國立成功大學

113學年度碩士班招生考試試題

編　號：126

系　所：系統及船舶機電工程學系

科　目：自動控制

日　期：0201

節　次：第 2 節

備　註：可使用計算機

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

I. Bode plot of a transfer function is illustrated as shown below (20%)

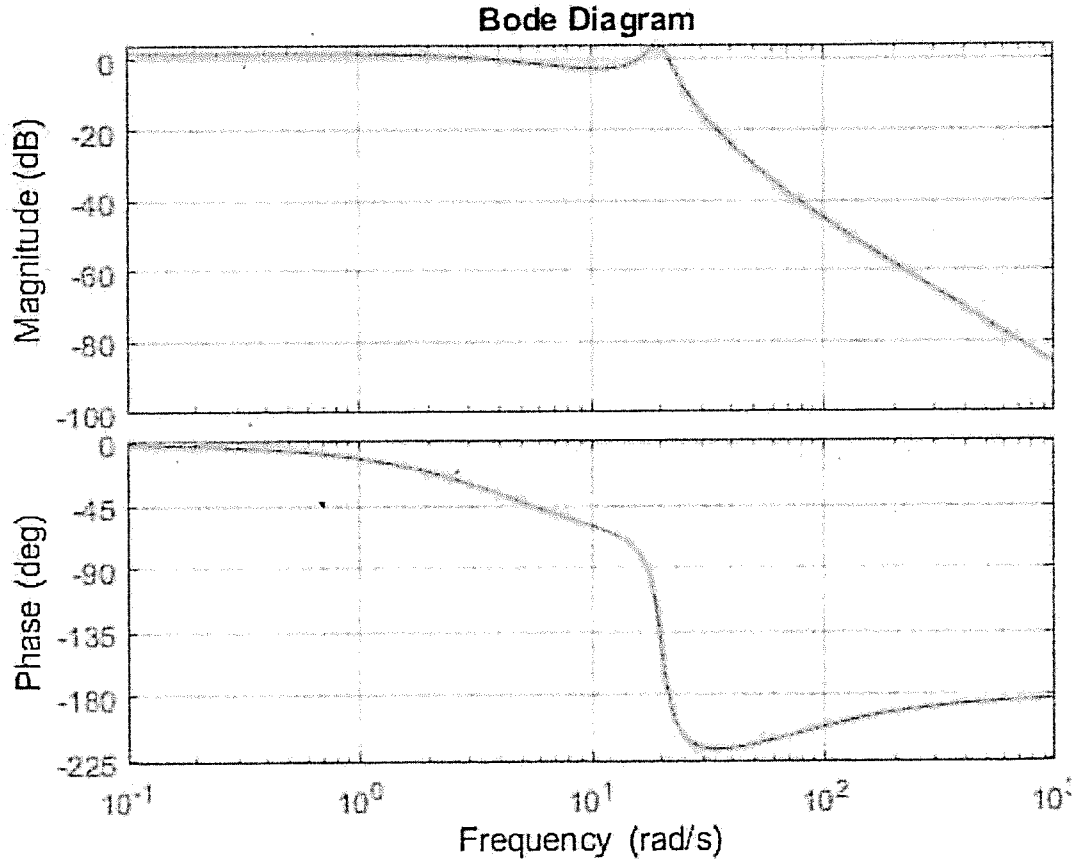
(1) Find the corresponding transfer function (5%)

(2) Calculate the gain margin and find the gain crossover frequency (5%)

(3) Calculate the phase margin and find the phase crossover frequency (5%)

(4) Find the resonant peak value and the related resonant frequency (3%)

(5) Find the bandwidth (2%)



II. Linearize the following nonlinear system by using Taylor expansion with respect to the operation point (x_0, u_0) (10%)

$$\dot{x} = f(x,u)$$

where $x \in R^n$, $u \in R^p$, and $f(x,u) \in R^n$ is a function vector.

III. Please answer the following questions (20%)

(1) Derive "Separation Principle" based on the following state space formulation and explain the meaning of separation principle in the practical control design (10%)

$$\begin{cases} \dot{Z} = AZ + Bu \\ y = CZ \end{cases}$$

(2) Explain "pole placement method" in detail with respect to a linear system which is expressed in control canonical form and is with a state feedback control law as: (10%)

$$u = -\begin{bmatrix} k_1 & . & . & . & k_n \end{bmatrix} X$$

IV. Consider the corresponding differential equation of a linear system as below: (20%)

$$\frac{dy^n(t)}{dt^n} + a_{n-1}\frac{dy^{n-1}(t)}{dt^{n-1}} + a_{n-2}\frac{dy^{n-2}(t)}{dt^{n-2}} + \ldots + a_0 = u(t)$$

(1) Derive the related state space form by selecting a set of state variables

$x_1 = y(t), x_2 = \frac{dy(t)}{dt}, \cdots$, and so on. (10%)

(2) Based on the derivation of (1), transfer the differential equation expressed below to the state space formulation. (10%)

$$7\frac{dy^5(t)}{dt^5} + 3\frac{dy^4(t)}{dt^4} + 9\frac{dy^3(t)}{dt^3} + 11\frac{dy^2(t)}{dt^2} + 17\frac{dy(t)}{dt} + 8 = u(t)$$

V. Express the state space representations of the following transfer function in cascade, parallel, control canonical and observer canonical form: (10%)

$$G(s) = \frac{1}{(s+1)(s+7)(s+19)}$$

VI. Assume a plant is not represented in control canonical form as (20%)

$$\begin{cases} \dot{Z} = AZ + Bu \\ y = CZ \end{cases}$$

(1) Calculate the controllability matrix of this system (5%)

(2) Assume that the system can be transformed into the control canonical representation with the transformation $Z = PX$. Please detail the derivations of finding the control canonical representation by using this transformation. (10%)

(3) Represent P by using controllability matrices of state space formulations described by Z and X. (5%)