

ECE 457
HOMEWORK #1
Due January 21, 2005

- Read Chapter 2.4-2.6 to review Fourier series, Fourier transform and linear systems.
- Office Hours: W, 11:30-1:00 p.m., Th, 9:30-11:00 a.m. 2210EB.

1. [25] a) Find the exponential Fourier series coefficients for the periodic signal shown in Figure 2.35a in the textbook.

b) Use MATLAB to plot the amplitude and phase spectrum for $A = 1, T_0 = 1$. Include your source code and the graph. (See Computer Example 2.1 in the textbook or the example shown in class.)

c) One can get approximations to the signal by using a finite summation of Fourier series terms, i.e. $x_N(t) = \sum_{k=-N}^N X_k e^{-j2\pi k f_0 t}$. Use MATLAB to plot the approximations for $N=2, 4$ and 10 and to compute the mean square error (MSE) between the original signal and the approximation. Use the coefficients you computed in part a. Include graphs of the approximated signals.

Note: The MSE is defined as $\frac{1}{T_0} \int_{T_0} |x(t) - x_N(t)|^2 dt$. You can use a MATLAB script

similar to the one given below for computing the approximations and MSE.

```
>> t=[0:0.01:1]; %define a time vector over one period;
>> signal=[ ]; %define the signal vector over one period; (you
need to fill in the empty vector to define this signal.)
>> for k=1:N; %add the harmonics multiplied with the coefficients up
to N;
xn=xn+coef(k)*exp(-j*2*pi*k*f0*t)+conj(coef(k))*exp(j*2*pi*k*f0*t);
>>end
>>xn=xn+x0; % add in the dc component of the signal x0;
>>error=mean((xn-signal).^2); %compute MSE;
```

2. [20] 2.25 a, b

3. [15] Find the Fourier transform of the signals given in 2.27 a, b and e.

4. [20] A periodic signal $x(t)$ is expressed by the following Fourier series:

$$x(t) = 3 \cos(4\pi t) + \cos\left(8\pi t - \frac{2\pi}{3}\right) + 2 \cos\left(16\pi t + \frac{2\pi}{3}\right)$$

- a) Sketch the amplitude and the phase spectrum for this signal.
- b) By inspection of spectra in part (a), write the exponential Fourier series for this signal.

5. [20] 2.46

Note: Take the input to the filter as $x(t) = |\cos(20\pi t)|$.