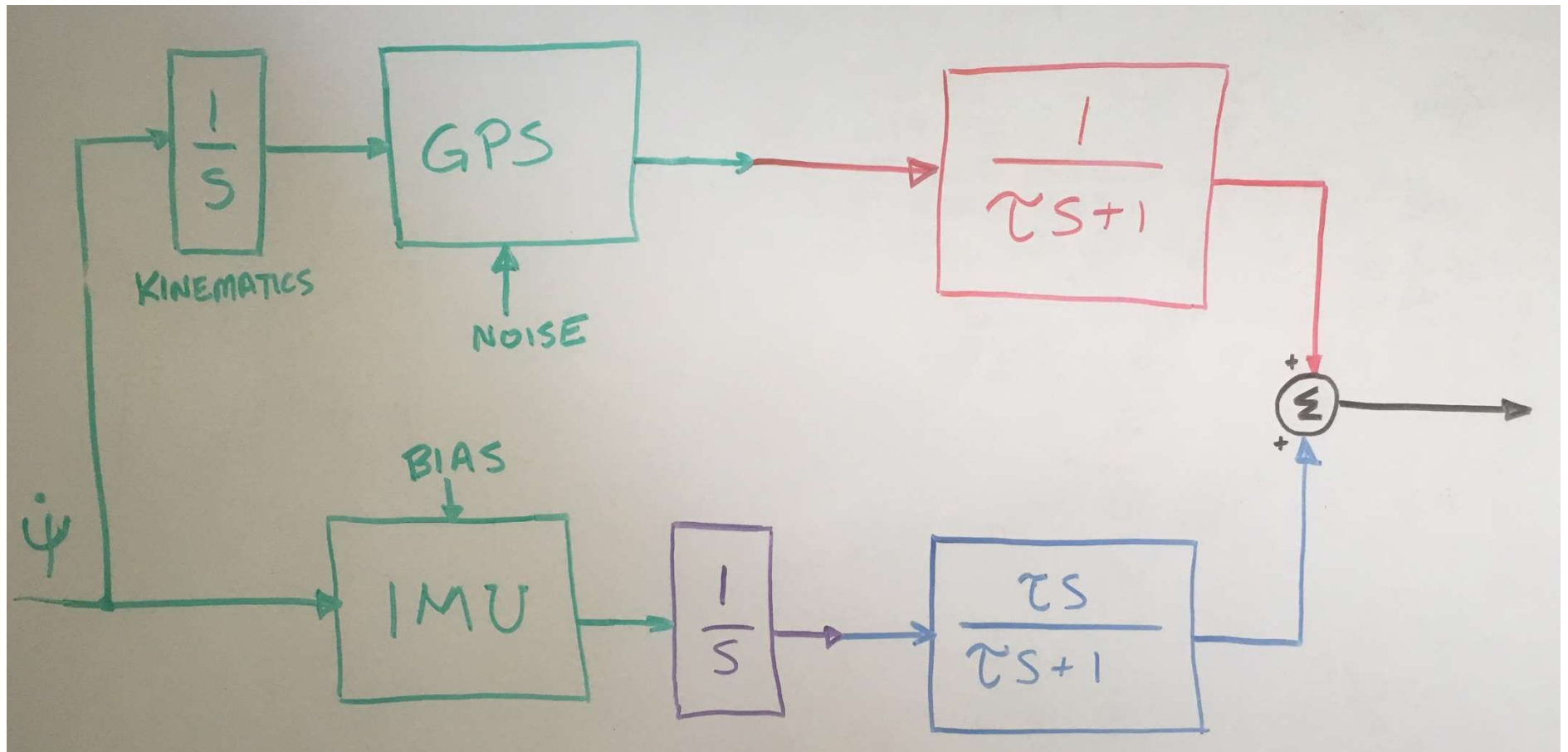
# Complementary Filter

Signal That is Accurate  
at Low Frequency /  
Steady State

Signal That is Accurate  
at High Frequency /  
After Rapid Change

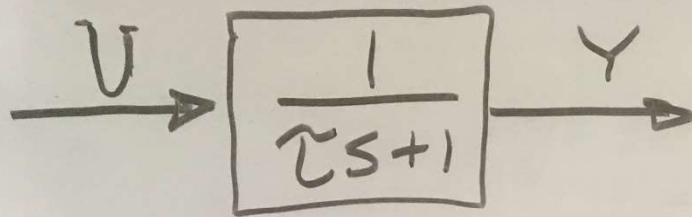


# Complementary Filter for Heading





# Implementation of Filters

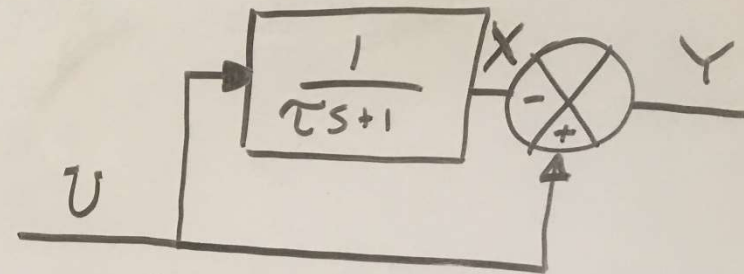
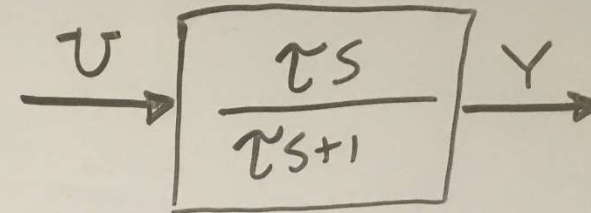


$$\tau \frac{dY}{dt} + Y = U$$

$$\frac{dY}{dt} = \frac{1}{\tau} (U - Y)$$

$$\frac{\Delta Y}{\Delta t} \approx \frac{1}{\tau} (U - Y)$$

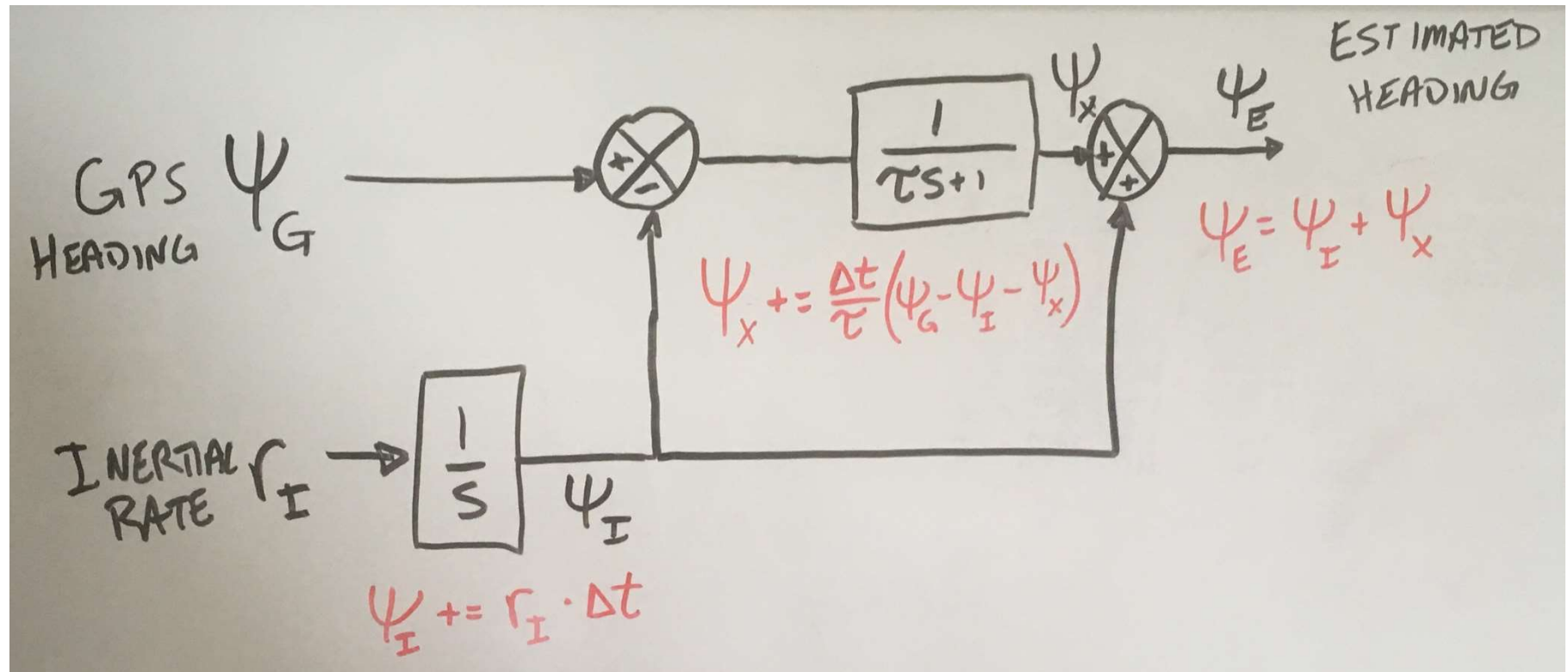
CODE  $Y += \left(\frac{\Delta t}{\tau}\right)(U - Y)$



$$\tau \dot{X} + X = U$$

$$\left. \begin{aligned} X &+= \left(\frac{\Delta t}{\tau}\right)(U - X) \\ Y &= U - X \end{aligned} \right\} \text{ CODE}$$

# Heading Complementary Filter Implementation



- Two Ways This Will Fail...
  1. "Heading Wrap" When Moving Due North
  2. "Integrator Drift" (May Only be Ugly, But Worth Fixing)
- How to Fix – Up to You!