Problem I (100%). Consider a control system with a 4th-order plant transfer function

$$G(s)=\frac{0.0008}{(s+0.8)s^2}$$

and a feedback compensator $D(s)$ to be designed.

(a) (10%) Draw a root locus plot for the closed-loop system with $D(s) = D_0(s) = K_0$, where K_0 is a positive scalar number.

(b) (10%) Determine the range of K_0 for the closed-loop system to be unstable.

(c) (20%) If the compensator $D(s)$ is in the lead/lag form

$$D(s)=D_1(s)=K_1\frac{s+c}{s+0.8}$$

and the targeted closed-loop system response has a damping ratio of 0.45 and a bandwidth of 0.05. Determine the proper value of c.

(d) (30%) Draw a root locus plot for the closed-loop system with $D(s) = D_1(s)$ and the c value determined in (c), versus K_1 which is a positive scalar number (10%). Determine the proper value of K_1 (10%) for the targeted closed-loop system response in (c) (10%). Determine the range of K_1 for the closed-loop system to be unstable.

(e) (10%) For a constant disturbance T_d applied at the plant input, determine the steady-state error caused by T_d, for the closed-loop system with $D(s) = D_1(s)$ designed in (c) and (d).

(f) (10%) Draw a Bode plot of $D_1(s)G(s)$, with asymptotes, slopes, and critical frequencies clearly indicated (5%). Determine the stability margins on the Bode plot drawn (5%).

(g) (10%) Draw a Nyquist plot of $D(s)_1G(s)$ (5%). Determine the system closed-loop stability from the Nyquist plot drawn (5%).

試題隨卷繳回