BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

EEE G613 ADVANCED DIGITAL SIGNAL PROCESSING,

I SEMESTER 2017-18

MID-SEMESTER TEST (Closed Book)

Marks: 25 **Time: 90 minutes** **Oct 13th 2017 (11.00-12.30)**

1. a) How an adaptive filter is different than normal frequency selective filters? Describe the key factors for choice of one adaptive algorithm over other? **(1+1)**
   b) Derive an expression for the principle of orthogonality for an unknown system with impulse response $h(n)$ which is completely identified by an adaptive filter with impulse response $w(n)$. **(3)**
2. a) Differentiate between closed and open loop adaptations with example. **(2)**
   b) The input to an adaptive filter in collected from a stochastic process which produces unity amplitude only at positive prime numbers for $0 < N \leq 5$. Find the input autocorrelation matrix for this signal and check the following properties of autocorrelation matrix. **(3)**
   i. Hermitian
   ii. Toeplitz
   iii. Singularity
3. Differentiate between AR, MA and ARMA stochastic random processes. Design AR process analyzer and synthesizer for 6 initial coefficients carrying positive definite values, and explain their operation. What are the practical applications of AR process synthesizer in filtering? **(1+3+1=5)**
4. a) State and prove Wold's theorem. **(2)**
   b) Derive the step-size convergence for NLMS adaptive algorithm and justify the reason for which NLMS algorithm is said to be normalized? How this convergence analysis is different from the convergence analysis of Steepest-Descent adaptive algorithm? **(2+1)**
5. a) Prove that the time average of a discrete time stochastic process is equal to the ensemble average. What is this phenomenon called as? What are its real-time significance? **(2+0.5+0.5)**
   b) The input to LMS filter is $X(n) = n^2$, $d(n) = n$ for $0 < n < 5$. For the optimized solution find the weight vector**.** **(2)**

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