

# Automatic Flight Control Systems

- Autopilot
  - Controls a/c trajectory w/o requiring input from pilot
- Stability Augmentation System (SAS) ← adjusting stability derivatives
  - Designed to improve dynamic stability
  - Relies on sensors, not on pilot inputs
- Control Augmentation System (CAS) ← adjusting control derivatives
  - Pilot input has two paths to control surfaces
    - Mechanical system
    - through the CAS electrical path
- Fly by Wire (FBW) ← choose your own derivatives
  - No mechanical link from pilot to actuators
    - (a CAS with complete authority)



Autopilot: 1910s  
(A/C: Lockheed Vega (1930s))



SAS (F-104) 1950s



CAS (F-15) Early '70s



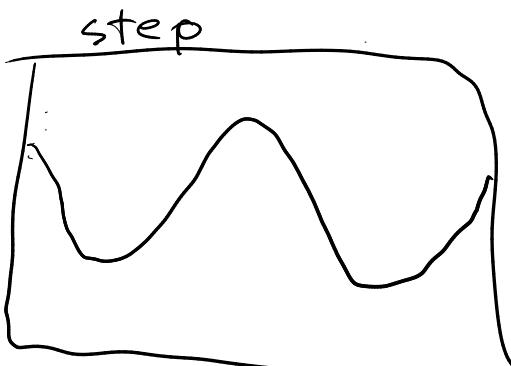
FBW (F-16) Late '70s

## Control Design Task 1: Pitch Attitude Controller

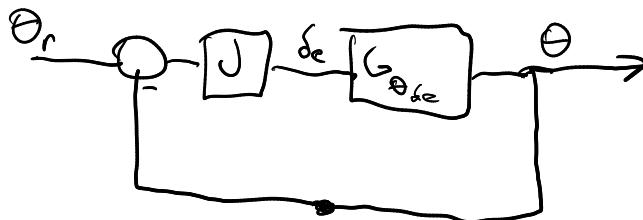
Input:  $\theta_r$       Goal:  $\theta \rightarrow \theta_r$  quickly (minimal Phugoid)



$J=1$

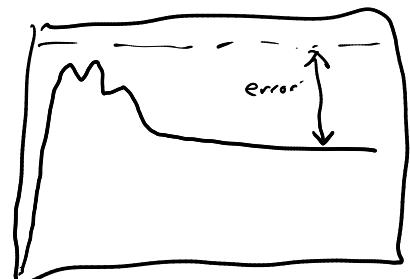
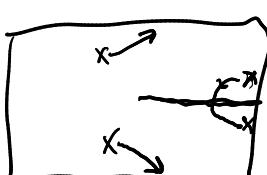


$J=K$

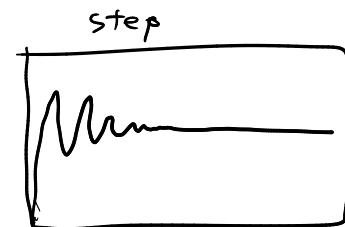
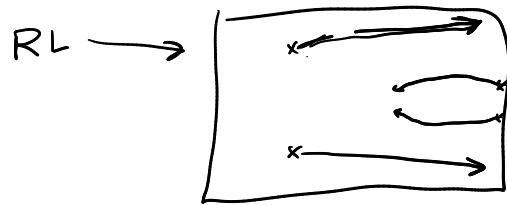
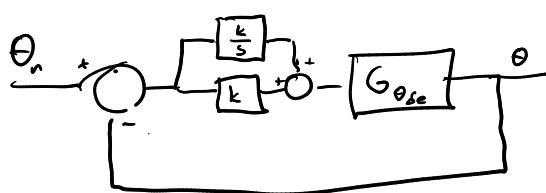


$K = -0.5$

RL



$$J = K \left( 1 + \frac{1}{s} \right)$$



$$J = K \left( 1 + \frac{1}{s} + s \right)$$

