GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Spring 2006
Problem Set #11

Assigned: 8-April-06
Due Date: Week of 17-April-06

Quiz #3 will be given on 21-April. One page ($8\frac{1}{2} \times 11$ in.) of **handwritten** notes allowed.

Reading: In *SP First*, all of Chapter 10: *Frequency Response*; Chapter 11: *Continuous-Time Fourier Transform*, Sections 11-1 through 11-9.

$\Longrightarrow$ **Please check the "Bulletin Board" often. All official course announcements are posted there.**

ALL of the **STARRED** problems will have to be turned in for grading. A solution will be posted to the web. Some problems have solutions similar to those found on the CD-ROM.

Your homework is due in recitation at the beginning of class. After the beginning of your assigned recitation time, the homework is considered late and will be given a zero.
Please follow the format guidelines (cover page, etc.) for homework.

PROBLEM 11.1*:

Signal Processing First, Chapter **11**, Problem **2**, page 342. (Forward Fourier Transform)

PROBLEM 11.2*:

Signal Processing First, Chapter **11**, Problem **3**, page 342. (Inverse Fourier Transform)

PROBLEM 11.3*:

Signal Processing First, Chapter **11**, Problem **14**, page 344. (Fourier Series Filtered by LTI System)

PROBLEM 11.4*:

A continuous-time LTI system is defined by the impulse response

$$h(t) = \delta(t) - be^{-bt}u(t)$$

(a) Determine the Fourier transform, $H(j\omega)$, which is also the frequency response of the system. Express your answer as a rational form with a simple numerator and denominator.

(b) Make a plot of the magnitude of the frequency response versus ω when $b = 200\pi$. The plot should cover the frequency range $0 \leq \omega < \infty$, but if you check your plot with MATLAB you will have to pick a maximum frequency, and that upper frequency should be at least ten times b.

(c) Describe the type of filter in the plot of the previous part (e.g., LPF, HPF, or BPF).

(d) Determine the phase of $H(j\omega)$ at $\omega = 0$, 200π, and 1000π.

(e) When the input signal is $x(t) = 10 + 20\cos(200\pi t + \pi/3) + 30\cos(1000\pi t)$, determine the output signal. Use the value of b given in part (b).

PROBLEM 11.5*:
The impulse response of an LTI system is

$$h(t) = \cos(80\pi(t - 1/100)) \frac{\sin(20\pi(t - 1/100))}{\pi(t - 1/100)}$$

(a) Determine the frequency response $H(j\omega)$ of the system which is an ideal filter.

(b) Make a sketch of the magnitude and phase of $H(j\omega)$ over the frequency range $-\infty < \omega < \infty$.

(c) Describe the type of filter in the plot of the previous part (e.g., LPF, HPF, or BPF).

(d) Using the filter defined above, determine the output of the system when the input signal is

$$x(t) = \cos(75\pi(t - 1/100)) + \frac{\sin(20\pi(t - 1/100))}{\pi(t - 1/100)}$$

Hint: Use frequency-domain methods: Determine the Fourier transform of the input signal, apply the filter in the frequency-domain to determine the Fourier transform of the output, and then do the inverse transform to get the corresponding output signal.