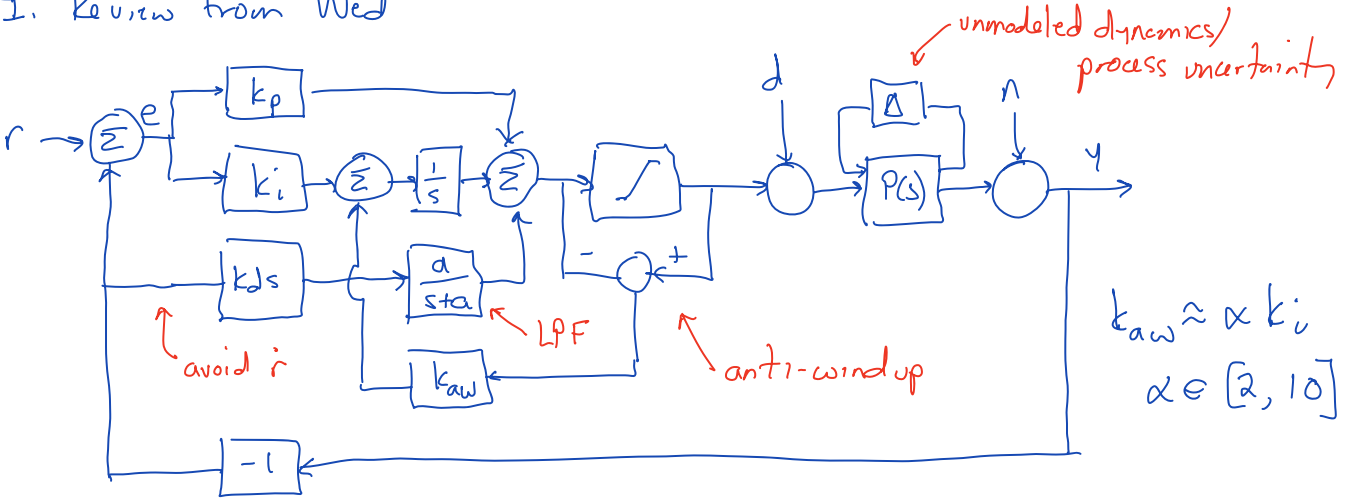
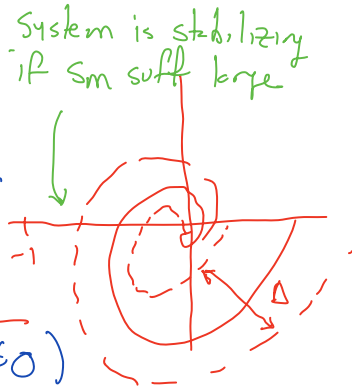
CDS 110, Lecture 9.2 – PID implementation

RMM 27 May 2024

I. Review from Wed



A. Useful properties
- avoid amplifying $\dot{r}$ by using $\dot{y}$ for derivative
- Filter derivative to attenuate high frequency noise
- integral action to offset disturbances and model error



B. Integral feedback

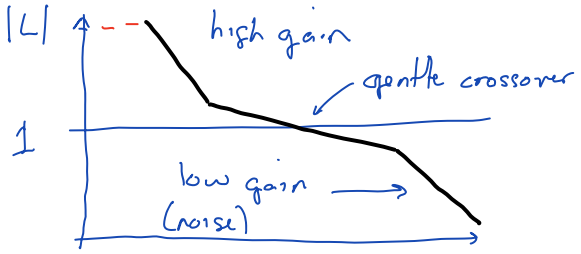
Claim: If system is stable, $e \to 0$ (even w/ $d \neq 0$, $\Delta \neq 0$)

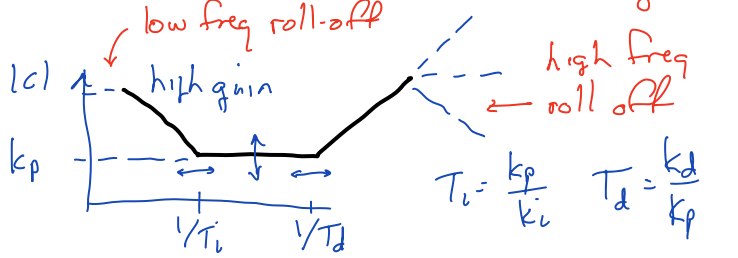
"PF" If stable, then $\exists$ stable eq pt (x_e, u_e)

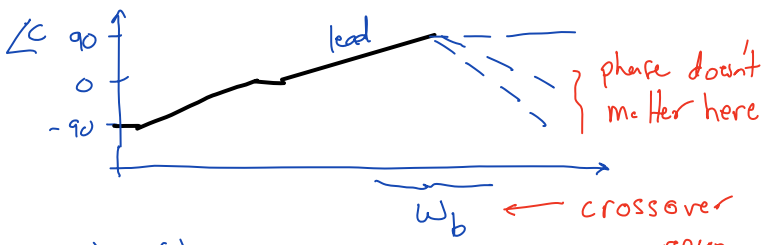
$u = k_p e + k_d \dot{e} + k_i \int e$ if $e \neq 0$ then $u \to \infty \Rightarrow e \to 0$

Note: integral action is much more general than PID $u = u_d - K(x - x_d) + k_i \int_0^t (y - y_d) dz$

C. Loop shaping w/ PID







II. Controller implementation

$G(s) \to C(sI - A)^{-1} B + D$

$\dot{x} = Ax + Bu$

$y = Cx + Du$

"realization"

$\dot{x} = \lim_{h \to 0} \frac{x(t+h) - x(t)}{h}$

$\Rightarrow x(t+h) = x(t) + h f(t+h)$

$y(t) = h(x, u)$

Implement on computer w/ fixed sampling time $\Delta t = h$