p1.

自動控制:

1. Consider the feedback control system of the following diagram as shown in figure A.

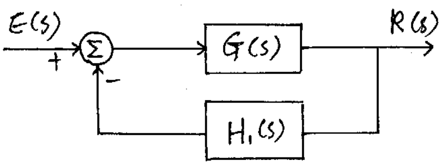

Fig. A. The feedback control system

Where $G(s) = \dfrac{K}{s(s+1)(s+4)}$

$H_1(s) = 1$

<u>Here is the question:</u>

Please find the range of K to let the system become stable.

2. Consider a first-order process with PI controller as shown in figure B. It can be easily shown that the closed-loop response is given by the following equation:

$$Y(s) = \frac{\tau_I s + 1}{\tau^2 s^2 + 2\zeta\tau s + 1} Y_{SP}(s)$$

where τ = natural period of oscillation of the system

ζ = damping factor

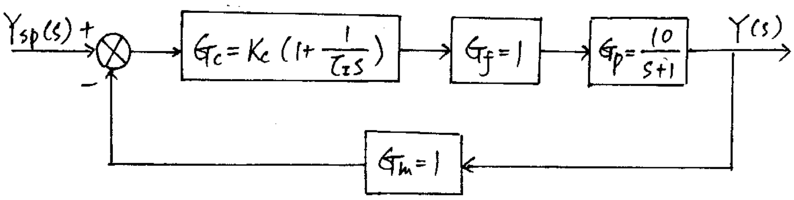

Fig. B. A closed-loop system

p2.

We notice that the closed-loop response is second-order. For the selection of the "best" values for K_c and τ_I we will use simple criteria stemming from the underdamped response of a second-order system.

Here is the question:
If we select the one-quarter decay ratio criterion, please find the best K_c and τ_I to satisfy the one-quarter decay ratio criterion.

3. Consider the temperature control system for the heater of figure C. The temperature T is the controlled output while the inlet temperature T_i is the load and steam temperature is the manipulated variable.

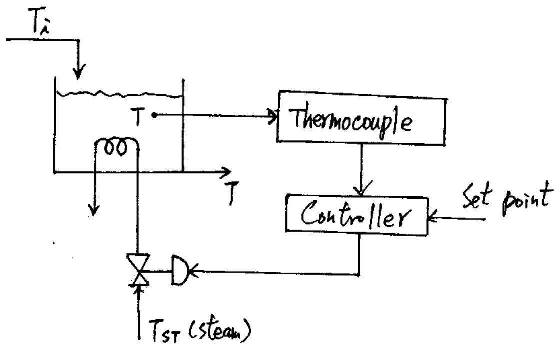

Fig. C. A closed-loop of temperature control system

The transfer functions for each component of the feedback loop are:

(a) Process:
If T, T_i and T_{ST} are deviation variables, then the response of the process is given by

$$T(s) = \frac{1/\tau}{s+a} T_i(s) + \frac{K}{s+a} T_{ST}(s)$$

(where τ, a and K are all constants)

(b) Temperature sensor (thermocouple):
Assume that the response of the thermocouple is very fast and its dynamics can be neglected. Thus,

$$T_m(s) = K_m T(s)$$

(where K_m is a constant)

p3.

(c) Controller:

Let T_{SP} be the set point. Then

$\varepsilon(s) = T_{SP}(s) - T_m(s)$

and for a proportional controller the actuating output is given by

$C(s) = K_c \varepsilon(s)$

(where K_c is a constant)

(d) Control valve:

Assume first-order dynamics:

$$T_{ST}(s) = \frac{K_v}{\tau_v s + 1} C(s)$$

(where K_v and τ_v are all constants)

<u>Here is the two questions:</u>

(1) Please draw the block diagram for the closed-loop system with the transfer functions for each component of the loop.

(2) If the closed-loop response is found to be

$$T(s) = G_{SP}(s) T_{SP}(s) + G_{load}(s) T_i(s)$$

please find the closed-loop transfer functions $G_{SP}(s)$ and $G_{load}(s)$.