Prelab 11

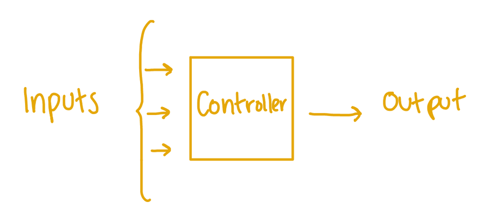
Wednesday, October 23, 2024 21:17

Control loops

open loop - has feedback system

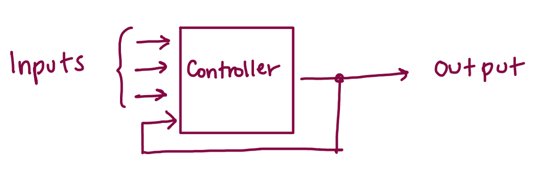
closed - do not

Open loop



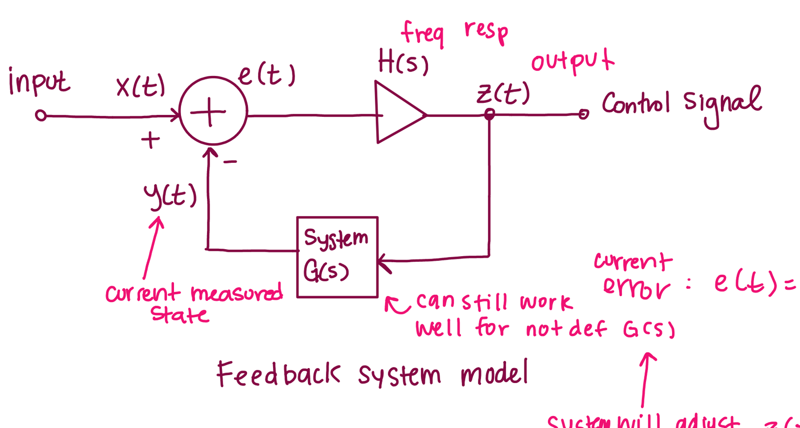
- do not verify motor is in correct state
  - require calibration so its correct when it recieves input
- tasks that don't require adaption to changing output conditions without user interaction

Closed loop control system



- can ensure it is in correct state instead of relying on making assumptions

ex. thermostat



Feedback system model

current error : $e(t) = x(t) - y(t)$

system will adjust $z(t)$ until the error is minimized

- changes to the system change $y(t)$

loop amp will detect and adjust $z(t)$

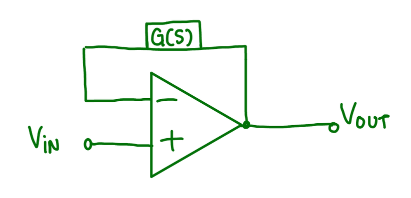
- changes in $x(t)$ cause error to ↑
  - requires change in ctrl sig

$$\frac{Z(s)}{X(s)} = \frac{H(s)}{1 + G(s)H(s)}$$

if $H(s)$ large, $\frac{Z(s)}{X(s)} \approx \frac{1}{G(s)}$

in simple systems, you only need to have $H(s)$ a large linear gain so sys drives G to minimize error

P I D controller



3 terms in $H(s)$: proportional — gain K_p

integral — K_I

derivative — K_d

transfer function $H(s) = K_p + \frac{1}{s} K_i + s K_d$

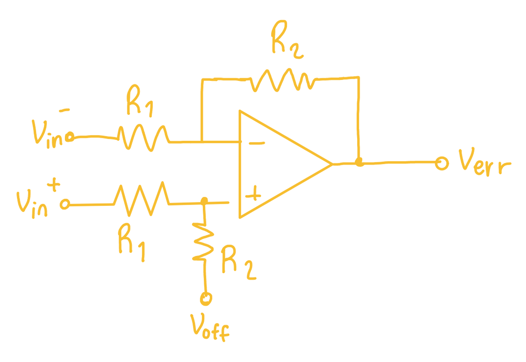
adjusts input of system based on a const proportion of the error

integrates the error {eliminates the offset that occurs at the output of a proportional only system}

in a syst that needs to quickly change derivitive adds to

Analog control circuits

Several op amps can make a feedback controller



single sided error amplifier

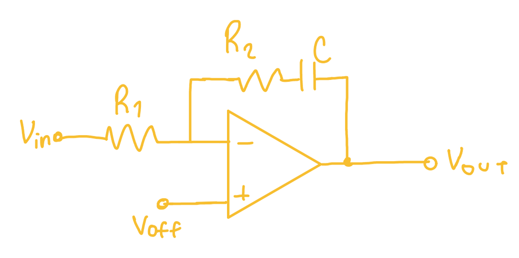
gain too large
- can lead to nonlinear behavior

Error amplifier - drives input of PID

$$V_{Err} = \frac{R_2}{R_1}(V_{in}^+ - V_{in}^-) + V_{off}$$

offset voltage allows for operation with single sided supply

- ensures output & input values stay within acceptable values



PI controller circuit

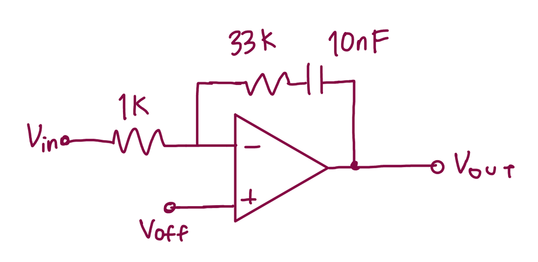
V_{OUT} = 11.4 on page 131

Prelab

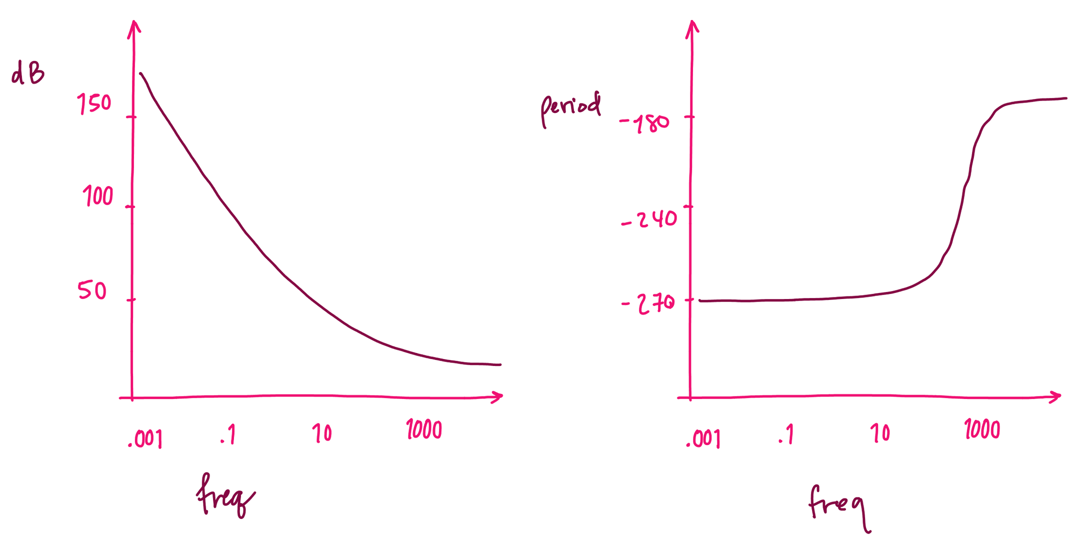
1. open loop - has feedback

   Closed loop - doesn't have feedbak

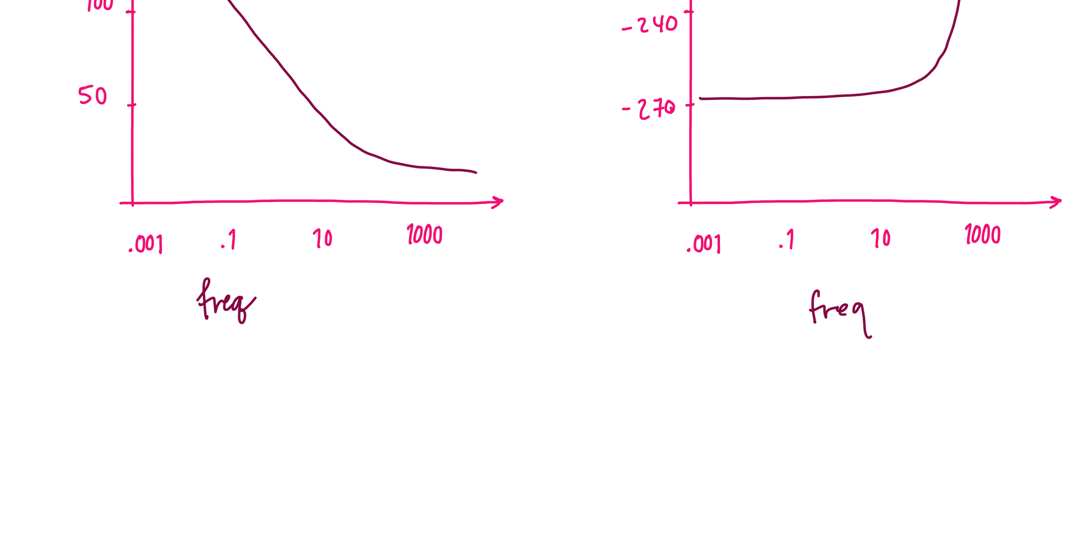
2. Magnitude & Phase response $\frac{V_{OUT}}{V_{IN}}$ for 11.6



a. $\frac{V_{out}}{V_{in}} = -\frac{1}{sR_1C} - \frac{R_2}{R_1} = \frac{1}{s10\mu} - 33 = \frac{-1}{20\mu \cdot j \cdot f} - 33$



b. $\frac{V_{OUT}}{V_{in}} = \frac{-1}{S \cdot 10\mu} - 2.2 = -\frac{1}{20\mu \cdot j \cdot f} - 2.2$



3. a. $K_p = \frac{33K\Omega}{1K\Omega} = 33$ b. $K_p = \frac{2.2K}{1K} = 2.2$

   $K_i = \frac{1}{1K \cdot 10nF} = 1 \times 10^6$ $K_i = \frac{1}{1K \cdot 10nf} = 1 \times 10^6$

4. $\frac{V_{ERR}}{R_2} + \frac{V_{REG}}{R_1} = 0$, $\frac{V_{OFF}}{R_2} + \frac{V_{REF}}{R_1} = 0$

   $\frac{V_{ERR}}{R_2} + \frac{V_{REG}}{R_1} = \frac{V_{OFF}}{R_2} + \frac{V_{REF}}{R_1} = 0$

   $R_1 V_{ERR} = R_2 V_{REF} + R_1 V_{OFF} - R_2 V_{REG}$

   ↓

   $R_1 = R_2 = 22K\Omega$