

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (25%)

- (a) (5%) Please explain describe the four characteristics of the closed loop system.
- (b) (5%) Please explain the meaning of the Mason's gain formula ?
- (c) (5%) Please explain the steady-state error  $E(s)$  from Laplace transform ?
- (d) (5%) Please explain the meaning of the transfer function of a closed system?
- (e) (5%) Please use a block diagram eqn. to explain the meaning of the sensitivity  $S_G^T$ , for large or small value is better? assume  $G$  is the parameter variation and  $T$  is the transfer function.

2. (15%)

An electromechanical open-loop control system is shown in Fig.1. The generator, driven at a constant speed, provides the field voltage for the motor. The motor has an inertia  $J_m$  and bearing friction  $b_m$ . determine the transfer function  $\theta_L(s)/V_f(s)$ .

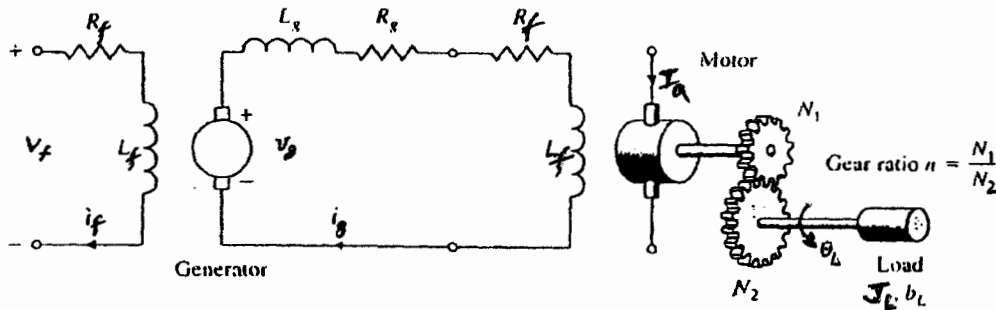


Fig. 1

3. (25%)

- (a) (5%) Please explain the optimal control error performance index ITAE?
- (b) (5%) If the characteristic equation is  $1 + G(s) = a_n \cdot S^n + a_{n-1} \cdot S^{n-1} + a_{n-2} \cdot S^{n-2} + \dots + a_1 \cdot S + a_0 = 0$ , Please describe the Routh-Hurwitz criterion of the system?
- (c) (5%) Please explain the root locus, ends at the infinity or at the zero (both are required to be answered, only one answer, you can only get 2%) ?
- (d) (5%) Why the poles must be in the left half s plane ?
- (e) (5%) Please mark the damping ratio  $\xi$  and natural frequency  $\omega_n$  of a second order system; if the two poles locate on the s-plane, as Fig.2 shows.

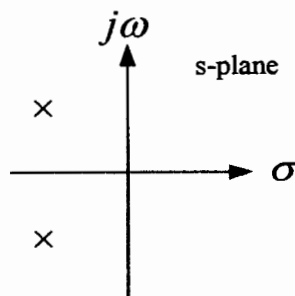


Fig.2

(背面仍有題目,請繼續作答)

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

4. (25%)

(a)(10%) 1. (5%) Find the bandwidth of the frequency response in second-order system, using the Fig.3 ?

2.(5%) From figure 4, please sketch the bandwidth, and choose which one is the faster system? Why?

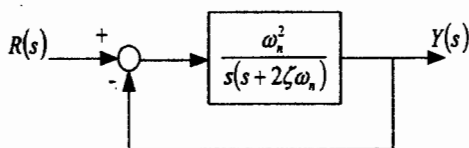


Fig. 3

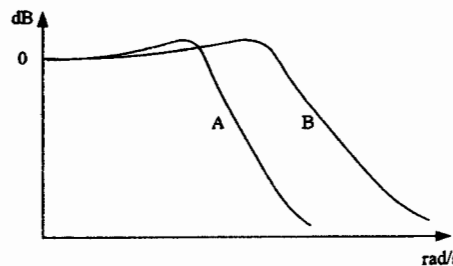


Fig. 4

(b)(10%) 1. (3%) What is the gain margin and phase margin on the polar plot?

2. (3%) What is the gain margin and phase margin on the bode plot?

3. (4%) Please describe why and how we use phase margin and gain margin?

(c) (5%) Please describe the Nyquist stability criterion in detail from the  $GH(s)$  polar plot.

5. (10%)

The spring-mass-damper system is shown in Fig. 5.

Define the state variables as  $x_1(t) = y(t)$ ,  $x_2(t) = \frac{dy(t)}{dt}$ , and  $\mathbf{x} \equiv \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ .

(a)(5%) Derive the state variable model as follows: 
$$\begin{cases} \dot{\mathbf{x}} = \mathbf{Ax} + \mathbf{Bu} \\ y = \mathbf{Cx} + \mathbf{Du} \end{cases}$$

find the  $\mathbf{A}$ ,  $\mathbf{B}$ ,  $\mathbf{C}$ , and  $\mathbf{D}$ . (Hint: first write the dynamic equation of the system)

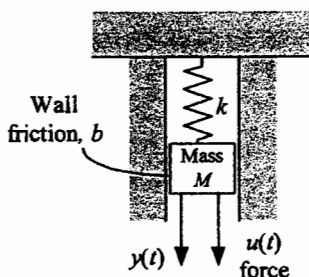


Fig. 5

(b)(5%) How is the characteristic equation? ( Hint: Only by using the matrix method, Then, get the points. )