CMPE323 Fall 2014 Exam 2 Student ID # ______________________________

11/09/2016

**Instructions:**

1) **This is a take-home exam, and it is critical that you follow these directions exactly.**
2) **The UMBC policy on academic integrity will be strictly enforced. I will disqualify your exam on the slightest hint that the rules have been violated.**
3) **Make sure your student ID # is on the sheet that you scan.**
4) **You may use any notes from this course, any homework solutions, and the textbook. You may use external references *if they are accompanied by a properly formatted citation and reference* as indicated in the examples posted on Blackboard.**
5) **You may *not* consult with any human other than Dr. LaBerge, who will provide clarifications to questions submitted by e-mail before 6 PM on Monday November 14. All requests for clarifications will be posted to the entire class, so all are on a common basis. You may consult with pets that live in your domicile.**
6) **You may use MATLAB in any manner you desire. Please submit any and all of your MATLAB files (scripts or special-purpose functions) so that I can be assured that a) you did the work and b) the MATLAB you turn in gives me the exact plots and results that you turned in. MATLAB submission must be on Blackboard. I will be comparing MATLAB files, so do your own work.**
7) **The exam (other than MATLAB files) must be submitted in hard copy by 4 PM on Wednesday November 16. *I will remain in my office that day until 4 PM*. Please be sure your work is legible and the steps you take in your solution are well documented so I can follow your logic.**
8) **Although I'm usually lenient, *I will not accept late exams* in this case. You can't afford for this exam to not count.**

**By submitting this exam including the MATLAB portions, you agree to be bound by the constraints of the UMBC Policy on Academic Integrity and you confirm that you *have read, understood, and complied with the rules listed above*. Your submission indicates that you agree with this condition. Penalties for violations will be severe.**

**There are 120 points on this exam. You can only earn 100 points.**

***GOOD LUCK***

1. (20 points) Use the differentiation property of Laplace Transforms to find the inverse Laplace transform $x(t)$ corresponding to
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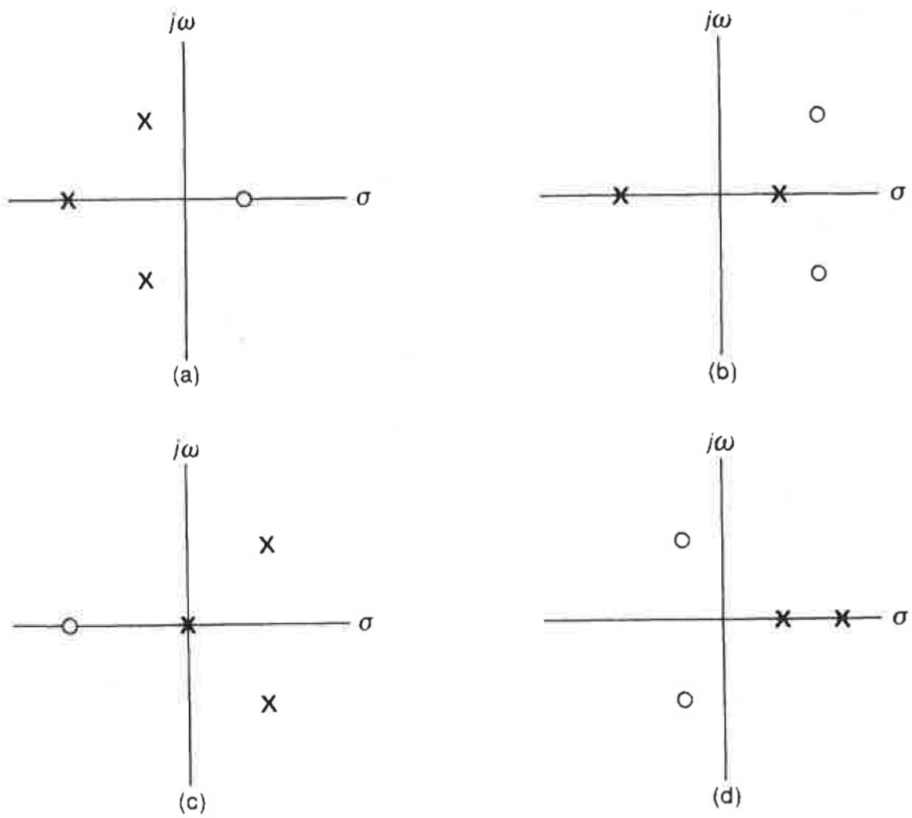
$$X(s) = \frac{1}{(s+a)^2}, \ \mathrm{Re}\left[s\right] > -a$$

   b. Repeat the process for $\mathrm{Re}\left[s\right] < -a$
   c. If $a = 2$, which of the solutions is stable?
   d. For which solution does the Fourier Transform exist and why?
   e. What is the Fourier Transform $X(\omega)$ or $X(j\omega)$ of that solution?

2. (20 points) For each of the following pole/zero plots show the RoC for stability. Which of these RoCs also implies causality.



3. (50 points) For both of the integro-differential equations indicated in a. and b. below, do the following. (Yes, this is an extension of what we covered in class). *Hint: Follow the same process we did in class. Have either of the equations already been through part of the process?*
   3.1 (10 pts each)Draw the direct form Type II (canonical) realization of the causal continuous time LTI systems satisfying the differential equations a. and b. below.
   3.2 (10 pts each) Develop the Laplace Transforms of the transfer functions, $H(s)$, of the systems corresponding to the equations.
   3.3 (5 pts each) Find the impulse responses, $h(t)$, of the systems. For full credit, your answer should be reduced to sines, cosines, exponentials and polynomials in $t$, with the appropriate unit step functions as necessary.

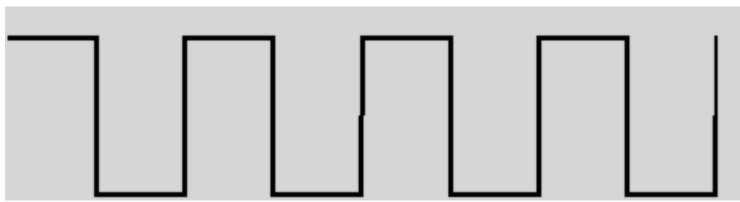
Please organize your work with the solutions to 3.1, 3.2, and 3.3 for equation a. presented together, followed by the solutions to 3.1, 3.2, and 3.3 to equation b.

a. $$2\frac{d^4y(t)}{dt^4}+16\frac{d^3y(t)}{dt}+48\frac{d^2y(t)}{dt^2}+64\frac{dy(t)}{dt}+32y(t)=x(t)+4\frac{d^2x(t)}{dt^2}$$

b. $$3\frac{d^2y(t)}{dt^2}+6\frac{dy(t)}{dt}+15y(t)+12\int_{-\infty}^{t}y(\tau)\,d\tau+12\int_{-\infty}^{t}\int_{-\infty}^{\tau}y(\sigma)\,d\sigma\,d\tau=24x(t)+6\frac{d^2x(t)}{dt^2}$$

4. (30 points)
   a. Compute the Fourier series coefficients, $c_k$, associated with the periodic function

      $x(t) = \sum_{n=-\infty}^{\infty} p(t-2n\beta,\beta)$, where the period, $T = 2\beta$, and $p(t,\tau)$ is our usual unit amplitude pulse of duration $\tau$ that we have used in several labs. Explicitly identify the numerical values (in terms of $\beta$) associated with $c_k, k \in \{-4,-3,\ldots,3,4\}$, that is, the "central" nine coefficients. *Hint: Label the following plot to help you visualize the problem. No credit or penalty for your labeling.*



   b. Compute the Fourier Transform, $P(f)$, of the basic pulse $p(t,\beta)$ as a function of $f$ with $\beta$ as a parameter. You may use any applicable properties of Fourier Transforms as long as you clearly state what you are doing.
   c. Using your result from b., write an expression for the Fourier Coefficients of the periodic extension computed in a.