國立臺灣科技大學

九十學年度碩士班招生考試試題

系所組別： 電機工程系乙一組、電機工程系乙二組

科　目： 控制系統

共六題, 滿分爲一百分

Problem 1. (20%)

A closed-loop control system is described by

$$\dot{X}(t) = AX(t) + Bu(t)$$

$$u(t) = -GX(t)$$

where $X(t) = n \times 1$ state vector, $u(t) = r \times 1$ input vector, A is $n \times n$, B is $n \times r$, G is the $r \times n$ feedback matrix.

(a) Show that the roots of the characteristic equation of the closed-loop system are the eigenvalues of $A - BG$.

(b) Let

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -2 & -5 & -10 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}, \quad G = [g_1 \quad g_2 \quad g_3 \quad g_4]$$

where the elements of G are constants. Find the characteristic equation of the closed-loop system. Then, determine the elements of G so that the eigenvalues of $A - BG$ are at *-1*, *-2*, *-1+j1*, and *-1-j1*.

(c) Can all the eigenvalues of $A - BG$ be arbitrarily assigned for this system? Why?

Problem 2. (20%)

A unity feedback control system has an open-loop transfer function

$$G(s) = \frac{K}{s(1 + 0.02s)(1 + 0.05s)}$$

(a) Sketch the root locus diagram of the system for $0 \le K < \infty$.

(b) Determine the marginal value of K for stability.

(c) Determine the value of K when the system has two equal real characteristic roots.

Problem 3. (10%)

The loop transfer function of a feedback control system is given by

$$G(s)H(s) = \frac{K(s + 5)}{s(1 + Ts)(1 + 2s)}$$

The parameters K and T are represented in a plane with K as the horizontal axis and T as the vertical axis. Determine and sketch the region in which the closed-loop system is stable.

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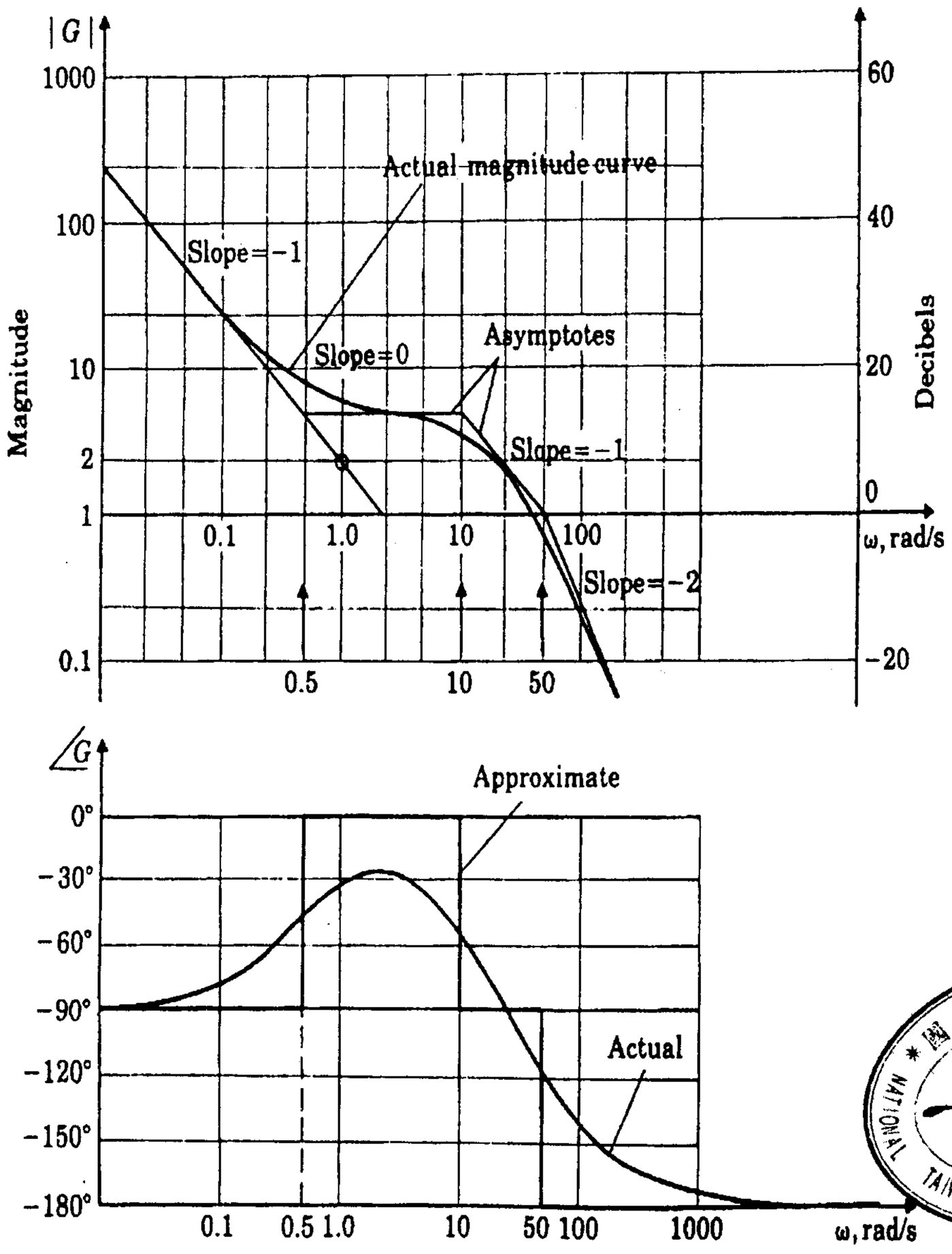
Problem 4. (15 %)

Determine the following properties from the given Bode plot: (a) the phase margin, (b) the system type, (c) the error constant for the corresponding type, (d) the order of the characteristic equation of the system, and (e) for which gain, the system will become unstable. Be sure to give reasons for your answers. No explanation, no credits.



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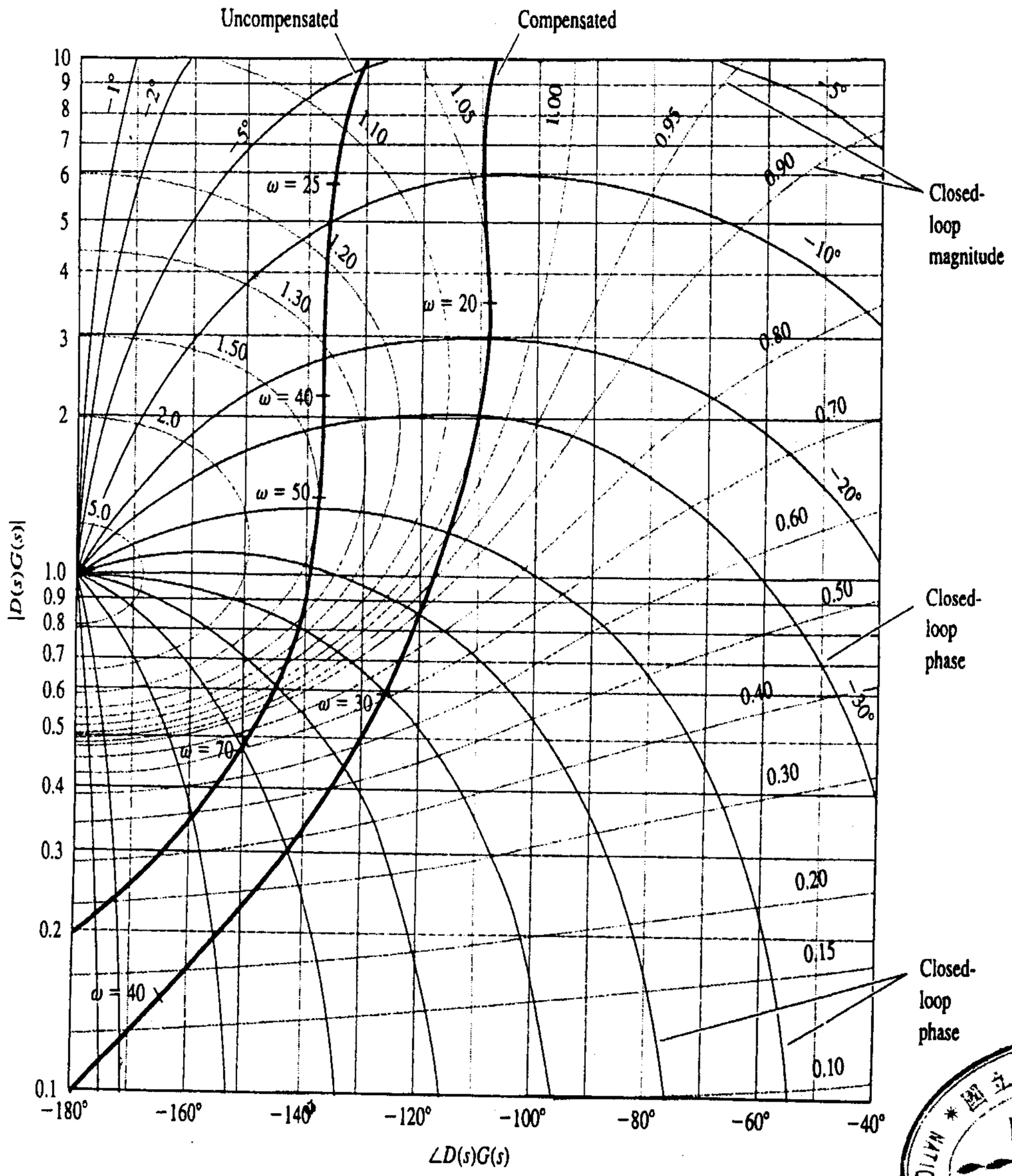
Problem 5. (25%)

The Nichols chart of an uncompensated and a compensated system is shown in the following. Please find the following properties for those two systems: (a) the resonance peaks, (b) the phase margins, (c) the gain margins, and (d) the bandwidths. (e) Besides, please determine why type of compensation is used. Be sure to give reasons for your answers. No explanation, no credits.



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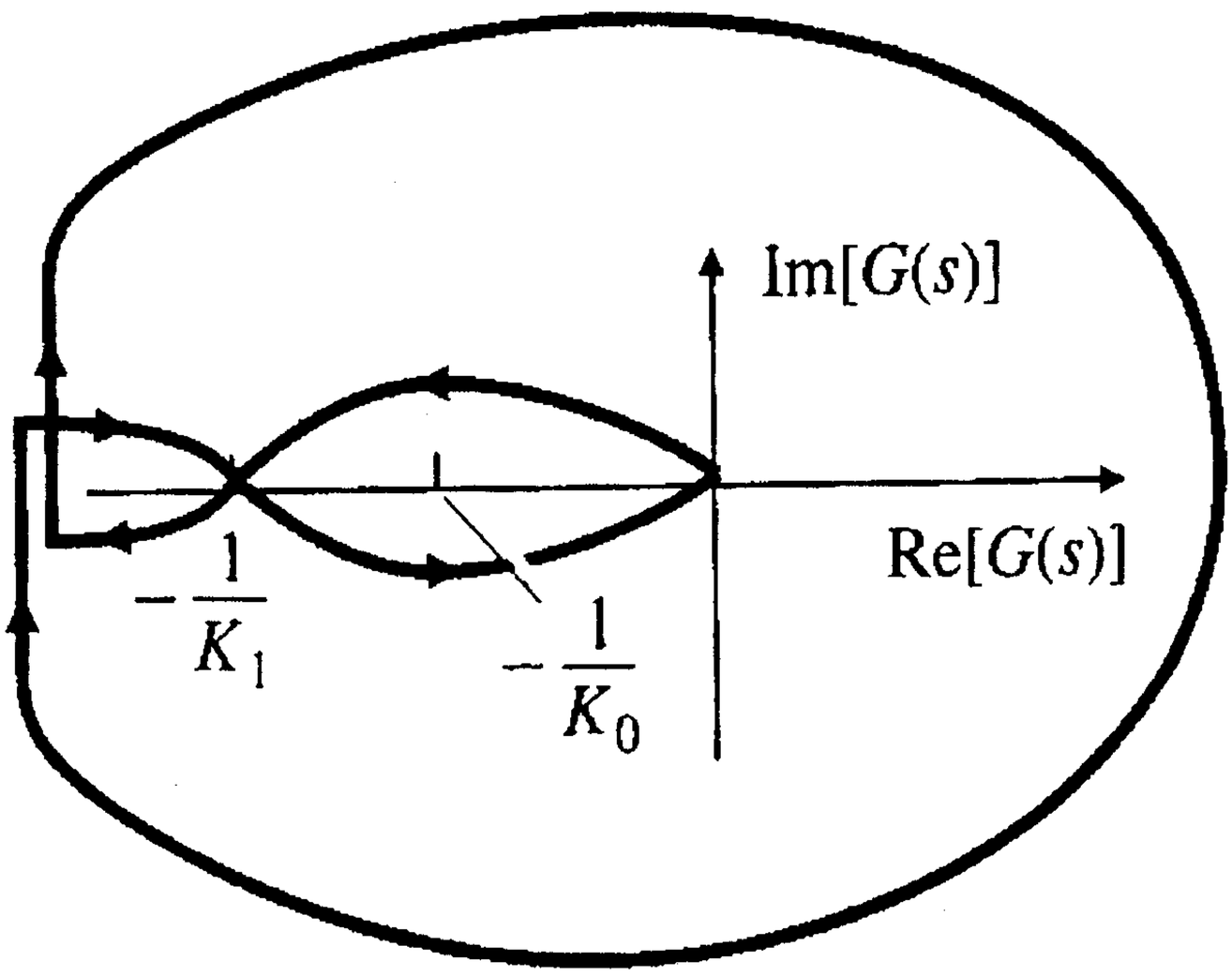
Problem 6. (10 %)

When the used gain is K_0, the Nyquist plot of a stable open-loop system is shown in the following. Please estimate (a) the gain margin, (b) the system type, and (c) the range of gain with which the system is stable. Be sure to give reasons for your answers. No explanation, no credits.



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