系所組別：電機工程學系乙組

考試科目：控制系統 考試日期：0222，節次：2

※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. The Nyquist plot of the open loop transfer function $L(s)$ is given in Figure 1. The plot $L(j\omega)$ intersects with the negative real axis at $-K_3$, $-K_2$, and $-K_1$, respectively. It is known that the transfer function $L(s)$ does not have poles in the right half plane. Suppose that the open loop system is perturbed as $KL(s)$ for some positive gain K, determine the range of K so that the unity feedback closed-loop system remains stable. **(15%)**

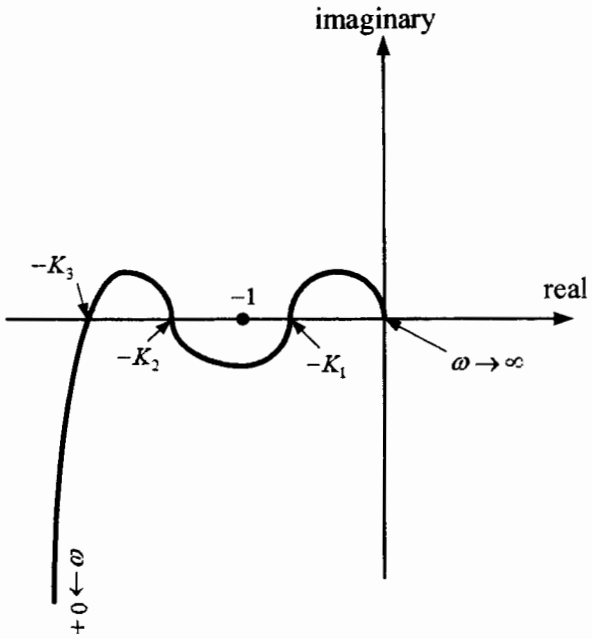

Figure 1

2. A PID controller is used to stabilize a plant given by $G(s)=\frac{1}{s^2}$ in a unity feedback control system. **(20%)**

(a) What is the transfer function of a PID controller? (5%)

(b) Under PID control, what are the angles of departure of the root locus for the poles at the origin. (5%)

(c) What are the conditions of the PID controller so that the closed-loop system is stable? (10%)

3. Let $\boldsymbol{Q}$ be an $n\times n$ real, symmetric matrix and $\boldsymbol{A}$ be an $n\times n$ matrix, the Lyapunov equation is given by

$$\boldsymbol{AP}+\boldsymbol{PA}^T+\boldsymbol{Q}=0$$

where $\boldsymbol{A}^T$ is the transpose of $\boldsymbol{A}$. **(15%)**

(a) Determine the condition for the existence of the matrix $\boldsymbol{P}$. (5%)

(b) If $\boldsymbol{A}$ is stable, find the solution $\boldsymbol{P}$. (10%)

（背面仍有題目，請繼續作答）

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4. For the unity feedback system with an open-loop transfer function, $G(s) = K/[s(s+2)(s+8)]$, design and realize a PD controller $G_c(s)$ that will yield a settling time $T_s = 1\,\text{sec}$. **(25%)**

5. Given the root locus shown in Figure 2 for the unity feedback system with an open-loop transfer function, $G(s) = K[(s+3)(s+4)]/[(s+1)(s+2)]$, find the value of K to yield a closed-loop step response with a settling time $T_s = 1.6\,\text{sec}$. Evaluate the pole sensitivity of the resulting control system. **(25%)**

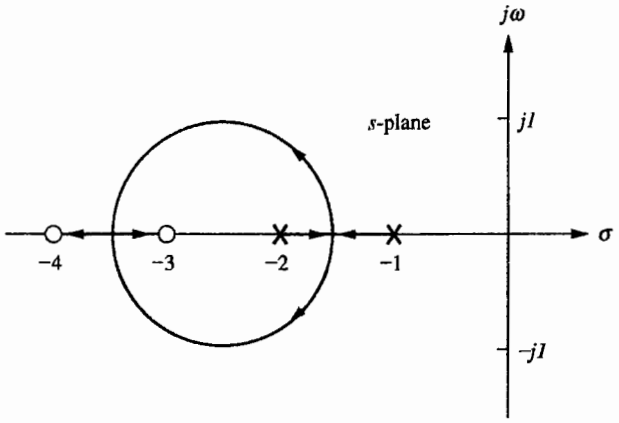

Figure 2