EEE-6285 **BIOMEDICAL SIGNAL PROCESSING I** FALL 2016
INDIVIDUAL PROJECT 3 EMG MODIFICATIONS WITH FATIGUE

DUE DATE: Thursday, December 8, 2016 12:00 noon to 2:00 PM in Room EC-1113
YOU MUST INCLUDE A CD-ROM WITH YOUR CODE WITHIN YOUR REPORT

I. DATA FILES:

In this assignment you will be given eight data files (or Matlab vectors). These are segments of two EMG records obtained from the Gastrocnemius muscle of a human subject during exercise. The sampling frequency used was 1000 samples/sec.

RECORD 1 was obtained at the beginning of an exercise session.

RECORD 2 was collected after a significant amount of fatigue had occurred

The organization of the data is explained below:

SAMPLE RANGE	RECORD 1	RECORD 2
1 to 1000	SS11	SS21
1001 to 2000	SS12	SS22
2001 to 3000	SS13	SS23
3001 to 4000	SS14	SS24

Each file (vector) contains 1000 samples. Thus each segment represents an interval of one second.

Show a plot of each signal, after the DC component has been removed from the record. **Work with these modified (no_DC) signals for the rest of the project.** In this case the specific amount of offset in each signal is not known.

In your report, include a plot of each one of the segments after DC removal.

II. OBJECTIVE:

The overall objective of the assignment is to observe the changes in the Electromyogram (EMG) signal associated with fatigue, and to develop graphical and quantitative mechanisms to assess the change.

III. EMG FREQUENCY ANALYSIS BASED ON POWER ESTIMATION IN SELECTED FREQUENCY BANDS

In order to appreciate the changes in the frequency distribution of the EMG before and after fatigue, develop digital filters to isolate the following 10 frequency bands:

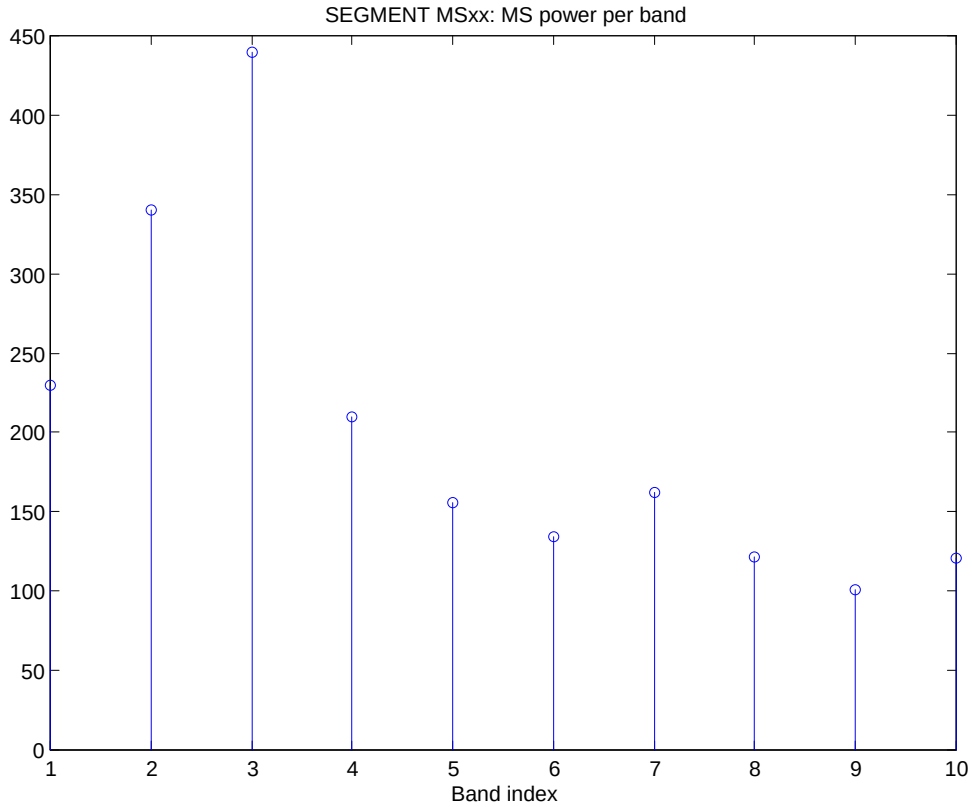
Band 1: Up to 40 Hz,
Band 2: From 55 to 95 Hz
Band 3: From 105 to 145 Hz
Band 4: From 155 to 195 Hz
Band 5: From 205 to 245 Hz
Band 6: From 255 to 295 Hz
Band 7: From 305 to 345 Hz
Band 8: From 355 to 395 Hz
Band 9: From 405 to 445 Hz
Band 10: Higher than 460 Hz

Each filter may be an FIR or an IIR digital filter. The design requirement is that the filter should have (approximately) unity gain in its pass band and, at least 20 dB attenuation in the adjacent band(s).

After processing each one of the eight data segments through all these filters, you will calculate the power (Mean Square value) of the output of each filter.

Then, for each one of the eight data segments:

a) Develop a "STEM" plot of the power values from the 10 filters. Example (**fictitious**) :



In the FICTITIOUS example shown above the power vales assumed were (from band 1 to band 10):

220
340
440
210
156
134
162
122
101
121

b) Determine the total accumulated power (sum of the ten individual power measurements), and its average (divide the sum by 10). In the above example the results would be Total Power = 2006, Average Power = 200.6

c) Determine which filter had the highest power vale (Frequency band with the HIGHEST PEAK). Example: The highest power value (440) was obtained from band 3, centered at 125 Hz.

d) Determine the frequency value that divides the accumulated values of power below and above this frequency in equal halves. I.e., there should be approximately 50% of the total accumulated power (The sum of powers of the 10 bands), on each side of this frequency. This will be an approximation to the "Mean Power Frequency". In the fictitious example presented before, the gap closest to 50% of the total power (2006 / 2 = 1003) is between band 3 and band 4. The accumulated power up to band 3 is 220 + 340 + 440 = 1000, which is below 1003. If we include the power from band 4 the accumulated value would be 1210, which is already above 1003. So, a coarse approximation to the "Mean Power Frequency" would be the center of the gap between Band 3 and Band 4, i.e., 150 Hz. A BETTER APPROXIMATION TO THE "MEAN POWER FREQUENCY" CAN BE ACHIEVED BY INTERPOLATING WITHIN THE "GAP" FOUND.

Once you have plotted and calculated all of these features for all 8 data segments, compare your observations to the opinions found in the reference provided: "Muscles Alive: Their functions revealed by Electromyography", J. V. Basmajian, The Williams and Wilkins Co. (Chapter 4).

Write your own description of the changes observed in these EMG signals, due to fatigue. Support all your interpretations on:

a) The plots and values found by your signal analysis system, and
b) The opinions found in the text used as reference. Make sure to indicate the name of any researcher whose previous observations and/or interpretations you will be using to support your own opinions.