Duke University
Edmund T. Pratt, Jr. School of Engineering

ECE 141 Spring 2009
Test III - Part I
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Name (please print)_____

In keeping with the Community Standard, I have neither provided nor received any assistance on this test. I understand if it is later determined that I gave or received assistance, I will be brought before the Undergraduate Judicial Board and, if found responsible for academic dishonesty or academic contempt, fail the class. I also understand that I am not allowed to speak to anyone except the instructor about any aspect of this test until the instructor announces it is allowed. I understand if it is later determined that I did speak to another person about the test before the instructor said it was allowed, I will be brought before the Undergraduate Judicial Board and, if found responsible for academic dishonesty or academic contempt, fail the class.

Signature:_____

Problem I: [15 pts.] System Categorization and Gain Control I

Given a unity feedback system with a gain controller K and a plant with a transfer function:

$$G_{\mathrm{p}}(s) = \frac{s-2}{s^2-2s+5}$$

- Determine the range of stability for the gain controller.
- Accurately sketch the root locus assuming gain control with $K > 0$. Be sure to denote any interesting locations such as open loop poles, zeros, marginal stability frequencies, centers of asymptotes and any break-in or break-out points. Clearly label these points along with their values.
- With respect to steady-state error, determine the system type, the appropriate static error constant, and the steady state error assuming each of the following inputs and further assuming that the gain is set such that the response is critically damped.

  (a) $r(t) = 6u(t)$
  (b) $r(t) = 6t^2u(t)$
  (c) $r(t) = 3t^2u(t)$

Name (please print):
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Problem II: [15 pts.] System Categorization and Gain Control II

Given a system with a gain controller K and an overall transfer function - including the gain controller, of:

$$T(s) = \frac{(s^2 - 6s + 8)K}{s^3 + (8 + K)s^2 + (15 - 6K)s + 8K}$$

- Determine the range of stability for the gain controller.
- Accurately sketch the root locus assuming gain control. Be sure to denote any interesting locations such as open loop poles, zeros, marginal stability frequencies, and centers of asymptotes. Clearly label these points along with their values. On this problem, rather than explicitly solving for any break-in or break-out points, write the equation you would use to eventually solve for them.
- With respect to steady-state error, determine the system type, the appropriate static error constant, and the steady state error assuming each of the following inputs and further assuming K is equal to one half of its maximum value for stability:

  (a) $r(t) = 10u(t)$
  (b) $r(t) = 10t^2u(t)$
  (c) $r(t) = 5t^2u(t)$