

國立高雄海洋科技大學 100 學年度碩士班考試入學
輪機工程研究所—自動控制學試題(※不須使用計算機)

1. (10%) Consider the following differential equation:

$$\frac{d^3 y(t)}{dt^3} + 5 \frac{d^2 y(t)}{dt^2} + \frac{dy(t)}{dt} + 2y(t) = u(t)$$

Find the state equation expressed by a vector-matrix form $\frac{d\mathbf{x}(t)}{dt} = \mathbf{A}\mathbf{x}(t) + \mathbf{B}u(t)$

under the assumption of $x_1(t) = y(t)$, $x_2(t) = \frac{dy(t)}{dt}$, and $x_3(t) = \frac{d^2 y(t)}{dt^2}$.

2. (16%) Find the inverse Laplace transform $f(t)$ of the following functions:

(a) $F(s) = \frac{6s^2 + 26s + 26}{(s+1)(s+2)(s+3)}$, (b) $F(s) = \frac{100(s+25)}{s(s+5)^3}$.

3. (14%) Consider the block diagram of a multi-variable control system shown in Fig. 1:

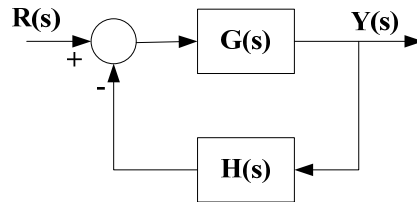


Fig. 1

Find the closed-loop transfer matrix under $\mathbf{G}(s) = \begin{bmatrix} \frac{1}{s+1} & -\frac{1}{s} \\ 2 & \frac{1}{s+2} \end{bmatrix}$ and $\mathbf{H}(s) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$.

4. (20%) For the feedback system of Fig.1 with $G(s) = K \frac{(s-2)(s-4)}{(s+2)(s+4)}$, $\mathbf{H}(s) = 1$.

- (a) Sketch the root locus for $K > 0$.
- (b) Find the breakaway and break-in points.
- (c) Find the frequency and gain at imaginary-axis crossing.
- (d) Determine the range of K to ensure stability.

5. (20%) For the feedback system of Fig.1, with $\mathbf{H}(s) = 1$ and

$$(a) G(s) = \frac{1}{s^5 + s^4 + 2s^3 + 2s^2 + 2s},$$

$$(b) G(s) = \frac{3}{s^5 + 3s^4 + 2s^3 + 6s^2 + s}.$$

Find the number of poles for the closed-loop system in the right half plane, the left plane, and on the $j\omega$ -axis with (a) and (b), respectively.

6. (20%) For the feedback system of Fig. 1 with $G(s) = K \frac{(s+6)}{s(s+2)(s+4)}$, $\mathbf{H}(s) = 1$.

- (a) Sketch the root locus for $K > 0$.
- (b) In order to obtain the finite steady state error, which signal should be used?
(step, ramp, and parabola)
- (c) Find the value of K to achieve that the steady state error equal to 0.3 for unit test signal.