Examination Feedback for ACS342 – Feedback Systems Design
Autumn Semester 2013-14

Feedback for ACS342 Session: 2013-2014

Feedback: Please write simple statements about how well students addressed the exam paper in general and each individual question in particular including common problems/mistakes and areas of concern in the boxes provided below. Increase row height if necessary.

General Comments:

Performances ranged from appalling to near-perfect. Encouragingly, however, the majority of candidates had a reasonable attempt at the paper. The tendency for candidates to prefer learning procedures, without understanding their underlying aims, implications or concepts, remains a concern. For example, many were able to perform the phase-lag compensator design in Q1 but were not able to explain how the compensator was being used to increase phase margin. Likewise, as last year, candidates are able to perform to root locus construction steps but often ignore, or fail to interpret correctly, what their calculations are telling them. A particularly alarming issue this year is the inability of many to perform basic AC circuit analysis, by either using Kirchhoff's laws or spotting a potential divider. Bode diagrams remain a problem; few candidates produce correct sketches for gain and phase. Sketching in general (Bode and root loci) is poor, often scruffy and without labels. Most of these sketches are constructed with straight lines, and so it seems that many candidates cannot draw straight lines and/or do not have the use of a rule.

Question 1:

This question was attempted by 80% of candidates. In part (a), candidates were asked to calculate the error constants for a given system. The majority managed this. The question involved taking the limit of a function, and most of the incorrect answers arose from errors, or inability, in doing this. Alarmingly, a few candidates wrote 10/0 = 10. Part (b) was a standard Bode plot/sketch question. Few managed to produce two correct plots. As last year, most sketches were scruffy, without labels, and many were produced without workings or explanations. Part (c) was bookwork, asking for a sketch and explanation of how a phase-lag compensator may be used to increase phase margin. Few managed this. Many recalled the correct sketch, but were unable to offer the explanation. Amazingly, some of those unable to answer (c) went on to correctly answer part (d), which put into practice the phase-lag compensator design method. This suggests that many students are able to memorize the design steps, but do not understand the underlying process.

Question 2:

Question 2 was attempted by 90% of candidates and was, generally, well done. Most managed the block diagram / transfer function manipulation in part (a), and I was pleased to see that most eliminated the inner feedback loop correctly. In part (b), most candidates managed to calculate the velocity error constant, but fewer were able to determine the gain needed for 5% error. A minority of candidates formed the closed-loop transfer function at this point and tried to determine the error constant of that, missing the point that the open-loop error constant can be used to inform about closed-loop error performance. Most candidates were able to recall and use the Routh array procedure and correctly answer part (c). Part (d) asked for a description of the effect of a PID controller on the system's velocity error constant. Answers were largely incomplete or poor, indicating a lack of understanding about the effects of the P, I and D gains. Part (e) was generally well done by those who got this far into the question. The most common problem was not knowing how to calculate the oscillation period. An even more common occurrence, even among those candidates who answered this part correctly, was to repeat the Routh array analysis (already done in part (c)) in order to find the critical gain. That is, many candidates failed to spot that the critical gain they calculated in part (c) is exactly the same as the critical proportional gain needed to answer part (e).

Question 3:

Attempted by more than 95% of candidates, Question 3 asked candidates about poles, root loci and phase-lead compensator design. The vast majority were able, in part (a), to identify correctly the system as 2nd order, type zero, and its pole locations. Some were unable to calculate the pole locations (just the roots of a quadratic), and a few more mistakenly identified the system as type one or type two, perhaps indicating a lack of understanding. Part (b) asked candidates to sketch the root locus of the provided system. While this was, ostensibly,very straightforward (second order; no zeros) there was one twist: no poles on the real axis. The vast majority of candidates knew this from part (a), and correctly located the open-loop poles on their diagrams. Most were then able to go through the construction rules and determine the salient information about the locus. However, as last year, many proceeded to selectively ignore, or fail to interpret, what their calculations were indicating, and draw an incorrect sketch. The most common error was to draw the loci as emanating from the real axis, and not from the complex open-loop poles. This error stemmed from candidates performing, unnecessarily, the break-away point calculation, which informed them that a break-away/-in point existed at s=-1. What candidates ought to have realized is that the s=-1 is not on the locus, therefore this could not be a break point. The better candidates did realize that, since none of the locus lies on the real axis, there was no need even to perform the break-away point calculation. A final comment on the root locus is that, as last year, sketches were often scruffy. This is especially surprising given that the sketch in this case was constructed from four straight lines. Parts (c) and (d) were either done well or very badly, with little in between. The most common mistake was to equate the provided C(s)G(s) with the standard second order transfer function in an attempt to calculate the values of damping ratio, frequency, p and z. Of those who attempted part (d), most correctly selected the zero of the compensator, but failed, subsequently, to calculate the pole location. Most knew the procedure, but made errors in calculation or even set up the calculation – which was based on basic trigonometry – incorrectly.

Question 4:

This question was attempted by only 30% of candidates, probably because of its more unusual topic and structure compared to the other questions and the practice tutorial questions. Of those who did attempt this question, most only attempted parts (a), (b) and (c), leaving the later parts of the question, on digital control. Part(a) should have been very familiar: using circuit analysis to derive the transfer function of a passive RC circuit. Astonishingly few candidates managed to do this. For part (b), most spotted that the circuit was a phase-lead network and were able to say why. Part (c) was conceptually simple but required a bit of algebra and arithmetic, hence errors crept in to the calculations of many candidates. Parts (d) and (e) gave a relatively large number of marks for a bookwork continuous- to discrete-time conversion of a controller. Few attempted this. Those who did seemed to select the correct procedure, but made errors in their algebraic manipulations. A couple of candidates performed the conversion correctly.