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% A Matlab program to calculate average power, PSD, etc. of a discretized
% signal. It also demonstrates Parseval's relation.
% The example signal is a periodic rectangular pulse
%
clear
close all
Fs=10000; % Fs=sample rate
T=1; % T=time duration of the waveform, in secs.
n=T*Fs; % n=number of samples
time=(1:n)/Fs; % time is the vector of the sample times
f=1000/(2*pi);
x=cos(2*pi*f*time);
%t=find(x<0);
%x(t)=zeros(size(t)); % x is a half-wave rectified cosine waveform

x=sign(x);
t=find(x<0);
x(t)=zeros(size(t)); % x is a half-wave rectified cosine waveform
%sound(x/max(abs(x)),Fs) % plays the waveform as an audio file
figure(1)
plot(time,x)
axis([0 10/f -1.2 1.2]) % Displaying just 10 cycles of x(t)
title('First few cycles of the waveform, x(t)');
grid
%
% Calculating power from the time signal
% This is a Riemann sum approximation of Average Power
% Note: Duration, T=n*Ts, where Ts=1/Fs
%
Power_of_x=sum(x.^2)/n % Riemann approximation of the integral
%
% Looking at frequency domain
% fft evaluates the discrete Fourier transform (DFT)
% at a set of equally spaced points on [0,1]
%
XFf=fft(x)/Fs; % scale fft(x) to get spectrum of x(t)
%
% fftshift moves this to [-0.5, 0.5] for better visualization
%
Xf=fftshift(XFf);
%
% Computing energy spectrum
%
Exf=abs(Xf).^2; % Note: Exf can also be computed as abs(Xf).^2
%
% Pxf is an approximation to the continuous time PSD
%
Pxf=Exf/T;
%
% Assigning frequencies to the samples of the PSD
%
figure(2)
df=Fs/n; % Df=freq separation between two consecutive fft points
freq=[-(n/2)+1:1:n/2]*df;
maxPxf=max(Pxf);
subplot(211)
plot(freq,Pxf)

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axis([-5000 5000 0 maxPxf])
title('Power Spectral Density of x(t) ');
subplot(212)
plot(freq,10*log10(Pxf/maxPxf))
axis([-5000 5000 -100 0])
grid
title('Power Spectral Density of x(t) in dB ');
%
% Calculating power from the PSD using Parseval's relation:
% i.e., power = integral of (Pxf) over all frequencies.
% This is a Riemann sum approximation to the actual power
%
Power_from_PSD=sum(Pxf)*df

%Now use Matlab's PSD function to plot the PSD
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