國立嘉義大學九十四學年度
生物機電工程學系碩士班招生考試試題

科目：自動控制

一、For a system with output y and input r described by the following equation:

$$\frac{d^5y}{dt^5}+2\frac{d^4y}{dt^4}+8\frac{d^3y}{dt^3}+11\frac{d^2y}{dt^2}+16\frac{dy}{dt}+12y=5\frac{d^2r}{dt^2}+4\frac{dr}{dt}+7r$$

(a) Find the transfer function of the system. (5%)
(b) Determine the stability of the system using the Routh-Hurwiz criterion. (10%)
(c) Write down an equivalent state space representation. (5%)
(d) Sketch the state variable diagram. (5%)

二、The block diagram of a control system is given in Figure 2.

(a) Determine the closed-loop transfer function from R(s) to Y(s). (5%)
(b) Draw the root locus of the system with α as a varying parameter. (15%)
(c) Determine the value of α for the system to be critically damped. (5%)

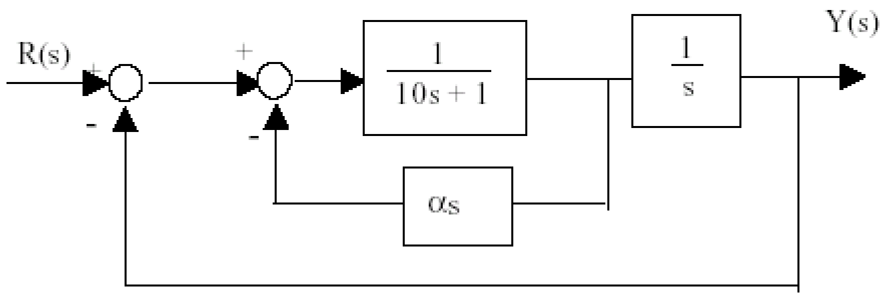

Figure 2

三、(a) The individual responses of two linear control system elements A and B each to a unit step input are given in Figure 3a. Use the response data to estimate transfer functions for A and B. (15%)

(b) The elements A and B are now placed in a feedback control system, as shown in Figure 3b, in which the proportional gain constant K is adjustable. Derive an expression for the closed-loop transfer function and determine the range of values of K for which the system will be stable. (10%)

Note: Values of peak overshoot for a second order system are given in Table 1.

Table 1 Peak overshoot for second order system

ζ	0.2	0.3	0.4	0.5	0.6	0.7	0.8
% overshoot	53	37	25	16	10	4	1

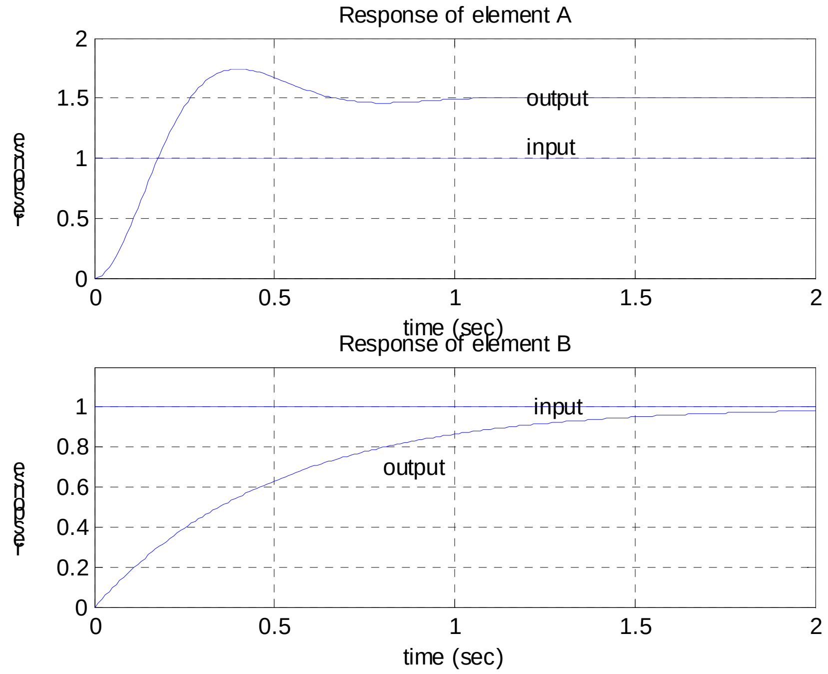

Figure 3a

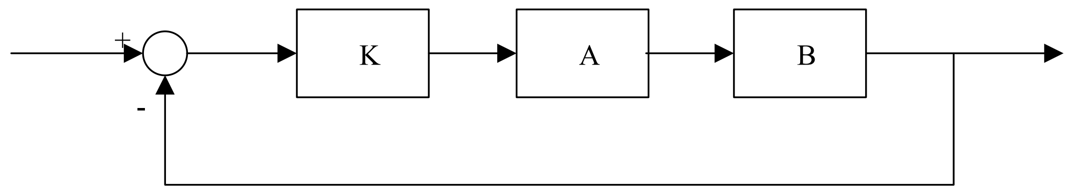

Figure 3b

四、Derive the state variable equations (10%) for a DC motor system (Figure 4) that has a constant field voltage E_F, an applied armature voltage $e_a(t)$, and a load torque $\tau_L(t)$. Also obtain the transfer function (5%) with ω_L as the output, and determine the steady-state angular velocities corresponding to the following sets of inputs:

(1) $e_a(t)=E$, $\tau_L(t)=0$ (5%) and (2) $e_a(t)=0$, $\tau_L(t)=L$ (5%).

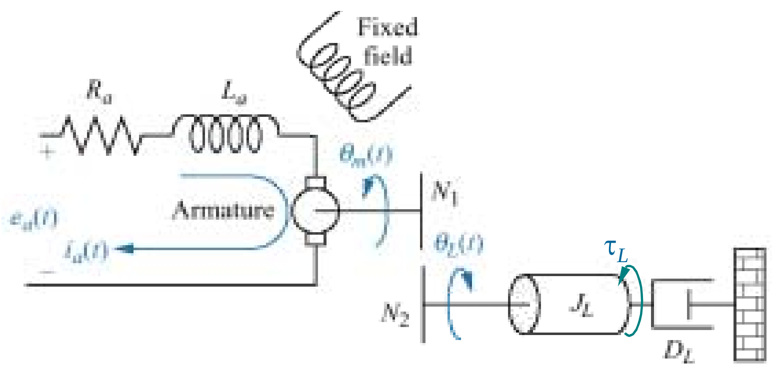

Figure 4