**EC60064: Biomedical System Engineering and Automation**

**Experiment 4**

1. The signal in the file emg\_dog2.mat was recorded from the crural diaphragm of a dog using fine-wire electrodes sewn in-line with the muscle fibers and placed 10mm apart. The signal represents two cycles of breathing, and has been sampled at 10 kHz.

Write a Python program to perform full-wave rectification (absolute value) or half wave rectification (threshold at zero, with the mean value of the signal being zero). Apply a lowpass Butterworth filter of order eight and cutoff frequency in the range 10 to 20 Hz to the result. Analyze and evaluate the results with the two methods of rectification and at least two different lowpass cutoff frequencies. Compare the results with the envelope provided in the emg\_dog2\_env.mat.

1. Develop a Python program to compute the root mean squared (RMS) value and turns count in causal moving windows of duration in the range 50 – 150 ms. Apply the method to the EMG signal in the file emg\_dog2.mat, study the results for different thresholds in the range 0-200 µV.

Compare the envelope, RMS, and turns count curves in terms of their usefulness as representatives of inspiratory airflow (data provided in the file emg\_dog2\_flo.mat)

1. The file safety.wav contains the speech signal for the word “safety” uttered by a male speaker, sampled at 8 kHz. The signal has a significant amount of background noise (as it was recorded in a normal computer laboratory). Develop procedures to segment the signal into voiced, unvoiced, and silence (background noise) portions using short-time RMS, turns count, or ZCR measures. Use moving windows of duration in the range 10 – 100 ms.

What do you expect the results to be if the procedures are applied to the first derivative of the signal? Confirm your assertions or expectations by performing the study.

1. Develop a program to derive the envelogram. Apply the procedure to the PCG signals in the files pec1.mat, pec33.mat, pec52.mat.

Extend the procedure to average the envelograms over several cardiac cycles using the ECG as the trigger. How will you handle the variations in the duration (number of samples) of the signals from one beat to another?

1. The ECG signal in the file ecg\_pvc.mat contains a large number of PVCs. Apply the Pan–Tompkins procedure to detect and segment each beat. Label each beat as normal or PVC by visual inspection. Record the number of beats missed, if any, by your detection procedure.

Compute the RR interval and the form factor FF for each beat. Use a duration spanning the QRS – T portion of each beat to compute FF. The P wave need not be considered in the present exercise.

Compute the mean and standard deviation of the FF and RR values for the normal beats and the PVCs. Evaluate the variation of the two parameters between the two categories of beat.