**EC60064: Biomedical System Engineering and Automation**

**Experiment 2**

1. The ECG signal in the file ‘ecg\_noisy.dat’ (sampled at 360Hz) has a wandering baseline (low frequency artifact). Filter this signal with derivative based filters and study the results. Study the effect of variation of pole in the filter equation



Also, compute the SNR of the output in each case by considering the signal in ‘ecg\_orig.dat’ as reference signal.

1. Filter the signal in the file ‘ecg\_noisy.dat’ (sampled at 360Hz) using Butterworth high pass filters with order 2-8 and cut-off frequencies 0.5-5 Hz. Study the efficacy of filtering in removing the base-line drift and the effect on the ECG waveform itself. Determine the best compromise acceptable.

Also, compute the SNR of the output in each case by considering the signal in ‘ecg\_orig.dat’ as reference signal.

1. Design a Wiener filter to remove the artifacts in the ECG signal in the file ecg\_hfn\_ds.dat (sampled at 500Hz). The equation of desired filter is :



where, Sd and Sm represent the PSDs of desired signal and noise respectively.

The required model PSD may be obtained as follows:

Create a piece-wise linear model of desired version of the signal by concatenating linear segments to provide P, QRS, and T waves with amplitudes, durations, and intervals similar to those in the given noisy ECG signal. Compute the PSD of the model signal. Select a few segments from the ECG signal that are expected to be iso-electric (for example T-P interval). Compute the PSD and obtain their average. The selected noise segment should be zero mean. Compare the results of Wiener filter with those obtained by synchronized averaging and low pass filtering.