Homework2

Control Theory

February 18, 2020

Deadline is March 06, 2020, 23:59 (MSK)

All results should be beautiful packed in one pdf and loaded to Github in PR. Plots should be signed. Do not forget to describe and explain your results.

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1. Select your variant.

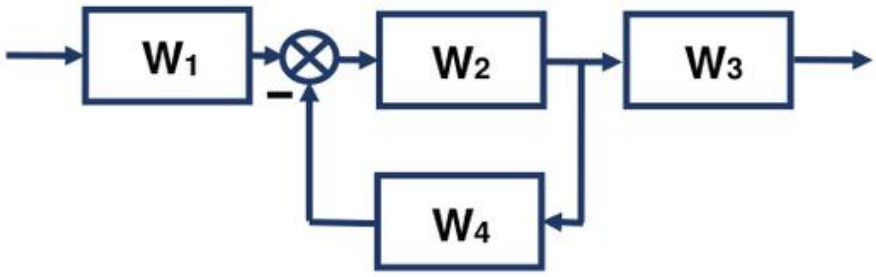
   Open link: Link to variants

   Change name and email and press button "run".

   You will see your variant on the right side. Use it for all tasks.

   Put name and email that you use for generation and your variant in report.

2. Transfer functions calculations.



   (A) Calculate the total Transfer Function of the system. Calculations - in the report.

   (B) Build initial system shown in the block diagram and simplified in one Simulink schema and analyze its Step, Impulse and Frequency responses. Results should have a schema with both systems and 3 Scope plots(for each input). Each plot should have 3 lines - input signal, and two outputs from each system.

   (C) For one of the inputs (write down what you choose) generate a Bode and Pole-Zero map plots. Put plots and result - stable or unstable is system and why - in the report.

(D) Analyze Bode plot - calculate asymptotes and frequence breaks and put calculations in report. Also calculate intersections of the plot with axes.

Variants for the task:

(a) $W_1 = \frac{1}{s^2+3s+2}$, $W_2 = \frac{1}{s+3}$, $W_3 = \frac{2}{s+0.8}$, $W_4 = \frac{1}{s+0.5}$

(b) $W_1 = \frac{s+3}{s^2-1}$, $W_2 = \frac{1}{s}$, $W_3 = \frac{2s+1}{s+1.5}$, $W_4 = \frac{1}{s+0.4}$

(c) $W_1 = \frac{2}{s^2+s-2}$, $W_2 = \frac{1}{3s+2}$, $W_3 = \frac{s+1}{s+0.3}$, $W_4 = \frac{1}{s+0.2}$

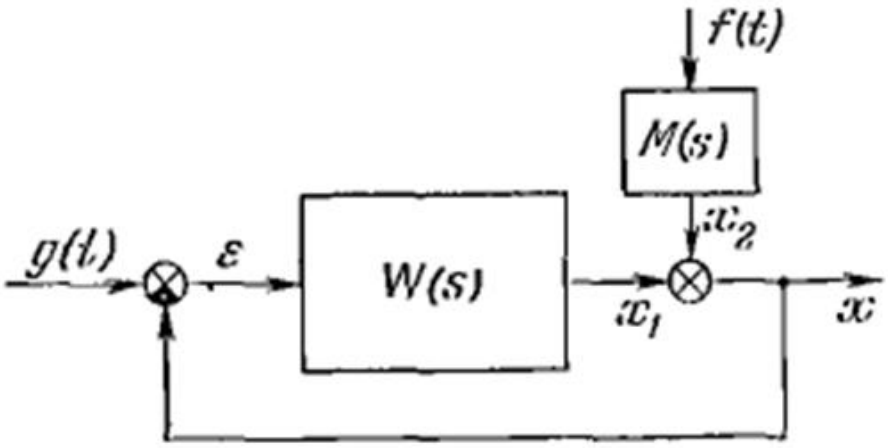
(d) $W_1 = \frac{3}{s+2}$, $W_2 = \frac{1}{2s+3}$, $W_3 = \frac{1}{s+0.2}$, $W_4 = \frac{1}{s+0.7}$

(e) $W_1 = \frac{2}{s+1}$, $W_2 = \frac{1}{s}$, $W_3 = \frac{2}{s+1.5}$, $W_4 = \frac{1}{s+3}$

(f) $W_1 = \frac{s+3}{s+1}$, $W_2 = \frac{1}{s+2}$, $W_3 = \frac{1}{s+0.1}$, $W_4 = \frac{1}{s+2.5}$

(g) $W_1 = \frac{2}{s+5}$, $W_2 = \frac{s+1}{s+0.5}$, $W_3 = \frac{1}{s+0.25}$, $W_4 = \frac{1}{2s+3}$

3. Find total transfer function for a closed-loop system.



Variants for the task:

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

(b) $W(s) = \frac{s^2+4s+1}{2s^2+5s}$, $M(s) = \frac{3}{s-3}$

(c) $W(s) = \frac{s+4}{3s+2}$, $M(s) = \frac{1}{s+1}$

(d) $W(s) = \frac{s+2}{3s^2+3s+5}$, $M(s) = \frac{2}{2s+1}$

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

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

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

4. Find transfer function of the system.

   Variants for the task:

   (a) $A = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 0 \end{pmatrix}, D = \begin{pmatrix} 0 \end{pmatrix}$

   (b) $A = \begin{pmatrix} 1 & -1 \\ 2 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 2 \\ 1 \end{pmatrix}, \quad C = \begin{pmatrix} 3 & 0 \end{pmatrix}, D = \begin{pmatrix} 0 \end{pmatrix}$

   (c) $A = \begin{pmatrix} 2 & 0 \\ -3 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} -1 \\ 1 \end{pmatrix}, \quad C = \begin{pmatrix} -2 & 0 \end{pmatrix}, D = \begin{pmatrix} 2 \end{pmatrix}$

   (d) $A = \begin{pmatrix} 3 & 1 \\ 0 & 2 \end{pmatrix}, \quad B = \begin{pmatrix} 0 \\ 2 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 1 \end{pmatrix}, D = \begin{pmatrix} 1 \end{pmatrix}$

   (e) $A = \begin{pmatrix} -1 & 2 \\ 0 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 1 \\ 1 \end{pmatrix}, \quad C = \begin{pmatrix} 0 & 1 \end{pmatrix}, D = \begin{pmatrix} 3 \end{pmatrix}$

   (f) $A = \begin{pmatrix} 1 & 0 \\ 2 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 2 \\ 2 \end{pmatrix}, \quad C = \begin{pmatrix} -1 & 4 \end{pmatrix}, D = \begin{pmatrix} 2 \end{pmatrix}$

   (g) $A = \begin{pmatrix} 3 & 1 \\ -2 & 2 \end{pmatrix}, \quad B = \begin{pmatrix} 2 \\ 0 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 3 \end{pmatrix}, D = \begin{pmatrix} 1 \end{pmatrix}$

5. Find transfer functions of the system.

   Variants for the task:

   (a) $A = \begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 1 & 3 \\ 1 & 0 \end{pmatrix}, \quad C = \begin{pmatrix} 0 & 1 \end{pmatrix}, D = \begin{pmatrix} 3 & 2 \end{pmatrix}$

   (b) $A = \begin{pmatrix} 1 & -2 \\ 2 & -1 \end{pmatrix}, \quad B = \begin{pmatrix} 2 & 3 \\ 2 & 0 \end{pmatrix}, \quad C = \begin{pmatrix} -1 & 4 \end{pmatrix}, D = \begin{pmatrix} 2 & 1 \end{pmatrix}$

   (c) $A = \begin{pmatrix} 4 & 1 \\ -2 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 2 & 1 \\ 3 & 0 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 3 \end{pmatrix}, D = \begin{pmatrix} 1 & 2 \end{pmatrix}$

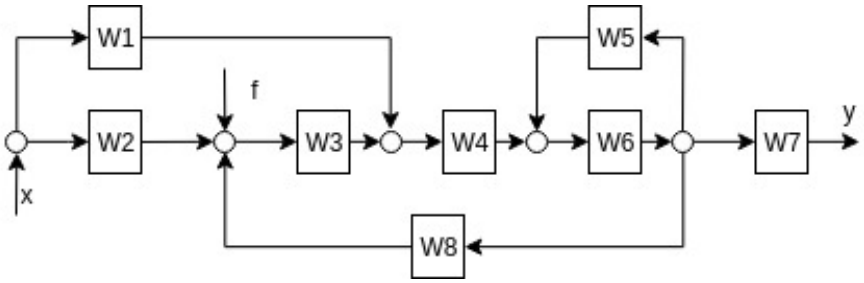
   (d) $A = \begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix}, \quad B = \begin{pmatrix} 2 & 0 \\ 4 & 1 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 0 \end{pmatrix}, D = \begin{pmatrix} 0 & -2 \end{pmatrix}$

   (e) $A = \begin{pmatrix} 1 & -2 \\ 1 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}, \quad C = \begin{pmatrix} 3 & 0 \end{pmatrix}, D = \begin{pmatrix} 0 & 3 \end{pmatrix}$

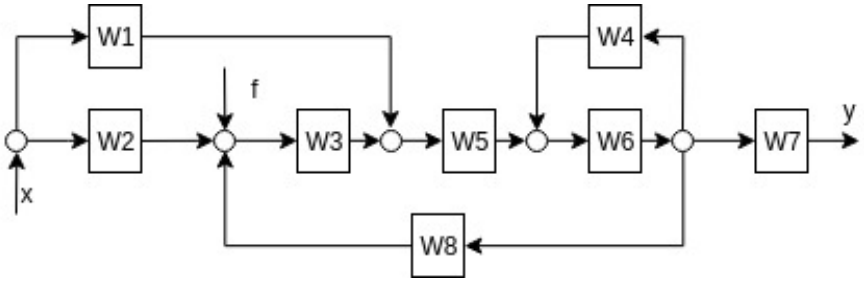
   (f) $A = \begin{pmatrix} 2 & 1 \\ -3 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} -1 & 5 \\ 3 & 1 \end{pmatrix}, \quad C = \begin{pmatrix} -2 & 0 \end{pmatrix}, D = \begin{pmatrix} 2 & 4 \end{pmatrix}$

   (g) $A = \begin{pmatrix} 5 & 1 \\ 0 & -2 \end{pmatrix}, \quad B = \begin{pmatrix} 0 & 2 \\ 2 & 3 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 1 \end{pmatrix}, D = \begin{pmatrix} 1 & 6 \end{pmatrix}$

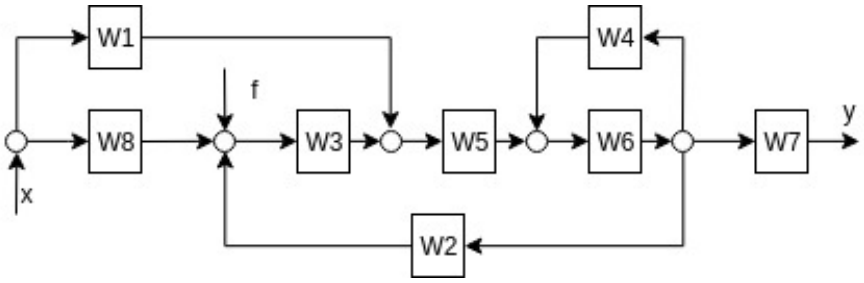
6. Simplify the system step by step and calculate total transfer function for both inputs x and f. For schemas you can use https://www.draw.io , for example. PS. All summators are positive here. Variants for the task:


W1
W5
f
W2
W3
W4
W6
W7
y
x
W8

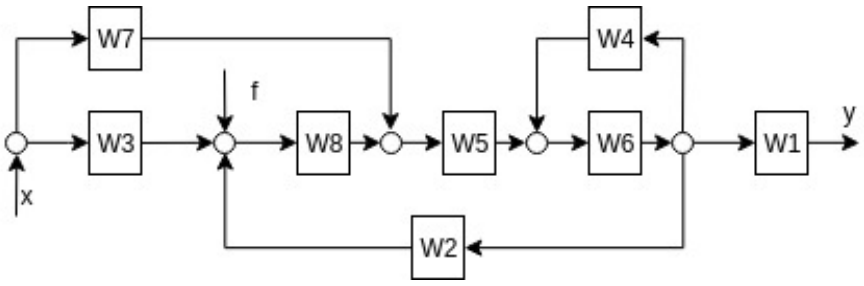
(a)


W1
W4
f
W2
W3
W5
W6
W7
y
x
W8

(b)

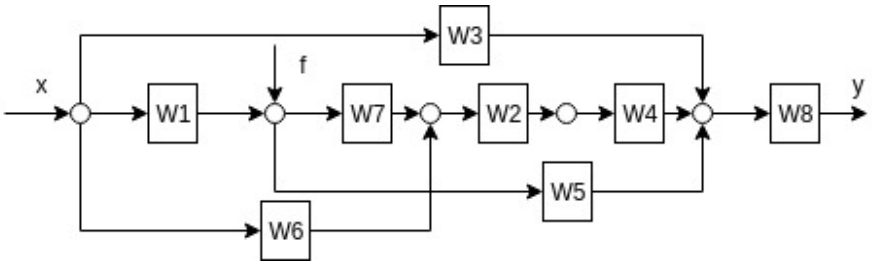

W1
W4
f
W8
W3
W5
W6
W7
y
x
W2

(c)

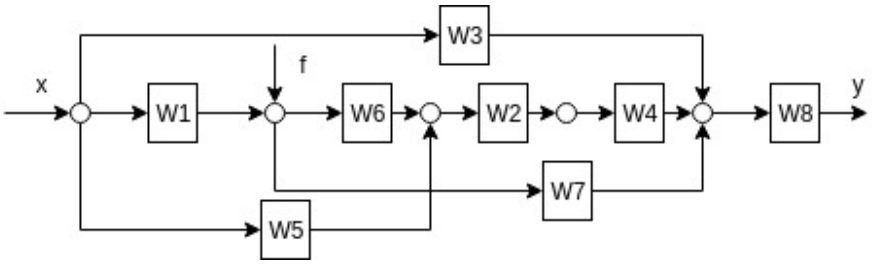

W7
W4
f
W3
W8
W5
W6
W1
y
x
W2

(d)

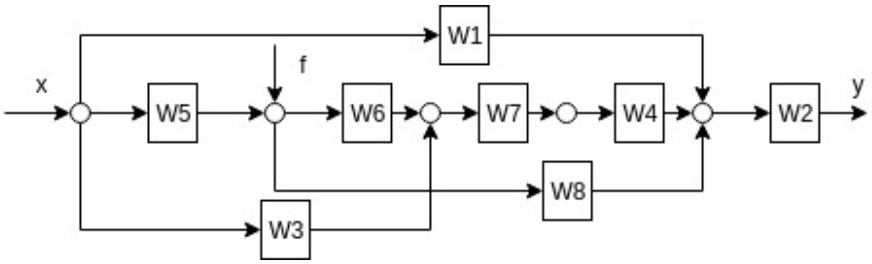
(e)



(f)



(g)



Some suggestions(the same):

All results should be in the PullRequest(PR) in a separate branch.

Do not forget to add Readme.md with description what the repo is, how to run the code, all dependencies installation, maybe other instructions. Put matlab/python versions, operating system that you use.

Report should contains calculations, pictures, maybe some descriptions, all - but only useful information.

For pdf generation, i suggest practising in usage LaTeX with overleaf.com for example.

Merge PR only after Mike approve it.

Do not leave the task for the last day. You can meet difficulties that you will not manage to solve in 30 minutes.