Summary for EE3331C

Question 1:

- This question is on root-locus and its application. Most students were able to do part (a).
- For part (b), you need to substitute $s = 0$ into the closed-loop pole equation to get the value of K. The closed-loop poles can be obtained by equating the closed-loop pole equation with the desired closed-loop pole equation taking into account that all the poles are real at this value of K. Many did not compute the poles, it is important to read the question carefully.
- For part (c), from the given closed-loop poles, you can observe that the pair of complex poles are far away from the real-pole (real-part more than 4 times). Hence we can approximate it as a 2^{nd} order system with the pair of complex pole. The last portion is to match the DC gain which most students made mistake. You need to compare with the original closed-loop system.
- Part (d) is requires you to derive the 5% settling time formula which is an extension in Chapter 4 of our notes (page 4-53).

Question 2:

- Part (a) is on block diagram manipulation. Most students are able to do it, there are a few careless mistake where in your output expression of a block diagram, the input is missing, e.g. $y = G$ instead of $y = Gu$
- Part (b) is a design problem, you need to be able to extract the damping ratio and undamped natural frequency from the 2 given specifications. Quite a handful of students has difficultly converting the maximum overshoot formula to the requirement on damping.
- Part (c) is relatively straightforward, with the closed-loop pole equations from part (b), the values of k_1 and k_2 can be chosen to the coefficients of s and the constant term takes on any value desired.

Question 3:

This question has five parts, each covering one particular aspect of frequency domain method.

- Part (a) tests students' ability to find phase-crossover frequency of a given loop transfer function. Find phase-crossover frequency. The numerator of the function $G(j\omega)$ is real but the denominator is complex. Phase-crossover frequency can be obtained by setting the imaginary part of the denominator to zero. Most students were able to do it.
- Part (b) tests students' ability to sketch Bode plot. The transfer function is non-minimum phase. Most students could sketch the magnitude plot. Care is needed while sketching the phase plot due to the additional 180° phase for RHS pole or zero. Many students made mistake with the phase plot.
- Part (c) gives both the Nyquist contour and the Nyquist plot for a loop transfer function. It is clear from the diagram that the plot is for K>0. As the Nyquist plot doesn't encircle (-1,0) and there is one RHP pole of the open loop transfer function (Np=1), the closed loop is unstable with one unstable pole for all values of K>0. Many students tried to find the range of

negative values of K as well. This was not necessary, but such attempt was not discredited while marking. Most students answered this question correctly.

- Question Q3(d) is about sketching the Nyquist plot of a given transfer function with two integrators. Intersection of the negative real-axis by the mapping of $j\omega$-axis must be checked before sketching the Nyquist plot. Most students answer this question correctly.
- Question Q3(e) tests student' ability to interpret the information found in the Bode(mag) plot of a Type 1 system. Some students answered this question by looking at the given Type 1 transfer function while others obtained a Type 0 transfer function first by removing the integrator. Both approaches are correct. Quite a large number of students didn't answer this question.

Question 4:

This question covers mainly topics related to design of compensator using Bode plot method.

- Part (a) tests students' ability to interpret the relation between the gain of a loop transfer function and corresponding gain margin. Find phase-crossover frequency and then determine the value of K for which gain is 1 at the phase-crossover frequency. Gain margin is reciprocal of this gain. Most students answered this question correctly.
- Part (b) is descriptive question involving advantages and disadvantages of using a lead compensator. Almost all students answered this question, however, most students didn't write all advantages/ disadvantages.
- Part (c) tests students' ability to design a compensator using Bode plot method. This question is further divided into small segments, each dealing with one aspect of the design. Similar design problems were solved during tutorials. Most students answered this question correctly