EE324, Control Systems Lab, Problem sheet 7
(Report submission date: 5th October 2021)

Q1) For the open-loop transfer function 1 /s(s^2 +4s+8).
a) Find the value of K (gain) for which the closed-loop characteristic equation has gain margin and phase margin equal to zero.
b) Can you have a K for which the gain margin is non-zero but phase margin is 0? And vice versa?
c) Can you comment on the stability of the system for the K in part a?

Q2) Consider having a **lag-compensator** that has a ratio of zero-magnitude to pole-magnitude of say 20. This assignment aims to change the absolute pole-zero pair location of this lag-compensator (maintaining the ratio of 20) and see the effect on the transients.
a) Consider G(s)=1/(s^2+3s+2) and first choose a constant gain K to achieve 10% OS in the closed-loop.
b) Find the steady-state error and now add the above lag-compensator and (with the above ratio of 20), find the new steady-state error.
c) Change the location of the pole-zero pair (with say 5 different pole-zero locations) to see the degrading effect on the planned %OS and the trade-off with how late the lag-compensator effect comes into action.

Q3) Design the following:
a) Design a lead compensator for G(s) of Q2 to have 2% settling time made half of the case for Q2-a, and %OS still the same.
b) Design a PD controller to achieve the specification in Q3a.

Report Format:

Q1)

- **a)** Show the calculation of the K value and add a picture of the Bode Plot(Magnitude and Phase response).
- **b)** State your answer along with the reason/explanation.
- **c)** State your answer along with the reason/explanation.

Q2)

- **a)** Show the calculation of the K value.
- **b)** Show the calculation of steady-state error before and after adding the lag-compensator. Add the picture of step response before and after the addition of the lag-compensator.
- **c)** Show the plot of the step-response for different pole-zero locations.

Q3)

- **a)** Show the calculation of the lead compensator. Show the plot of root locus and step-response before and after the addition of the lead compensator.
- **b)** Show the calculation of the PD controller. Show the plot of root locus and step-response before and after the addition of the PD controller.

Note:

- **At least these are things to be added to the report and if anyone wants to add extra required plots/values can be also added.**
- **Add the Scilab code for all questions.**