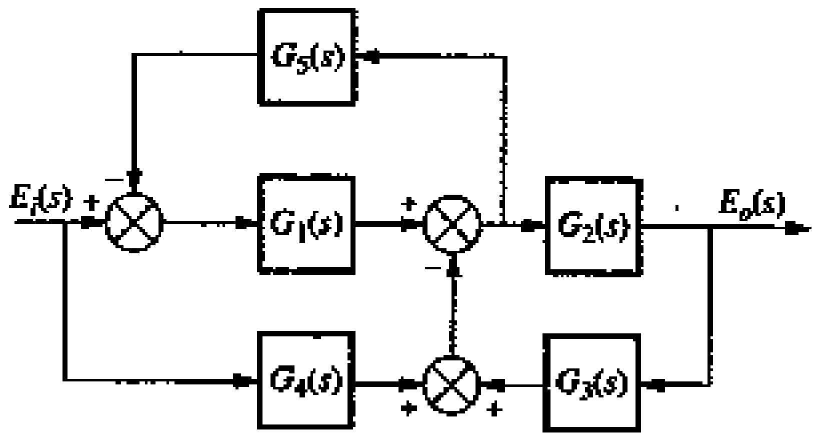
九十學年度 工程與系統科學 系（所） 丁 組碩士班研究生招生考試

控制原理 科號 3004 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. Reduce the system shown below to a single equivalent transfer function $T(s) = E_o(s)/E_i(s)$. (10%)



2. Consider the follow second-order system:

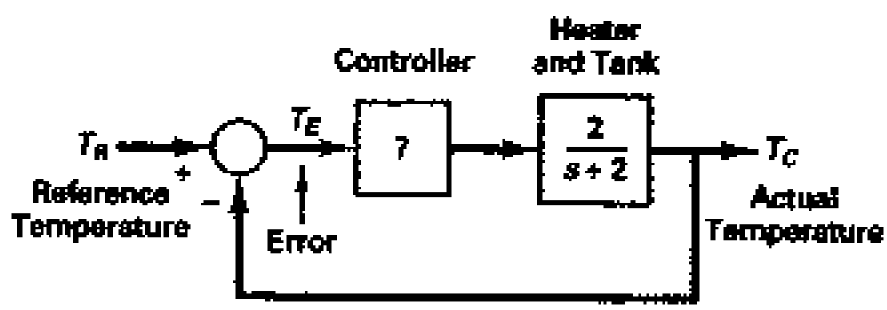
$H(s) = \omega_n^2 / (s^2 + 2\zeta\omega_n + \omega_n^2)$

Show that the unit step response is

$y(t) = 1 - 1/(1-\zeta^2)^{0.5} \exp(-\zeta\omega_n t)\sin(\omega_d t + \theta)$

where $\omega_d = \omega_n(1-\zeta^2)^{0.5}$ and $\theta = \cos^{-1}\zeta$ (20%)

3. Design a simplest controller for the system shown below such that the steady-state error with a step input is zero, the damping ratio is unity, and the undamped natural frequency is 4 rad/s. (10%)



4. Show that when $0 < \zeta < 0.707$, the frequency response of a system with transfer function H(s), which is shown in problem 2, has a peak amplitude given by

$1/[2\zeta(1-\zeta^2)^{0.5}]$. (20%)

5. Consider the transfer function $G(s) = K(s+1)^2/[s(s-1)^2]$.

a. If K=1, plot the Bode plot. (8%)

b. If K=1, plot the polar plot. (6%)

c. Plot the loot locus. (6%)

d. Find the range of K that will ensure stability in the unity feedback system. (3%)

e. Find the value of K that will cause oscillation and the frequency of oscillation.(2%)

6. The Bode plot of the plant is shown below. The design is to met (1) phase margin $\geq 60°$ and (2) gain margin $\geq 10\text{dB}$. Discuss if the phase-lead or phase-lag controller can met these conditions. You must give your reasons. (15%)