國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：自動控制【機電系碩士班丙組】　　題號：438004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

1. (20%) A modified PID controller is given in Fig. 1. Please derive the transfer function $\frac{E_o(s)}{E_i(s)} = K\frac{(s+a)(s+b)}{s(s+d)}$, where the coefficients K, a, b, d can be determined by using $C_1, C_2, R_1, R_2, R_3, R_4, R_5$.

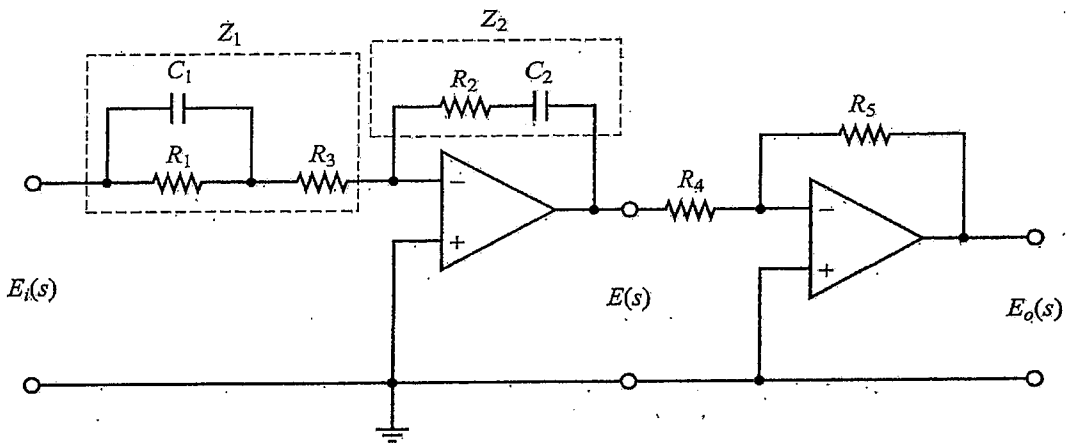

Fig. 1

2. (10%) Consider a unit-feedback system $G(s) = \frac{K(5-s)}{(s+1)(s^2+5s+10)}$.
   (a) (5%) Plot the root loci for the system.
   (b) (5%) Determine the range of K for stability.

3. (20%) Consider the servo system shown in Fig. 2.
   (a) (10%) Find the error signal $E(s)$ in the presence of the reference input $R(s)$ and disturbance input $D(s)$ if $K=2, J=2, B=3, K_h=0.5$.
   (b) (5%) From (a), calculate the steady-state error of the system when $R(s)$ is a unit ramp and $D(s)$ is unit step.
   (c) (5%) Sketch the output $c(t)$ when $R(s)$ is a unit step and $D(s)$ is zero.

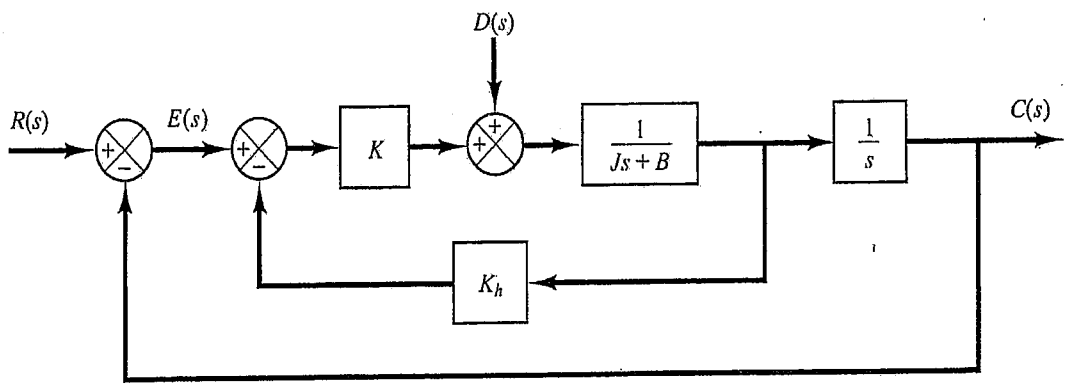

Fig. 2

4. (15%) With $x(t)$ as input and $y(t)$ as output, determine the transfer function, damping ratio and natural frequency for the second order system represented by $2D^2y + 4Dy + 8y = 8x$. Note that D is the differential operator.

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5. (15%) With $x(t)$ as input and $y(t)$ as output, this problem considers a first order system whose transfer function is $G(s) = 1/(s+1)$.
   (a) (5%) What is the time constant of this system?
   (b) (5%) What is the bandwidth of this system? Note that the bandwidth is the frequency ω_B at which the frequency response has declined 3 dB from its low-frequency value.
   (c) (5%) What is the steady-state response of this system if $x(t) = e^{-2t}$.

6. (20%) Consider a system represented by $H(s) = 1/(s+3)$. For a particular input $x(t)$, the steady-state response of this system is $y(t) = e^{-3t}u(t) - e^{-4t}u(t)$ where $u(t)$ is the unit step function.
   (a) (10%) Determine $x(t)$.
   (b) (10%) If $x(t) = 3\cos(2t)$, it is known that the steady-state response of this system can be represented as $y(t) = A\cos(2t+\theta)$. Determine A and θ.