國立中山大學109學年度
碩士暨碩士專班招生考試試題

科目名稱：控制系統【電機系碩士班乙組】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

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※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 2 頁第 1 頁

1.(20%) Given a system described by the following differential equation

$$\frac{d^2y(t)}{dt^2}+5\frac{dy(t)}{dt}+6y(t)=\frac{du(t-1)}{dt},$$

where u is the input and y is the output.

(a)(10%) Find the transfer function of the system.

(b)(10%) Is the system of minimum phase, and why?

2.(20%) Design a feedback controller to regulate the output of the plant

$$P(s)=\frac{10}{0.1s+1}$$

to any prescribed constant level without any steady-state error, and make the resulting closed-loop poles at $s=-70,\ -100$.

3.(10%) Given a controller $C(s)=(s-1)/(s+1)$ and a plant $P(s)=s/\left[(s-1)(s+2)\right]$ in negative feedback, determine the stability of the feedback system.

4.(18%) Given a characteristic equation of a control system as

$$s^2(s^2+8s+24)+(32+k)s+6k=0.$$

Find the

(a)(2%) open loop pole(s) and zero(s);

(b)(3%) intersection of the asymptotes (Centroid);

(c)(3%) angles of asymptotes;

(d)(4%) intersection of the Root Loci with the imaginary axis and the value of k, then

(e)(6%) construct the Root Loci for $-\infty \le k \le \infty$.

5.(32%) Consider a control system with the following loop transfer function

$$L(s)=\frac{K(s+1)}{s(s-1)},\qquad -\infty \le K \le \infty$$

(a)(18%) A Nyquist path is shown in Fig. 1.

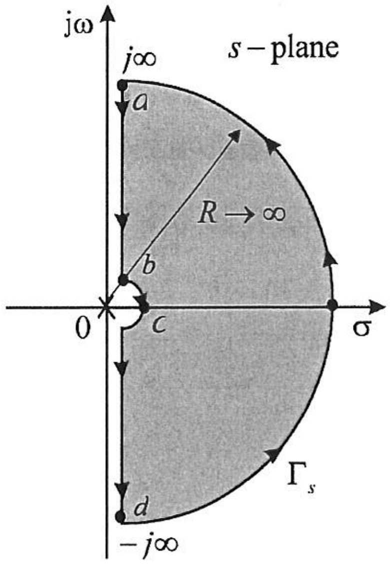

Figure 1: A Nyquist path.

Sketch the Nyquist plot of this system for $K>0$ in accordance with fig. 1, and indicate clearly I. the intersection(s) of the Nyquist plot with real and imaginary axes if any II. each mapping of point $a:(0+j\omega, \omega\to\infty^+)$, $b:(0+j\omega, \omega\to 0^+)$, $c:(\epsilon e^{j\phi}, \epsilon\to 0, \phi\to 0^+)$ and $d:(0-j\omega, \omega\to\infty^+)$ in your plot.

(b)(8%) Suppose that the Nyquist plot ($K>0$) you obtained in part (a) is depicted in Fig. 2, where the solid line is part of the Nyquist plot when ω is from ∞^+ to 0^+, and it has an intersection with axis $-Re(L(s))$ at $-K$.

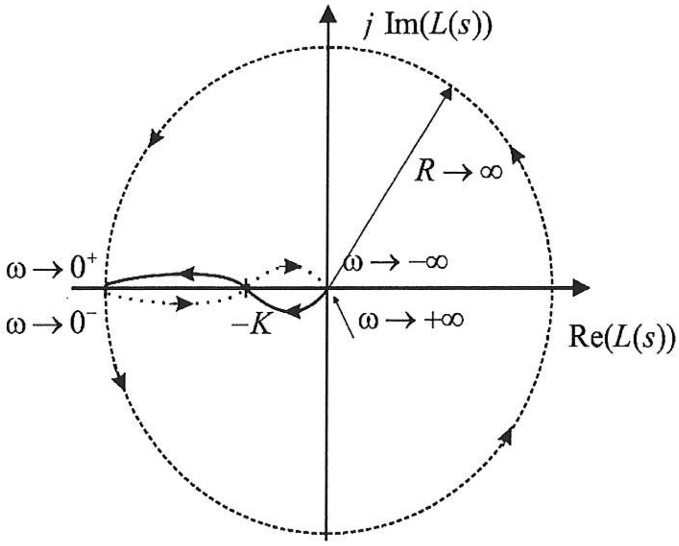

Figure 2: Your answer in part (a) (Assumption).

Using Nyquist criterion, determine the range of $K>0$ such that the closed-loop system can be stabilized. If the system is unstable due to the range of *K*, find the number of closed-loop pole(s) in the right-half of *s*-plane.

(c)(6%) Using Nyquist criterion and Fig. 2, determine the range of $K<0$ such that the closed-loop system can be stabilized. If the system is unstable due to the range of *K*, find the number of closed-loop pole(s) in the right-half of *s*-plane.