Istanbul Technical University
Faculty of Electrical and Electronics
Department of Control and Automation Engineering

Feedback Control Systems
(KON313E)

Homework Assignment 2

Prepared By

1.
2.
3.
4.

2015 - 2016 Fall Term
Deadline: 30.11.2015

FEEDBACK CONTROL SYSTEMS (KON 313E)

HOMEWORK ASSIGNMENT - 2 SOLUTIONS

Question 1.a:

Numerical values,

$$A = \begin{bmatrix} & & & \\ & & & \\ & & & \\ & & & \end{bmatrix} \quad B = \begin{bmatrix} \\ \\ \\ \\ \end{bmatrix} \quad C = \begin{bmatrix} & & & \end{bmatrix}$$

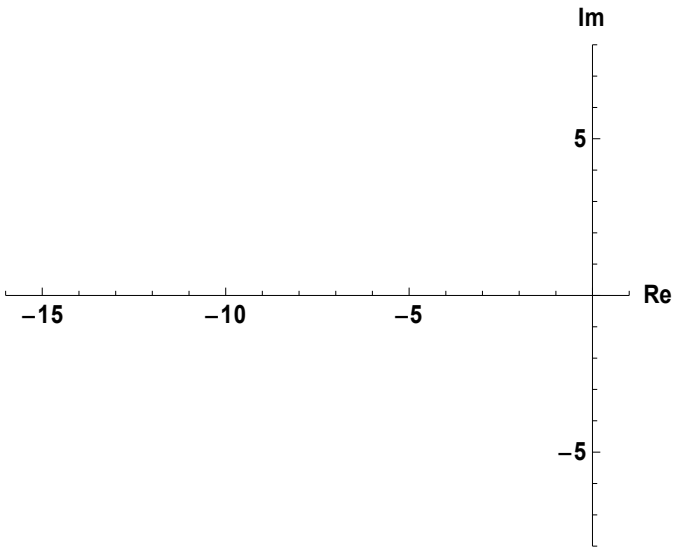
$$T(s) = \frac{\Delta\delta(s)}{\Delta V_{ref}(s)} = C\ (sI - A)^{-1}B$$

If the necessary calculations are done,

Question 1.b:

- Order:
- Type:
- Poles and zeros:
- Is it stable?

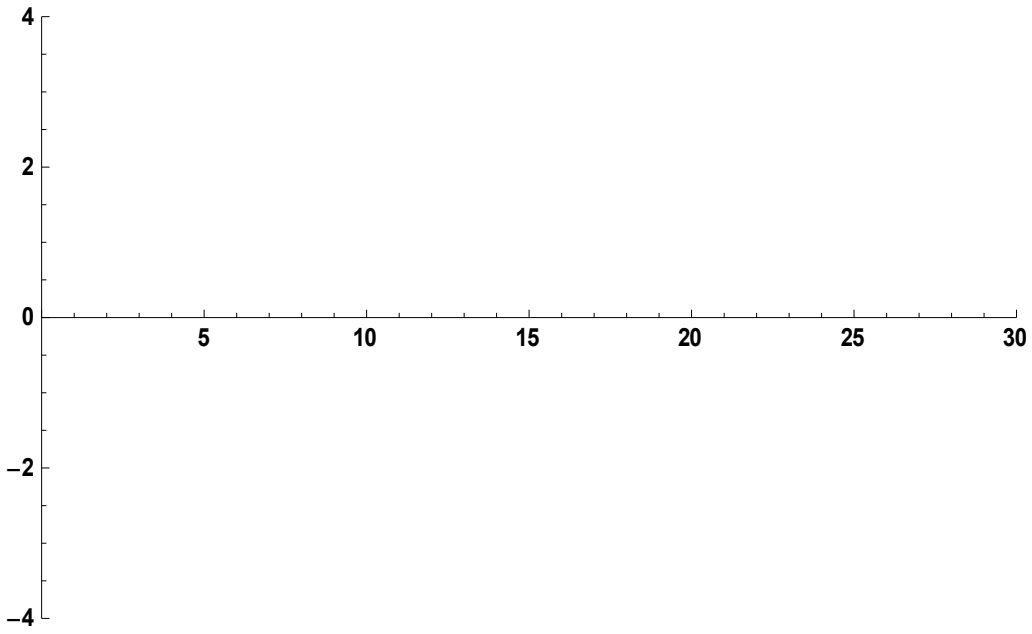
- Poles in s-plane:



Question 1.c:

- Dominant poles:
- Calculation of the overshoot:
- Calculation of the settling time:
- Calculation of the final value:

- Step response:



Question 1.d:

- Transfer functions:

$T_y(s) = \frac{Y(s)}{R(s)} =$

$T_{d1}(s) = \frac{Y(s)}{D_1(s)} =$

$T_{d2}(s) = \frac{Y(s)}{D_2(s)} =$

Question 1. e:

- For $C(s) = k$

- For $C(s) = \frac{2k}{s}$

Question 1. f:

- For $D_1(s) = \frac{2}{s}$

- For $D_2(s) = \frac{2}{s}$

Question 1.g:

s^4	
s^3	
s^2	
s^1	
s^0	

Question 1.h:

- Stability range:

s^4	
s^3	
s^2	
s^1	
s^0	

Question 1.i:

1- Poles and zeros:

2- Number of branches:

3- Symmetry:

4.1- Number of asymptotes:

4.2- Intersection point of asymptotes:

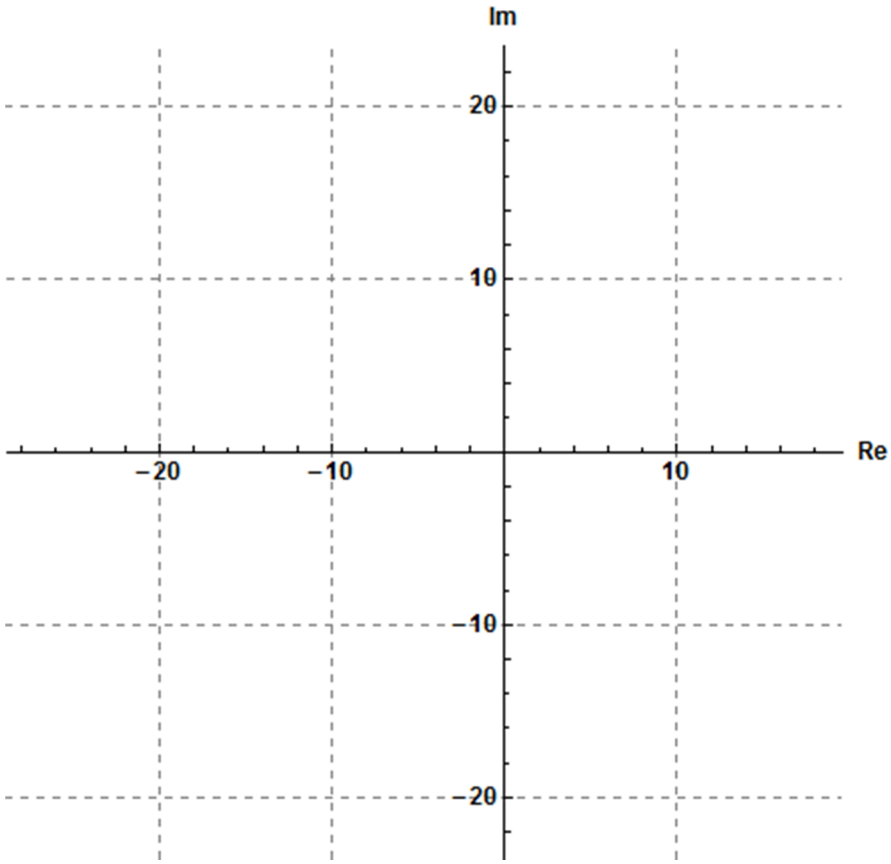
4.3- Angle with the real axis:

5- Root-locus on the real axis: (To be shown on the drawing)

6- Calculation of the angle of departure:

7- Calculation of the breakpoints of imaginary axis:

8- Calculation of the breaking points:

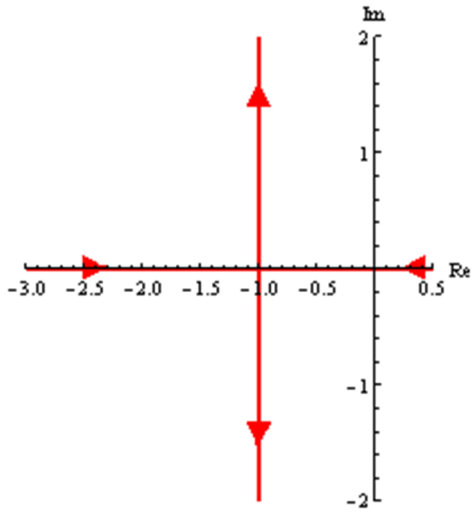


Question 1.j:

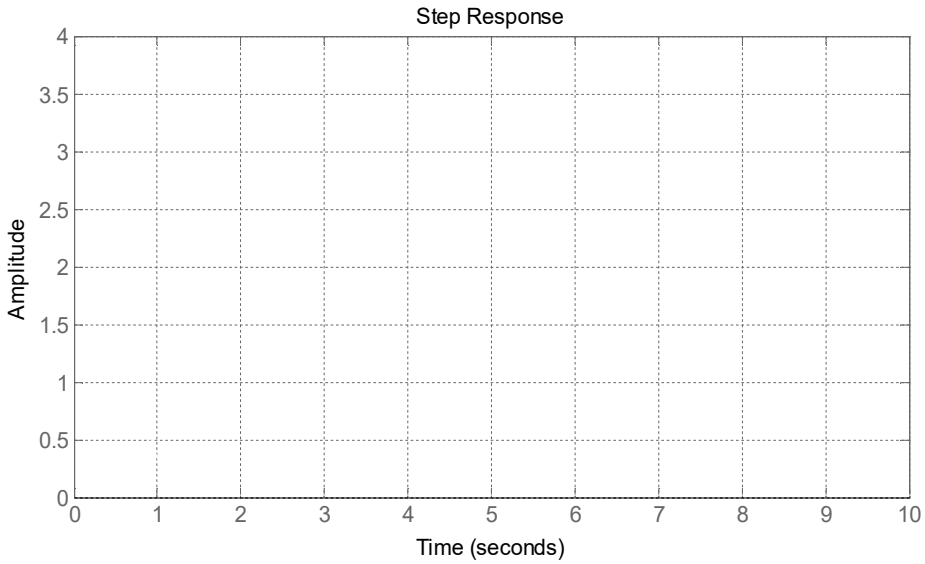
- Explanation:

Question 2.a:

- Open-loop transfer function:



- Step response:



Question 2.b:

- Position error constant:

- Velocity error constant:

- Acceleration error constant:

Question 2.c:

- Calculation of the value range with the help of root-locus:

Question 2.d:

- Calculation of the other pole:

Question 2.e:

- Modification:

- The interval of the parameter k:

s^2	
s^1	
s^0	

Question 3.a:

1.1-Type and order:

1.2- Poles and zeros:

2- Number of branches:

3- Symmetry:

4.1- Number of asymptotes:

4.2- Intersection point of asymptotes:

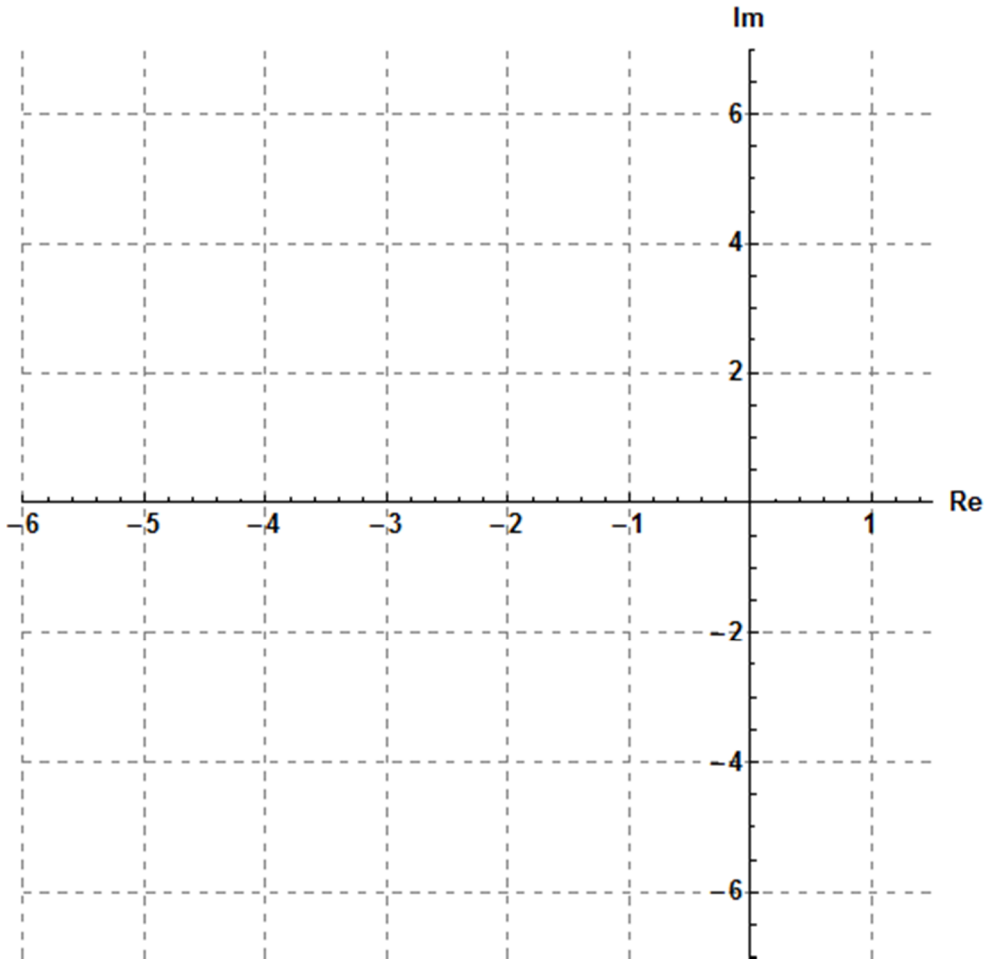
4.3- Angle with the real axis:

5- Root-locus on the real axis: (To be shown on the drawing)

6- Calculation of the angle of departure:

7- Calculation of the breakpoints of imaginary axis:

8- Calculation of the breaking points:



Question 3.b:

- Stability range:

s^3	
s^2	
s^1	
s^0	

Question 3.c:

- Rearrangement of the transfer function:

1- Poles and zeros:

2- Number of branches:

3- Symmetry:

4- Number of asymptotes:

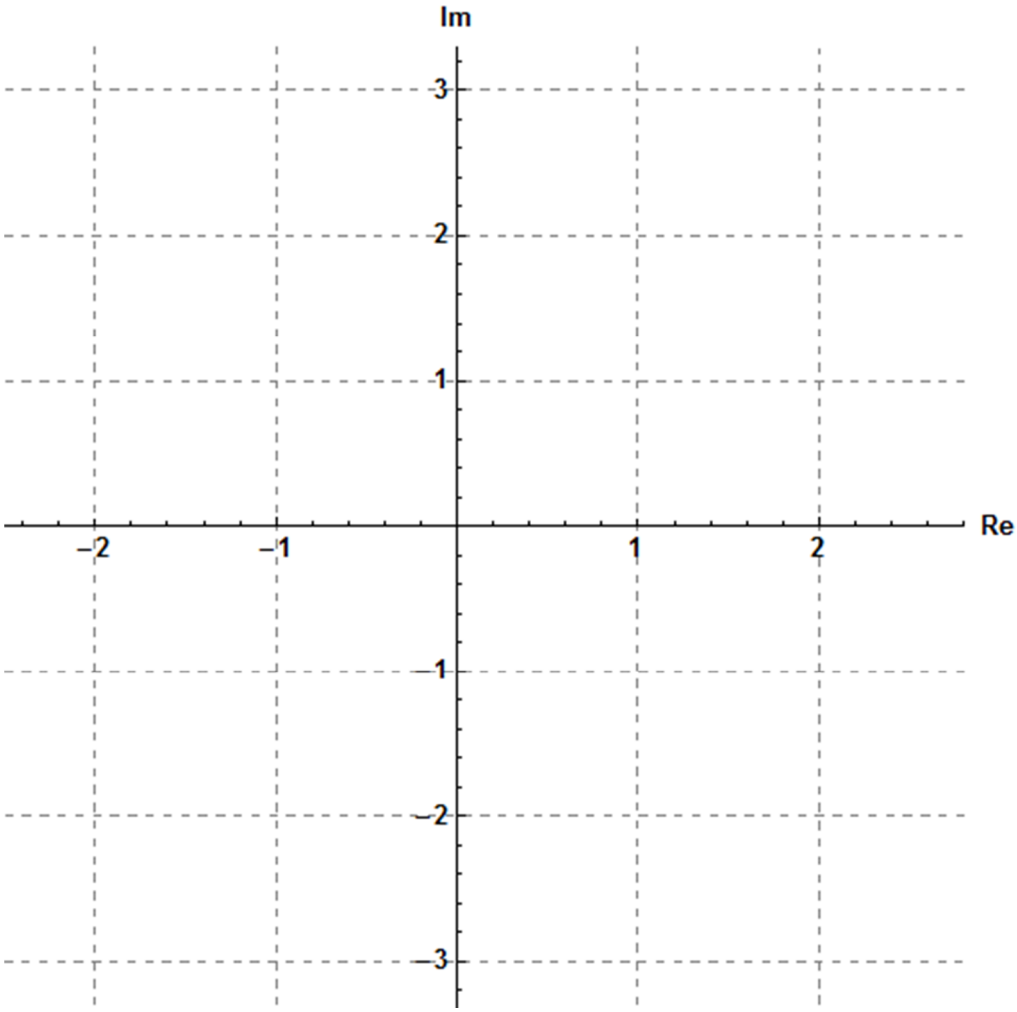
5- Root-locus on the real axis: (To be shown on the drawing)

6.1- Calculation of the angle of departure:

6.2- Calculation of the angle of arrival:

7- Calculation of the breakpoints of imaginary axis:

8- Calculation of the breaking points:



Question 3.d:

- Location of the 3rd pole:

Question 3.e:

- Dominant poles:

- Calculation of the overshoot:

- Calculation of the delay time: