1615/17

M.E(EXTC) - Sem-I
(Choice-Based)
Statistical Signal Processing

03

QP Code : 841900

(3 Hours) **[Total Marks : 80**

N.B. : (1) Question No. 1 is compulsory.
(2) Attempt any three questions from the remaining five questions.
(3) Assume **suitable data** if needed and state it clearly.
(4) Figures to right indicate full marks.

1. Attempt **any five :**
   (a) Find the nullspace of **4**

$$A = \begin{bmatrix} -3 & 6 & -1 & 1 & -7 \\ 1 & -2 & 2 & 3 & -1 \\ 2 & -4 & 5 & 8 & -4 \end{bmatrix}$$

   (b) Explain the application of Discrete KL Transform in data compression. **4**
   (c) Derive an expression for mean value of the output of an LTI system when input is WSS process. **4**
   (d) Define and explain Skewness and Kurtosis. **4**
   (e) State the CRLB theorem. **4**
   (f) State the Kalman filtering problem. **4**

2. (a) Define Metric, Metric space, Norm, Induced norm. Vector space and state its properties. **5**
   (b) Construct an orthonormal basis of R^3 using Gram-Schmidt orthogonalisation for the set of vectors $u_1 = (1, 2, 2)$, $u_2 = (-1,0,2)$ and $u_3 = (0,0,1)$. **10**
   (c) State the SVD theorem and explain its applications. **5**

3. (a) State the central limit theorem **5**
   (b) Find mean, variance and characteristic function of uniform Random variable. **7**
   (c) Let Y=W+X, where W and X are independent random variables. Derive an expression for the pdf of Y. **8**

4. (a) For $x(n) = A+w(n)$ $n= 0,1,....,N-1$ where w(n) is WGN with zero mean and variance σ^2. Determine the CRLB for a DC level A. **12**
   (b) Define and explain bias of estimator, consistent estimator, minimum variance unbiased estimator and efficient estimator. **8**

[TURN OVER]

5. (a) Consider a transformation $\mathbf{y} = \mathbf{Q}^{H}\mathbf{x}$, where $\mathbf{Q}$ is an eigen matrix and H denotes Hermition. Find the mean and autocorrelation of $\mathbf{y}$. It is given that $\mathbf{x}$ is a zero mean random vector with correlation matrix. **10**

$$R_x = \begin{bmatrix} 1 & 0.5 \\ 0.5 & 1 \end{bmatrix}$$

(b) Explain LDU decomposition of an autocorrelation matrix $\mathbf{R}$ and also explain its linear filtering interpretation. **10**

6. (a) Explain in detail Kalman Filter I- Bayes Approach **10**
(b) Write short note on Positive definite matrices **5**
(c) State and explain Applications of Estimation theory. **5**
