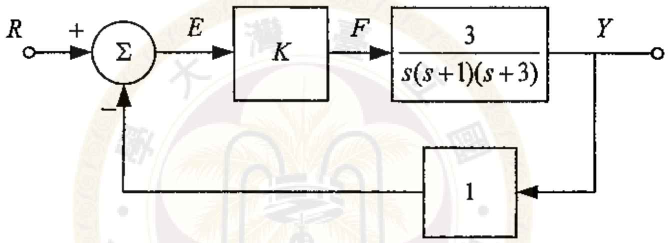
Problem I (30%). Linearity and time-invariance.

1. (a) Give a mathematical and graphical explanation about linear systems (5%). (b) Give a mathematical and graphical description of a system which is linear and time-variant (5%).
2. (a) Give a mathematical and graphical explanation about time-invariant systems (5%). (b) Give a mathematical and graphical description of a system which is time-invariant and nonlinear (5%).
3. (a) Give a mathematical and graphical explanation about linear time-invariant systems (5%). (b) Give a mathematical and graphical description of a system which is neither linear nor time-invariant (5%).

Problem II (25%). Nyquist plot versus root locus techniques. For the system shown below, determine the Nyquist plot and apply the Nyquist criterion to

(a) (15%) Determine the range of values of K (both positive and negative) for which the system will be stable, and
(b) (10%) Determine the number of roots in the right-half-plane for those values of K for which the system is unstable. Check your answer using a rough root-locus sketch.



Problem III. (25%) Compensator design on Bode plots. For the third-order system:

$$G(s)=\frac{50000}{s(s+10)(s+50)}$$

(a) Use Bode plot sketches to design a compensator so that PM > 50° and ω_{BW}>20 rad/sec, where PM stands for phase margin and ω_{BW} is the closed-loop bandwidth (15%). (b) Verify your design by drawing compensated Bode plots. Refine and verify your design again if necessary (10%).

Problem IV (20%). State-space methods. Consider the plant dynamics described by

$$\dot{x}=\begin{bmatrix}0 & 2\\ 5 & -4\end{bmatrix}x+\begin{bmatrix}1\\ 2\end{bmatrix}u$$
$$y=[1 \quad 2]x$$

1. Draw a block diagram for the plant with one integrator for each state variable (5%).
2. Find the transfer function using matrix algebra (5%).
3. Find the closed-loop characteristic equation if the feedback is (a) $u=Ky$ (5%) (b) $u=-[K_1 \quad K_2]x$ (5%)

試題隨卷繳回