**Question1:**

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**Question2:**

In this experiment the reference position changes from 0 to 1 at 1sec time. Our system with the help of the PD controller tries to reach the reference position. As we have set Kp = 48 and Kd = 23.7, which was obtained by calculating for critically damped, we obtained a system response for a critically damped system.

The below picture (Fig.1) shows the parameter value I used for this particular experiment.

Graphical user interface, application

Description automatically generated

Fig.1

The next image (Fig.2) shows the Simulink Model of the system.

Diagram, schematic

Description automatically generated

Fig.2

A screenshot of a computer

Description automatically generated with medium confidenceThis next image (Fig.3) shows the system response (output.) Here we can see that with these Kp and Kd constants my system performs in critically damped condition with zero overshoot. It looks like it takes more settling time than 1 second but it is because the relation is an approximate relation.

Fig.3

**Question3:**

Here in this next image (Fig.4), we can see that the Settling time (when the output response is within 2% of the desired response) is 1.24765s (2.24765-1)

Chart

Description automatically generated

Fig.4

Now since our system was not overshooting, we only need to reduce our Settling time. To improve the settling time, I changed the Kp value to 60 and keeping Kd as same as the old one (23.7). This leads to a very little overshoot that is less than 0.2% of the desired output, which can be seen in this Fig.5.

Chart

Description automatically generated

Fig.5

This reduces the Settling time to 0.8564s (1.8564 - 1) approximately, as it can be seen in Fig.6.

Chart

Description automatically generated with medium confidence

Fig.6

So Now in next step I increased Kd to 30 and saw that the Settling time increases a lot so to compensate this further I increased the Kp value to 80 and hence observed that the Settling time now is 0.9233s (1.9233-1) as seen in Fig.7

A picture containing line chart

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I observed that I was able to witness this weird result as here very high oscillations are not observed and the system is critically damped so the effect of parameter change (Kp and Kd) on the settling time is similar to that of the effect on rise time, since system does not oscillate and directly reaches in 2% of the desired output with the rise time.

So, the final System response is seen in figure.9 and the final system parameters are seen in Fig.8.

Graphical user interface, application

Description automatically generated

Fig.8

Chart

Description automatically generated

Fig.9

**Question4:**

The parameters used for this experiment are as seen in Fig.10

Graphical user interface, application

Description automatically generated

Fig.10

The system model with a constant disturbance term is as observed in Fig.11

Diagram

Description automatically generated with low confidence

Fig.11

The output system response of this system with an added constant disturbance is as seen in Fig.12

Chart

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Fig.12

The steady error of this complete closed loop system is 0.008785745 as it can be seen in Fig.13

A picture containing graphical user interface

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Fig.13

**Question5:**

After tuning the P, I and D constants for this particular experiment are as seen in the Fig.14.

Graphical user interface, application, Word

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Fig.14

The system model is as shown in Fig.15.

Diagram, schematic

Description automatically generated

Fig.15

The System output response is as shown in the Fig.16

Graphical user interface

Description automatically generated with low confidence

Fig.16

The desired output shows zero overshoot, has almost 1 sec Settling time and has zero seady state error. The steady state error can be seen in Fig.17 which is equivalent to zero.

A screenshot of a computer

Description automatically generated with medium confidence

Fig.17