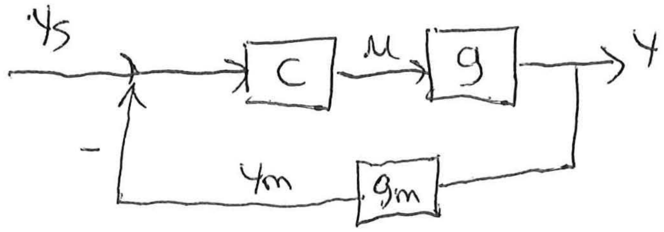
1/12-2023

SIMC-rule with measurement delay (θ_m)



$$g \approx \frac{k e^{-\theta s}}{(\tau_1 s+1)(\tau_2 s+1)}$$

(approximated using half rule)

Before we assumed $g_m = 1$.

Now assume that $g_m = e^{-\theta_m s}$.

Rule: Design C based on $\boxed{\theta_{tot} = \theta + \theta_m}$.

SIMC-rule (cascade PID): $K_c = \frac{1}{k}\frac{\tau_1}{(\tau_c + \theta_{tot})}$, $\tau_I = \min(\tau_1, 4(\tau_c + \theta_{tot}))$, $\tau_D = \tau_2$

θ_{tot} !!!

Should also choose $\tau_c = \theta_{tot}$ ("tight" control)

Proof: We design for desired setpoint response ("direct synthesis")

$y = T y_s$ where $T = \frac{gC}{1+g g_m C}$. Desired $T = \frac{e^{-\theta s}}{\tau_c s+1}$

Delay in g only! (setpoint from y_s to y)

Algebra:
$$\frac{k\frac{\cancel{e^{-\theta s}}}{(\tau_1 s+1)(\tau_2 s+1)}\cdot C}{1 + \frac{k e^{-\theta s} e^{-\theta_m s} C}{(\tau_1 s+1)(\tau_2 s+1)}} = \frac{\cancel{e^{-\theta s}}}{\tau_c s+1}$$

Get
$$\frac{1}{\frac{(\tau_1 s+1)(\tau_2 s+1)}{k\cdot C} + \underbrace{e^{-(\theta+\theta_m)s}}_{\approx 1-\theta_{tot}\cdot s \text{ (usual approx.)}}} = \frac{1}{\tau_c s+1} \Rightarrow \frac{(\tau_1 s+1)(\tau_2 s+1)}{k\cdot C} = (\tau_c + \theta_{tot})s$$

$$\Downarrow$$

$$C = \frac{(\tau_1 s+1)(\tau_2 s+1)}{k(\tau_c + \theta_{tot})s}$$

QED