國立成功大學 106 學年度碩士班招生考試試題

系　　所：系統及船舶機電工程學系

考試科目：自動控制

考試日期：0213，節次：2

※ 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。

1.

(i) Which concept can be used to linearize nonlinear equations or nonlinear systems, and how to realize it? (5%)

(ii) Linearize the following nonlinear system as a linear form $\Delta\dot{X} = A\Delta X + B\Delta U$ based on the concept in (i) and show us the details of A and B. (15%)

$$\dot{X} = F(X,U)$$

where $X \in R^{n\times1}$ is the state vector, $U \in R^{p\times1}$ is the input vector, and $F(X,U) \in R^{n\times1}$ is a function.

2.

(i) Describe the transfer function of the bode plot in Fig. 1. (14%)

(ii) Describe Gain Margin, Phase Margin, and Bandwidth. (6%)

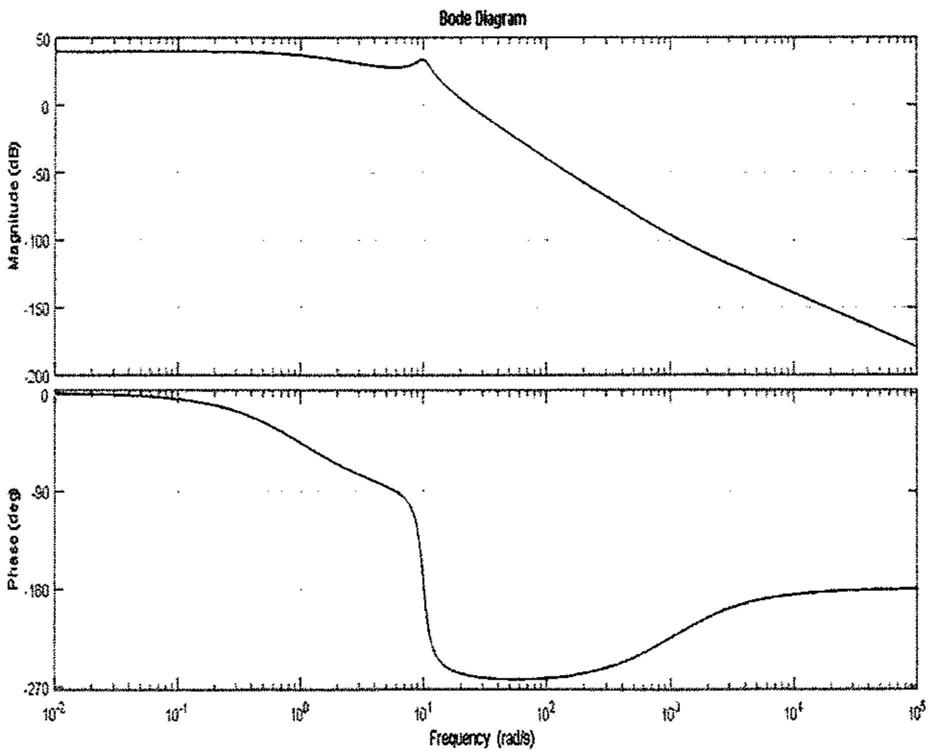

Fig. 1 Bode plot

3.

(i) A proportional integral derivative controller is expressed as below:

$$u(t) = K_p e(t) + K_I \int_0^T e(t)dt + K_D \frac{de(t)}{dt}$$

where $K_p = 0.5$, $K_I = \frac{1}{462}$, and $K_D = \frac{1}{20.1}$.

Please illustrate the circuit of this controller with operational amplifiers (OP amp) and components as resistances, capacitors, and so on. (10%)

(ii) Find the transfer function $T(\mathrm{s}) = \frac{E(\mathrm{s})}{U(\mathrm{s})}$. Suppose K_p is a variable and calculate the sensitivity of $T(\mathrm{s})$ with respect to K_p. (10%)

4.

(i) Formulate the detailed model of Fig. 2, and calculate the transfer function $T(\mathrm{s}) = \frac{\Theta_m(s)}{E_a(s)}$ between applied voltage e_a and output motor displacement θ_m. (10%)

(ii) Derive the state space formulation for this system. (10%)

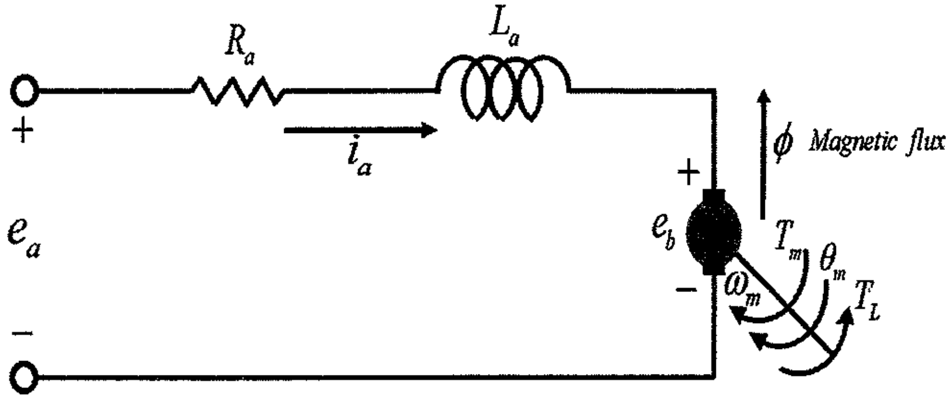

Fig.2 Model of a separately excited DC motor

where $e_a(t)$=applied voltage ,$i_a(t)$=armature current, R_a=armature resistance, L_a=armature inductance, $T_L(t)$=load torque, ϕ=magnetic flux in the air gap, $T_m(t)$ =motor torque, $\omega_m(t)$

=motor angular velocity, $\theta_m(t)$=motor displacement, J_m=motor inertia, K_t=torque constant, B_m=viscous-friction coefficient.

5. A linear system with the state space formulation as follows:

$$\dot{X} = AX + BU$$
$$y = CX$$

(i) Derive the steady state error $e(\infty) = 1 + CA^{-1}B$, when input U is a unit step. (10%)

(ii) Derive the steady state error $e(\infty) = \lim_{t\to\infty}\left[(1 + CA^{-1}B)t + C\left(A^{-1}A^{-1}\right)B\right]$, when input $U = t$ (10%)