

國立臺灣科技大學

九十四學年度碩士班招生考試試題

系所組別：機械工程系碩士班丁組

科目：線性系統控制

※ 總分 100 分

1. In a DC servo motor speed control system, the system constants are:

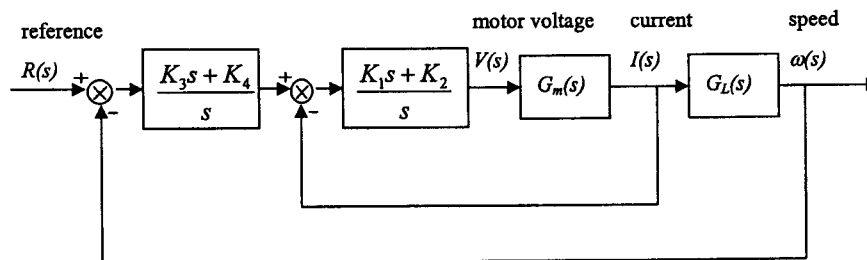
Moment of inertia of the motor and load =  $2\text{kg}\cdot\text{m}^2$

Motor torque constant =  $1\text{ N}\cdot\text{m}/\text{Amp}$

Motor back emf constant =  $1\text{ V}/\text{rad}/\text{s}$

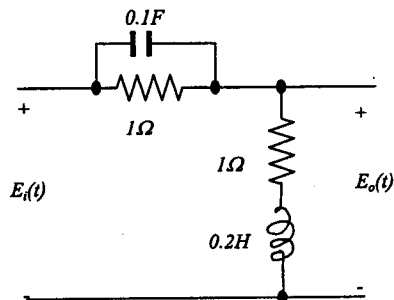
Motor armature resistance =  $0.5\ \Omega$

The system is controlled by a current feedback and a velocity feedback. The block diagram is shown as



- (1) Find the transfer function  $I(s)/V(s)$  and  $\omega(s)/I(s)$  [10%]
- (2) If the current step response has steady-state error of 10% and very fast response, find the current controller  $(K_1s + K_2)/s$  [10%]
- (3) If the speed step response has damping ratio of 0.8 and undamped natural frequency of 1 rad/sec, find the speed controller  $(K_3s + K_4)/s$  [10%]

2. In electrical circuit,  $E_i(t)$  is the input voltage, and  $E_o(t)$  is the output voltage.



- (1) Find the transfer function of  $E_o(s)/E_i(s)$  in this form  $K \frac{s^2 + as + b}{s^2 + cs + d}$  [10%]
- (2) Sketch the Bode plot to show the system characteristics. [10%]

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3. Consider a linear system  $\ddot{x} + 5\dot{x} + a(t)x = b(t)u$ , where  $a(t) \in [-1, 1]$ .

(1) Suppose only  $x(t)$  is available and it is not proper to get  $\dot{x}(t)$  from calculations.

Find all stabilizing controllers for the system with  $b(t) = 1$ . [15%]

(2) Repeat (1) but with  $b(t) \in [1, 2]$ . [10%]

4. Given a linear system  $\ddot{x} = -10\dot{x} + (|d_1| + 1)u + d_2$ , where  $d_1$  and  $d_2$  are two known disturbances. Suppose that all states are accessible.

(1) Design a controller  $u$  such that  $x$  copies the dynamics of the system

$$\ddot{y} = -2\zeta\omega_n\dot{y} - \omega_n^2 y$$

where  $\zeta = 0.707$  and  $\omega_n = 1$ . [15%]

(2) What condition is necessary and sufficient for  $x(t)$  to be identically equal to  $y(t)$  for all  $t \in [0, \infty)$  if a proper controller can be found in (1). [10%]

