Contol theory Homework #2 report. Variant F.

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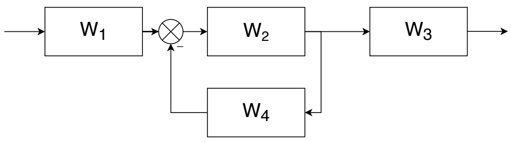
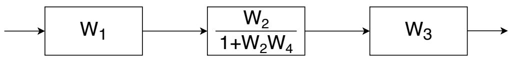
1 Task 1.

A. Calculate total transfer function

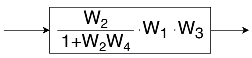
Calculate total Transfer Function of the system:



As a first step I will simplify feedback chain:



And then our system can be represented as one block:



In variant F I have:

$$W_1 = \frac{s+3}{s+1}, W_2 = \frac{1}{s+2}, W_3 = \frac{1}{s+0.1}, W_4 = \frac{1}{2s+3}$$

Substituting $W_1, ..., W_4$ to the system block: [1]

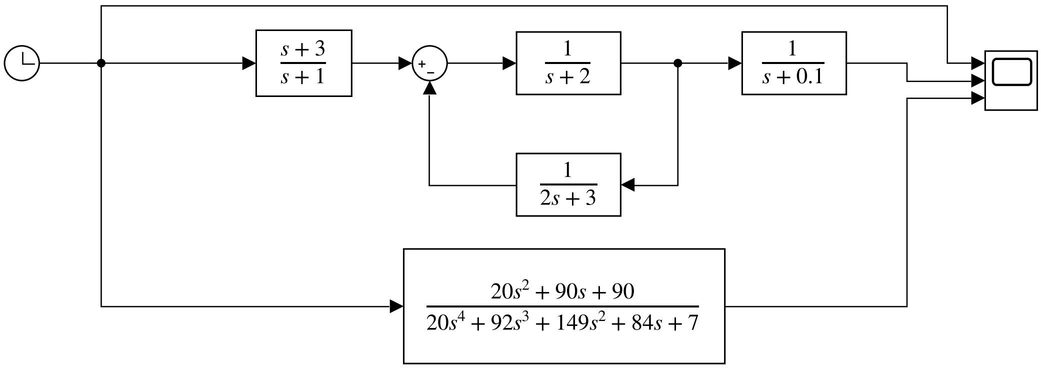
$$W_1 * W_3 * \frac{W_2}{1 + W2 * W4} = \frac{20s^2 + 90s + 90}{20s^4 + 92s^3 + 149s^2 + 84s + 7}$$

Hence, our total Transfer Function is

$$W = \frac{20s^2 + 90s + 90}{20s^4 + 92s^3 + 149s^2 + 84s + 7} \tag{1}$$

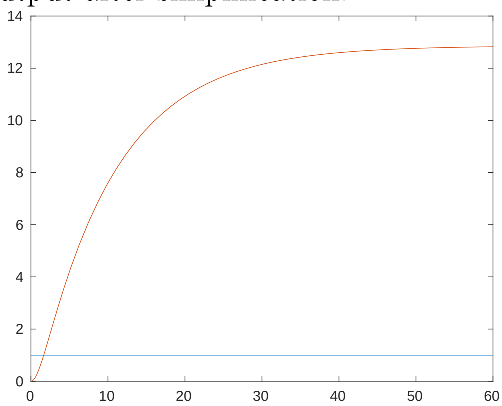
[1]This answer was get with Matlab script simplify_fraction.m in Task1 folder

B. Build initial and simplified systems and analyse responses

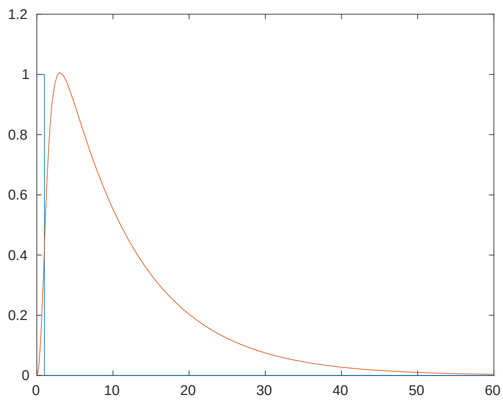


Simulink model for response analysis. For analysing different responses, one just need to put signal source to input instead of the clock.

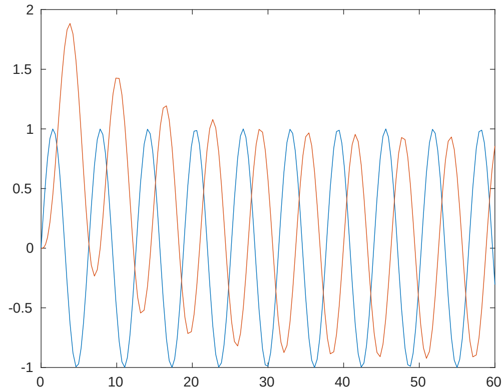
Step, Impulse, and Frequency responses plots. On each plot blue line is system input, red one is the initial system output, and the orange one is system output after simplification:



Step response



Impulse response

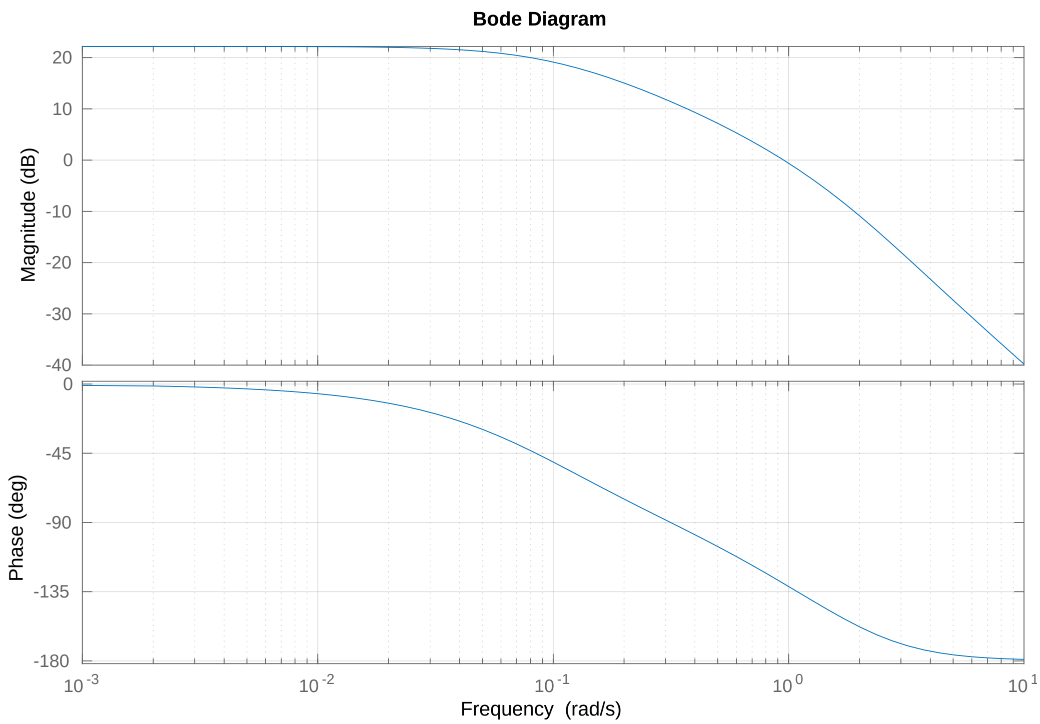


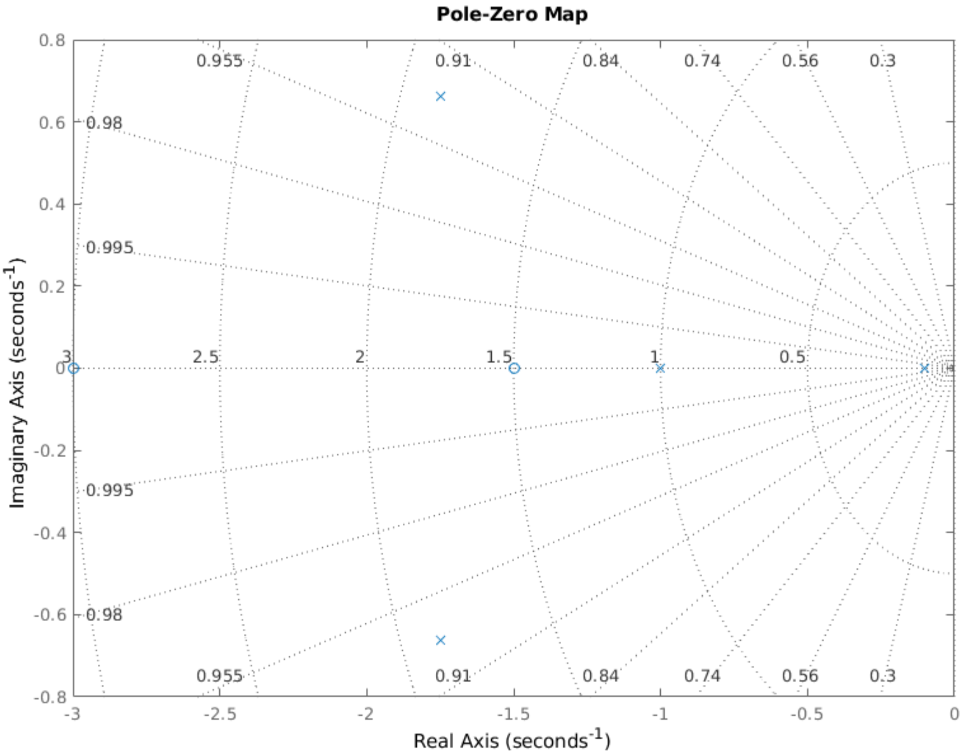
Frequency response

Note, that plots look like there is only one output, but it is not true – they are just very close to each other.

C. Bode and Pole-Zero map plots

As a input signal, for which I will generate the plots I have chosen a Frequency response (sine function).





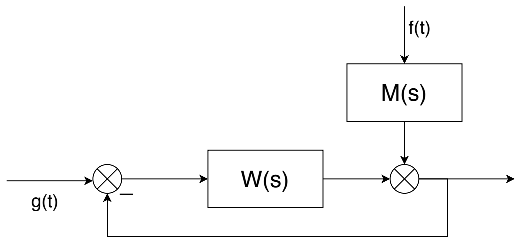
According to Matlab `pzmap()` function, our Transfer Function (1) has following poles and zeroes:

$$poles = \begin{bmatrix} -1.7500 + 0.6614i \\ -1.7500 - 0.6614i \\ -1.0000 + 0.0000i \\ -0.1000 + 0.0000i \end{bmatrix} \; zeroes = \begin{bmatrix} -3.0000 \\ -1.5000 \end{bmatrix}$$

As it can be seen, all our poles have negative real part, and that says us that the system is stable.

2 Task 2.

Find total Transfer Function of the system:



Firstly, let's consider case when $f(t) = 0$. In this case our Transfer Function is $\frac{W}{1+W}$. Then we'll consider case, when $g(t) = 0$, and our Transfer Function will be $M \times \frac{1}{1+W}$. Hence, total transfer function for the system in general case is

$$output = \frac{W}{1+W} \times g(t) + \frac{M}{1+W} \times f(t)$$

In variant F I have:

$$W(s) = \frac{s+1}{s^2+3s+2}, M(s) = \frac{1}{s+3}$$

After simplification of fractions with Matlab, we get

$$output = \frac{1}{s+3} \times g(t) + \frac{s+1}{(s+3)^2 \times f(t)}$$

3 Used software.

- Python 3.8.1
- Matlab R2018b 9.5.0
- draw.io

All software was run under Manjaro Linux with 5.4.18-rt kernel