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B.E/B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, APRIL/MAY 2012
ELECTRONICS AND COMMUNICATION ENGINEERING
SEVENTH SEMESTER (REGULATION 2008)
EC 9037 – ADVANCED DIGITAL SIGNAL PROCESSING

Time : 3 Hrs Max. Mark :100

Answer ALL Questions

PART-A **(10 x 2 = 20 Marks)**

1. Differentiate between stationary and non-stationary random process
2. Define white noise.
3. What is meant by an unbiased estimate?
4. Define periodogram.
5. Bring out the difference between prediction and estimation
6. What is meant by Kalman filter and where it is used?
7. List out the applications of adaptive filter.
8. What is the advantage of an adaptive filter over Wiener filter?
9. What is meant by Homomorphic filtering?
10. List out the applications of wavelet transform.

PART-B **(5 x 16 = 80 Marks)**

11.(i) Explain in detail about short time fourier transform and also bring out the difference between Fourier transform, STFT and wavelet transform. (8)
(ii) With necessary equations, explain in detail about 2-D Fast wavelet transform. (8)

12.a) Starting from the basic principles of LMS algorithm, derive the expression for the minimum mean square error $\varepsilon(n)$ and excess mean square error $\varepsilon_{ex}(n)$. (16)

(OR)

12.b)(i) With a neat block diagram, explain the operation of an adaptive equalizer. (8)
(ii) The first three autocorrelations of a process x(n) are $r_x(0) = 1$, $r_x(1) = 0.5$, $r_x(2) = 0.5$. Design a two coefficient LMS adaptive linear predictor for x(n) that has a misadjustment M=0.05 and also find the steady state mean square error. (8)

13.a) Obtain the transfer function of a causal Wiener filter considering the estimation of a signal d(n) from the noisy observation x(n) = d(n)+v(n) where v(n) is a unit variance white noise that is uncorrelated with d(n). d(n) is generated by the difference equation $d(n) = 0.8d(n-1) + w(n)$ where w(n) is a white noise with variance $\sigma_w^2 = 0.36$. Let $r_d(k) = (0.8)^{|k|}$. Also find the minimum mean square error. (16)

(OR)

13.b) Consider a linear prediction in a noisy environment and suppose if the signal d(n) is corrupted by noise, x(n) = d(n) + w(n) where $r_w(k) = 0.5\delta(k)$ and $r_{dw}(k) = 0$. The signal d(n) is an AR(1) process that satisfies the difference equation $d(n) = 0.5d(n-1) + v(n)$ where v(n) is white noise with variance $\sigma_v^2 = 1$. Assume that w(n) and v(n) are uncorrelated. Design a first order causal FIR linear predictor for d(n) and find the mean square prediction error $\varepsilon = E\{[d(n+1) - \hat{d}(n+1)]^2\}$. (16)

14.a) With necessary expressions, explain briefly about the method of averaging the periodogram and also bring out the difference between periodogram averaging method and modified periodogram technique. (16)

(OR)

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14.b)(i) List the steps in Levinson-Durbin recursion algorithm. (6)

(ii) Determine the autocorrelation sequence $r_x(k)$ given the reflection coefficients, $\Gamma_1 = \Gamma_2 = \Gamma_3 = 0.5$ and the modeling error is $\varepsilon_3 = 2(0.75)^3$. (10)

15.a)(i) Using spectral factorization, find a moving average model of order 2 for a process whose autocorrelation sequence given as $r_x = [3, 1.5, 1]^T$. (8)

(ii) Determine the mean and autocorrelation of the signal $x(n) = A \sin(n\omega_0 + \Theta)$ where A and ω_0 are fixed constants and Θ is a random variable that is uniformly distributed over the interval $-\pi$ to π, i.e., the probability density function for Θ is

$$f_\Theta(\alpha) = \begin{cases} (2\pi)^{-1} & ; -\pi \le \alpha \le \pi \\ 0 & ; \text{otherwise} \end{cases}$$ (8)

(OR)

15.b)(i) Briefly explain about an ergodic random process and also mention it's properties. (8)

(ii) The power spectrum of a WSS process x(n) is $P_x(e^{j\omega}) = [25-24\cos\omega]/[26-10\cos\omega]$. Find the whitening filter H(z) that produces unit variance white noise when the input is x(n). (8)