國立臺北科技大學

九十二學年度機電整合研究所入學考試

自動控制試題

填准考證號碼

注意事項：

1. 本試題共[redacted]題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. 25% A motor with a transfer function $G(s)=\dfrac{4}{s(0.1s+1)(s+1)}$ is implemented for position and velocity control. The Bode diagram of G(s) is partially shown in Figure 1-a.

   A. With unity negative feedback, determine the steady-state errors, e_{ss_step} for unity step input and e_{ss_ramp} for unity ramp input commands.

   B. Estimate the damping ratio and the 2% settling time of the unity negative feedback system

   C. If a lead compensator $G_c = K\alpha\dfrac{Ts+1}{\alpha Ts+1}$ is applied to the motor as shown in Figure 1-b such that the phase margin is 57° and the steady-state error e_{ss_ramp} for unity ramp input is 0.25. Determine the parameters of the lead compensator to meet these requirements.

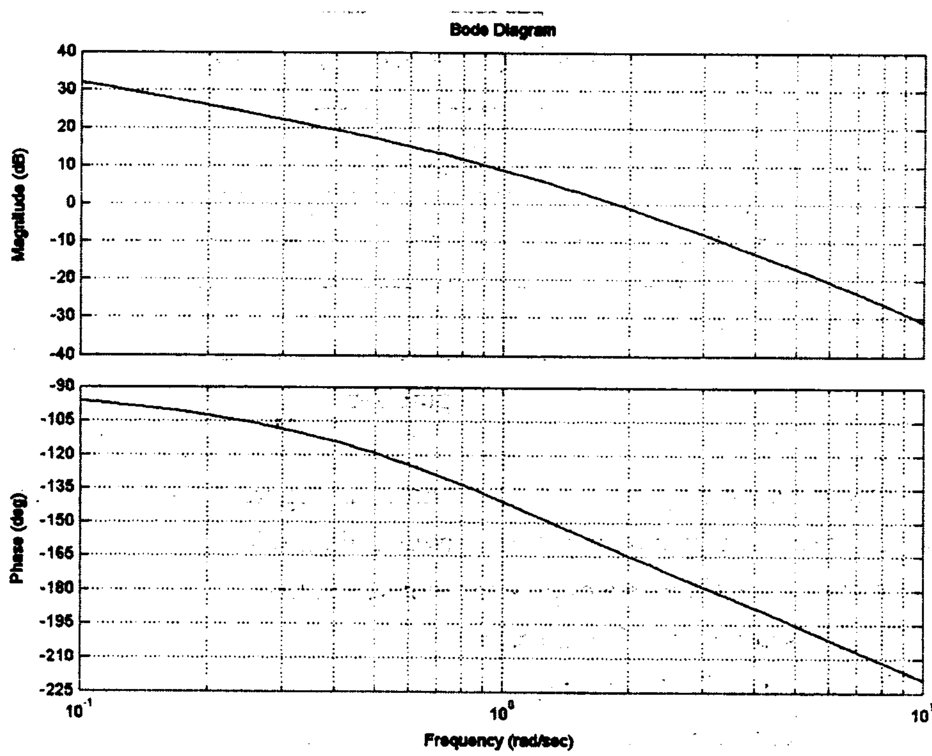


Figure 1-a

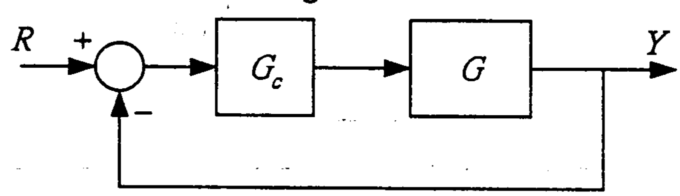


Figure 1-b

2. 25% The block diagram of cascaded processes is shown in Figure 2-a. Processes G_1 and G_2 are described as

$$G_1: \quad \dot{x} = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0.5 \end{bmatrix} u \qquad G_2: \quad T(s) = \frac{5}{s^2 + 5s + 4}$$
$$y = \begin{bmatrix} 0.5 & 1 \end{bmatrix} x$$

A. Determine the transfer function of this system and check its stability
B. Describe the system in state space form and check the controllability, observability and stabilizability
C. If unity negative feedback and a gain K are applied as shown in Figure 2-b, draw the root loci of the closed-loop system with varying K. Determine the breakaway (from the real axis) point and crossover (imaginary axis) point and the corresponding values of K.

注意：背面尚有試題

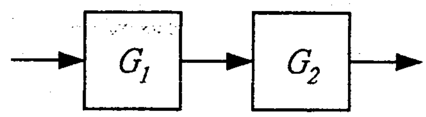


Figure 2-a

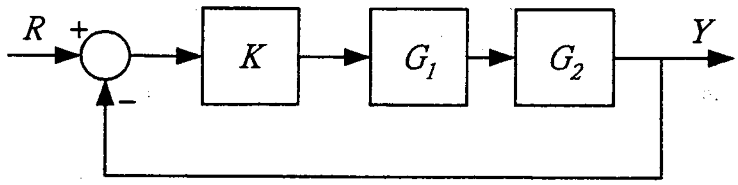


Figure 2-b

3. 20% A system block diagram is given as shown in Figure 3-a where the minimum-phase process G is described by a bode plot as shown in Figure 3-b

   A. Draw the permissible area of pole locations such that

      i. The 5% settling time $T_s < 3$ second

      ii. The peak time $T_p < 1$ second

      iii. The undamped natural frequency ω_n, $2 < \omega_n < 5$

   B. Determine the system parameters K and p such that the damping ratio is minimum

   C. Determine the output function $y(t)$ if an input command of $0.5 + 2t$ is applied at $t = [0, \infty]$

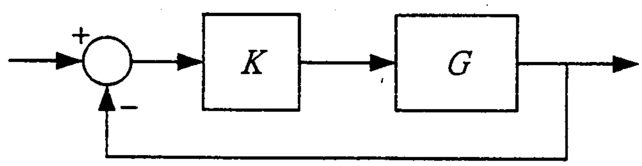


Figure 3-a

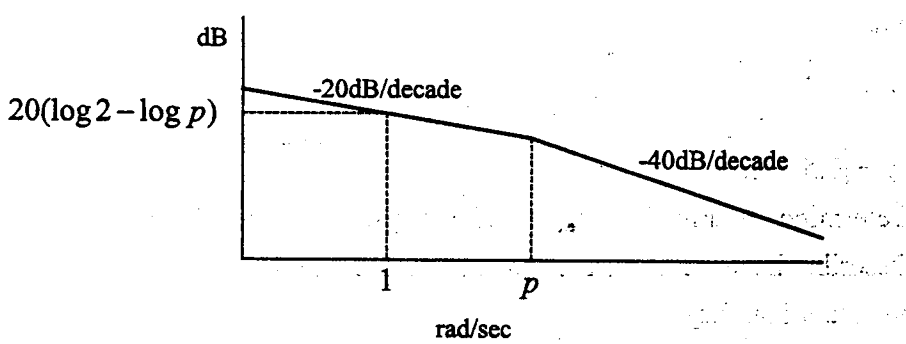
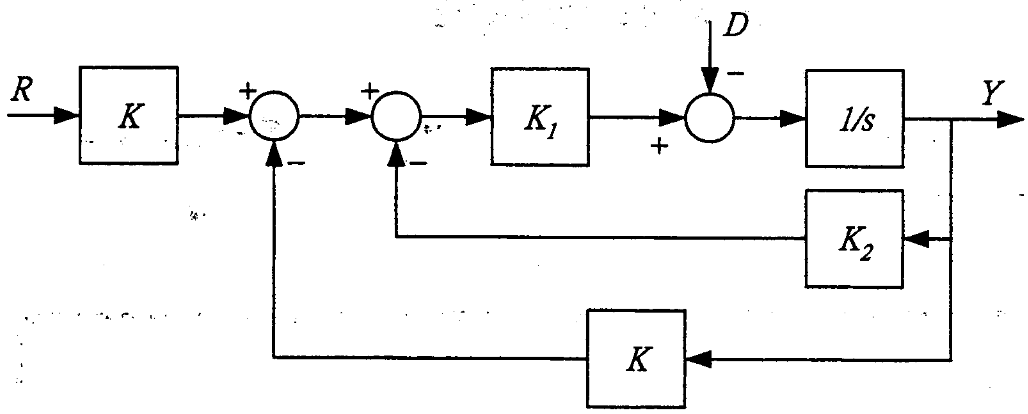


Figure 3-b

4. 20% A system block diagram is as shown below.
   A. Determine the closed-loop transfer function $T(s)=Y(s)/R(s)$
   B. Determine the sensitivity $S_{K_1}^{T}$
   C. Determine the steady-state error due to a input $R(s) = 1/s$ while a disturbance $D(s) = 0.5/s$ exists when $K = K_2 = 1$ and $1 < K_1 < 10$. Select K_1 for the fastest response.



5. 10% A system with two inputs and two outputs has the transfer matrix

$$H(s) = \begin{bmatrix} \frac{1}{(s+1)} & \frac{2}{(s+1)(s+2)} \\ \frac{1}{(s+1)(s+3)} & \frac{1}{(s+3)} \end{bmatrix}$$

is to be controlled. Describe your approach to analyze the system and design a controller to meet certain requirements, such as pole locations etc..