

**ECE 300**  
**Signals and Systems**  
Homework 4

**Due Date:** Tuesday October 2, 2007 *at the beginning of class*

**Problems**

1. For the following system models, determine if the model represents a BIBO stable system. If the system is not BIBO stable, give an input  $x(t)$  that demonstrates this.

a)  $y(t) = \dot{x}(t) + x(t)$       b)  $y(t) = \sin\left(\frac{1}{x(t)}\right)$   
c)  $y(t) = x^2(t)$               d)  $y(t) + y(t)x(t) = x(t)$

2. ZTF Problem 3-19. For this problem, first expand the first equation out using trigonometric identities. Secondly, expand out the second equation given in the problem using trigonometric identities, and then determine expressions for  $A(t)$  and  $\theta(t)$  using the two expansions. Plot the resulting waveform assuming  $f_0 = 220$  Hz and  $\Delta f_0 = 3$  Hz (ignore the parameters given in the book). Plot the waveform from 0 to  $300 T_0$  (i.e., plot over 300 periods) using 10,000 points (this sounds like a job for **linspace**) Finally, listen to the waveform using **soundsc(x,1/dt)**, where dt is the interval between samples (**dt = t(2) – t(1)**). Turn in your code and you plot.

3. (Matlab Problem) Read the **Appendix**, then

Download **Fourier\_Sine\_Series.m** from the class website.

a) If you type (in Matlab's command line) `Fourier_Sine_Series(5)` you should get a plot like that shown in Figure 1. As you increase the number of terms in the Fourier series, you should get a better match to the function. Run the code for  $N=100$  and turn in your plot.

b) Read through the code and answer the following questions:

- What variable in the code represents the Fourier series approximation to the input?
- In extending this program to implement a full trigonometric Fourier series, does the computation for  $a_0$  need to be inside a for loop?

c) Copy **Fourier\_Sine\_Series.m** to a file named **Trig\_Fourier\_Series.m** and implement a full trigonometric Fourier series representation. This means you will have to compute the average value  $a_0$  and the  $a_k$ , and then use these values in the final estimate.

d) Using the code you wrote in part c, find the trigonometric Fourier series representation for the following functions (defined over a single period)

$$f_1(t) = e^{-t}u(t) \quad 0 \leq t < 3$$

$$f_2(t) = \begin{cases} t & 0 \leq t < 2 \\ 3 & 2 \leq t < 3 \\ 0 & 3 \leq t < 4 \end{cases}$$

$$f_3(t) = \begin{cases} 0 & -2 \leq t < -1 \\ 1 & -1 \leq t < 2 \\ 3 & 2 \leq t < 3 \\ 0 & 3 \leq t < 4 \end{cases}$$

Use  $N = 10$  and turn in your plots for each of these functions. Also, turn in your Matlab program for one of these. *Notes: (1) the values of **low** and **high** will be different for each of these functions! (2) we are going to use these functions again, so once your code is working it is best to comment out the function description.*

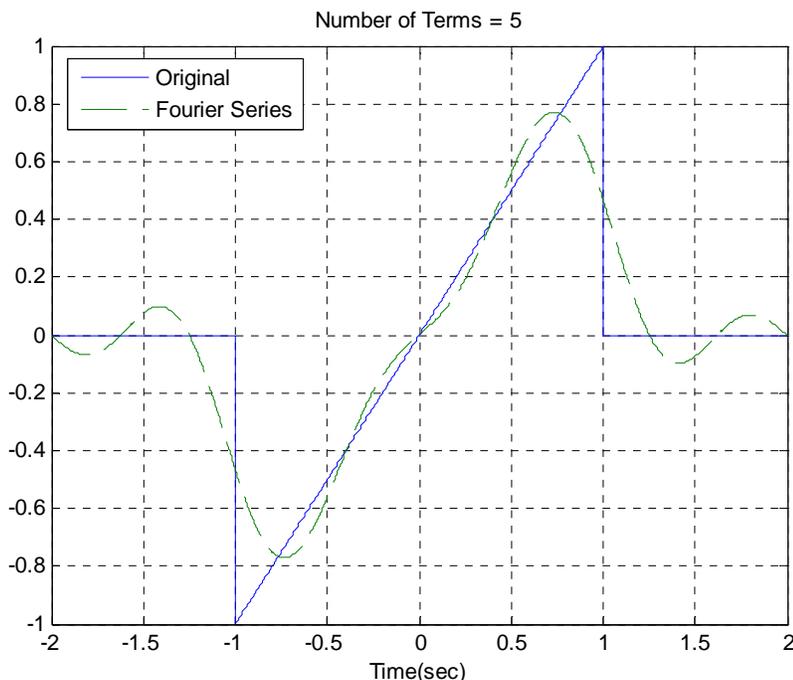


Figure 1. Trigonometric Fourier series for problem 2b.