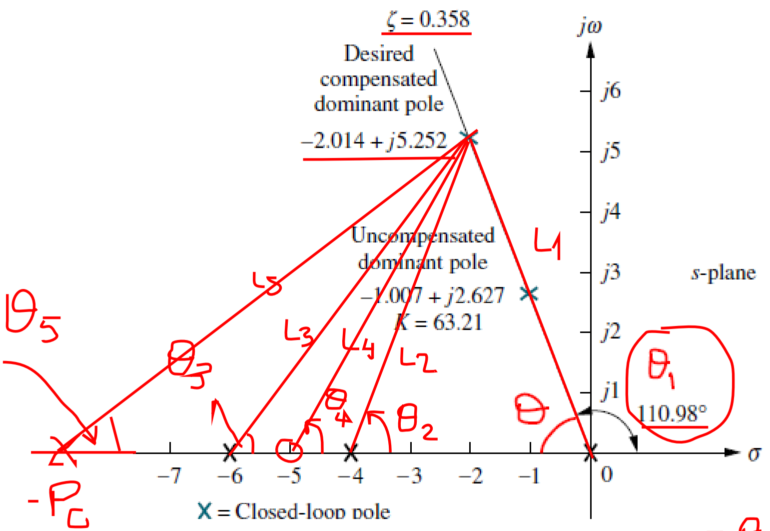
Example 9.4

Lead Compensator Design

PROBLEM: Design three lead compensators for the system of Figure 9.17 that will reduce the settling time by a factor of 2 while maintaining 30% overshoot. Compare the system characteristics between the three designs.



$z_c = -5$, $p_c = ?\ -42,96$

$$\theta_2 = \tan^{-1}\left(\frac{5,252}{1,986}\right) \cong 69,286^\circ$$

$$\theta_3 = \tan^{-1}\left(\frac{5,252}{3,986}\right) = 52,803^\circ$$

$$\theta_4 \approx 60,38^\circ$$

$$-\theta_1 - \theta_2 - \theta_3 + \theta_4 - \theta_5 = -180^\circ$$

$$180 - \theta_1 - \theta_2 - \theta_3 + \theta_4 = \theta_5 = 7,31^\circ$$

$$K = \frac{L_1 \times L_2 \times L_3 \times L_5}{L_4} = 1423$$

Eski Ts:

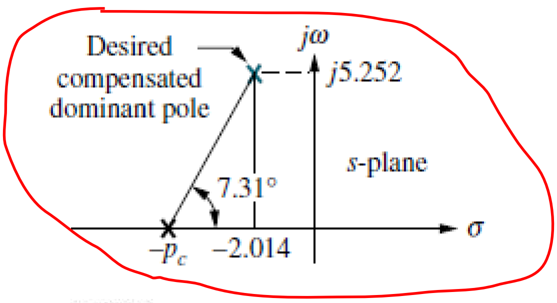
$$T_s = 4/1.007 = 3.972$$

Yeni Ts:

$$T_s = 3.972/2 = 1.986$$

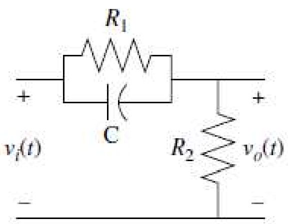
bu durumda:

$$-\zeta\omega_n = -4/T_s = -2.014.$$



$$\frac{5.252}{p_c - 2.014} = \tan 7.31^\circ \qquad p_c = 42.96$$

Lead compensation



$$\frac{s+\frac{1}{R_1C}}{s+\frac{1}{R_1C}+\frac{1}{R_2C}} = \frac{s+5}{s+42,96}$$

$c = 1\,\mu F$

Example 9.10

Realizing a Lead Compensator

PROBLEM: Realize the lead compensator designed in Example 9.4 (Compensator b).

SOLUTION: The transfer function of the lead compensator is

$$G_c(s) = \frac{s+4}{s+20.09} = \frac{s+5}{s+42,96} \tag{9.51}$$

Comparing the transfer function of a lead network shown in Table 9.11 with Eq. (9.51), we obtain the following two relationships:

$$\frac{1}{R_1C} = \cancel{4}\ 5 \longrightarrow \tag{9.52}$$

$R_1 = ? = \frac{1}{5 * C} = 0,2\,M\Omega$

$R_2 = ?$

$\boxed{C = 1\,\mu F}$ ✓

and

$$\frac{1}{R_1C} + \frac{1}{R_2C} = \cancel{20.09}\ 42,96 \tag{9.53}$$

Hence, $R_1C = 0.25$, and $R_2C = 0.0622$. Since there are three network elements and two equations, we may select one of the element values arbitrarily. Letting $C = 1\,\mu F$, then $R_1 = 250\,k\Omega$ and $R_2 = 62.2\,k\Omega$.

$\frac{1}{R_2C} = 37,96$

$R_2 = 0,026\,M\Omega$