國立彰化師範大學103學年度碩士班招生考試試題

系所：車輛科技研究所　　選考 3　　科目：自動控制

☆☆請在答案紙上作答☆☆　　

1. Please state the following terminologies. (16%)

(1) Asymptotic stability; (4%)

(2) Gain margin; (4%)

(3) Impulse response; (4%)

(4) Linear time-invariant system. (4%)

2. Determine the transfer function of the system in Figure P2 from *u* to *y*,

where $P \equiv \begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix}$ and $\begin{bmatrix} y \\ z \end{bmatrix} = \begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix}$ for

(1) *u*, *v*, *y*, and *z* are scalar signals (SISO system); (6%)

(2) *u*, *v*, *y*, and *z* are vector signals (MIMO system). (8%)

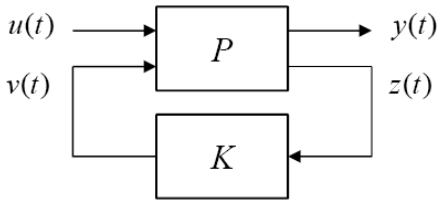

Figure P2.

Hint: Transfer function can be in terms of P_{11}, P_{12}, P_{21}, P_{22}, and *K*.

3. Solve the following differential equation

$\ddot{y} + 3\dot{y} + 2y = 5u(t)$,

where $u(t)$ is the unit-step input function, and the initial conditions are $\dot{y}(0) = 2$ and $y(0) = -1$. (20%)

Hint: Laplace transform.

4. Determine the range of *K* if the system is stable with the characteristic equation

$s^4 + 3s^3 + 12s^2 + (K - 16)s + K = 0$. (15%)

Hint: Routh-Hurwitz criterion.

5. Consider a spring-mass-damper system as shown in Figure P5.

(1) Find the dynamic equation of this system; (10%)

(2) Find the transfer function of this system where the input is *F(t)* and the output is *x(t)*. (10%)

(*M* denotes the mass, *B* denotes the viscous friction coefficient, *K* denotes the spring constant, *x*(*t*) denotes the displacement of the mass, and *F*(*t*) denotes the applied force on the mass. The positive directions of *x*(*t*) and *F*(*t*) are also assigned as in Figure P5, respectively.)

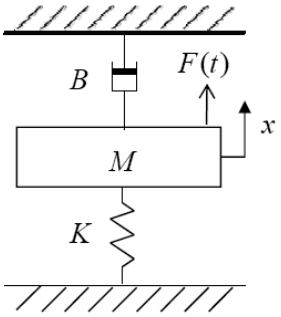

Figure P5.

6. Obtain the transfer function of the system from *u* to *y* with the dynamic equation as follows. (15%)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}.$$

Hint: Transfer function is equal to $C(sI - A)^{-1}B + D$ with dynamic equation:

$$\dot{x} = Ax + Bu$$
$$y = Cx + Du.$$