Cairo University
Faculty of Engineering

Dereqment of Computer
Engineering

Control Engineering

Project

Submitted to

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Submitted by

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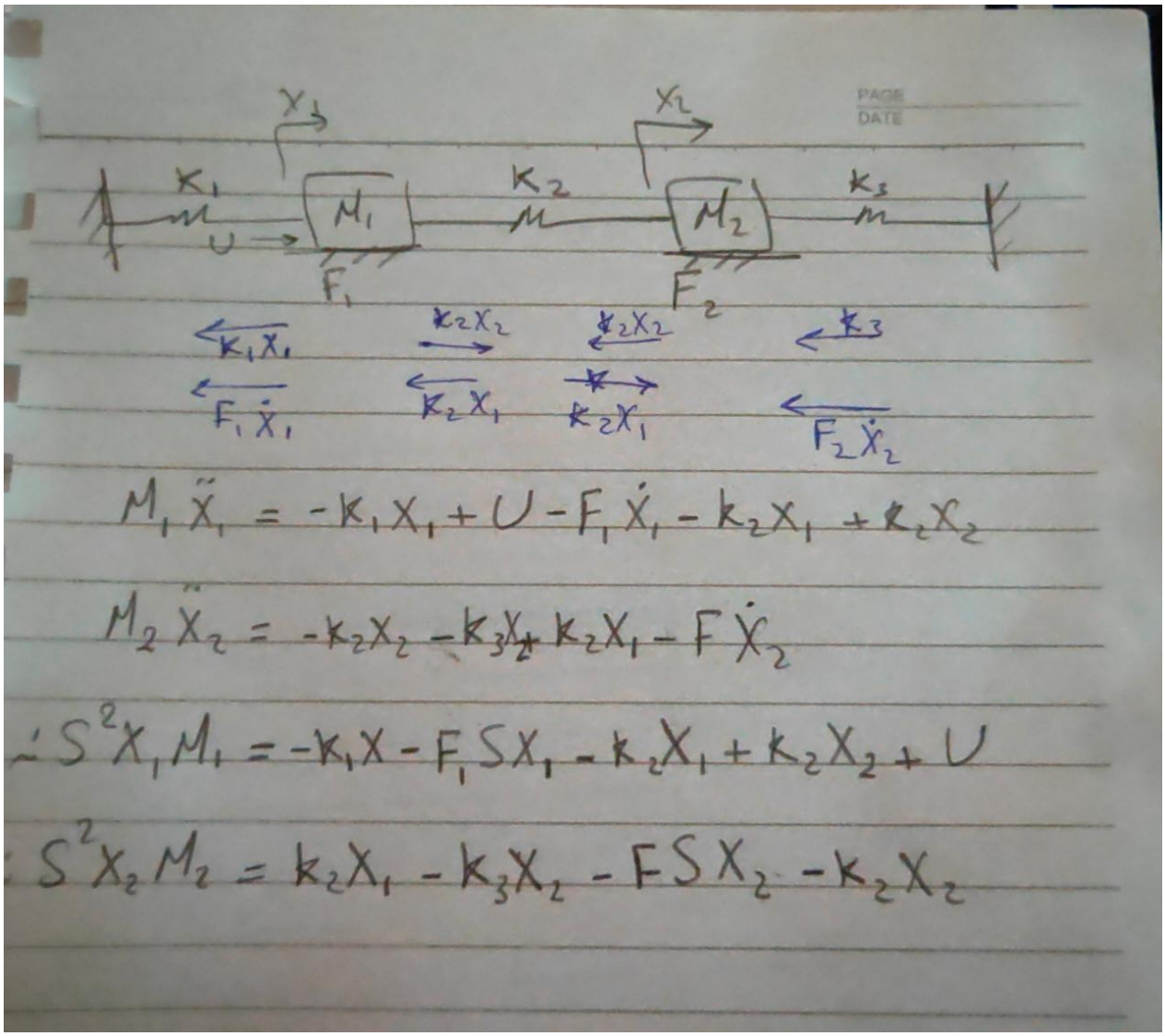
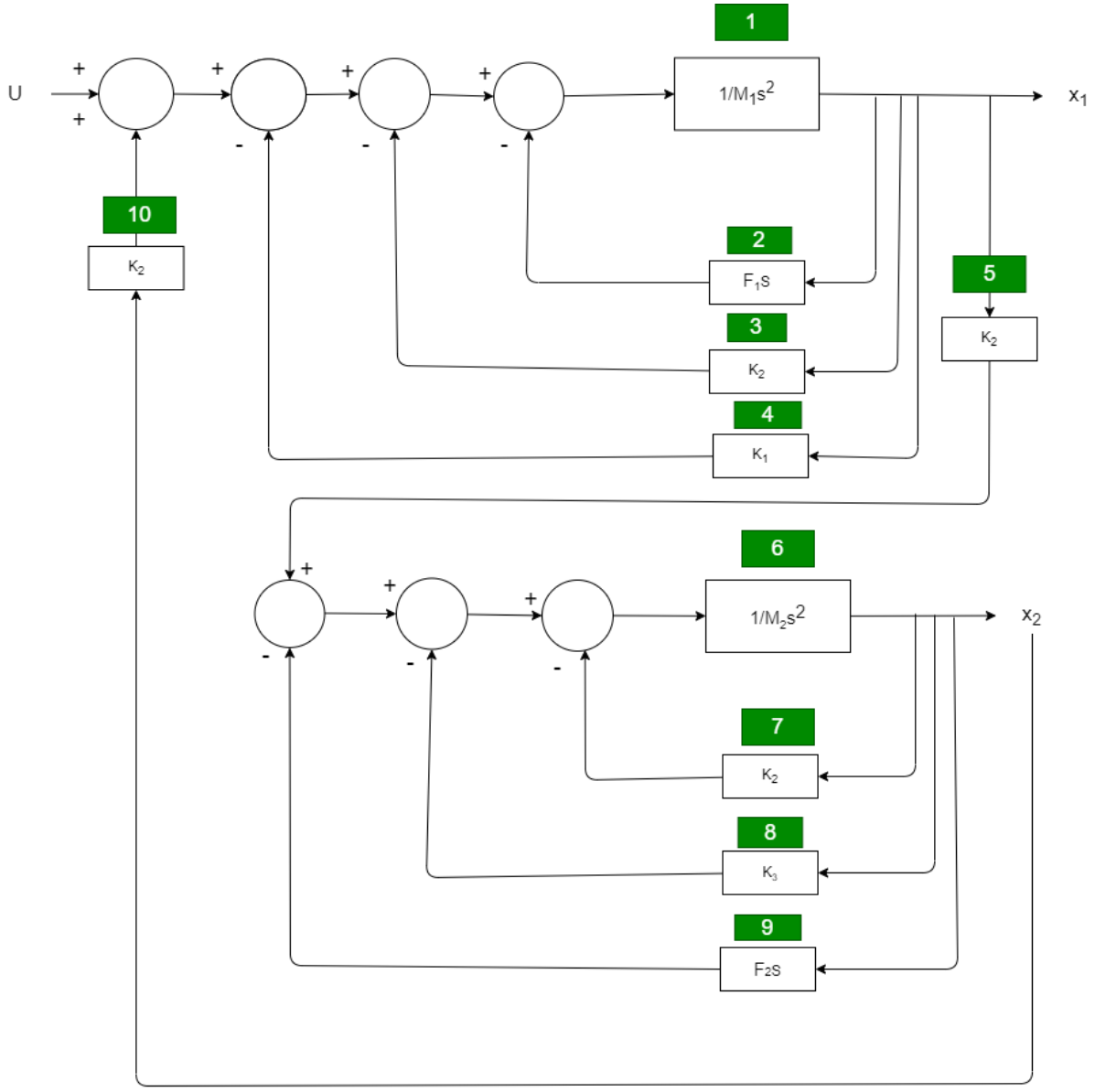
Req 1 :

Dynamic Equations:



BlockDiagram:



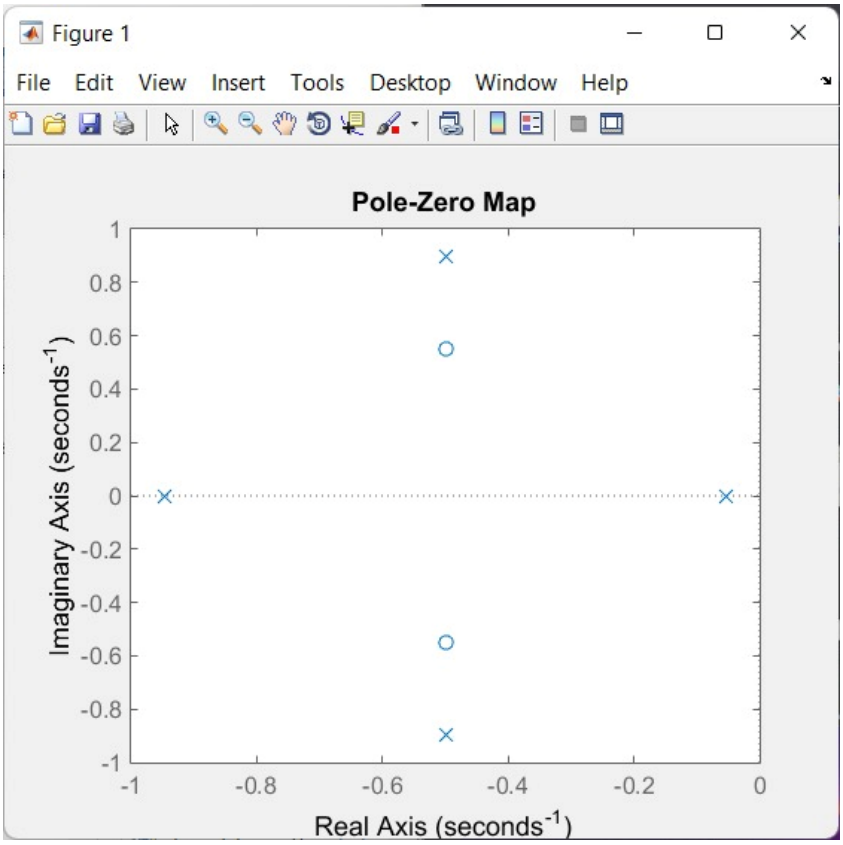
Req 2:

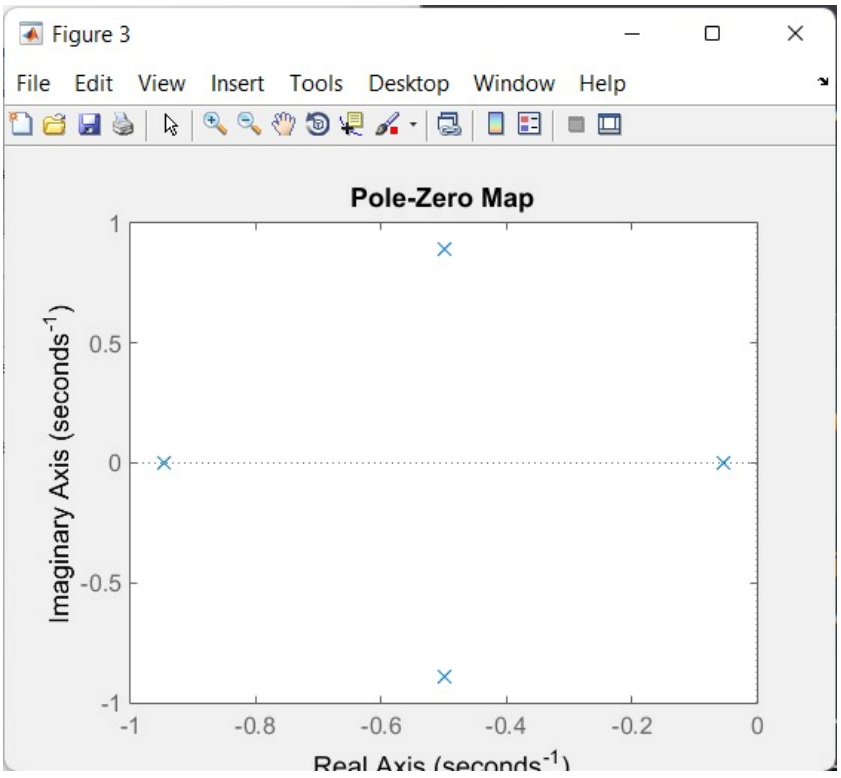
TF:

```
The value of X1/U transfer function is:
numerator: [0 0 0.01 0.01 0.00550000000000001]
denominator: [1 2 2.1 1.1 0.0525000000000001]
```

```
The value of X2/U transfer function is:
numerator: [0 0 0 0 0.005]
denominator: [1 2 2.1 1.1 0.0525]
```

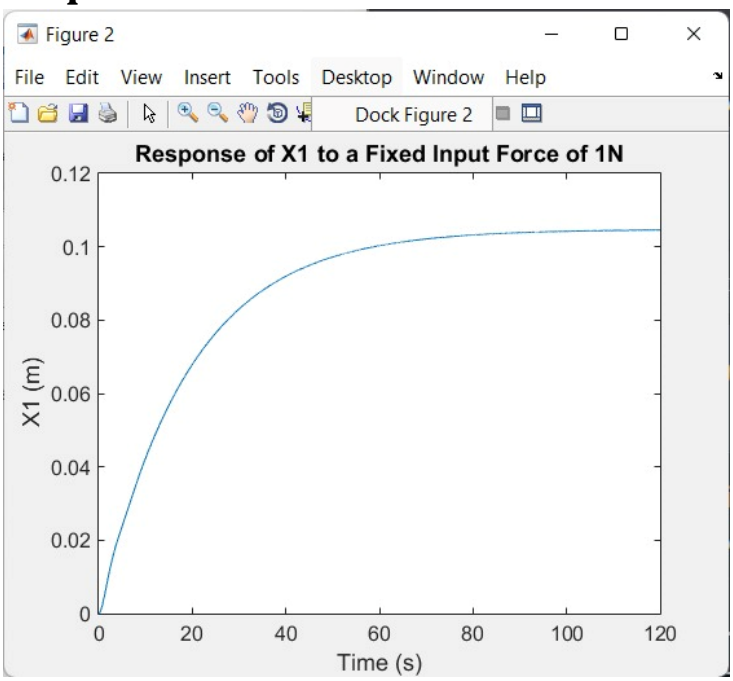
Req 3 :

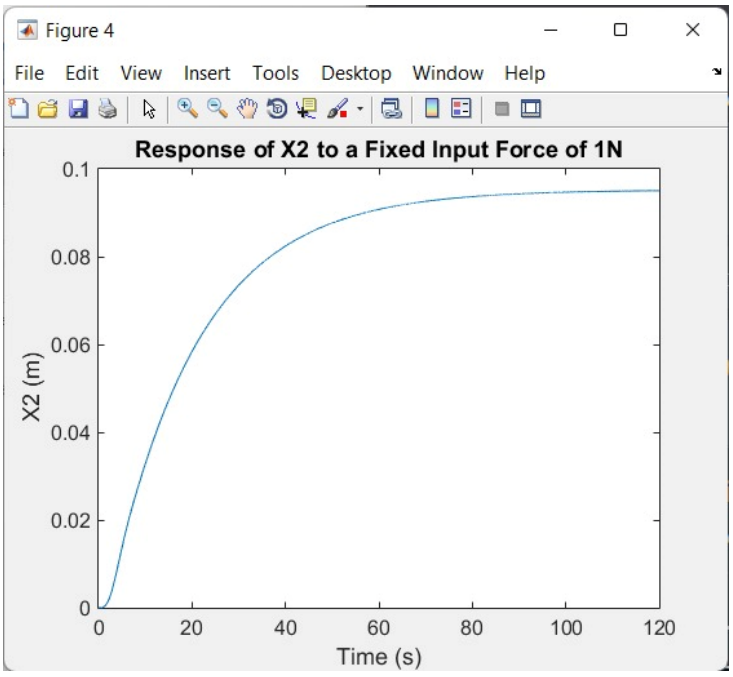




Both Systems are stable

Req 4 :





SteadyStateValues:

```
The steady state value of X1 is 0.104569 m
The steady state value of X2 is 0.095045 m
```

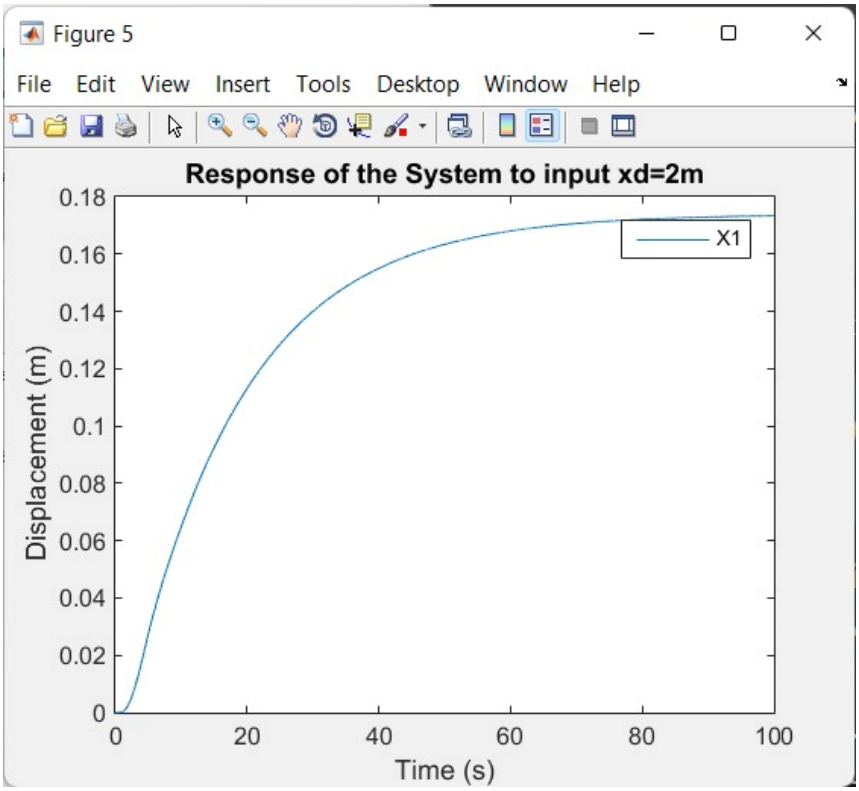
Req 5:

We used unity feedback to compare the actual output to the desired input displacement .

```
% Define the closed-loop transfer function
closed_loop_tf = feedback(sys2, 1);

% Simulate the system for X1
t = 0:0.01:100;
Xd = ones(size(t))*2 ; % Desired displacement
X1 = lsim(closed_loop_tf, Xd, t);
```

Req 6:



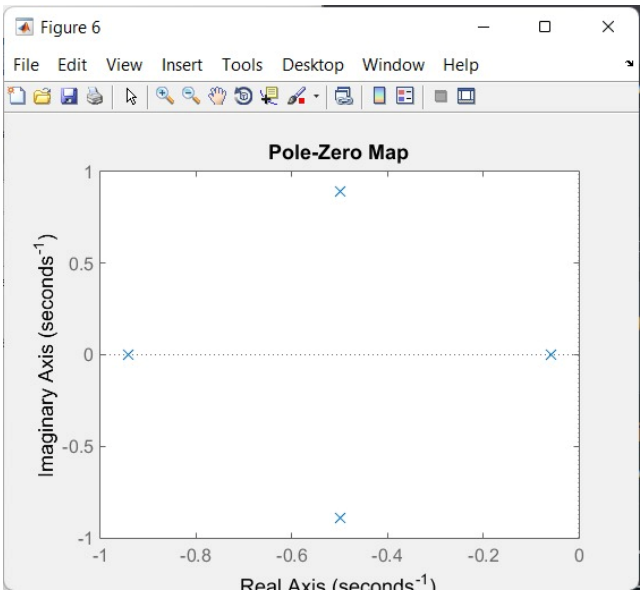
Req7:

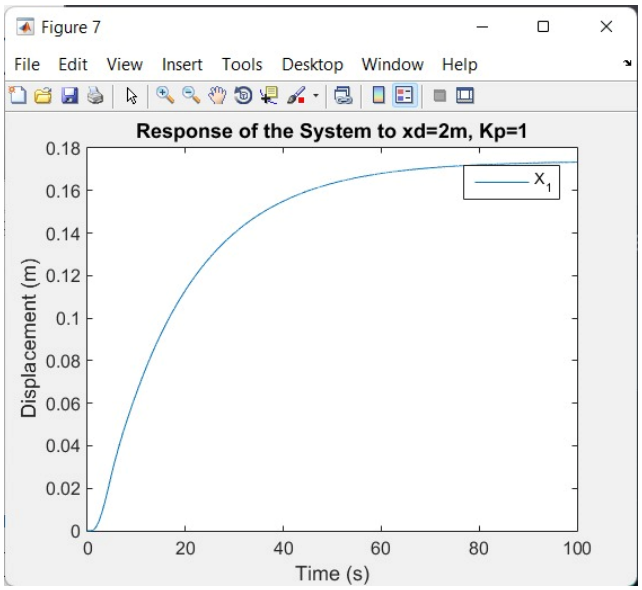
```
Rise Time: 37.47 s
Peak Time: 125.29 s
Maximum Peak: 0.17
Settling Time: 68.97 s
Ess: 1.83
```

Req 8:

As kp increase ess,rise time(time to reach yss for first time),settling time and peak time(time to reach shooting time for first time)decrease while max peak increase until Kp reaches a critical value , the system becomes unstable and unpredictable .

Kp=1

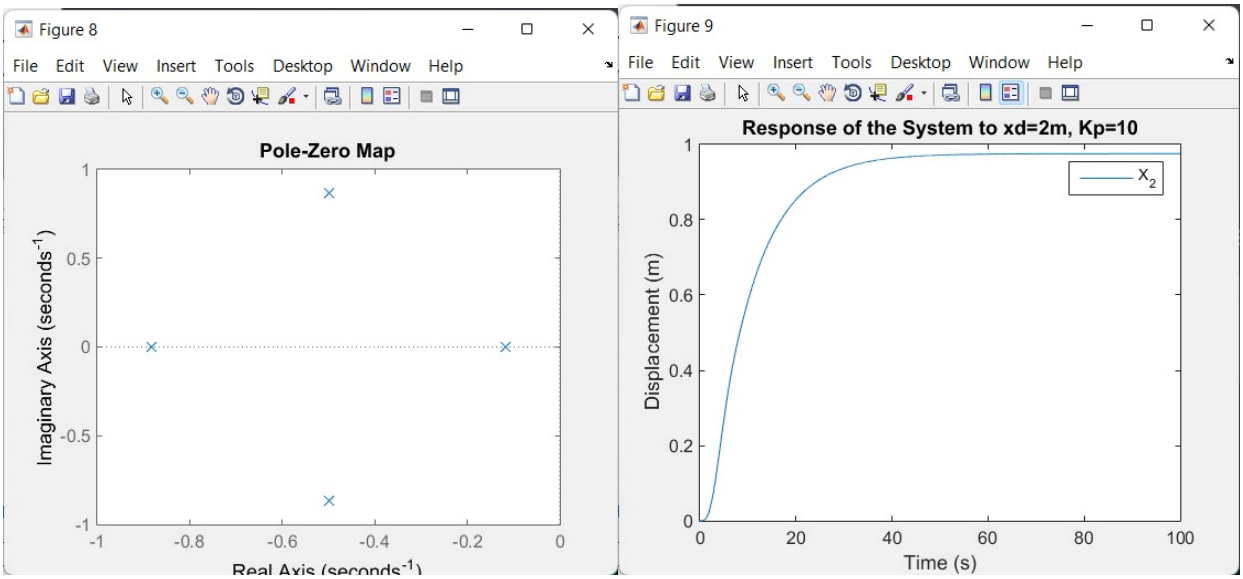




Transient Response:

```
Kp: 1.00
The system is stable
Rise Time: 37.47 s
Peak Time: 125.29 s
Maximum Peak: 0.17
Settling Time: 68.97 s
Ess: 1.83
```

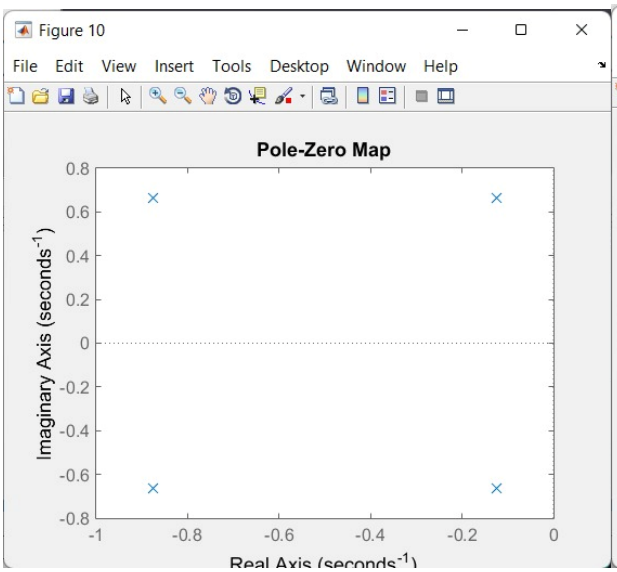
Kp=10

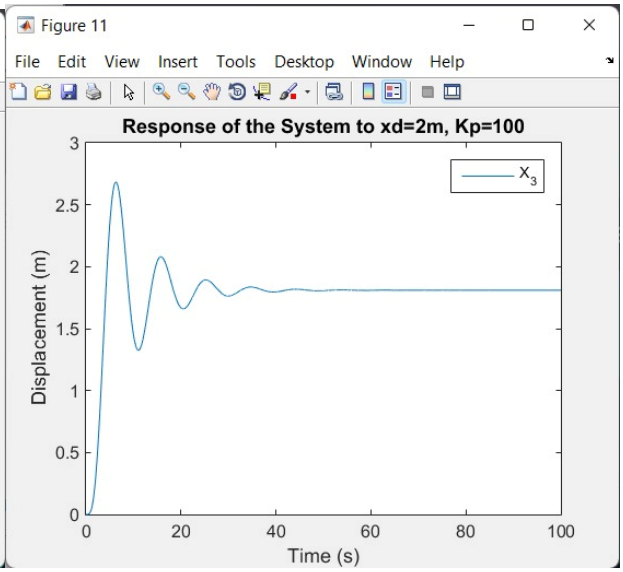


Transient Response:

```
Kp: 10.00
The system is stable
Rise Time: 18.85 s
Peak Time: 61.39 s
Maximum Peak: 0.97
Settling Time: 35.78 s
Ess: 1.02
```

Kp=100

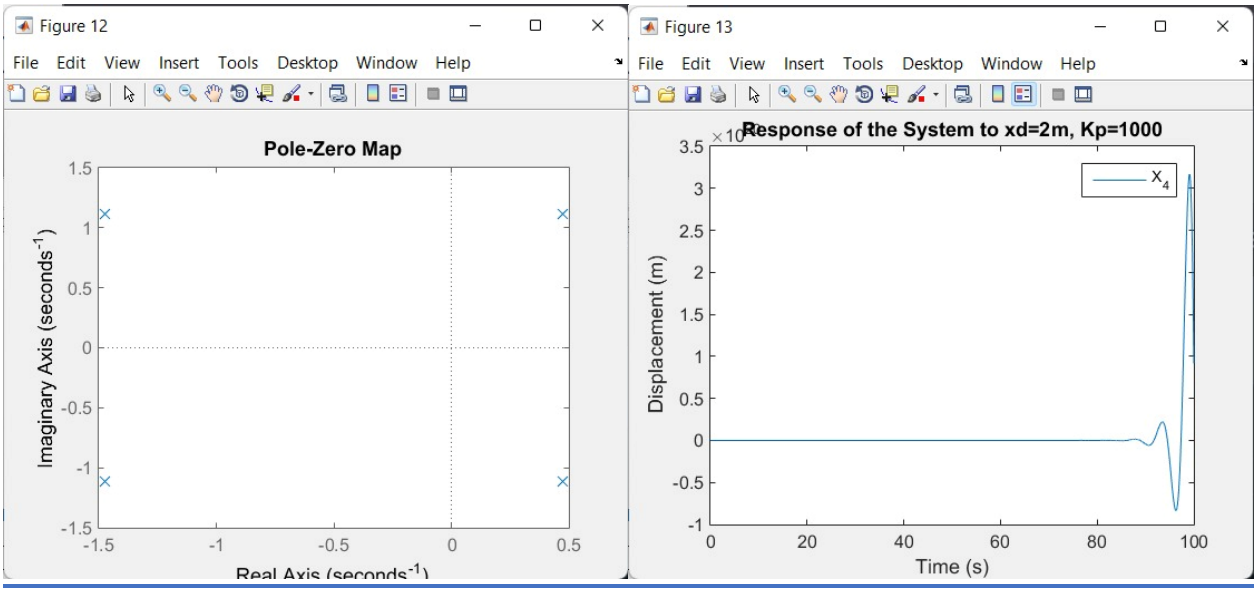




Transient Response:

```
Kp: 100.00
The system is stable
Rise Time: 2.22 s
Peak Time: 6.31 s
Maximum Peak: 2.68
Settling Time: 31.01 s
Ess: 0.19
```

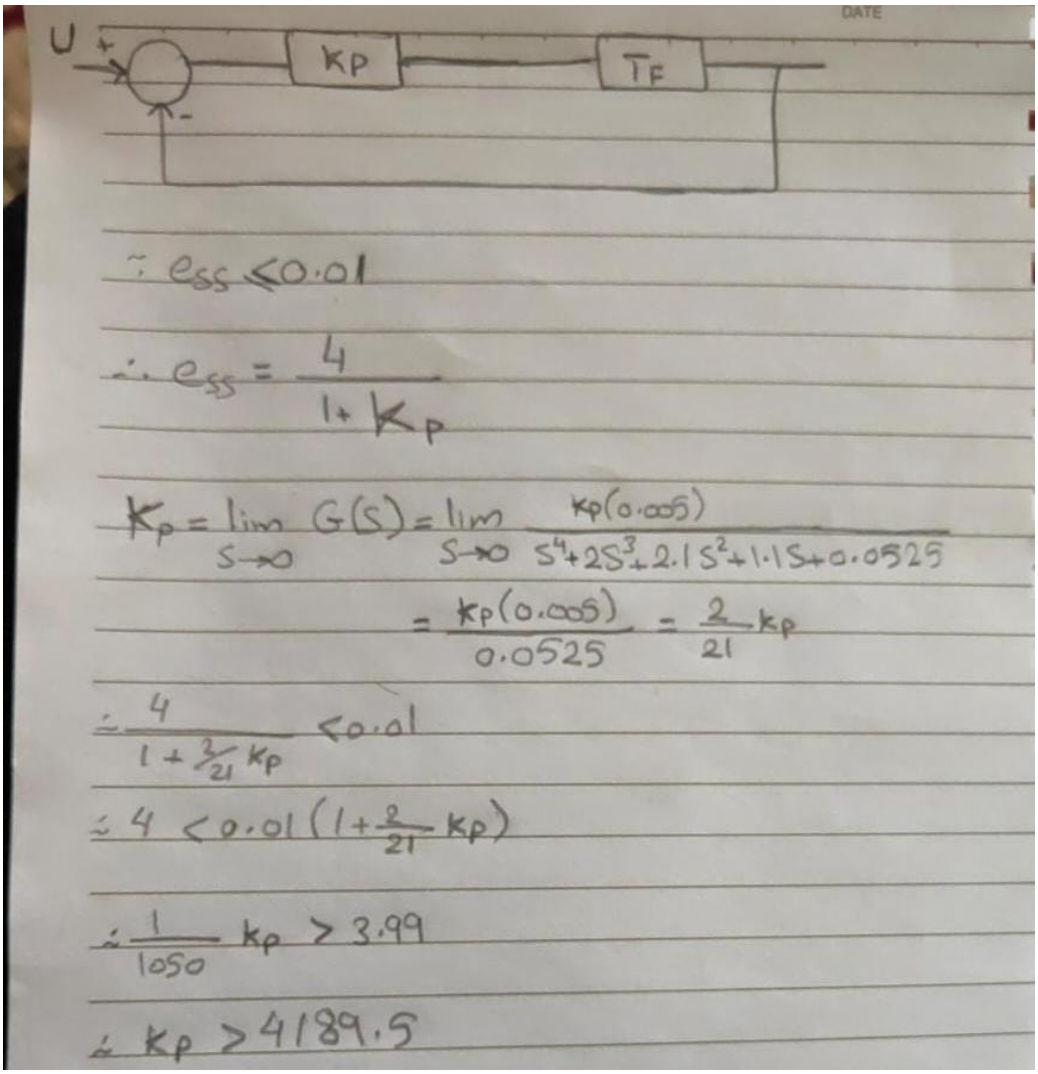
Kp=1000



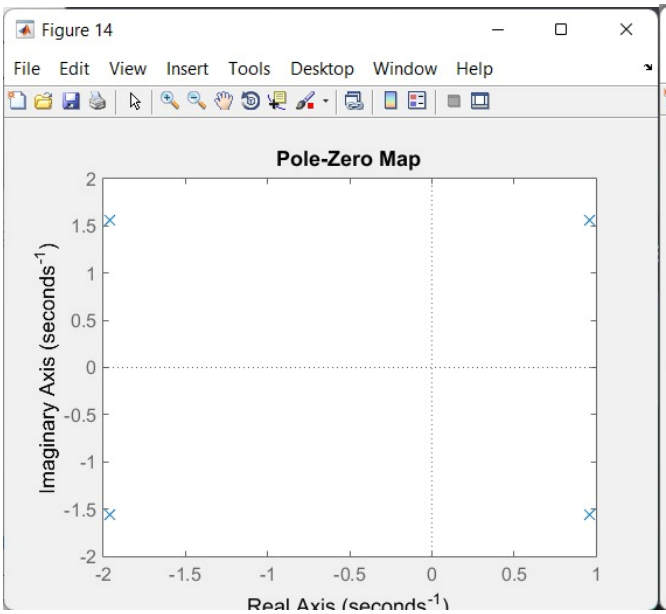
Transient Response:

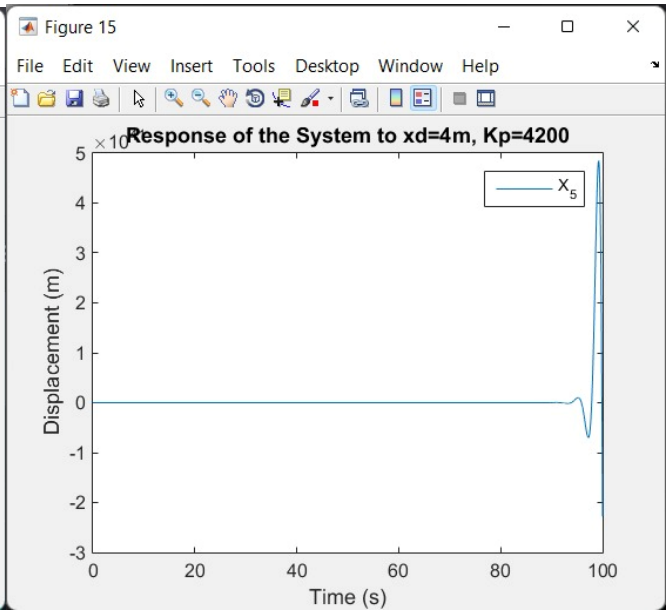
```
Kp: 1000.00
The system is unstable
Rise Time: NaN s
Peak Time: Inf s
Maximum Peak: Inf
Settling Time: NaN s
Ess: -91602882863363833856.00
```

Req 9:



From the analysis we can see that we need Kp to be greater than 4189.6 to satisfy the requirement , but as we can see in the output this makes the system unstable .





The System is unstable

Req 10:

In order to enhance the performance of the system, we have decided to implement a PI controller (proportional-integral) mechanism. Through extensive experimentation, we have tested various parameter values to ensure system stability. After thorough analysis, we have determined that setting the integral gain (KI) to 3.8 and the proportional gain (KP) to 110 successfully fulfill this requirement.