1. Consider the pipe-welding system shown in Fig. 1.
   (a) Write the closed-loop system characteristic equation.
   (b) Use the Jury test to determine the range of K for stability.
   (c) Let K=10, find the damping ratio, the natural frequency, and the time constant for the transient response of the closed-loop system.

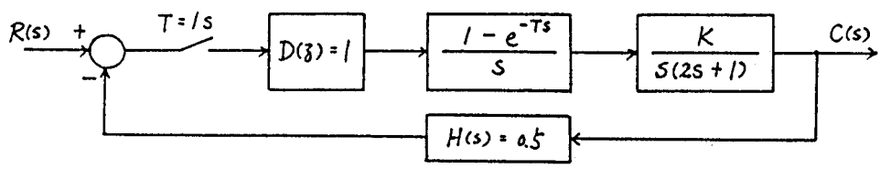

Fig. 1

2. Consider the feedback system shown in Fig. 2.
   (a) Find the value of K and a [illegible] the following frequency domain specifications:
   (b) For the [illegible] the peak

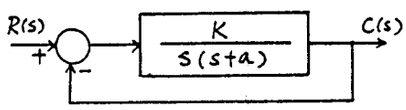

Fig. 2

3. (a) Sketch the inverse Nyquist plot of a unity feedback system characterized by the open-loop transfer function

$$G(s) = \frac{K}{s(1+0.1s)(1+s)}$$

   (b) Find the value of M_r for K=1.
   (c) By what factor should the gain K be changed so that M_r is 1.4?
   (d) Determine the value of ω_r for the new setting of gain.

4. A discrete-time system has state and output equations given by

$$x_1(k+1) = 0.25x_1(k) + u(k)$$
$$x_2(k+1) = 0.125x_1(k) + 0.125x_2(k) + u(k)$$

$$y(k) = [0.5 \;\; 0] \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

   Solve for the output y(k) when u(k)=unit impulse and $\underline{x}(0)=\underline{0}$.

5. Show that controllability and observability of linear time-varying dynamical equations are invariant under any equivalence transformation $\bar{x} = P(t)x$ where P is nonsingular for all t and continuously differentible in t.

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