EL2450 – Assignment I

1 Question 3

The reference signal is a step of 10 units from time 100 seconds, with an offset of 40 units, as seen in figure 1.

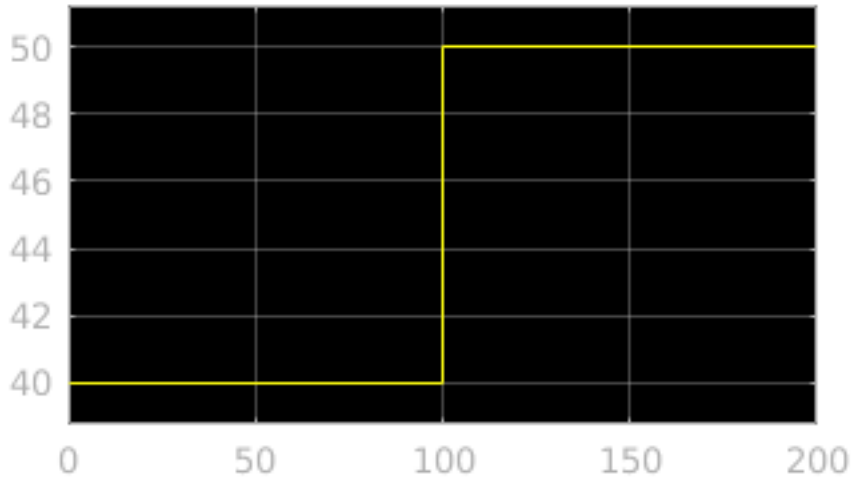

Figure 1: The reference signal.

2 Question 4

Table 1 illustrates the corresponding values of the K, T_I, T_D and N coefficients for set χ, ζ and ω_0.

χ	ζ	ω_0	K	T_I	T_D	M
0.5	0.7	0.1	2.6062	14.4445	5.5143	0.9791
0.5	0.7	0.2	5.9243	9.3823	3.1938	1.1191
0.5	0.8	0.2	6.3325	10.3873	3.1523	1.1591

Table 1: Coefficients of the PID controller per set χ, ζ and ω_0 values.

3 Question 5

Table 2 illustrates the rise time, overshoot and settling time for set values of χ, ζ and ω_0.

χ	ζ	ω_0	T_r	M	T_s
0.5	0.7	0.1	8.2	14.40	39.0
0.5	0.7	0.2	5.0	34.67	23.7
0.5	0.8	0.2	4.95	31.72	24.25

Table 2: Rise time (T_r) in seconds, overshoot (M) as a percentage of the output's steady state value, and settling time T_s in seconds for set values of χ, ζ and ω_0.

Due to our step response requirements, the best control performance is given by the third set of (χ, ζ, ω_0) parameters. All three requirements are fulfilled, as opposed to the case of the first set, and in comparison to the case of the second set, the rise time and overshoot are less, while their settling times are comparable.

Figures 2, 3 and 4 depict the step response for the three sets of (χ, ζ, ω_0) parameters.

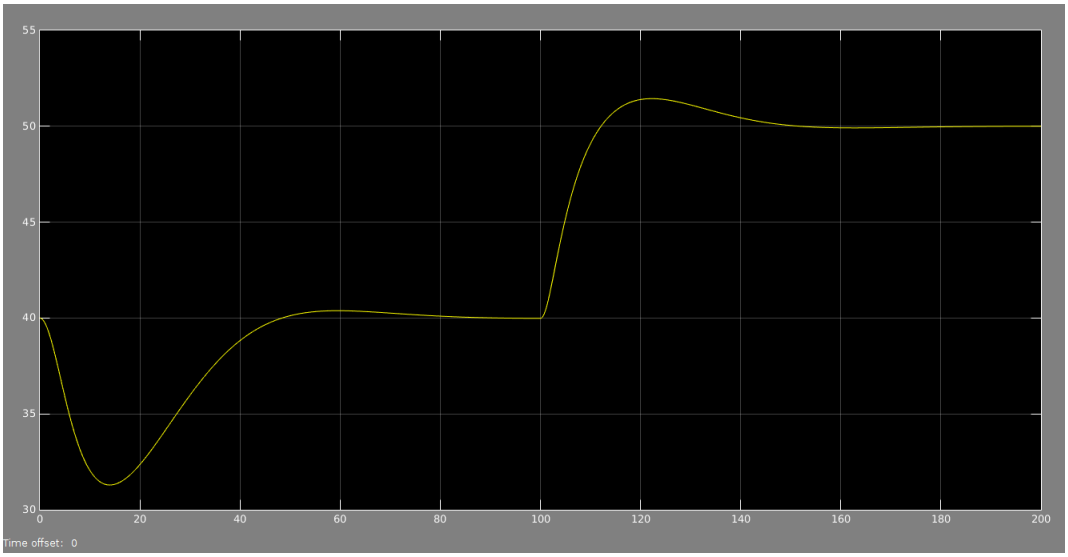

Figure 2: Step response for $(\chi, \zeta, \omega_0) \equiv (0.5, 0.7, 0.1)$.

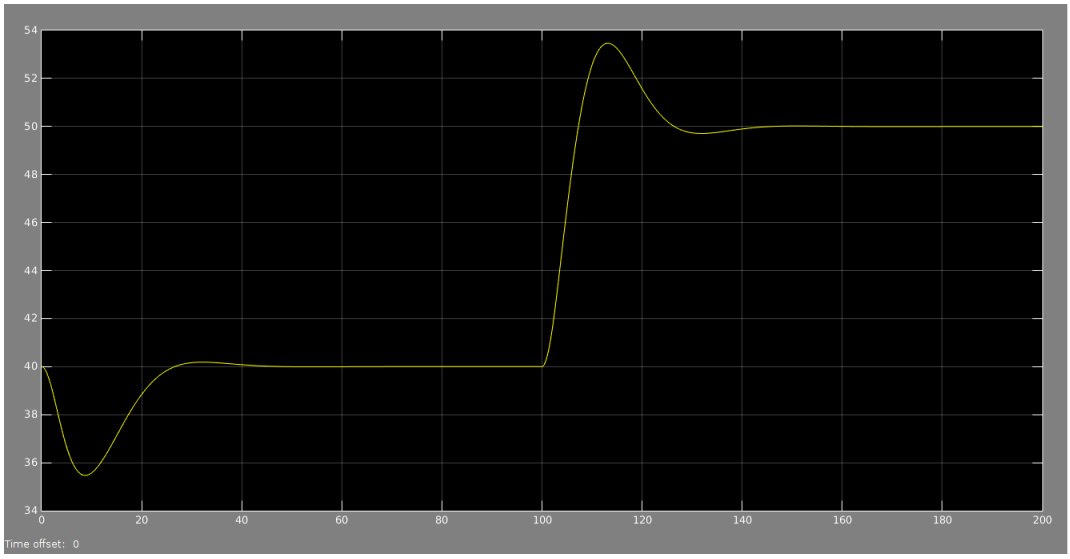

Figure 3: Step response for $(\chi, \zeta, \omega_0) \equiv (0.5, 0.7, 0.2)$.

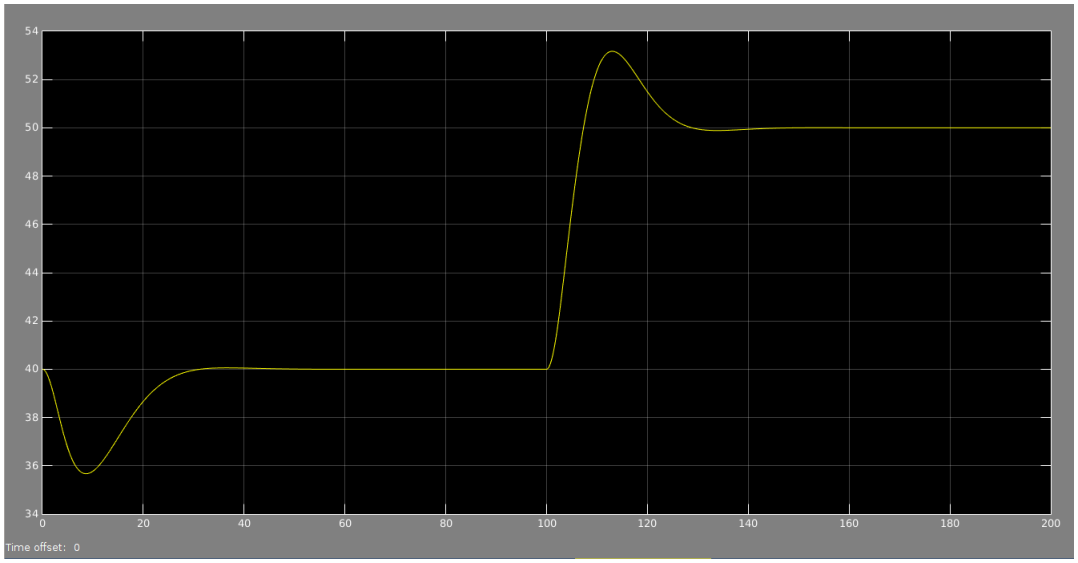

Figure 4: Step response for $(\chi, \zeta, \omega_0) \equiv (0.5, 0.8, 0.1)$.

4 Question 6

The open-loop transfer function is equal to the product of the transfer function of the controller $F(s)$ and that of the process $G(s)$. The crossover frequency ω_c is the frequency at which the magnitute of $F(j\omega)G(j\omega)$ is 1.0.

In practice, we were able to derive the crossover frequency by using MATLAB's `margin()` function, with argument the open-loop transfer function.

Table 3 illustrates the crossover frequencies in rad/s for set values of the χ, ζ and ω_0 parameters.

χ	ζ	ω_0	ω_c
0.5	0.7	0.1	0.2239
0.5	0.7	0.2	0.3426
0.5	0.8	0.2	0.3619

Table 3: Crossover frequencies depending on the set values of χ, ζ and ω_0.