# Program 2

**Due on November 15, 2019**

Consider the noise cancellation system and adaptive filter shown below

s(k)

Original

m(k)

Noise path

t(k)

+

Restored

-

v(k)

D

w11



w12

v(k)

Adaptive Filter

Let (i) *s*(*k* )

*U* (2, 2) , (ii) *v*(*k* ) 1.2 sin 2*k* / 3 , and (iii) *m*(*k* ) 0.12 sin 2*k* / 3 **/ 2.

1. Find the eigenvalues and eigenvectors of the Hessian matrix for the mean-square error. Locate the minimum point and sketch a rough contour plot (use**0.12 ).
2. Find the maximum stable learning rate for the LMS algorithm.
3. Implement the LMS algorithm for this problem.
4. Plot the original and restored signals.
5. Comment on why the restored signal is not exactly same as the original signal.
6. Repeat (a) through (d) for *m*(*k* ) 1.2 sin 2*k* / 3 3**/ 2.
7. Record and play background, noise, corrupted signal, and filtered outputs.

Hint: Google “**Noise Reduction via Adaptive Temporal Filtering” and read to get the concept about various background and noise audios and their corrupted and filtered outputs from http://www.sdltd.com/tutorials/noise\_cancellation.htm**