Computer Problems

2.23 A rectangular pulse $x(t)$ of unit amplitude and duration T is applied to an ideal low-pass filter of bandwidth B.

(a) What is the impulse response of the ideal low-pass filter?

(b) Determine and plot the response $y(t)$ of the filter for $BT = 5$. 10, 20. Using the following Matlab script,

```
% - - - Simulation parameters - - - -
BT      = 5; %BT product
T       = 1;
B       = BT/T;
Delta_t = T/100;
t       = [-6*T: Delta_t: 6*T];
```

```
% - - - Pulse of unit amplitude and duration T - -
x       = zeros(size(t));
index   = find (abs(t)< T/2);
x(index) = 1;

% - - - (truncated) impulse response of ideal filter - - -
t1 = [-3*T: Delta_t: 3*T];
h = 2*B*sinc(2*B*t1);

% - - - filter response - - -
y = filter(h, 1, x) * Delta_t; % has delay of 3T

% - - - plot results (removing delay) - - - -
subplot(2,1,1), plot(t,x), axis([-T T -0.25 1.25]), grid on;
subplot(2,1,2), plot(t - 3*T, y), axis([-T T -0.25 1.25]),
grid on;
```

(c) Prepare a table with columns of BT, the oscillation frequency of the response, and the percentage overshoot.

(d) Repeat the experiment for the case of $BT = 100$ but vary the sample period Δt. What is observed? Add the value $BT = 100$ to the table of part (c). Draw conclusions from the table.

2.26 Use the sound card on a PC with the following Matlab script to capture the sound output of an MP3 player, radio, microphone, or similar device.

```
Fs = 8000;                          % sample rate: eg. 2250, 8000,
                                    11025, or 44100 Hz
N = Fs*10;                          % number of samples in 10s of data
FFTsize = 1024;
y = wavrecord(N, Fs);               % collect data
Y = spectrum(y, FFTsize);           % compute average amplitude spec-
                                    trum
Freq = [0:Fs/FFTsize:Fs/2];         % frequency scale
Time = [1:N]/Fs;                    % time scale
subplot(2,1,1), plot(Time, y),
ylabel('Amplitude'), xlabel('Time(s)');
subplot(2,1,2), plot(Freq,10*log10(Y/max(Y))),
ylabel('Spectrum(dB)'), xlabel('Frequency(Hz)');
```

(a) Collect several samples from the same type of source, for example, music. Compare and comment on your results.

(b) Collect samples from different sources, for example, music and speech. Compare and comment. What happens if the sample rate is changed? Explain.