How is the setpoint tracking and the disturbance compensation performance of the control system?

- **Setpoint tracking** is as if the feedback loop did not have time delay, and therefore *faster setpoint tracking* can be achieved with a dead-time compensator than with ordinary feedback control (with PID controller). However, the time delay of the response in the process measurement can not be avoided with a dead-time compensator.

- **Disturbance compensation**: In [12] the disturbance compensation with a dead-time compensating control system is investigated for a first order with time delay process. It was found that dead-time compensation gave better disturbance compensation (assuming a step in the disturbance) compared to ordinary feedback control only if the time delay (dead-time) τ is larger than the time constant T of the process.

Example 23.1 ***Dead-time compensator***

Given a process with the following transfer functions (cf. Figure 23.1):

$$H_p(s) = \underbrace{\frac{K_u}{T_u s + 1}}_{H_u(s)} e^{-\tau s} \tag{23.4}$$

$$H_v(s) = \frac{K_v}{T_v s + 1} \tag{23.5}$$

where

$$K_u = 1;\ T_u = 0.5;\ K_v = 1;\ T_v = 0.5;\ \tau = 2 \tag{23.6}$$

The following two control systems have been simulated:

- *Dead-time compensator* for the process defined above. The internal controller, $H_{pid}(s)$, is a PI controller with the following parameter values:

  $$K_p = 2.0;\ T_i = 0.36 \tag{23.7}$$

  These PI parameters are calculated using Skogestad's method, cf. Table A.1, with $\tau = 0$, $T_C = 0.25$ $(= T/2)$ and $k_1 = 1.44$.

- *Ordinary feedback control* with PI controller for the process defined above.The PI controller, $H_{pid}(s)$, is a PI controller with the following parameter values:

$$K_p = 0.12;\ T_i = 0.5 \tag{23.8}$$

  These PI parameters are calculated using Skogestad's method, cf. Table A.1, with $T_C = 2\ (= \tau)$ and $k_1 = 1.44$.

Figure 23.2 shows the simulated responses for the two control systems due to a setpoint step and a disturbance step. The dead-time compensator gives better setpoint tracking and better disturbance compensation than ordinary feedback control does.

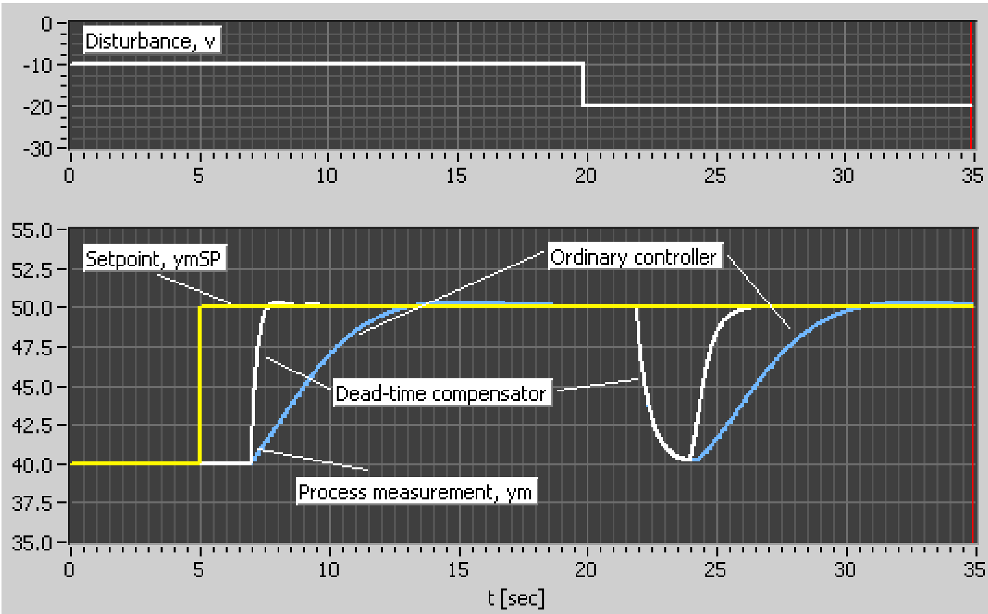

Figure 23.2: Example 23.1: Simulated responses for the two control systems due to a setpoint step and a disturbance step

[End of Example 23.1]

The dead-time compensator is model-based since the controller includes a model of the process. Consequently, the stability and performance robustness of the control system depend on the accuracy of the model. Running a sequence of simulations with a varied process model (changed model parameters) in each run is one way to investigate the robustness.