

大同大學 九十二 學年度研究所碩士班入學考試試題

考試科目：自動控制

所別：機械工程研究所

第 1/2 頁

註：本次考試 不可以參考自己的書籍及筆記； 不可以使用字典； 可以使用計算器。

- (1) (25 points) Consider the system of Fig. 1, where k_1 and $k_2 > 0$. (a) Determine the allowable range of k_2 so that the steady-state error $e_{ss} < 0.02$ for $D(s) = 0, R(s) = 1/s$, where $e(t) = r(t) - y(t)$. (b) Based on the result of part (a), determine the range of k_1 so that the closed-loop system is stable. (c) Find the minimum steady-state error for $R(s) = 0, D(s) = 1/s^2$.

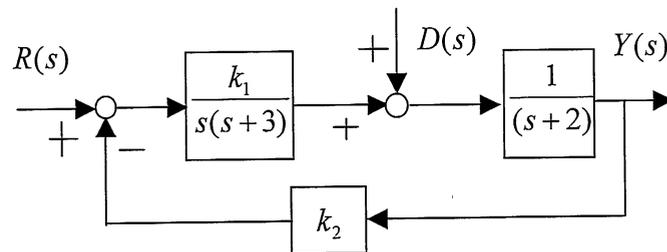


Fig. 1

- (2) (25 points) Consider the first order system $G(s) = \frac{7}{s+12}$.

The system signals are: input $u(t)$, output $y(t)$, reference $r(t)$, load disturbance $d(t)$ and error signal $e(t)$

(a) Sketch a block diagram for a simple proportional compensator control architecture with compensator gain K . Mark each of the system signals at the relevant points in the block diagram.

(b) Compute the sensitivity function for the system. That is the transfer function from reference $r(t)$ to error signal $e(t)$ of the closed-loop system.

(c) Compute the minimum bound on the compensator gain K that guarantees the relative tracking error to a step input is less than 1%.

$$\lim_{t \rightarrow \infty} \frac{|y(t)|}{|r(t)|} \leq 0.01$$

(d) Compute the transfer function from load disturbance $d(t)$ to output $y(t)$.

(e) Compute the minimum bound on the compensator gain K that guarantees better than a relative 5% disturbance rejection to a step disturbance.

$$\lim_{t \rightarrow \infty} \frac{|y(t)|}{|d(t)|} \leq 0.05$$

- (3) (10 points) The open-loop transfer function $G(s)$ of a unit feedback system is as follows:

$$G(s) = \frac{K}{s(1+0.2s)(1+0.05s)}$$

(a) Find the gain K so that the system's gain margin equals to 20 dB.

(b) Find the gain K so that the system's phase margin equals to 40° .

〈背面繼續〉

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第 2/2 頁

〈接前頁〉

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(4) (15 points) Sketch the polar plots of the following closed-loop transfer functions $GH(s)$, and determine the stable range of gain K using the Nyquist criterion.

(a) $GH(s) = \frac{10K(s+2)}{s^3 + 4s^2 + 10}$

(b) $GH(s) = \frac{K(s-1)}{s(s+1)}$

(5) (25 points) 如下圖所示(a)與(b)兩個電路：

(a) 若 $u(t)$ 與 $v(t)$ 分別為輸入， $w(t)$ 與 $y(t)$ 分別為輸出，請推導兩個電路的傳遞函數(transfer function) $G_1(s)$ 及 $G_2(s)$ 。

(b) $G_1(s)$ 及 $G_2(s)$ 何者會濾掉高頻訊號？何者會濾掉低頻訊號？

(c) 若 $R = C = 1$ ， $u(t)$ 及 $v(t)$ 皆為 1 volt 的 DC 輸入，求 $w(t)$ 與 $y(t)$ 的穩態響應(steady state response)。

(d) 如果將圖(a)電路的輸出 $w(t)$ 與圖(b)電路的輸入端 $v(t)$ 相連結，連結後以 $u(t)$ 為輸入， $y(t)$ 為輸出，請問連結後電路的傳遞函數(transfer function)為何？與 $G_1(s)G_2(s)$ 直接相乘的結果是否相同？為什麼？

