4.13. Consider a system with the plant transfer function $G(s) = 1/s(s+1)$. You wish to add a dynamic controller so that $\omega_n = 2$ rad/sec and $\zeta \geq 0.5$. Several dynamic controllers have been proposed:

1. $D(s) = (s+2)/2$,
2. $D(s) = 2\dfrac{s+2}{s+4}$,
3. $D(s) = 5\dfrac{(s+2)}{s+10}$,
4. $D(s) = 5\dfrac{(s+2)(s+0.1)}{(s+10)(s+0.01)}$.

(a) Using MATLAB, compare the resulting transient and steady-state responses to reference step inputs for each controller choice. Which controller is best for the smallest rise time and smallest overshoot?

(b) Which system would have the smallest steady-state error to a ramp reference input?

(c) Compare each system for peak control effort, that is, measure the peak magnitude of the plant input $u(t)$ for a unit reference step input.

(d) Based on your results from parts (a) to (c), recommend a dynamic controller for the system from the four candidate designs.

4.14. A certain control system has the following specifications: rise time $t_r \leq 0.010$ sec, overshoot $M_p \leq 16\%$, and steady-state error to unit ramp $e_{ss} \leq 0.005$.

(a) Sketch the allowable region in the s-plane for the dominant second-order poles of an acceptable system.

(b) If $Y/R = G/(1+G)$, what condition must $G(s)$ satisfy near $s = 0$ for the closed-loop system to meet specifications; that is, what is the required asymptotic low-frequency behavior of $G(s)$?

4.15. For the system in Problem 4.4, compute the following steady-state errors:

(a) To a unit-step reference input.

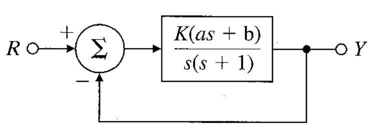
(b) To a unit-ramp reference input.

(c) To a unit-step disturbance input.

(d) For a unit-ramp disturbance input.

(e) Verify your answers to parts (a) to (d) using MATLAB. Note that a ramp response can be generated as the step response of a system modified by an added integrator at the reference input.

4.16. Consider the system shown in Fig. 4.43. Show that the system is type 1 and compute the K_v,



4.43
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