EECS 210 Fall 99
Homework #2
Assigned Wednesday 9/13/2000. Due(in class) Wednesday 9/13/2000

Read Chapter one in your textbook.

1. Consider the following periodic waveform with period T=3.

$x(t)=1$ for $0 \leq t<1$ and $x(t) = 0$ for $1 \leq t<3$

Determine
(a) the frequency f (in Hz).
(b) the angular frequency ω(in radians/s).
(c) the third and fifth harmonic frequency (in Hz).
(d) the coefficients a_n and b_n for its Fourier series(you must evaluate the integrals to compute the coefficients).
(e) the coefficient A_n and the phase angle θ_n for the Fourier series.

(f) Sketch the magnitude and phase spectra of the signal showing the first 4 harmonic terms.

2. Consider the voltage waveform shown in Fig. P16.8b (see pg. 870 in your textbook). Note the vertical axis should be labeled V(t) (volts). Determine
(a) the period T.
(b) the angular frequency ω(in radians/s).
(c) the fourth harmonic frequency (in Hz).
(d) the coefficients a_n and b_n for its Fourier series(you must evaluate the integrals to compute the coefficients).
(e) the coefficient A_n and the phase angle θ_n for the Fourier series.

(f) Sketch the magnitude and phase spectra showing the first 4 harmonic terms.
(g) Use Matlab to compute and plot the sum of the first 20 harmonics in the Fourier series representation of the signal. Attach a copy of your program to your solutions.

3. Consider the system with input x(t) and output y(t) given by

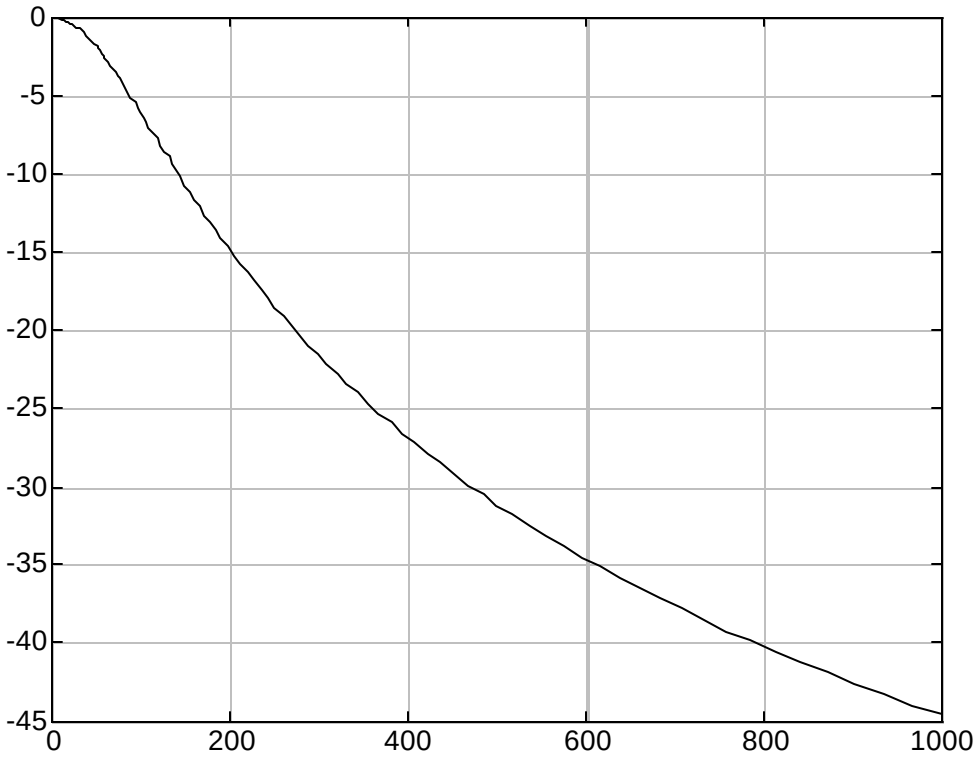
$y(t) = x(t) – x(t-1)$

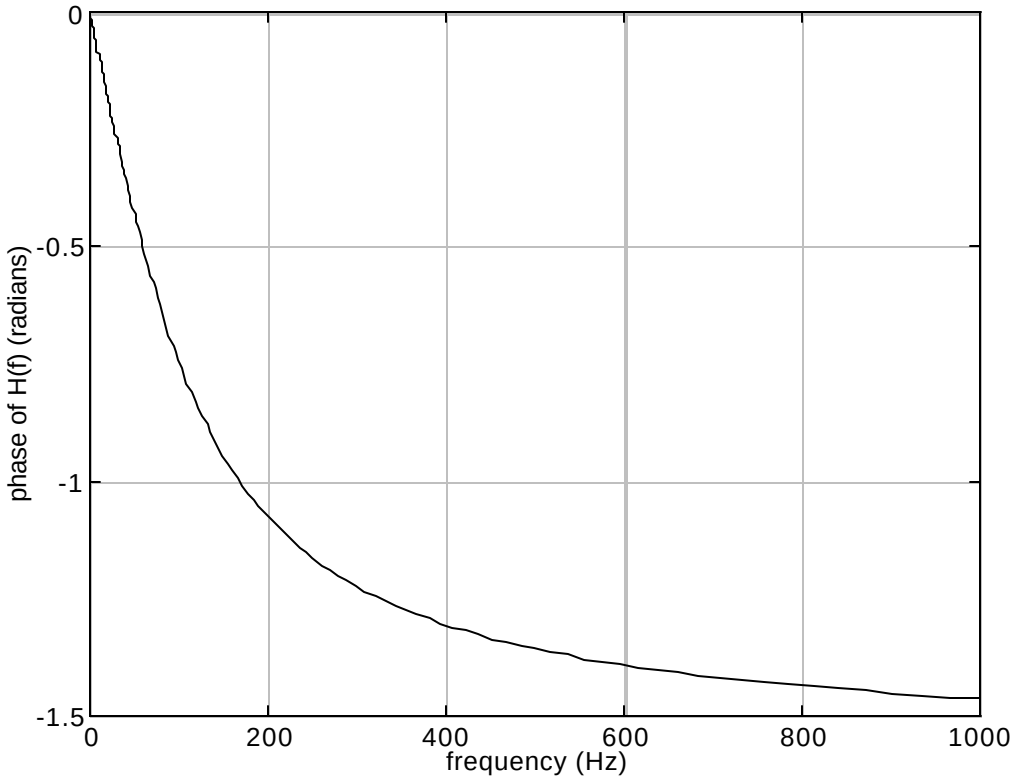
(a) Prove that this system is linear(i.e. the superposition property holds: If $x_1(t)$ in yields $y_1(t)$ out and $x_2(t)$ in yields $y_2(t)$ out, then $\alpha\, x_1(t) + \beta\, x_2(t)$ in yields $\alpha\, y_1(t) + \beta\, y_2(t)$ out).
(b) Prove that this system is time-invariant.
(c) Use your results from problem 3 on homework 1 to find the magnitude($|H(f)|$) and phase(angle H(f)) of the transfer function of this system.
(d) Use the system transfer function to compute the output of this system when the input waveform is $x(t) = \sin(2\pi 50t + \pi/3)$.

4. Assume that the signal x(t) given in problem 1 above is the input to the system given in problem 3 above.
(a) Use the transfer function of the system to compute the output(expressed as a Fourier series).
(b) Evaluate and plot the sum(versus time) of the first twenty harmonics in the resulting Fourier series derived in part (a).
(c) Compute the output of this system directly by substituting the input signal(x(t)) into $y(t) = x(t) - x(t-1)$. How do your results in parts (b) and (c) compare.

5. $|H(f=50\text{ Hz})| = 0$ for a linear time-invariant circuit. Furthermore when the input to this circuit is $3\sin(2\pi 30t + \pi/6)$ the output is $6\cos(2\pi 30t)$. Find the output of this system when the input is $2\sin(2\pi 50t + \pi/12)+4\cos(2\pi 30t + \pi/3)$.

6. Consider a system which has the following transfer function The vertical axis is the magnitude of the transfer function (in dB) and the horizontal axis is frequency in Hz.





Find the output of this system when the input is $10\sin(2\pi 200t + \pi/6)$.