**1.** Consider a feedback control system, as in Fig.1, with controlled plant $G(s)=\dfrac{2}{(s+1)(s+2)}$,

sensor $G_1(s)=\dfrac{5}{s+3}$ and controller $K$.

(a) Please find the range of $K$ to make the system stable. (10%)
(b) Please find the range of $K$ so that the steady state error will less than 0.02 as the input $x(t)$=0.1 for $t>0$. (10%)

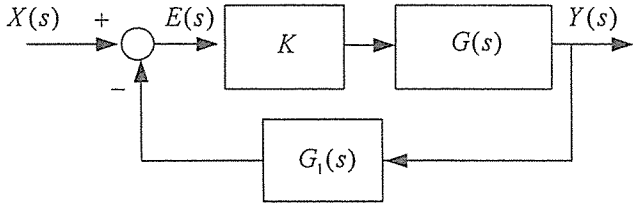


Fig.1

**2.** Consider a unit feedback control system, as shown in Fig. 2, with the controlled plant

$G(s)=\dfrac{1}{s^2+s-2}$ and the controller $G_c(s)=K$.

Define the state variables as $x_1=y$, and $x_2=\dot{y}$. The control system can be described as

$$\dot{\mathbf{x}}=\mathbf{A}\mathbf{x}+\mathbf{B}r$$
$$y=\mathbf{C}\mathbf{x}$$

(a) Please derive the state equation and output equation. (5%)
(b) Please solve the eigenvalue of **A**. (5%)
(c) Find the range of $K$ according to the eigenvalue in (b) for system stability. (5%)
(d) Compare your result in (c) with that by Routh's stability criterion. (5%)

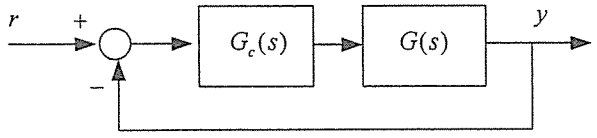


Fig.2

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**3.** A hydraulic servo control system is designed as in Fig.3 with $G(s)=\dfrac{1}{(s+2)^2(s+3)}$.

(a) Please find the dominant poles to yield the settling time (2% criterion) of 1.6 sec and the maximum percent overshoot of 25%. (10%)

(b) Please design a compensator $G_c(s)=K_c\dfrac{s+z}{s+p}$ with zero at -1 to satisfy the conditions in (a). (10%)

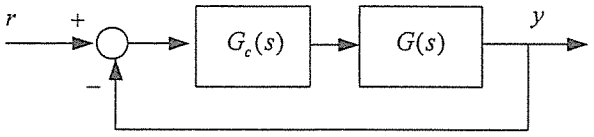


Fig.3

**4.** Consider a controller design problem in frequency domain in Fig.4.

(a) Please find the controller $K$ to make the open loop system have a phase margin of $60°$. (10%)

(b) Please find the gain margin, the gain crossover frequency and position error constant of the compensated system. (10%)

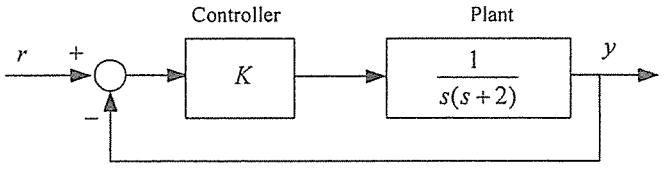


Fig.4

**5.** Consider a unity feedback control system as in Fig.5.

(a) Please find the range of $K$ using Routh's stability criterion for system stability. (5%)

(b) Please sketch the Nyquist plot. (10%)

(c) Please use Nyquist stability criterion to compare the result in (a). (5%)

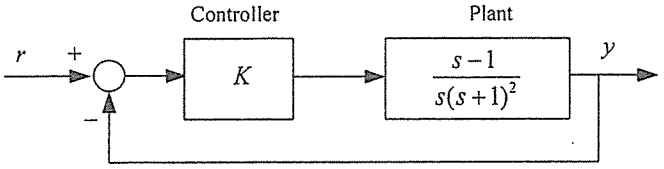


Fig.5

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