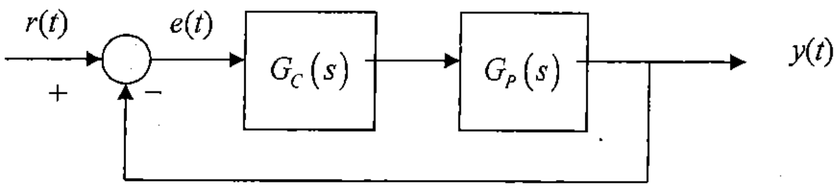
類組：電機類　科目：控制系統(300D)　　　　共 2 頁 第 1 頁

※請在答案卷內作答

Note: In this exam, you have 4 problems need to solve. Each problem has its own credit point as shown. The total credit point is 100.

1. (28 %) The following control system has the plant $G_P(s)=\dfrac{1}{s(s+1)}$ and controller $G_C(s)$.




(a) (3%) To completely reduce the steady-state error for ramp inputs, which controller, PI, $G_c=\dfrac{K_I}{s}+K_P$, or PD, $G_c=K_D s+K_P$, where $K_P$ , $K_I$ , and $K_D$ are nonnegative, will you choose? Why?

(b) (10%) Plot the root contour with the controller you select, including the asymptotes. Let $K_P$=0 first when you plot the contour.

(c) (3%) What range of $K_P$ is so that the contour has no breakaway points on the real-axis?

(d) (6%) For what condition of the controller you select, the closed-loop system is marginally stable? Find out all of the natural frequencies of the closed-loop system.

(e) (6%) For some reasons, you hopes the closed-loop poles have the damping ratio $\varsigma=0.5$ and $\omega_n=0.5$. Design the controller you select in (a).

2. (22%) Consider a unity-feedback system with the open-loop system $L(s)=\dfrac{Ke^{-sT}}{1+s}$, where $K$>0 and $T$>0. Noted: $L(j\omega)=K\dfrac{(\cos\omega T-\omega\sin\omega T)-j(\sin\omega T+\omega\cos\omega T)}{\omega^2+1}$ and $|L(j\omega)|=\dfrac{K}{\sqrt{\omega^2+1}}$.

(a) (5%) Sketch the Nyquist Plot.

(b) (9%) What are Gain Margin, $T$, and the range of $K$ for stabilizing the closed-loop system, when $\omega_p=1$?

(c) (3%) Under what condition of $K$, PM exists and find it?

(d) (5%) What is the maximum $T$ so that the system is still stable when $K$=2?

3. (22%) Consider a unity-feedback control system as given in the Figure A below and answer the questions follow:

(a) (4%) Suppose the transfer function of the closed-loop system is obtained as $\dfrac{\mathrm{Y}(s)}{\mathrm{U}(s)}=\dfrac{s^2+3s+1}{s^3+4s^2+2s+5}$ with $G_c(s)=1$. Then what will be the open-loop transfer function $G_p(s)$?

(b) (4%) Let $G_c(s)=1$ and $G_p(s)=\dfrac{b}{s(s+a)}$. Suppose the transfer function of the closed-loop system has poles with damping ratio $\zeta=0.3$ and the undamped-natural frequency $\omega_n = 2$. What are the values of $a$ and $b$, respectively?

(c) (8%) Based on the conditions of part (b), what will be first two largest values of the output $Y$ and their corresponding time for the input $U$ being a unit-step timing function.

(d) (6%) Let $G_p(s) = \dfrac{10}{s(s+1)}$. Construct a controller $G_c(s)$ so that the output $y(t)$ due to the unit-step input will have damping ratio $\zeta = 0.1$ and the settling time (defined by 2% error) $t_s \cong 8$ second.

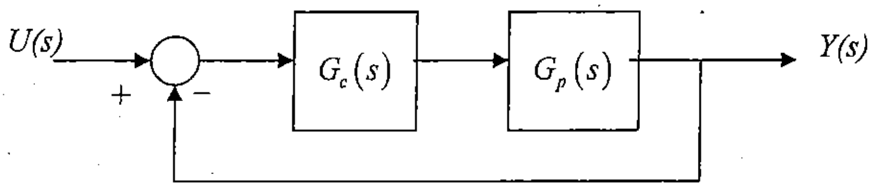



Figure A

4. (28%) Consider a unity-feedback control system as given in the Figure A above and answer the questions follow:

(a) (2%) Let $G_c(s) = 1$ and $G_p(s) = \dfrac{q(s)}{p(s)}$ with $p(s) = s^4 + 2s^3 + s^2 + s + 2$ and $q(s) = \alpha s^2 + s + 1$. Find the condition on $\alpha$ so that the closed-loop system is stable.

(b) (8%) Let $G_p(s) = \dfrac{1}{s(s+1)(s-2)}$. Will the closed-loop system be stable with $G_c(s) = 1$ and why? If your answer is "no", please find the range of $K_p$ and $K_D$ so that a PD-controller $G_c(s) = K_p + K_D\, s$ can stabilize the system. Instead, if your answer is "yes," then skip this part of question.

(c) (6%) Let $G_c(s) = K$. Suppose the characteristic equation of the closed-loop system is calculated as $s^3 + 4s^2 + (K+3)s + 8K = 0$. Where are the zeros and poles of $G_p(s)$? Find the range of $K$ so that the close-loop system is stable.

(d) (4%) Where will be the imaginary-axis crossing point and the real-axis intercept of the asymptotes of the root-locus for the system given in part (c)?

(e) (4%) Let $G_p(s) = \dfrac{K(s+10)}{s(s^2+5s+6)}$. For $G_c(s) = 1$, find the condition on $K$ so that the closed-loop system is stable.

(f) (4%) Find a controller $G_c(s) = \dfrac{s+z}{s+p}$ which will make the closed-loop system with $G_p(s)$ given in part (e) be stable for all $K > 0$. (Note: To earn the credit point, you may need to specify the values or the range of $p$ and $z$ with derivation.)

注意：背面有試題