國立中正大學105學年度碩士班招生考試試題

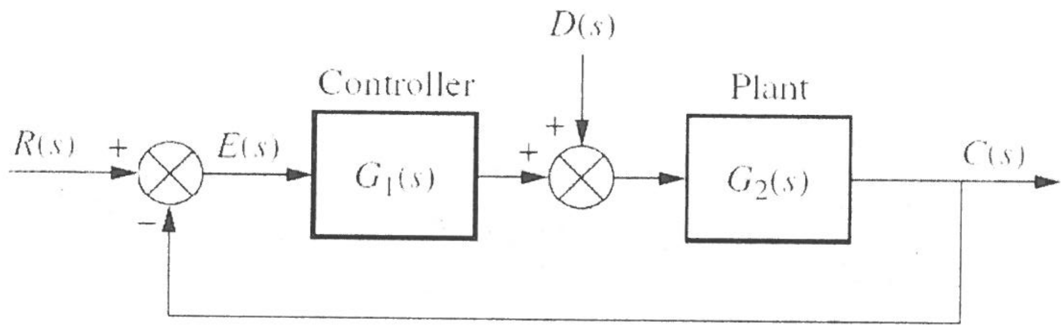
系所別：機械工程學系-乙組
光機電整合工程研究所

科目：自動控制

第3節

1. (10%) For each of the transfer functions shown below, plot the poles on the *s*-plane, and state the nature of each response (overdamped, underdamped,..,etc.)
   (a) (5%) $T(s)=5/[(s+3)(s+6)]$
   (b) (5%) $T(s)= 1/(s^2+9)$

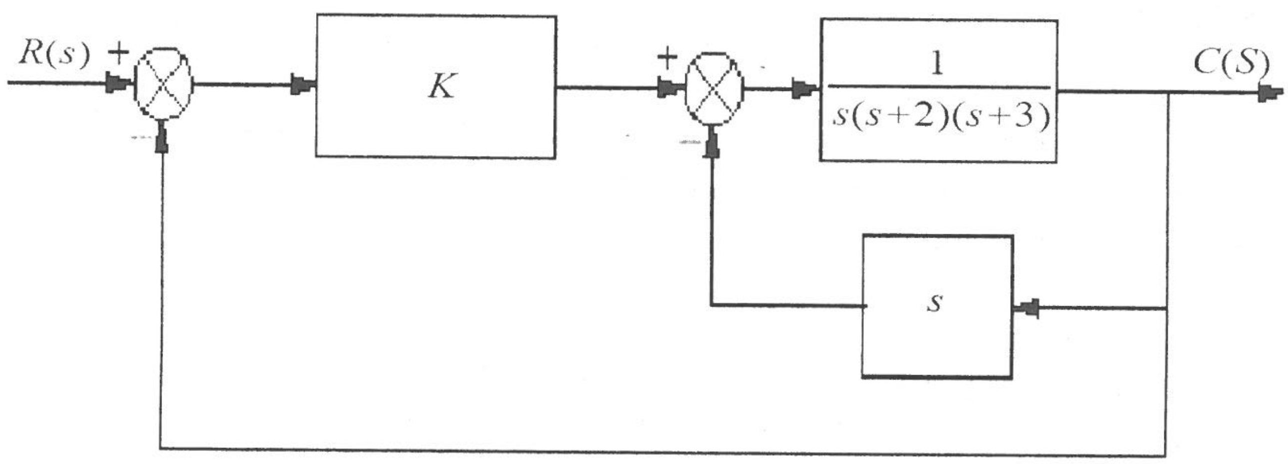
2. (20%) Consider the following feedback system



where $G_1(s)=\dfrac{100(s+1)}{(s+10)}$, $G_2(s)=\dfrac{\beta}{s(s+3)}$, and the nominal value of $\beta=3$

(a) (5%) What is the system type with respect to the reference input R(s)?
(b) (5%) What is the steady-state tracking error when the reference input $r(t)=2$ and the disturbance input $d(t)$ is zero?
(c) (5%) What is the system type with respect to the disturbance input $D(s)$?
(d) (5%) What is steady-state error when the reference input is zero and the disturbance input $d(t)=2$?

3. (20%) For the system shown below



(a) (5%) Find the equivalent transfer function $T(s)=C(s)/R(s)$
(b) (5%) Find the range of K to keep the system stable
(c) (5%) Find the value of gain, K, that will make the system oscillate (marginally stable).
(d) (5%) Find the frequency of oscillation

4. (25%) A feed drive system consists of motor, ball screw, and table, as shown in Fig. 1. The motor will generate a rotation motion. The ball screw will transfer the rotation motion into the linear motion so that the table will move linearly. Suppose that the dynamics of a feed drive system is given by

$$\ddot{y} + \dot{y} = 2u$$

where y is the displacement of the table, and u is the input voltage to the motor. The corresponding block diagram is shown in Fig. 2, where $C(s)$ is the controller provided by the servo drive.

(a) (5%) With u as the input and y as the output, please determine the transfer function $G(s)$ for the open loop feed drive system

(b) (10%) Suppose a proportional-derivative controller (PD-control) is employed, i.e.,

$$C(s) = k(s+2), \qquad k \geq 0$$

Please plot the root-locus of the system, i.e., the closed-loop poles of the system as the feedback gain k varies from 0 to ∞.

(c) (10%) Please choose a feedback gain k such that the closed-loop system satisfies

(i) The settling time (within 2% of steady state) is less than 1.5 sec;

(ii) Damping ratio is greater than $\frac{1}{\sqrt{2}}$.

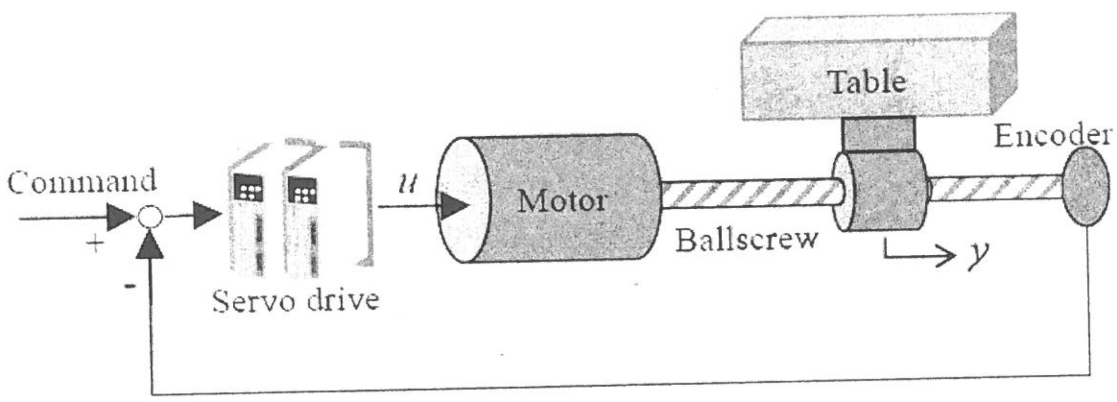


Fig. 1

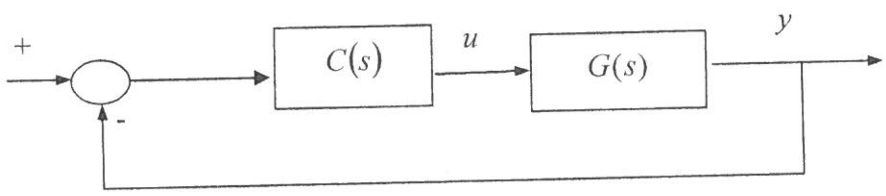


Fig. 2

5. (25%) Consider another feed drive system whose open loop transfer function is given by $G(s) = \dfrac{10}{s(s+10)}$.

(a) (5%) Please sketch the ***approximated*** Bode plot (the magnitude vs. frequency and phase vs. frequency plots) for the open loop system $G(s)$.

(b) (10%) From the Bode plot you sketch, please estimate the gain crossover frequency ω_c and phase margin ϕ_m.

(c) (10%) Suppose the feedback loop is the same as shown in Fig. 2. Also, suppose now that a lead compensator is employed, i.e.,

$$C(s) = k\frac{s+20}{s+100}, \qquad k \geq 0$$

Using frequency response techniques, please a feedback gain k such that the closed-loop system satisfies

(i) Bandwidth is greater than 10 rad/s;

(ii) Damping ratio is greater than 0.4.