Practical Assignment № 3

Digital and Microcontroller Devices

variant number: 6

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Practical Task 3

1) experimental values（Group 6）

1) Table 1 :

Variant	z_1	z_2	z_3	z_4	z_{p1}	z_{p2}	b_1	b_2	T_u	T_G	$\frac{T_0}{T}$	r
6	0, 56	0, 65	0, 98	0, 18	0, 34	0, 64	1	8	2	8	0. 5	0. 25

2) Calculate parameters of digital PID controller via pole-assignment design. Desired poles of closed-loop system and process parameters are in Table 1.

The parameters of a PID-control algorithm for process III are to be determined in such a way that the poles are located as follows:

$$z_1 = 0.56, z_2 = 0.65, z_3 = 0.98, z_4 = 0.18$$

The poles of the process ate $z_1 = 0.34, z_2 = 0.64$. Since $m = 2$ (4) is satisfied so that the controller:

$$G_R(z) = \frac{q_0 + q_1 z^{-1} + q_2 z^{-2}}{(1 - z^{-1})(1 + \gamma_1 z^{-1})}$$

can be used. This leads to the following characteristic equation:

$$(1 - z^{-1})(1 + \gamma z^{-1})(1 + a_1 z^{-1} + a_2 z^{-2}) + (q_0 + q_1 z^{-1} + q_2 z^{-2})(b_1 z^{-1} + b_2 z^{-2}) = 0.$$

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Following multiplying and comparing the coefficients with the characteristic equation (3) one obtains:

$$\begin{aligned}
\gamma + q_0 b_1 &= -(z_1 + z_2 + z_3 + z_4) + 1 - a_1 \\
\gamma(a_1 - 1) + q_0 b_2 + q_1 b_1 &= z_1 z_2 + z_3 z_4 + (z_1 + z_2)(z_3 + z_4) - a_2 + a_1, \\
\gamma(a_2 - a_1) + q_1 b_2 + q_2 b_1 &= -z_1 z_2 (z_3 + z_4) - z_3 z_4 (z_1 + z_2) + a_2 \\
q_2 b_2 - \gamma a_2 &= z_1 z_2 z_3 z_4
\end{aligned}$$

This equation system can be first solved for γ and then for the q_i :

$$\gamma = -0.3606,\ q_0 = -0.2707,\ q_1 = 0.4801,\ q_2 = -0.1955.$$

The step response of the controller becomes:

$$u(0) = -0.2707, u(1) = -0.1588, u(2) = -0.1046,$$

$$u(3) = -0.0712, u(4) = -0.0452, u(5) = -0.0219.$$

The expected PID behavior is then achieved.

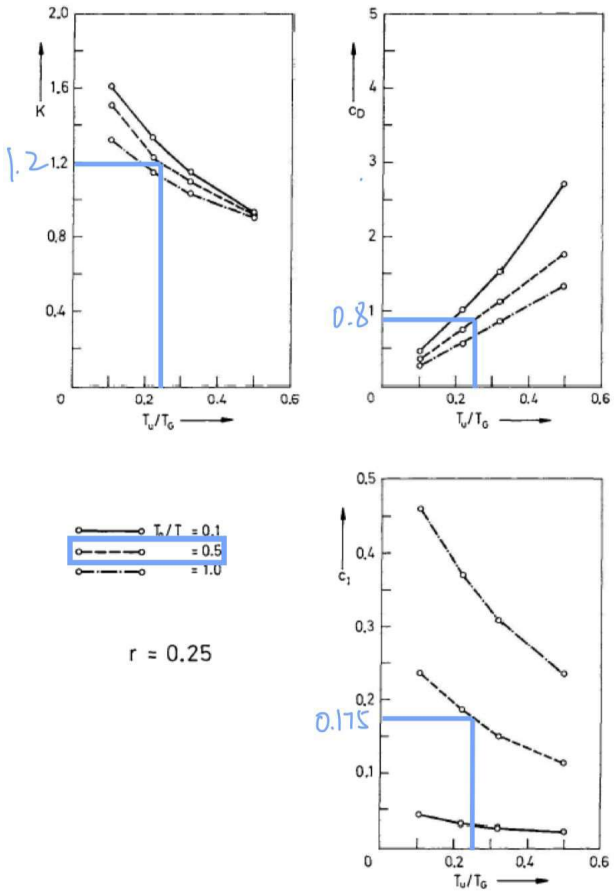
3) Calculate parameters of digital PID controller via measured step function method using figures. Parameters for calculation are in Table 1.

In a low-pass process $T_u = 14\text{sec}, T_G = 45\text{sec}$ and $K_p = 2$ were obtained from the measured step function. Sample time $T_0 = 10\text{sec}$.

1 $T_u/T_G = 0.25$.

2 $T_0/T = 0.5$.

3 $r = 0.25$,



4 $K_0 = 1.2, c_I = 0.175, c_D = 0.8$.

5 $K = 1.2/2 = 0.6, q_0 = 1.08, q_1 = -1.4550, q_2 = 0.48$.

conclusion:

- We can use two methods to obtain the parameters of digital PID controller:
  - Pole-assignment method
  - Measured step function method
- Through these two methods, we will get different controller parameters.