

ECE 493/593 Tele-Healthcare Engineering Simulation of Communication System with ECG Signal Transmission

Lab #2

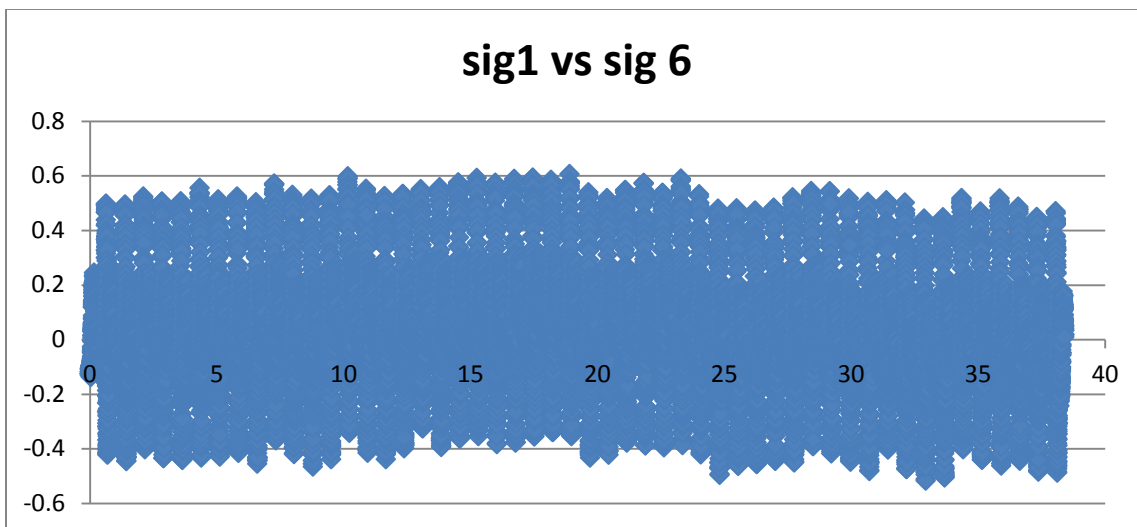
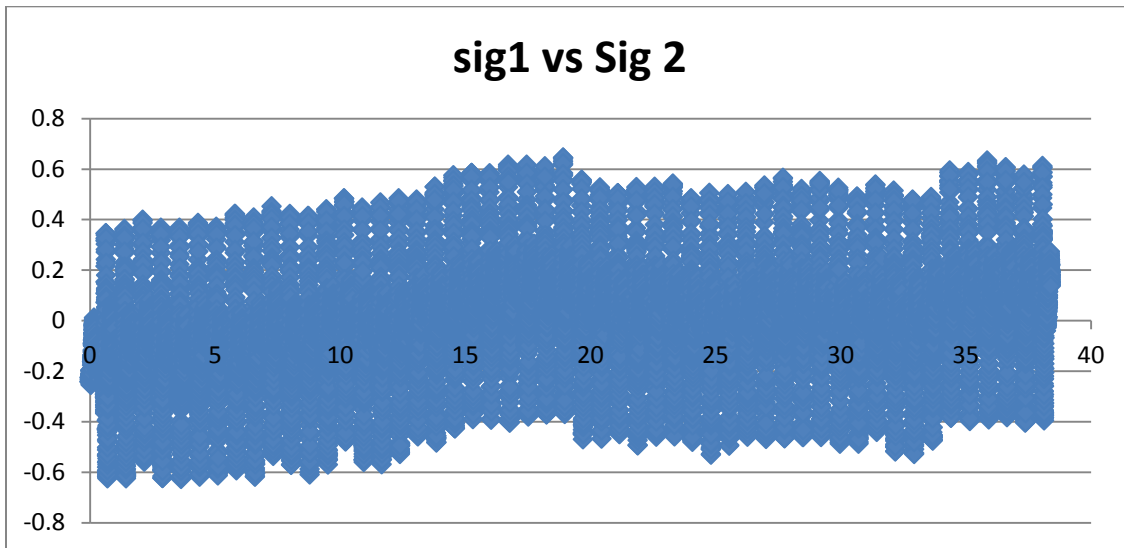
Raed Suaifh

Question 1: Print out one-page of ECG data from signals.mat.

Added to the appendix

Question 2: Use EXCEL (copy data from signals.mat to EXCEL data sheet) to display two leads of ECG signal curves.

Q2:



Question 3: Please finish the above Matlab code.

Hint: refer to AM principle: $s(t)=[A+m(t)]\cos(2\pi f_c t)$

```
s_am = [A + mt].*cos(2*pi*fc*t);
```

Question 4: Please finish the above Matlab code.

Hint: refer to AM demodulation principle: $r(t)=s(t)\cos(2\pi f_c t)$

```
Rt = s_am .* cos(2*pi*fc*t); % demodulating
```

Question 5: Why do we use the above function?

```
[f,rf]=T2F(t,rt); % the Fourier Transform
```

The above code uses the Fourier transform of the demodulated signal

```
[t,rt] = lpf(f,rf,fm);
```

The above equation is to perform the low pass filter and neglect the other unwanted higher signals (frequency)

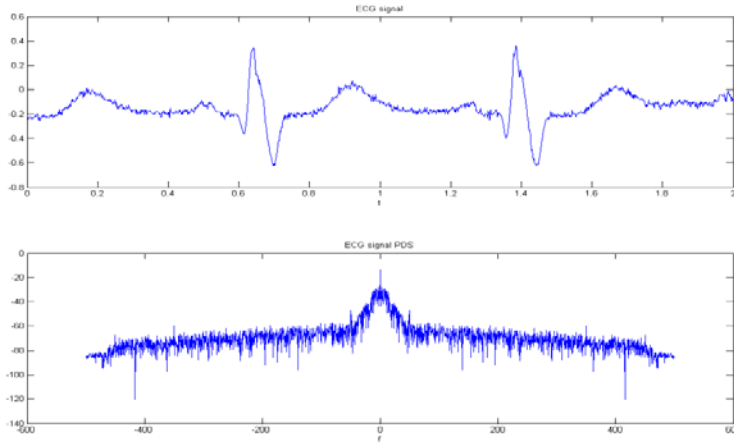
Question 6: Please add one code here to call the Fourier Transform function in order to obtain the frequency domain waveform of ECG signal **mt** (one of the leads).

```
subplot(212);  
[f,sf]=T2F(t,mt);  
plot(f,abs(sf))  
title('ECG Signal')  
xlabel('f') ; % the Fourier Transform
```

Question 7: Please add one code here to call the Fourier Transform function in order to obtain the frequency domain waveform of modulated AM signal **s_am**.

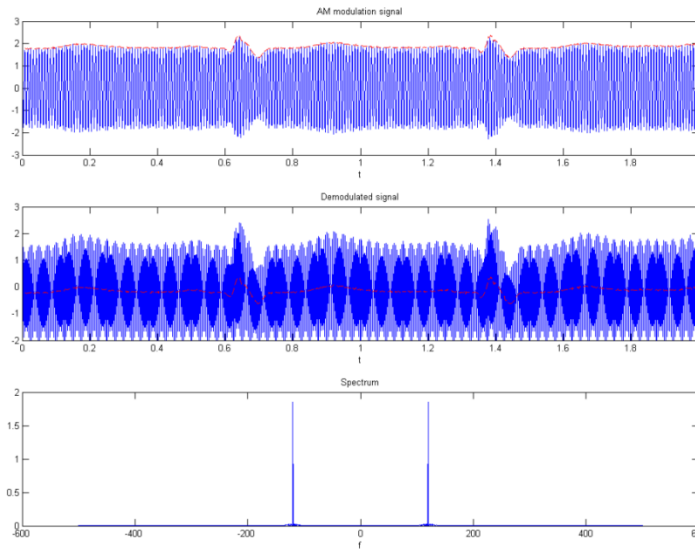
```
subplot(313)  
plot(f,abs(sf))  
title('Spectrum')  
xlabel('f') ; % the Fourier Transform
```

Question 8: Please show the figures of ECG signal and its PDS here.



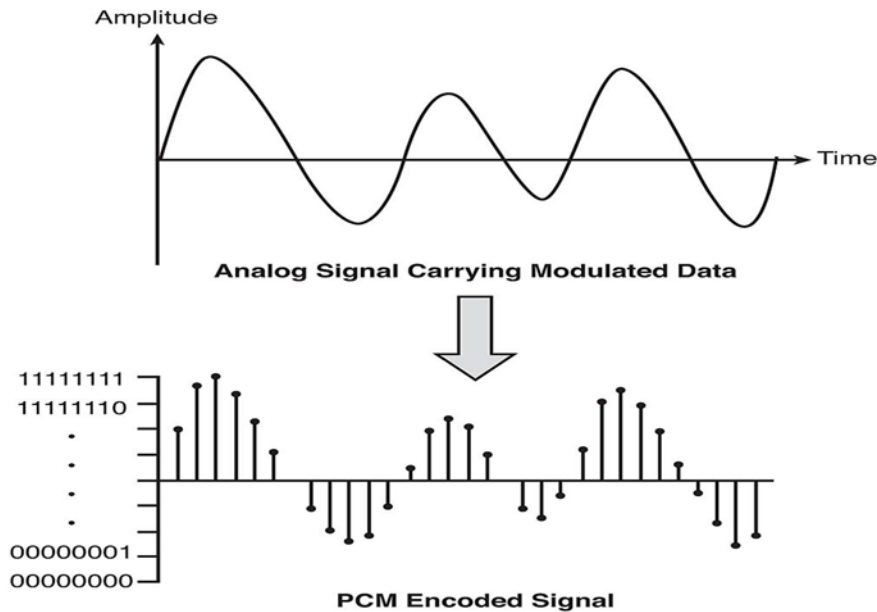
Question 9: Please show the figure of the modulated signal here (S_{am}). Explain how the AM works based on such a figure.

Question 10: Please show the figure of the demodulated signal here (rt). Explain how the demodulation recovers original signals.



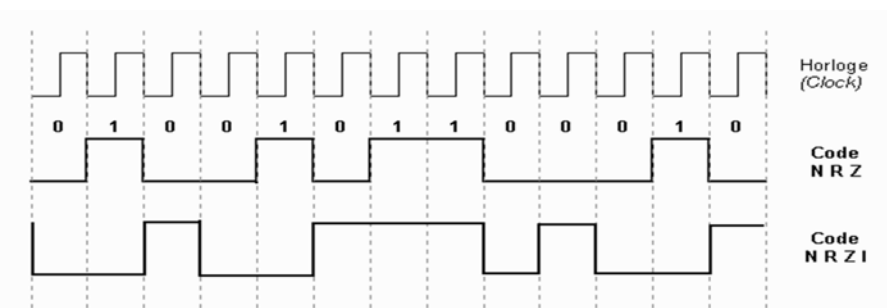
Question 11: Explain PCM quantization principle. (use one example to illustrate it).

The pulse code modulation is a method used to digitally represent for example digital telephone. PCM determine their fidelity of the original analog signal by the sample rate which is the number of times per second that samples are taken. The bit depth which determines the number of possible digital values that sample can take. The PCM quantization is If eight bits are allowed for the PCM sample, this gives a total of 256 possible values. PCM assigns these 256 possible values as 127 positive and 127 negative encoding levels, plus the zero-amplitude level. (PCM assigns two samples to the zero level.) These levels are divided up into eight bands called chords. Within each chord are sixteen steps.



Question 12: Explain NRZ principle. (use one example to illustrate it)

NRZ is the non-return to zero line code is binary code in which the first are represented by one significant condition which usually positive voltage. The change in the non-return zero is used by high level data link control and USB. They both avoid long periods of no transitions even if the data has long sequences of 1, so by using zero bit insertion transmitting the frame delimiter '01111110. NRZ-Level itself is not a synchronous system but rather an encoding that can be used in either a synchronous or asynchronous transmission environment, that is, with or without an explicit clock signal involved. Because of this, it is not strictly necessary to discuss how the NRZ-Level encoding acts "on a clock edge" or "during a clock cycle" since all transitions happen in the given amount of time representing the actual or implied integral clock cycle.



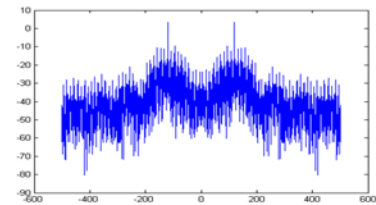
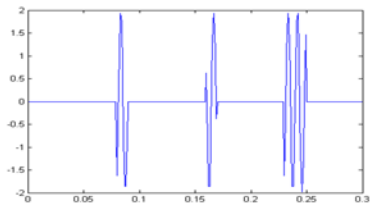
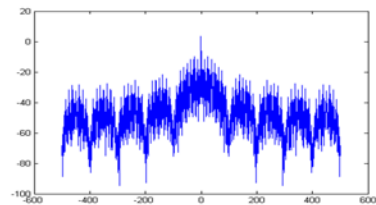
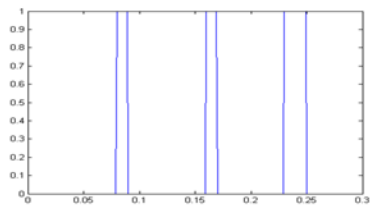
Question 13: What does this code do? Check the appended sigexpand function.

One is represented by one physical level (usually a positive voltage). Zero is represented by another level (usually a negative voltage). In clock language, in bipolar NRZ-Level the voltage "swings" from positive to negative on the trailing edge of the previous bit clock cycle.

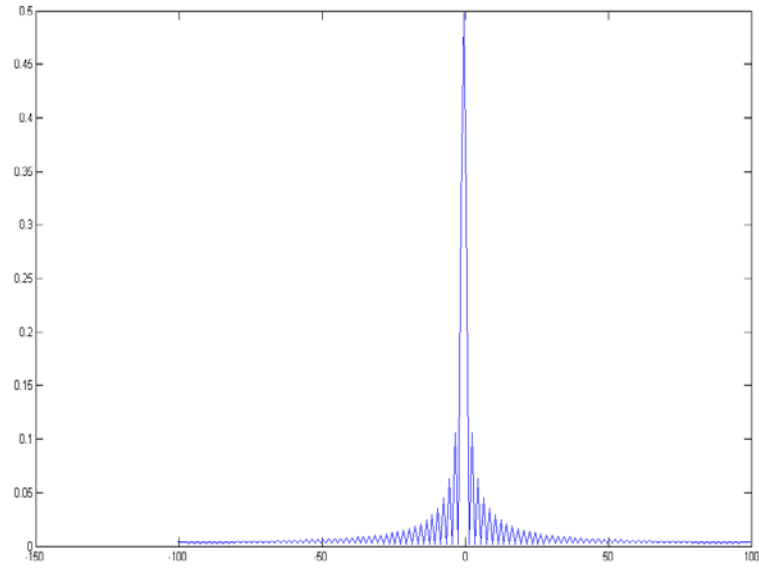
Question 14: What does the above code do?

The above code is to generate the NRZ waveforms and switch between the frequencies of the NRZ. The amplitude should shift the carrier of the NRZ.

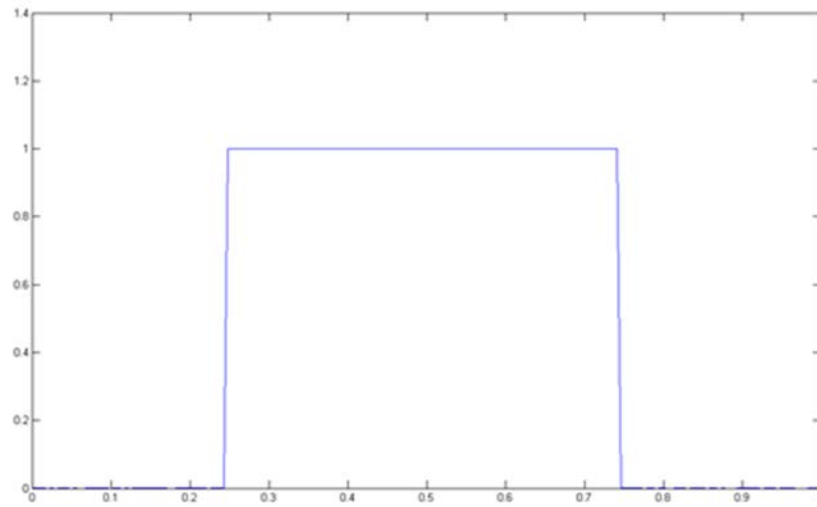
Question 15: Please provide your results here.



Question 16: Please provide rectangle function's Fourier Transform result here.



Question 17: Please provide **Sinc** function's Inverse Fourier Transform result here.



Question 18: Use a flow chat to show LPF's procedure based on the above codes.

