國立臺北科技大學 111 學年度碩士班招生考試

系所組別：1312、1322 車輛工程系碩士班甲、乙組

第二節　自動控制　試題（選考）

注意事項：

1. 本試題共六題，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、Before you start to design a controller, it is often necessary to understand the open-loop characteristics of the plant.

(一) Please apply Ruth array to check the stability of the plant $G(s)$, where $G(s) = \frac{b(s)}{a(s)}$, $a(s) = s^6 + s^5 + s^4 + 2s^3 + 5s^2 + 2s + 3$, and $b(s) = s^2 + 2s + 1$. Please explain if the system is stable. (10%)

(二) Does the DC gain exist for the plant $G(s)$? If yes, what is the value? If no, please explain why. (5%)

二、If a plant is given as a second-order system with $G(s) = \frac{1}{s(s+1)}$, you are required to design a controller to satisfy the following requirements for a unity feedback system.

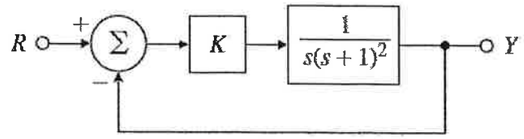
(一) Rise time t_r and overshoot M_p are often given as performance requirements of the transient response. Please use drawings in the s-plane to explain how to obtain the desired closed-loop pole locations as $s = -\sigma \pm j\omega_d$. (10%)

(二) If the desired poles are located at $s = -3.2 \pm j3.2$, is it possible to use only proportional control to satisfy this requirement? You need to provide reasons to support your answer. (5%)

(三) You are required to design a lead compensator $D(s) = K\frac{s+z}{s+p}$ such that the desired dominant complex poles are located at $s = -3.2 \pm j3.2$. From the design guideline, it is often to place the zero of the lead compensator below the desired pole location, i.e. $z = 3.2$. Please show how to design the pole and the gain of the lead compensator. You need to show the complete expression of the lead compensator as $D(s) = K\frac{s+z}{s+p}$. (25%)

三、For a unity-feedback system with respect to a ramp reference input, the steady-state error is 10%. Please show how to design an additional lag compensator $D(s) = \frac{s+z}{s+p}$ such that the steady-state error can be reduced to 1%. (10%)

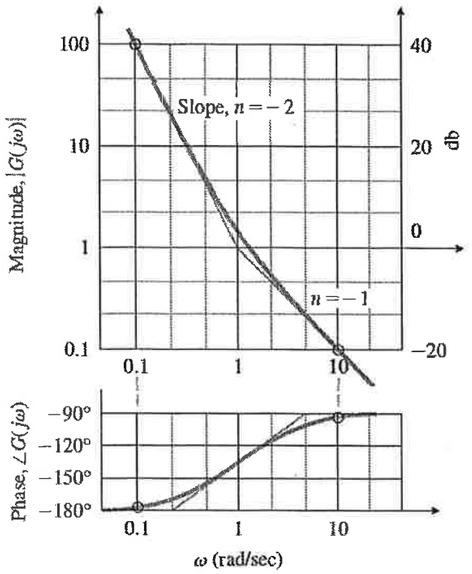
四、For a unity-feedback system as shown below, you are required to do the following analysis.



(一) Please draw the Bode plot of the open-loop system with $K = 1$. Then construct the Nyquist plot based on the Bode plot and show the intersection of the Nyquist plot and the negative real axis. (10%)

(二) What is the range of K for the system to be stable? (5%)

五、For a system $KG(s)$, the Bode plot with $K = 1$ is shown below. Please show how to design K to obtain good damping, i.e. $PM \cong 90°$. (10%)



六、A lead compensator $D(s) = \frac{T_D s+1}{\alpha T_D s+1}$ is generally used when a substantial improvement in damping of the system is required. For a system with the phase margin PM = 50° at the crossover frequency $\omega_c = 10\ rad/s$, please answer following questions.

(一) If the desired damping ratio is 0.7, what is the desired phase margin PM? (5%)

(二) If the maximum phase contribution is set to be 20° at $10\ rad/s$, is the new crossover frequency larger or smaller than $10\ rad/s$? Why? (5%)