8-4 For the digital space vehicle control system shown in Fig. P7-8, let $J_o = 41822$ and $T = 0.1$ s. Set the relation between $K_R$ and $K_P$ so that the ramp-error constant is 10. Sketch the Nyquist plot of an equivalent $G(z)$ that has $K_R$ as a multiplying factor. Determine the ranges of $K_P, K_R$ so that the system is stable using the Nyquist criterion.

![Block diagram diagram](image)

Figure P7-8.

I suggest, you work in the $w$-plane, construct a Bode diagram first by straight-line approximation, then sketch the Nyquist diagram (still in the $w$-plane) from it. Then you use the Nyquist criterion to determine the border of stability.
8-16 For the Large Space Telescope control system described in Problem 4-10, Fig. P4-10, let \( K_R = 731,885 \), \( K_p = 10,455,500 \), \( K_t = 41,822,000 \), \( J_v = 41,822 \), and \( T = 0.1 \) s. Construct the Bode diagram of \( G(z) = C(z)/E(z) \) for \( z = e^{j\omega T} \) for \( \omega \) up to \( \omega_s/2 \). Determine the gain and phase margins of the system.

![Diagram](image)

Work in the \( \mathbb{z} \)-plane.

10-12 The controlled process of a discrete-data control system is described by the transfer function

\[
G_{ao} G_p(z) = \frac{K(z + 0.5)}{(z - 1)(z - 0.5)}
\]

The sampling period is 0.1 s. Determine the value of \( K \), and design a cascade phase-lag digital controller with the transfer function

\[
D(z) = K_c \frac{z - z_1}{z - p_1}
\]

where \( D(1) = 1 \), so that the following design specifications are satisfied.

a. The ramp-error constant \( K_c = 100 \).

b. The phase margin is 60 degrees.

Plot the Bode diagrams of the open-loop transfer functions of the uncompensated and the compensated systems. Find the phase margin, gain margin, \( M_p \), and BW of the compensated system. Plot the unit-step response of the compensated system.

Work in the \( \mathbb{z} \)-plane.