國立中正大學九十一學年度碩士班招生考試試題

系所別：機電光整合工程研究所　　科　目：自動控制

共二頁

1. (25%) A closed-loop system is shown below (Figure. 1). The plant G(s) is given as $\frac{25}{s(s+1)}$.
   (a) (10%) Determine the error coefficients K_p, K_v and K_a. K_p, K_v and K_a correspond to step, ramp and parabolic error constants, respectively.
   (b) (8%) Determine the maximum overshoot and settling time of y(t) when r(t) is given as 1*u(t), where u(t) denotes a unit step function.
   (c) (7%) Determine the steady state error signal e(t) when r(t) is given as $(5+2t)u(t)$.

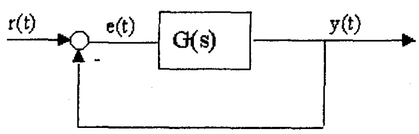

Figure. 1

2. (25%) A proportional feedback control system is shown in Figure. 2 below where G(s) is a minimum-phase system and is given as $\frac{c}{s(1+\tau_1 s)(1+\tau_2 s)}$. K is a constant gain controller. The asymptotic approximation of the Bode plot for G(s) is shown in Figure. 3.

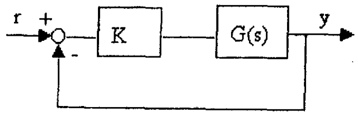

Figure. 2

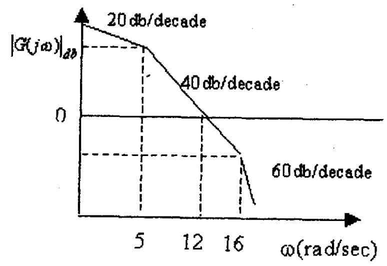

Figure. 3

   (a) (10%) Determine the parameter c, τ_1, τ_2.
   (b) (10%) Determine the gain margin and phase margin of the system.
   (c) (5%) Determine the range of K which makes the closed loop stable.

3. (20%) Consider a feedback control system as follows (Figure. 4).

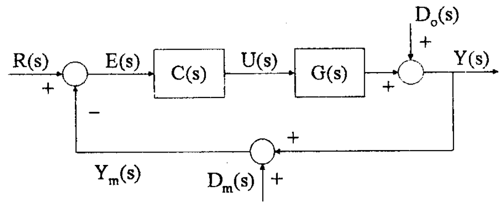

Figure. 4

where G(s) and C(s) are transfer functions of the plant and controller, R(s), U(s), and Y(s) indicate the Laplace transforms of reference command, input, and output, and $D_o(s)$ and $D_m(s)$ represent the Laplace transforms of output disturbance and measurement noise. Let T(s) and S(s) denote the transfer functions from R(s) to Y(s) and from $D_o(s)$ to Y(s).

(a) (5%) Express Y(s) as a linear function of R(s), $D_o(s)$, and $D_m(s)$.

(b) (5%) Show that the equation, T(s) + S(s) = 1, holds.

(c) (10%) What is the implication of the equation in (b) in regard to tracking performance, disturbance rejection and noise reduction? Or, put in another words, what are the trade-offs one should consider when designing the controller C(s)?

4. (30%) Consider the following closed-loop system with time delay, T_d.

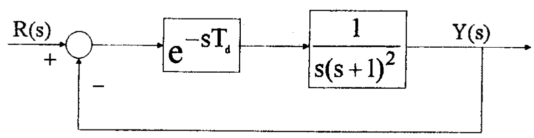

Figure. 5

(a) (5%) Explain **WHY** the Nyquist criterion works?

(b) (10%) Assume no time delay, i.e., $T_d = 0$. Apply the Nyquist criterion to study the closed-loop stability.

(c) (10%) Determine the gain and phase margins of the system. (When solving the problem, you may need to the following facts.

$x^6 + 2x^4 + x^2 - 1 = (x^3 + x + 1)(x^3 + x - 1)$,

the real root of $(x^3 + x - 1)$ is about 0.7, and $\tan^{-1}(0.35) = 19.2$ degree.)

(d) (5%) Assume $T_d \neq 0$. Determine the maximally allowable time delay before the system becomes unstable.