General comments on EE2-6 Control Engineering paper 2018

Overall, the students have done very well on the exam paper, scoring an exam average of 75% (65% scaled).

1. The students have done very well on this question, scoring approximately 80%. This is a mass-spring-damper modeling, proportional controller design and Routh Hurwitz stability analysis question and is a variation on a past exam question and typical study group questions.
   (a) Analysis and simple design for a mass-spring-damper system.
      i. Tests understanding of transfer functions for simple models.
      ii. Tests the use of the Routh array for stability range.
      iii. Tests understanding the conditions for marginal stability.
      iv. Tests understanding of the use of the final value theorem in simple design.
   (b) Use of the Routh–Hurwitz criterion to analyse the stability of P, PI and PD controllers, as well as a simple design.
      i. Tests the ability to use the Routh–Hurwitz criterion to analyse the stability of closed loop systems using P, PI and PD controllers.
      ii. Tests the use of the Routh–Hurwitz criterion in simple PD pole placement design.

2. This is a Nyquist diagram analysis and design question starting from a frequency response of the open–loop system. The students did relatively well on this question scoring approximately 73%.
   (a) Requires the students to demonstrate an understanding of the frequency response and its use in sketching Nyquist diagrams.
   (b) Requires an understanding of the the stability margins and the cross–over frequency.
   (c) Requires an understanding of the Nyquist stability criterion and its use in stability analysis for proportional control.
   (d) Tests the ability to understand the effect of a controller (given its frequency response) on the stability and performance of a closed–loop system.

3. This is a root–locus type analysis and design question for a feedback loop employing a PI compensator. The students did less well on this question, scoring approximately 70%.
   (a) Tests the ability to draw a simple root–locus.
   (b) Tests the ability to use the root–locus technique to design a PI controller for pole placement design.
      i. Tests the students' understanding of using two parameters (gain and zero location) to characterise a PI controller, and further tests the ability to draw a root–locus.
      ii. Tests the students' ability to analyse a root–locus to decide the range of performance that can be achieved.
      iii. Tests the students' ability to use the root–locus to fix the value of a parameter that achieves a pole placement design.
      iv. Tests the students' understanding of the use of the gain criterion in root–locus design.