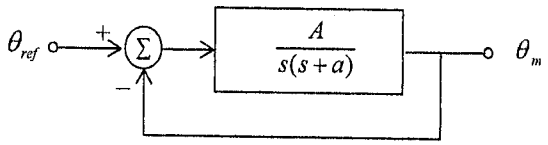
所別：機械工程學系碩士班 丁戊 科目：自動控制

(一) 如下圖，試求

(a) 閉路系統的轉移函數 (transfer function of the closed-loop system) (5 pts).

(b) 系統中 A 與 a 分別須設定爲多少才能使系統之 K_v (Velocity Constant)= 20，且 ζ (Damping Ratio)= 0.707。(20 pts)



(二) Given y''(t) +4y'(t) +3y(t) =2r(t), where r(t)=1, y(0)=1 and y'(0)=0, (y'' and y' are the 2nd and the 1st derivatives of y(t) respectively).

(a) Write down the total time response y(t) (10 pts).

(b) And identify the forced response and natural response respectively (5 pts).

(c) Identify those components due to initial condition. (5 pts).

(d) Identify those components due to system poles. (5 pts).

(三) Given a unity feedback system where the open loop forward transfer function is G(s)H(s)= 50 /{(s+1)^2(s+10)}, determine the value of Nyquist diagram of GH(jω) at the -180^0 (negative axis) crossover using Routh criterion.

(a) Finding the system characteristic equation (5 pts).

(b) Then applying Routh technique to determine the K gain such that instability occurs and determine the magnitude at the -180^0 crossover. (10 pts)

(c) Find the frequency at the -180^0 crossover. (5 pts)

(c) Sketch the Nyquist diagram. (5 pts)

(四) For the compensator $C(s) = \dfrac{Ts+1}{Ts+\beta}$, where $\beta > 1$.

(a) Show that the phase of the compensator is given by

$$\phi = \tan^{-1}(T\omega) - \tan^{-1}\left(\frac{T\omega}{\beta}\right). \quad (10\ \text{pts})$$

(b) Show that the frequency where the phase is maximal is given by $\omega_{max} = \dfrac{\sqrt{\beta}}{T}$, and that the maximum phase corresponds to $\sin\phi_{max} = \left(\dfrac{\beta-1}{\beta+1}\right)$. (10 pts)

(c) Rewrite your expression for ω_{max} and show that

$$\log\omega_{max} = \frac{1}{2}\left(\log\frac{1}{T} + \log\frac{\beta}{T}\right). \quad (5\ \text{pts})$$