
**YILDIZ TECHNICAL UNIVERSITY**

**FACULTY OF ELECTRICAL & ELECTRONICS ENGINEERING**

**DEPARTMENT OF CONTROL AND AUTOMATION ENGINEERING**

# KOM4221

# CONTROL LABORATORY

## Experiment 3

Emir OĞUZ

17016011

Group 2

**Asst. Prof. Levent UCUN**

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**Summary of Experiment**

The aim of this experiment is to design a full-state controller that stabilize the position of the ball in the ball and beam system.

**Theory Implementation and Numerical Calculations**

**Question 1)**

We know that

$$A \approx \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 0.4188 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -35.0474 \end{bmatrix}, B \approx \begin{bmatrix} 0 \\ 0 \\ 0 \\ 61.6381 \end{bmatrix}, C = [1 \quad 0 \quad 0 \quad 0]$$

$$\dot{X} = (A - BK)X$$
$$\Delta(\lambda) = |\lambda I - A + BK| = 0$$

If the necessary values are placed in the equations, the characteristic equation is obtained:

$$s^4 + s^3(61.638\, k_4 + 35.047) + s^2\, k_3\, 61.638 + s\, k_2\, 25.814 + k_1\, 25.814$$

**Simulation Studies**

**Question 2)**

Since my student number is 17016011, desired poles are:

$$\{-1.1 + 15.1\text{i}, -1.1 - 15.1\text{i}, -0.51 + 1.1\text{i}, -0.51 - 1.1\text{i}\}$$

Using $place$ function in MATLAB gives $K$ matrix as:

$$K = [13.0540 \;\; 9.1825 \;\; 3.7791 \;\; -0.5164]$$

**Question 3)**

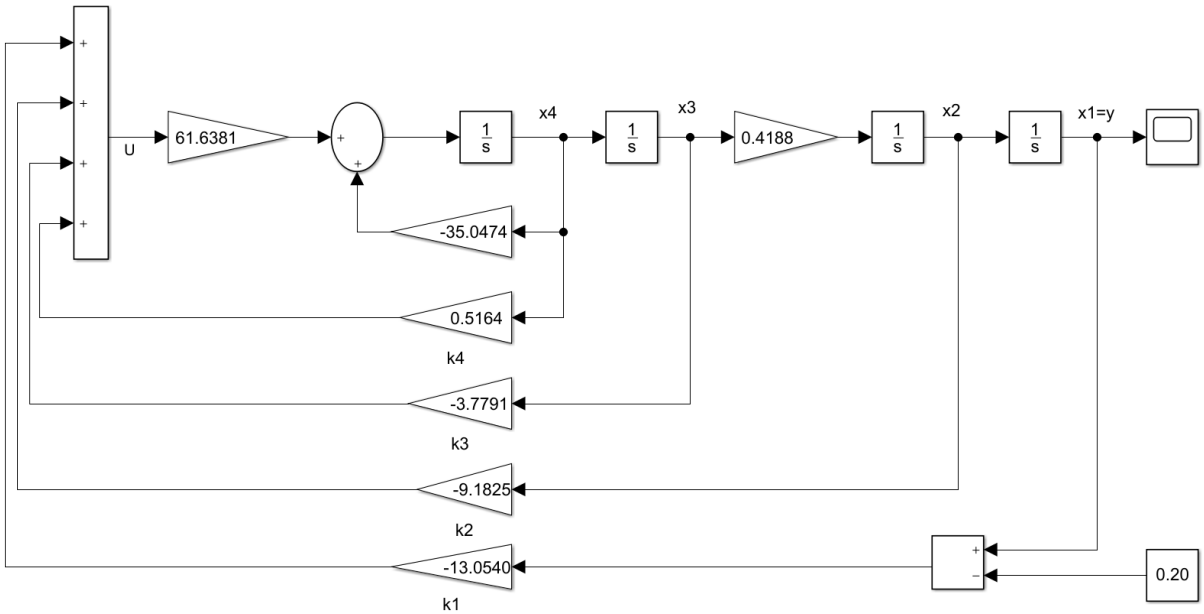


Figure 1: Closed-loop System of the Ball and Beam Plant

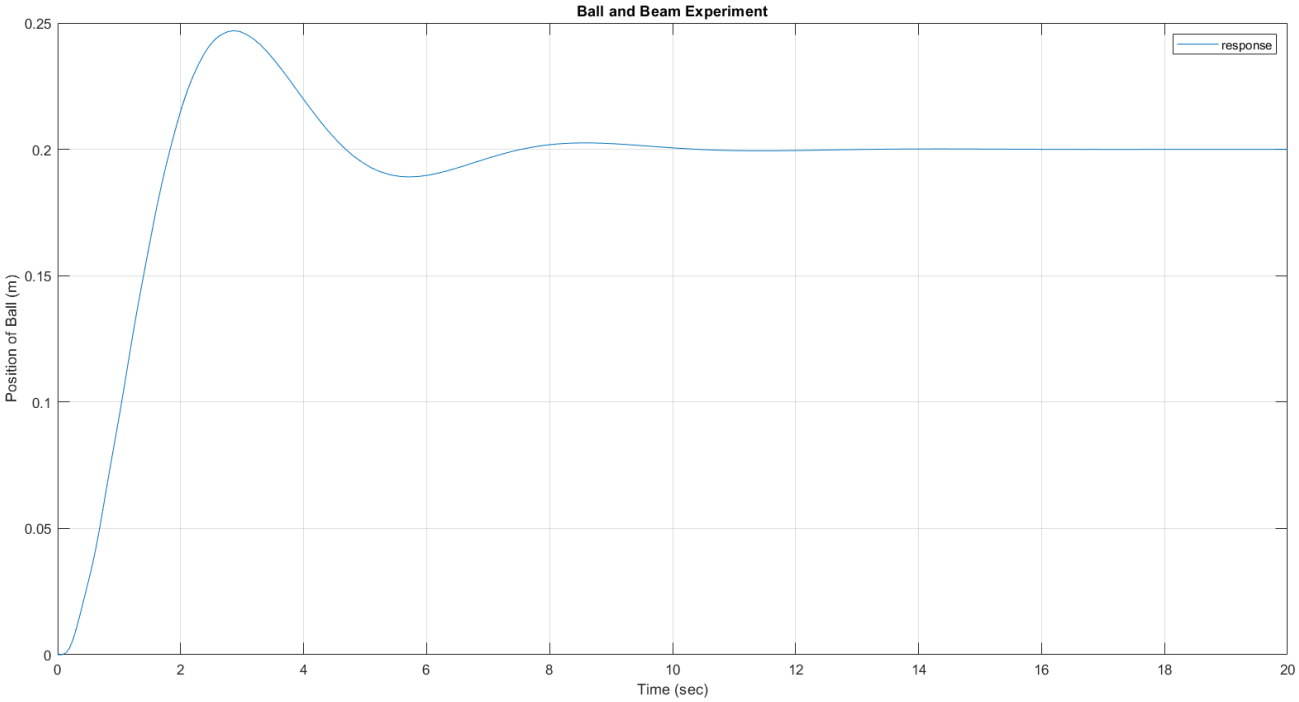


Figure 2: The Position of Ball