**Project 3**

**FM and PPM Demodulation Using the Iterative Method**

1- The Iterative algorithm is given $\boldsymbol{x_n(t)} = \boldsymbol{\lambda.PS\, x(t)} + (\boldsymbol{I} - \boldsymbol{\lambda.PS})\boldsymbol{x_{n-1}(t)}$, where $\boldsymbol{\lambda}$ is called the relaxation parameter and determines the rate of convergence. $\boldsymbol{P}$ and $\boldsymbol{S}$ are the lowpass filtering and the sampling operators. In this project S is the nonuniform samples derived from PPM pulses (product of Sawtooth-wave or Sine Wave Crossings (SWC and PPM impulses) or derived from the FM zero-crossings (nonuniform samples of the integral of the modulating signal). $\boldsymbol{G} = \boldsymbol{PS}$ (distortion operator) could also be regarded as the PPM modulator and lowpass filter version of PPM pulses, or the FM modulator and demodulator.

2- Simulate the iterative and the CA methods[1] using Mathcad for FM and PPM demodulation using their nonuniform samples
   - i- Find optimum $\lambda$ for each case
   - ii- In your simulations use FIR, IIR, and then try DFT for the lowpass operator P and compare the results with each other.

2- Try the inverse system for demodulation and compare the results to the nonuniform sampling method that you have simulated in part 1.

4- Extra Credits: Extend the above technique to Digital Modulations such as PSK, QPSK and QAM. Also show that the SWC yields a DSB signal at frequency $\frac{1}{T}$.

3- Your report should contain the following parts:
   - i. An abstract of about 50 words
   - ii. An introduction consisting of a statement of the problem, its relevance and history with references to previous works.
   - iii. Solution and algorithms
   - iv. Simulation results and discussions
   - v. Conclusion
   - vi. References
   - vii. Appendix: Mathcad codes

# References


1- F Marvasti, "The reconstruction of a signal from the FM zero-crossings, Trans of IECE of Japan", vol E68, no 10, Oct 1985.

2- F Marvasti, *A Unified Approach to Zero-Crossings and Nonuniform Sampling of Single and Multidimensional Signals and Systems*, Nonuniform Publication, 1987.


---

1) [1] . $x_n = (x_1 + x_{n-1} - \frac{2}{A+B} G x_{n-1} - x_{n-2})\lambda_n + x_{n-2}$ $n>1$, *where* $x_0 = \hat{x}$ and $x_1 = 2/(A+B)x_0$.

$\lambda_n = (1 - \frac{\rho^2}{4}\lambda_{n-1})^{-1}$ and $\rho = \frac{B-A}{B+A}$.