Subjects – System Theory and Automatization – 06.01.2022

Let the control system be characterized by the block diagram given in Fig. 1, where the reference input is $r(t)$ and the control error is $e(t)$.

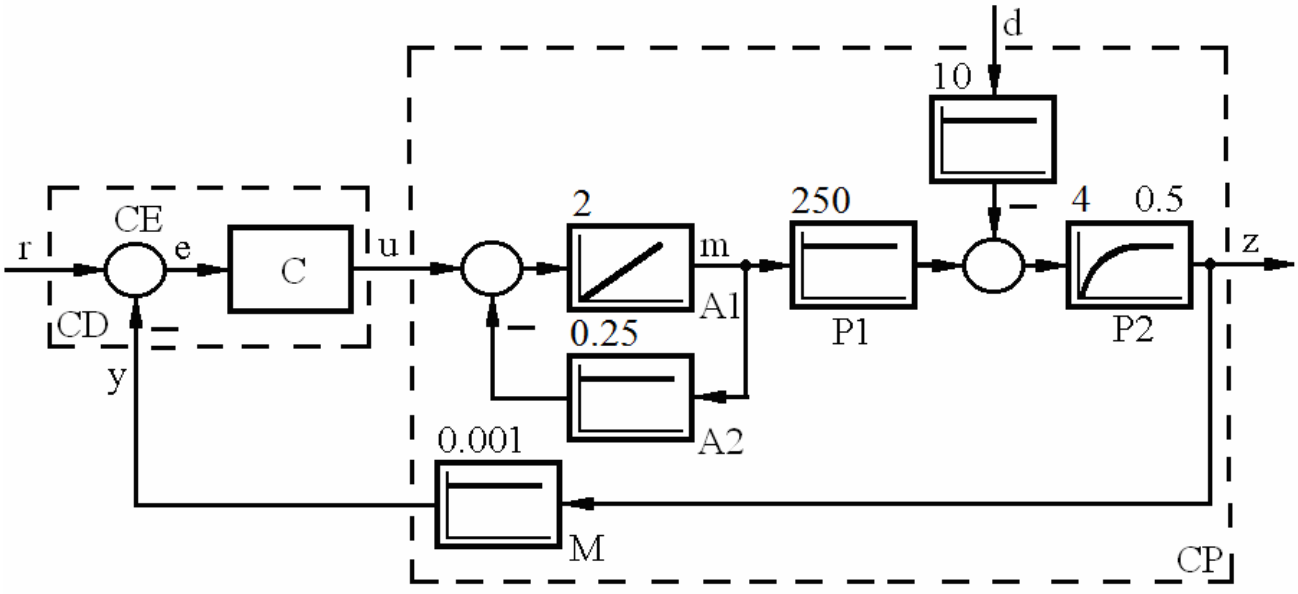

Fig. 1. Block diagram of the control system.

The transfer function of the controller C is

$$C(s) = k_C\,(1+\frac{1}{T_i s}).$$

Tasks:

(1) Calculate the transfer characteristics, i.e., the transfer function with respect to the reference input $H_{z,r}(s)$ (r is the input, z is the output) and the transfer function $H_{z,d}(s)$ with respect to the disturbance input $d(t)$ (d is the input, z is the output) if the controller parameter values are $k_C = 1$ and $T_i = 2.5\,\text{sec}$.

(2) Investigate the stability of the control system for the controller parameter values given at point (1).

(3) Using the value $T_i = 2.5\,\text{sec}$ of the integral time constant of C, find the domain of values of $k_C > 0$ that guarantees the stability of the control system.

(4) Using $T_i = 2.5\,\text{sec}$ and setting a value of $k_C > 0$ such that the control system is stable, if the steady-sate values of the system inputs are $r_\infty = 15$ and $d_\infty = 60$, calculate the steady-state values $\{e_\infty,\ u_\infty,\ m_\infty,\ z_\infty,\ y_\infty\}$.

(5) Using the controller parameter values at point (4), calculate the open-loop transfer function $H_0(s)$ and the two parameters k_r and k_d of the input-output static map $z_\infty = k_r r_\infty + k_d d_\infty$. Which is the value of the static coefficient?

(6) Using the controller parameter values at point (4) and assuming that a fault happens making the block A2 out of operation, analyze the effects on the point (3) (the control system stability) and the point (5) (the static map).

Grades: start: 1, (1): 1, (2): 2, (3): 1, (4): 2, (5): 2, (6): 1. Total: 10.