國立臺灣科技大學
九十三學年度碩士班考試試題
系所組別：電機工程系乙二組
科　　目：控制系統

『 總分 100分 』

Problem 1. (15%)

Consider a Laplace transform $X(s)=\frac{2s^2}{(s^2+4)^2}$ with the region of convergence $\mathrm{Re}(s)>0$.

(a) find $\lim_{t\to 0} x(t)$.
(b) find $\lim_{t\to \infty} x(t)$.
(c) find $x(t)$, $-\infty<t<\infty$.

Problem 2. (20%)

Consider a negative unity-feedback closed-loop control system with loop transfer function $L(s)=\frac{100}{s(s+10)^2}$.

(a) Find the gain margin *GM* and phase margin *PM* of $L(s)$.
(b) Find the steady-state error e_{ss} of the closed-loop system for input $r(t)=a+bt$, $t>0$.
(c) Find the steady-state response $y_{ss}(t)$ of the closed-loop system for input $r(t)=\cos(10t)$, $t>0$.

Problem 3. (15%)

Consider a closed-loop control system as shown in Fig. P. 3. Design a simple controller *H*(*s*), which has at most two parameters, such that the closed-loop system is stable and has a close-loop pole at $s=-2$, as well as rejects the constant disturbance w(t).

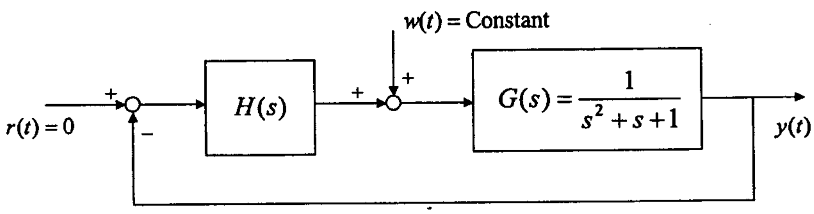

Fig. P. 3.

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Problem 4. (20%)

A system is described as:

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

where

$$X(t) = \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} \quad A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -2 & -1 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix}.$$

We can choose a new state vector $\bar{X}(t)$ to describe the same system. If we select the new state vector $\bar{X}(t)$ as

$$\bar{X}(t) = \begin{bmatrix} x_1(t) \\ y(t) \\ \dot{y}(t) \end{bmatrix},$$

the new state equation and output equation can be written as

$$\dot{\bar{X}}(t) = A_1 \bar{X}(t) + B_1 u(t)$$
$$y(t) = C_1 \bar{X}(t).$$

(a) Find A_1 and B_1.

(b) Find C_1.

Problem 5. (10%)

A state feedback closed-loop control system is described by

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

and

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

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Let

$$A=\begin{bmatrix}0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 1\\ 0 & -12 & -15 & -20\end{bmatrix}\quad B=\begin{bmatrix}0\\0\\0\\1\end{bmatrix}\quad G=[g_1 \quad g_2 \quad g_3 \quad g_4],$$

where the elements g_1, g_2, g_3, and g_4 are constant. Can all the eigenvalues of the closed-loop system be arbitrarily assigned? Please explain briefly.

Problem 6. (20%)

Given the state equation, $\dot{X}(t) = AX(t)$, where

$$A=\begin{bmatrix}-2 & 1 & 0\\ 0 & -2 & 1\\ 0 & 0 & -2\end{bmatrix}.$$

(a) Determine the state transition matrix $\phi(t)$ (15%)

(b) Determine the $\phi(0)$ (5%)