EGB345 Control and Dynamic Systems JJF/20

**Servo Motor Control Design Report**

Instructions: replace the yellow highlighted text with your own words and the requested plots (that is, delete the yellow text). Note: the plots and figure used in this report should be saved using MATLAB functions or Simulink (not screen captures).

Authorship details

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| --- | --- |
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| List others providing assistance |  |

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| Question 1 | 1. Working attached below 2. Text, letter     Description automatically generatedWorking attached below   Text, letter  Description automatically generated   1. Plot attached below   Chart, line chart  Description automatically generated   1. Comment: Using the in-built MATLAB function “Stepinfo” (results shown below) we can see that the %OS calculated in the analytical method and the matlab model are the same therefore the plot matches the results.   Text  Description automatically generated |
| Question 2 | 1. Working attached below 2. Working attached below   Text, letter  Description automatically generated   1. Plot attached below   Chart, diagram, line chart  Description automatically generated   1. Comment: Using the in-built MATLAB function “Stepinfo” we can see that the matlab gives a 5% overshoot and the analytic method was used to calculate for 5% overshoot. Attached below is a screenshot when the step info function is used. This shows that plot matches the analytical results.   Text  Description automatically generated |
| Question 3 | 1. Table attached  |  |  | | --- | --- | | K value | Closed loop poles and Plots | | 0.9K | Chart, line chart  Description automatically generated  -2.1350 + 2.0140i  -2.1350 - 2.0140i | | 0.8K | Chart, line chart  Description automatically generated  -2.1350 + 1.7604i  -2.1350 - 1.7604i | | 0.7K | Chart  Description automatically generated  -2.1350 + 1.4635i  -2.1350 - 1.4635i | | 0.6K | Chart, line chart  Description automatically generated  -2.1350 + 1.0884i  -2.1350 - 1.0884i | | 0.5K | Chart  Description automatically generated  -2.1350 + 0.4770i  -2.1350 - 0.4770i | | 1.1K | Chart, diagram, line chart  Description automatically generated  -2.1350 + 2.4434i  -2.1350 - 2.4434i | | 1.2K | Chart, diagram, line chart  Description automatically generated  -2.1350 + 2.6320i  -2.1350 - 2.6320i | | 1.3K | Chart, diagram, line chart  Description automatically generated  -2.1350 + 2.8080i  -2.1350 - 2.8080i | | 1.4K | Chart, line chart  Description automatically generated  -2.1350 + 2.9735i  -2.1350 - 2.9735i | | 1.5K | Chart, line chart  Description automatically generated  -2.1350 + 3.1303i  -2.1350 - 3.1303i |  1. Working attached below. Effect of increasing and decreasing gain changes the location of the poles along the y axis which is what you can expect from a root locus. The branches of the root loci would pass through the axis that the closed loop poles are on. It can be observed that there is a constant settling time along the axis.   A piece of paper with writing  Description automatically generated with medium confidenceDiagram  Description automatically generated with medium confidence |
| Question 4 | 1. Working attached below   Diagram  Description automatically generated   1. Working attached below   Text, letter  Description automatically generated   1. Plot attached below:   Chart, line chart  Description automatically generated  Text  Description automatically generated   1. Comment: The overshoot condition (under 5%) is satisfied, the system is stable, and the settling time is halved which is as expected therefore plots match results. It can be observed from the plot that the system settles at 1. |
| Question 5 | 1. Text, letter     Description automatically generatedWorking attached below   Text, letter  Description automatically generated   1. Justification: We use the Case 3 gain which is 0.994 so that when it is used in any system it has the lowest gain therefore allowing for an acceptable %overshoot. 2. Plot attached below   Chart, line chart  Description automatically generated  Text  Description automatically generated   1. Plot attached below   Chart, line chart  Description automatically generated  Text  Description automatically generated   1. Comment: The highest overshoot can be observed by system 3 with an overshoot of 4.99 with the lowest overshoot coming from system 2 with an overshoot of 0.03%. System 1 which has the highest settling time while system 4 has the lowest settling time. For any unknown value of Km and alpha the overshoot will not be higher than the expected 5% therefore the system will remain robust. |
| Question 6 | 1. Working attached below   Text, letter  Description automatically generated   1. Comment: Both plots show that the overshoot is under 5% therefore the design is robust. The lower gain is used to ensure that the system remains under the 5% overshoot. 2. Plot attached below (H = 0.9)   Chart  Description automatically generated  Text  Description automatically generated   1. Plot attached below (H= 1.1)   Chart, diagram, line chart  Description automatically generated  Text  Description automatically generated   1. Comment: Both plots which show the unknown range of gains have systems that have an overshoot that is under 5% this will ensure that the system is still robust whether it is at the lower or higher end of the unknown values. The lower gain is chosen to ensure that the system operates under the overshoot. In terms of steady state properties, the system with a lower gain takes almost twice the time to settle and the values that it settles at is also different with one system settling at 1.1 and the other at 0.9. |
| Question 7 | 1. Working attached below   Text, letter  Description automatically generated   1. Text, letter     Description automatically generatedWhen 10\*alpha 2. A piece of paper with writing     Description automatically generated with medium confidenceWhen 2 \* alpha 3. Plot attached below   Chart, diagram  Description automatically generated with medium confidence  Text  Description automatically generatedText  Description automatically generated   1. Comment: The new open loop response was used. The closed loop response was then used to calculate the location of the closed loop poles when there was a fast pole and when there wasn’t.   With the use of the 5x rule we can find which is the dominant pole. By observation of the pole location we can see that the system with the fast pole where it is closer to zero so it has a higher settling time as seen above. System 1 has a settling time of 73 seconds while the system 2 has a settling time of 13 seconds. Both systems end up settling at the same value even though they have a difference in their settling time. |

## Appendix A: Approved Extension Letter

## Text, letter Description automatically generated