ECE 421, Spring 2005, HW Assignment #1
Signals and Systems Review Problems
Due Tuesday, February 1

1. Determine the Laplace transform for the following time-domain signal. Express the answer in the normal transfer function format, that is, as a ratio of polynomials.

$$x_1(t) = \left\{ \begin{array}{ll} 0, & t < 0 \\ t - 3e^{-4t} + 2e^{3t}, & t \geq 0 \end{array} \right\} \tag{1}$$

2. Determine the time-domain expressions for each of the Laplace transforms shown below.

$$X_{2a}(s) = \frac{4}{s^2\,(2s+1)} = \frac{2}{s^2\,(s+0.5)} \tag{2}$$

$$X_{2b}(s) = \frac{5}{s\,(s^2+2s+5)} = \frac{5}{s\,(s+1+j2)\,(s+1-j2)} \tag{3}$$

3. Without computing inverse Laplace transforms, determine the output signals for each of the following three systems for the given sinusoidal inputs. The system transfer functions are given by the $G_i(s)$, and the input signals are $x_i(t)$.

$$G_{3a}(s) = \frac{10\,(s+2)}{(s+0.1)\,(s+10)\,(s+20)}, \qquad x_{3a}(t) = 5\cos\left(3t + \pi/3\right) \tag{4}$$

$$G_{3b}(s) = \frac{10\,(s+2)^2}{(s+10)\,(s+20)}, \qquad x_{3b}(t) = 2\cos\left(4t - \pi/4\right) \tag{5}$$

$$G_{3c}(s) = \frac{10}{(s+0.1)^3}, \qquad x_{3c}(t) = 4\cos\left(0.5t\right) + 10\cos\left(2t + \pi/3\right) \tag{6}$$

4. For each of the transfer functions below, determine the poles and zeros and indicate whether the system is stable or unstable. If the system is unstable, indicate what property of the transfer function makes it unstable.

$$G_{4a}(s) = \frac{10\,(s+2)}{(s+0.1)\,(s^2+30s+200)} \tag{7}$$

$$G_{4b}(s) = \frac{10\,(s-2)}{(s^2+6s+9)\,(s^2+11s+30)} \tag{8}$$

$$G_{4c}(s) = \frac{10\left(s^2+3s+2\right)}{(s^2-9)\,(s^2+9s+20)} \tag{9}$$

$$G_{4d}(s) = \frac{10\left(s^2+s-2\right)}{(s+9)\,(s^2-9s+20)} \tag{10}$$

5. Either sketching by hand or using MATLAB, draw the Bode magnitude and phase plots for the following transfer function. The frequency range should extend from 0.01 rad/sec to 1000 rad/sec.

$$G_5(s) = \frac{300\,(s+1)\,(s+2)}{s\,(s+0.4)\,(s+5)^2\,(s+30)} = \frac{2\,(s+1)\left(\frac{s}{2}+1\right)}{s\left(\frac{s}{0.4}+1\right)\left(\frac{s}{5}+1\right)^2\left(\frac{s}{30}+1\right)} \tag{11}$$