大同大學九十四學年度研究所碩士班入學考試試題

考試科目：控制系統　　所別：電機工程研究所　　第1頁　共2頁

註：本次考試 不可以 參考自己的書籍及筆記； 不可以 使用字典； 不可以 使用計算器。

1. Consider the system shown in **Fig. 1**. Let $T(s)$ denote the closed loop transfer function, i.e., $T(s) = Y(s)/R(s)$.
   (1) Find the S_{α}^{T} (the sensitivity of the $T(s)$ to the variation in α). (10%)
   (2) Find the S_{β}^{T} (the sensitivity of the $T(s)$ to the variation in β). (10%)

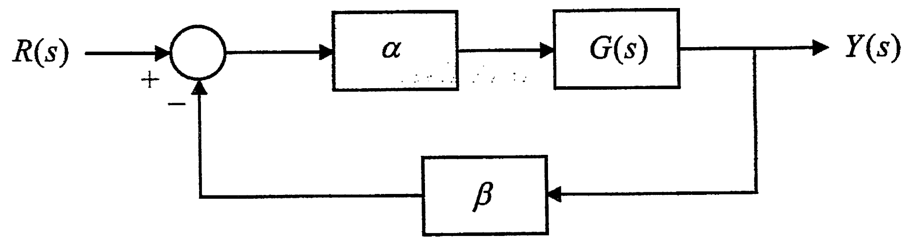

Fig. 1

2. The equations that describe the dynamics of a motor control system are

$$e_a(t) = R_a i_a(t) + L_a \frac{di_a(t)}{dt} + K_b \frac{d\theta_m(t)}{dt} \ ; \ T_m(t) = K_i i_a(t) \ ;$$

$$T_m(t) = J\frac{d^2\theta_m(t)}{dt^2} + B\frac{d\theta_m(t)}{dt} + K\theta_m(t) \ ; \ e_a(t) = K_a e(t) \ ; \ e(t) = K_s[\theta_r(t) - \theta_m(t)].$$

   (1) Assign the state variables as $x_1(t) = \theta_m(t)$, $x_2(t) = d\theta_m(t)/dt$, and $x_3(t) = i_a(t)$. Write the state equations of the system in the following vector-matrix form:

$$\dot{\mathbf{x}}(t) = \mathbf{A}\mathbf{x}(t) + \mathbf{B}\theta_r(t), \quad y(t) = \mathbf{C}\mathbf{x}(t),$$

   where $\dot{\mathbf{x}} = [\dot{x}_1 \ \dot{x}_2 \ \dot{x}_3]^T = [dx_1/dt \ dx_2/dt \ dx_3/dt]^T$ and $y(t) = \theta_m(t)$. (10%)
   (2) Find the closed-loop transfer function $M(s) = \Theta_m(s)/\Theta_r(s)$, where $\Theta_m(s)$ and $\Theta_r(s)$ denote the Laplace transforms of $\theta_m(t)$ and $\theta_r(t)$, respectively. (10%)

3. Determine the condition on b_1, b_2, c_1, and c_2 so that the following system is completely controllable and observable. (10%)

$$\frac{d\mathbf{x}(t)}{dt} = \mathbf{A}\mathbf{x}(t) + \mathbf{B}u(t), \quad y(t) = \mathbf{C}\mathbf{x}(t)$$

$$\mathbf{A} = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \quad \mathbf{B} = \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} \quad \mathbf{C} = [c_1 \ c_2]$$

TO BE CONTINUED

4. Consider that the process of a unity-feedback control system is

$$G_p = \frac{1000}{s(s+10)}$$

Let the series controller be a single-stage phase-lead controller:

$$G_c = \frac{1+aTs}{1+Ts}$$

Determine the values of a and T so that the zero of $G_c(s)$ cancels the pole of $G_p(s)$ at $s=10$. The damping ratio of the designed system should be unity. (10%)

5. The block diagram of a control system is shown in **Fig. 2.** The error signal is defined to be $e(t)$.

(1) Find the step-, ramp-, and parabolic-error constants. (10%)

(2) Find the steady state error when the input is as follows: (10%)

$r(t) = 3u_s(t) - tu_s(t) + \frac{t^2}{2}u_s(t)$, where $u_s(t)$ is the unit-step function.

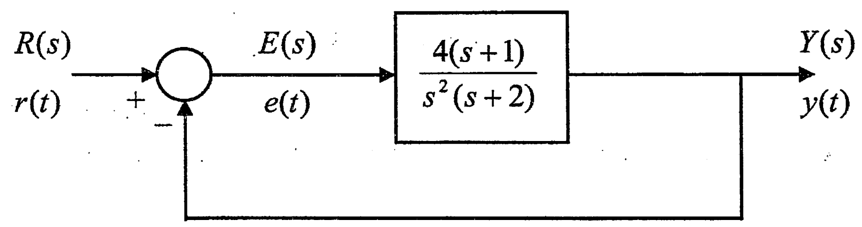

Fig. 2

6. The block diagram of a feedback control system is shown in **Fig. 3.**

(1) Apply the Nyquist criterion to determine the range of k for stability. (10%)

(2) Apply the Routh-Hurwitz criterion to determine the range of k for stability. (10%)

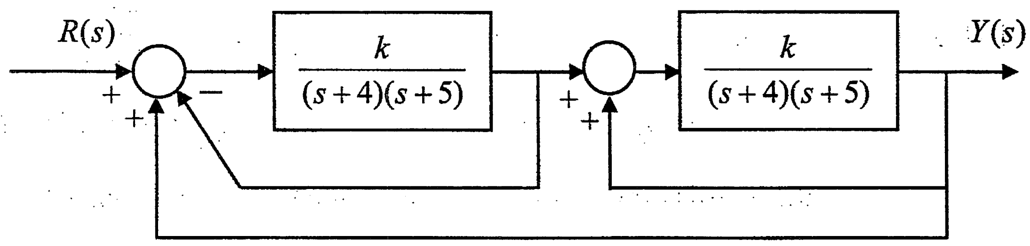

Fig. 3

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