國立中正大學102學年度碩士班招生考試試題

系所別：光機電整合工程研究所　　科目：自動控制

第3節　

1. (20%) The block diagram of a feedback control system is shown in Figure 1.

   (a) Derive the following transfer functions:

$$\left.\frac{Y(s)}{R(s)}\right|_{N=0} \qquad \left.\frac{Y(s)}{N(s)}\right|_{R=0}$$

   (b) The controller with the transfer function $G_4(s)$ is for the reduction of the effect of the noise $N(s)$. Find $G_4(s)$ so that the output $Y(s)$ is totally independent of $N(s)$.

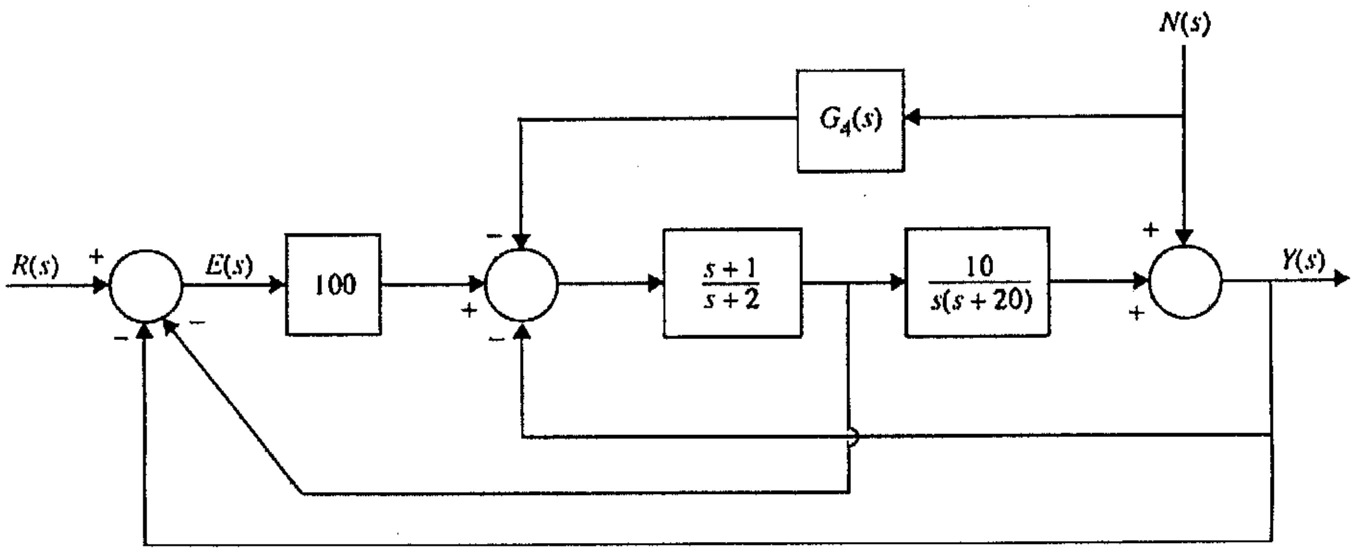

Fig. 1

2. (20%) A controlled process is represented by the following dynamic equations:

$$\frac{dx_1(t)}{dt} = -x_1(t) + 5x_2(t)$$

$$\frac{dx(t)}{dt} = -6x_1(t) + u(t)$$

$$y(t) = x_1(t)$$

   The control is obtained through state feedback with

$$u(t) = -k_1 x_1(t) - k_2 x_2(t) + r(t)$$

   where k_1 and k_2 are real constants, and $r(t)$ is the reference input.

   (a) Find the value of k_1 and k_2 such that ξ=0.707 and ω_n=10 rad/sec.

   (b) Let the error signal be defined as $e(t) = r(t) - y(t)$. Find the steady-state error when $r(t) = u_s(t)$ and k_1 and k_2 are at the values found in part (a).

3. (10%) Using the Routh-Hurwitz criterion, determine how many roots are to the right of the line $s = -1$ in the s-plane for the closed–loop system that has the following characteristic equation

$$s^3 + 4s^2 + 4s + 4 = 0$$

4. (10%) Consider the following system with a P (proportional) feedback control.

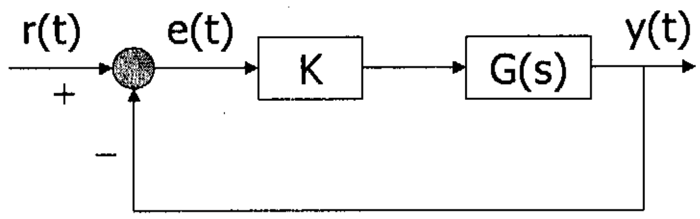

Fig. 2

where $G(s)=\dfrac{1}{(s+1)(s+2)(s+10)}$ and $K>0$.

Sketch its root locus step by step by answering the following questions.

(a) (2%) Identify the real-axis segments of the root locus.

(b) (3%) Determine the asymptotes.

(c) (3%) Determine the breakaway point.

(d) (2%) Determine the breakaway angles.

5. (40%) Consider the feedback system of Problem 4 again.

(a) (2%) Verify that the point $(-0.7+j3.92)$ is on its root locus. Note that $\tan^{-1}(3.92/0.3)\cong 85.6^{\circ}$, $\tan^{-1}(3.92/1.3)\cong 71.6^{\circ}$, and $\tan^{-1}(3.92/9.3)\cong 22.8^{\circ}$.

(b) (8%) Determine the K gain and closed-loop transfer function corresponding to the point $(-0.7+j3.92)$ of the root-locus as verified in (a).

(c) (5%) Determine the steady-state error in the unit-step response of the resultant closed-loop system of (b).

(d) (10%) Discuss that the resultant closed-loop system of (b) is a dominantly 2^{nd} order system.

(e) (10%) Discuss the unit-step response of the dominantly 2^{nd} order system of (d) in terms of the peak time, percent overshoot, and settling time within 2%.

(f) (5%) Discuss how a PI- (proportional-integral) feedback control can remove the non-zero steady-state error in the unit-step response of the original P-feedback system.