ECE414 Take Home Test, Due Thursday April 11, in class.

Using the function G = ece414planttf(month,day,alpha), generate a plant G(s) to be controlled based on the month and day of your birthday (no cheating, I can look it up). Your plant has uncertainty, so each alpha in the range $1 \leq \text{alpha} \leq 100$ gives a different version of your plant.

For this plant, design five proper controllers: (1) PID type (*e.g.*, P, PD, PI, or PID) unity feedback controller designed using root locus techniques, with the restriction that no zeros of the controller can be any closer than a distance of 2 from the real part of any of your plant poles. For this controller, gain is chosen by selecting a point on a MATLAB drawn root locus plot, (2) A PID type controller designed using pidtune or pidTuner functions in MATLAB, (3) A PID type controller designed using the pidsearch function, (4) A unity feedback linear algebraic design controller, and (5) A two parameter linear algebraic design controller.

The design goals across all possible plants include: (a) zero percent steady state error to a unit step input, (b) less than ten percent overshoot, (c) the step response may not go in the wrong direction first, (c) minimize settling time, (d) minimize peak control effort, (e) minimize peak sensitivity, (f) phase margin greater than forty-five degrees.

Turn in a writeup of what you did, including a narrative of your design approaches (failed ones as well as good ones). Describe how you found the final designs and what their individual performances are. Be sure to include important graphical plots in your writeup as well as all controller transfer functions in pzk format. Which of your designs is the “best” one, and why? How do you define “best”?

Have in mind that you are preparing a report that your boss will show to potential clients that are interested in purchasing a product based on your work. Compare and contrast your designs in terms of ease vs. difficulty in design, performance achieved, etc. Do NOT solve this problem strictly by exhaustive searching, *i.e.*, writing loops that sweep parameters over wide ranges of values. Doing so leads to unemployment and failure. Using employable engineering talent, you can narrow the range of possible solutions dramatically. Documenting this clearly leads to career advancement and a better grade on this work.

Documenting your process counts MUCH MORE than final results. How well you present your work counts MUCH MORE than final results. You may use the publishing capabilities in MATLAB as part of your results, but a more comprehensive and polished report is required for potential clients. Impress the clients who want to invest in your work. Don't make a fool out of your boss.

Be an employable engineer and ask questions. Your mentor (the instructor) will be gravely disappointed if you do this work without collaboration. Collaboration leads to better results and increases the likelihood of continued employment and career advancement.

On top of the first page of your report place a one page single-spaced executive summary of your work. This summary should be a concise description of the most important aspects of your work. It is up to you to decide what those aspects are.