

Statistical Signal Processing

[Time: Three Hours]

[Marks:80]

Please check whether you have got the right question paper.

- N.B: 1. Question No.1 is compulsory.
 2. Attempt any three questions from remaining five questions.
 3. Assume suitable data if necessary and state it clearly.
 4. Figures to right indicates full marks.

Q.1. Solve any five questions

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- (a) What is linear transformation? Define kernel and 'range' as applied to linear transformation.
- (b) Explain white noise process. Write expressions for autocorrelation and PSD of white noise process.
- (c) What is correlation Matrices of stationary process?
- (d) What is Unbiased Estimator?
- (e) State the properties of probability density and distribution function?
- (f) State the Kalman filtering problem also. state the important assumptions about the underlying state variable system

Q.2. (a) Check whether following vectors are linearly independent

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1) $P_1 = [2, -3, 4]^T$ 2) $P_2 = [-1, 6, -2]^T$ 3) $P_3 = [1, 6, 2]^T$

- (b) What is ill-conditioned matrix? Define matrix condition number. A matrix has a large condition number, What does this indicate?
- (c) What is pseudo inverse and state its properties.

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Q.3. (a) Let $x(n)$ be a real -valued random process generated by the system

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$$x(n) = ax(n-1) + w(n) \quad n \geq 10 \quad x(-1) = 0$$

Where $w(n)$ is a stationary random process with mean μ_w and $r_w(l) = \sigma_w^2 \delta(l)$
 The $x(n)$ process is first order autoregressive and $w(n)$ is white noise process.
 Determine μ_x of $x(n)$ and comment on its stationary.

- (b) Describe stationary process in frequency domain?
- (c) Determine the PSD of a zero mean WSS process $x(n)$ with $r_x(l) = a^{|l|}$, $-1 < a < 1$.

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Q.4. (a) Derive the Random signal response for an LTI system.

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(b) Let $w(n)$ be zero mean, uncorrelated Gaussian random sequence with variance variance $\sigma^2(n) = 1$

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- i) Characterize the random sequence $w(n)$
- ii) Define $x(n) = w(n) + w(n-1)$, $-\infty < n < \infty$ Determine mean and autocorrelation of $x(n)$. Also characterize $x(n)$

(a) Consider the observation

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$$x[n] = A + w[n] \quad n = 0, 1, \dots, N-1$$

Where A ($-\infty < A < \infty$) is parameter to be estimated and $w(n)$ is WGN. The estimator for average value of $x[n]$ is $\hat{A} = \frac{1}{N} \sum_{n=0}^{N-1} x[n]$

Find the mean of estimator. Is the estimator biased?

(b) State CRLB theorem

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(c) State the minimum variance criteria for the estimator

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- Q.6. (a) Describe Kalman filter I - Bayes approach.
(b) State the uses of Gram-Schmidt orthogonalization procedure?
(c) Explain application of Discrete Karhunen-Lo' eve Transform in signal coding using block diagram. Explain scheme for selection of reduced basis.

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