博士班資格考試自動控制

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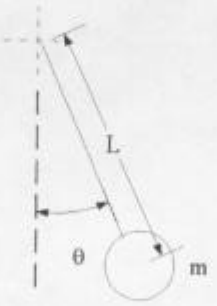
一個單擺系統中,一根長度爲 $L = 0.5\,m$ 的無質量剛性連桿,懸掛一個質量爲 $m = 4\,Kg$ 的重物...

1. 假設我們可以測量到單擺的角度 $\theta(t)$.請設計一項控制器,它可以控制位於轉軸馬達的輸出扭力 $T(t)$.使單擺系統的 damping rato 提高到 $\zeta = 0.8$;共振頻率 (undamped natural frequency)提高 $\omega_n = 10$ rad/s .
2. 以簡單的 Bode diagram 畫出 open loop system 及 closed loop system 的 frequency response.並標出 closed loop system 的 gain margin 及 phase margin.
3. 如果質量 $m = 4\,Kg$ 的重物會有所變化,請用根軌跡的方法,求出質量改變對閉路系統極點(poles)根軌跡的改變.
4. 請以數位控制的 state space 設計方法,設計一套 full state feedback 控制器,必須達到相同 1.的規格.在答案中,必須包含取樣頻率的決定過程
5. 如果只能測量到 $\theta(t)$,我們必須改採 output feedback 的方式,增加一項 state observer 設計控制器,請重新設計一次控制器
6. 請從,在 sensitivity function S 和 complementary sensitivity function T 的角度,說明如何設計 observer,並且說明採用這個方法設計出的控制系統,相較於 full state feedback 的閉路系統在 S,T 上有何改變.



自動控制:

7. If the type of feedback controller has been selected, we still have the problem of deciding what values to use for its adjusted parameters. This is known as the controller tuning problem. Please describe the three general approaches that we can use for tuning a controller.

8. Consider the control system of Fig. 1, which has been "opened" by disconnecting the controller from the final control element. Introduce a step change of magnitude A in the variable c which actuates the final control element. Record the value of the output with respect to time. The curve $y_m(t)$ is called the process reaction curve. Between y_m and c we have the following transfer function:

$$G_{PRC}(s) = \frac{\bar{y}_m(s)}{\bar{c}(s)} = G_f(s)G_p(s)G_m(s)$$

If we assume:

$$G_{PRC}(s) = \frac{\bar{y}_m(s)}{\bar{c}(s)} \approx \frac{Ke^{-t_d s}}{\tau s + 1}$$

Please use the Cohen-Coon method to decide these three parameters: static gain K, dead time t_d, and time constant τ.

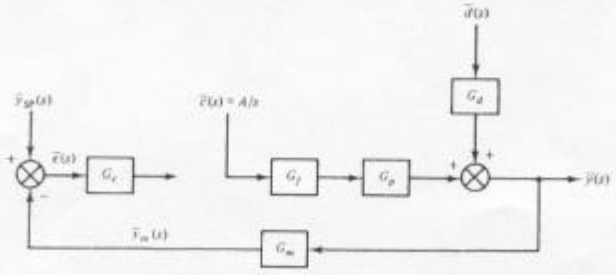


Fig. 1 Opened control loop

9. Consider the feedback control system of the following diagram as shown in Fig. 2.
We have:

$$G_p = \frac{1}{s^2 + 2s + 2} \quad G_f = 1 \quad G_m = 1 \quad G_c = K_c(1 + \frac{1}{\tau_I s})$$

Please use Routh-Hurwitz Criterion to determine the relationship of the K_c and τ_I if the system is stable.

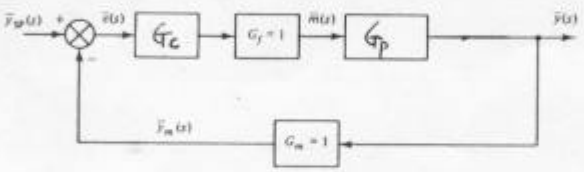


Fig. 2 Block diagram of the closed-loop system