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ELC 3335 – Signals and Systems

Fall 2016

Final Exam – December 12, 2016

Closed Book/Closed Notes/Formula Sheet Provided

2 hours

1. The exam is closed-book/closed-notes. Only the formula sheet provided with the exam may be used.
2. A calculator may be used to assist with the test. No laptops or tablets are allowed. No cellular phones may be used in any way during the test. Unauthorized electronic device use will result in disqualification.
3. You must circle or box your answers to get full credit.
4. All work and steps toward a solution must be clearly shown to obtain credit.
5. Partial credit may be given provided that the grader can clearly follow your work to the extent that an understanding of the problem is demonstrated.
6. No collaboration is allowed on this examination. Only Dr. Baylis or a teaching assistant may be consulted for clarification.
7. You may attach extra sheets to the exam if necessary. Each page should contain your name, the problem number, and the page number for that problem.

Please sign the statement below. **YOU MUST SIGN THE STATEMENT OR YOU WILL GET A ZERO FOR THIS EXAMINATION!!!**

I hereby testify that I have neither provided or received information from unauthorized sources during the test and that this test is the sole product of my effort.

Signed _____

Date _____

PROBLEM 1 (20 points): Find $f(t)$ if

$$F(s) = \frac{(3s + 1)e^{-2s}}{(s + 5)(s + 1)^2}.$$

PROBLEM 2 (20 points): Solve the following differential equation using the Laplace transform.

Initial conditions are $y(0^-) = 3$, $y'(0^-) = 0$. Let $f(t) = 6u(t)$. (Note: You must solve this differential equation using the Laplace transform. No points will be given for using time-domain solution techniques).

$$\frac{d^2 y}{dt^2} + 3 \frac{dy}{dt} + 2y(t) = \frac{df}{dt} - 3f(t)$$

(Additional workspace for Problem 2):

PROBLEM 3 (15 points): Draw the canonical block diagram implementation of the transfer function

$$H(s) = \frac{2s^3 + 4s^2 - 9s + 5}{s^3 + 3s^2 + 10s + 7}$$

You are allowed to use only the following blocks: summers, integrators (transfer function = $1/s$), and constant multiplication blocks. Please indicate + and - signs clearly at the summer inputs.

PROBLEM 4 (15 points): The unit impulse response of an LTIC system is $h(t) = e^{-4t} u(t)$. Use convolution to find the zero-state response $y(t)$ of this system for the input $f(t) = u(t) + u(t - 2) - 2u(t - 3)$. Provide a single, closed-form expression for $y(t)$ containing appropriate unit step functions. You do not need to simplify.

(Additional workspace for Problem 3):

PROBLEM 5 (15 points): The exponential Fourier series of a certain periodic signal is given by

$$f(t) = 2e^{j(-5t+\pi/3)} + 3e^{j(-4t+\pi/4)} + 5e^{j(-2t-\pi/2)} + 2e^{j(-t-\pi/4)} + 6 + 2e^{j(t+\pi/4)} + 5e^{j(2t+\pi/2)} + 3e^{j(4t-\pi/4)} + 2e^{j(5t-\pi/3)}$$

(a) (5 points) Sketch the exponential Fourier series spectra (that is, provide plots of $|D_n|$ and $\angle D_n$ versus ω). Clearly label all radian frequencies, amplitudes, and phases of the spectral components on your plots.

(b) (5 points) From the exponential spectral plots, plot the compact Trigonometric Fourier series magnitude and phase spectra (provide plots of C_n and θ_n versus ω). Clearly label all radian frequencies, amplitudes, and phases of the spectral components on your plots.

(c) (5 points) By inspection of the plot in part (b), write the compact trigonometric Fourier series expression for $f(t)$.

PROBLEM 6 (15 points): Determine the Nyquist sampling rate and the Nyquist sampling interval for the signal

$$f(t) = \text{sinc}(10\pi t) \text{sinc}^2(10\pi t).$$