FEEDBACK CONTROL

Topics

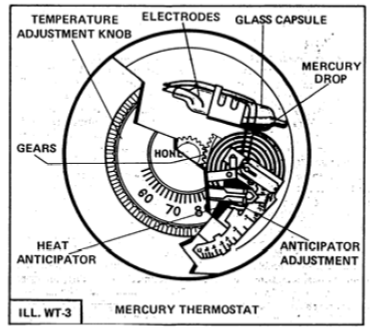
- Open-loop control
- Feedback control
- Feedforward control

At the end of this section, students should be able to:

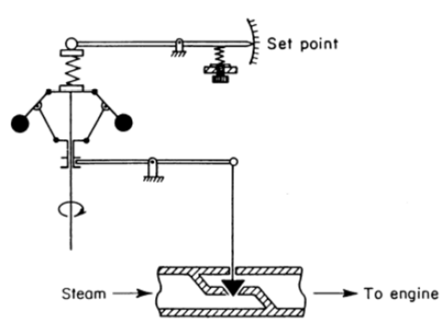
- Start to remember that long-ago undergraduate controls course.
- Draw a control loop including reference, disturbance, and noise.
- Determine closed-loop transfer functions.

WHAT IS FEEDBACK CONTROL?

A THERMOSTAT IS A SIMPLE CONTROL SYSTEM.



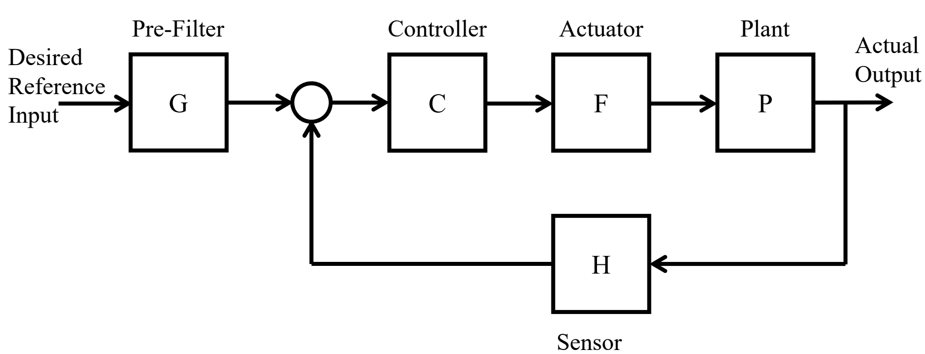
A FLYBALL GOVERNOR IS A PURELY MECHANICAL CONTROL SYSTEM



OTHER EXAMPLES

- Toilet tank level control

TYPICAL FEEDBACK CONTROL SYSTEM



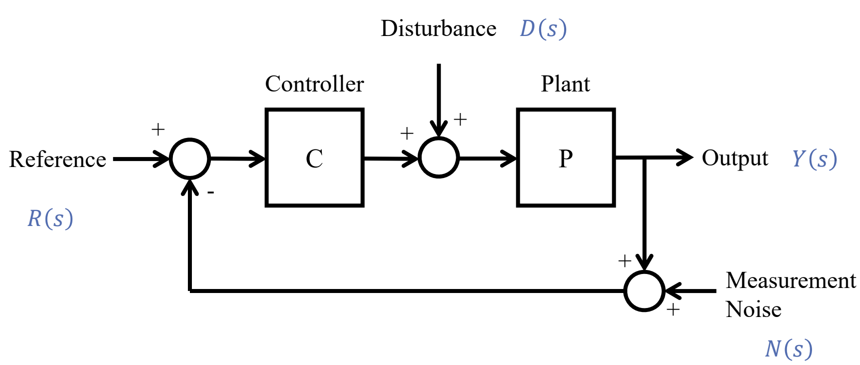
WHY DO WE USE FEEDBACK CONTROL?

HOW DO WE DESIGN CONTROLLERS?

1. Define problem & performance requirements
2. Select actuators & sensors
3. Model the process:
4. Design controller to meet performance specs
5. Simulate control system & redesign if necessary
6. Implement control design in hardware & validate
7. Redesign if necessary

CASE STUDY: OPEN-LOOP AND CLOSED-LOOP

CONSIDER A GENERAL CONTROL LOOP



$Y(s) =$

REFERENCE, DISTURBANCE, AND NOISE AFFECT CONTROLLER DESIGN

Desired Condition	TF Component	Requirement on C
$Y_R \to R$	$Y_R(s) = \dfrac{CP}{1+CP} R(s)$	
$Y_D \to 0$	$Y_D(s) = \dfrac{P}{1+CP} D(s)$	
$Y_N \to 0$	$Y_N(s) = \dfrac{-CP}{1+CP} N(s)$	

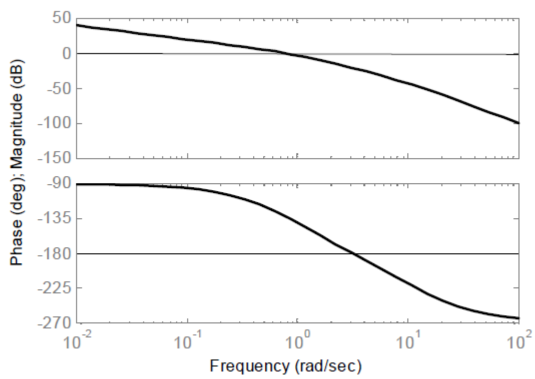
FEEDBACK PROVIDES A MECHANISM TO COMPENSATE FOR DISTURBANCES

Takeaways

- High-gain feedback essentially approximates plant inversion (the essence of control).
- High-gain proportional control provides good reference tracking and disturbance rejection, but aggravates noise rejection.

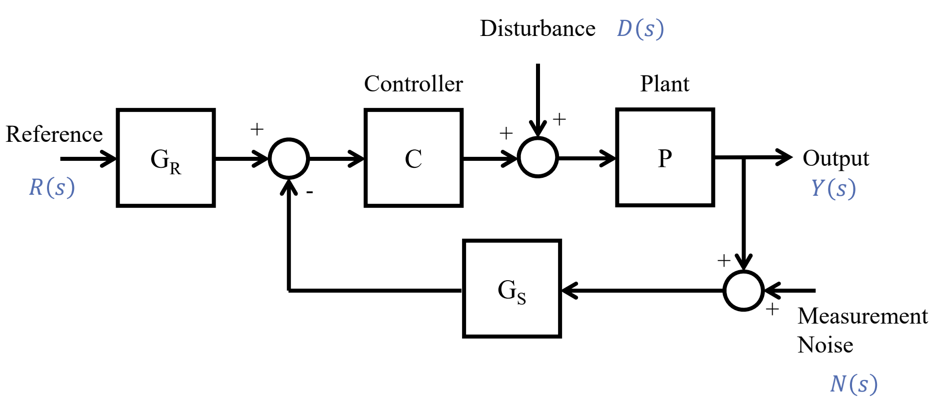
How can we reconcile this apparent contradiction?

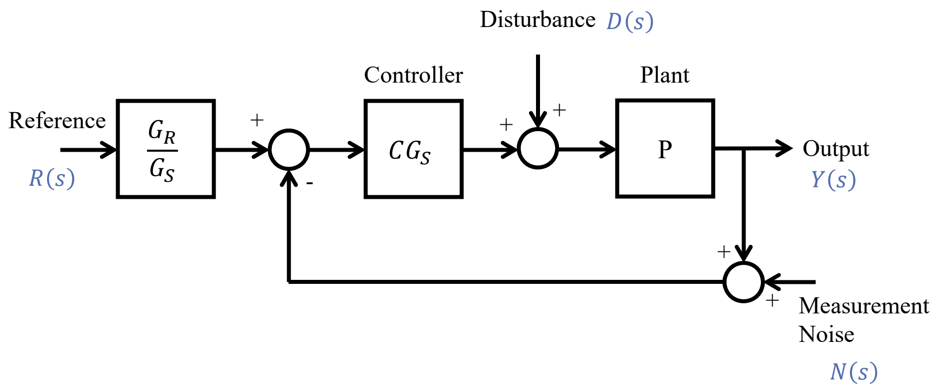
CONSIDER A FREQUENCY DOMAIN DESIGN



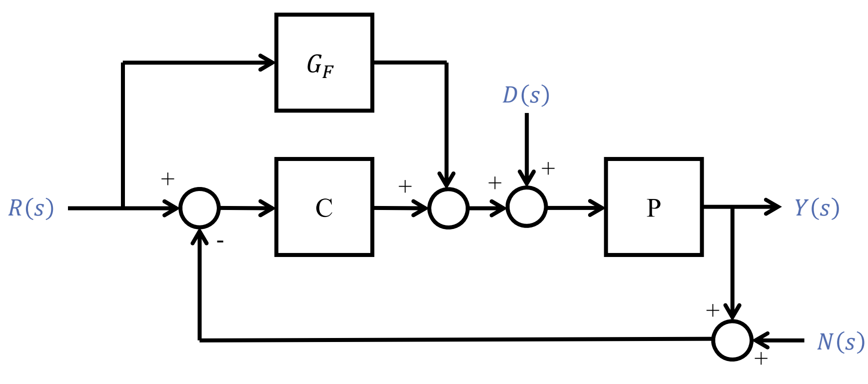
Assume the reference trajectory is primarily specified at low frequencies and the noise is primarily at high frequencies.

WHAT ABOUT NON-UNITY FEEDBACK?

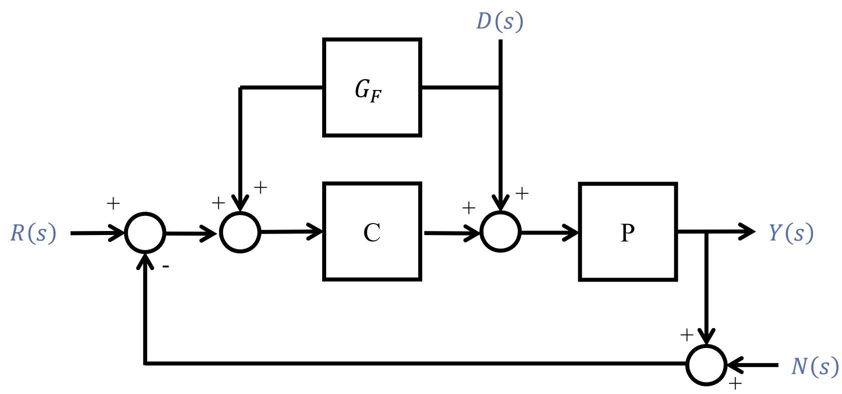




WHAT IF WE COMBINED FEEDBACK WITH FEEDFORWARD CONTROL?



DISTURBANCE FEEDFORWARD CAN CANCEL THE DISTURBANCE EFFECT



COMING UP…

Modeling Physical Systems

- Why we model dynamic systems
- How we model dynamic systems

Case Study: Hard disk drive read/write head