Name: **A**

Reg. No.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

07 THRISSUR CLUSTER

SECOND SEMESTER M. TECH. DEGREE EXAMINATION, APRIL 2018

Electronics & Communication Engineering

(Communication Engineering & Signal Processing)

07EC6202 ESTIMATION AND DETECTION

Max. Marks: 60 Duration: 3 Hours

Q function table may be permitted in the exam hall

Answer all six questions. Part 'a' of each question is compulsory

Answer either Part 'b' or Part 'c' of each question

Q. no.	**Module 1**	**Marks**
1a	Determine the NP test for distinguishing between the hypotheses, H_0: $\mathbf{x} = \mathbf{w}$ and H_1: $\mathbf{x} = A + \mathbf{w}$; where A is a constant and $\mathbf{w} \sim \mathbf{N}(\mathbf{0}, \sigma^2\mathbf{I})$. The observation vector contains N samples. Also derive the expression for $\mathbf{P_D}$ in terms of $\mathbf{P_{FA}}$.	**4**
	Answer b or c	
b	For the NP test for distinguishing between the hypotheses, H_0: $\mathbf{x} = \mathbf{w}$ and H_1: $\mathbf{x} = 2 + \mathbf{w}$; where $\mathbf{w} \sim N(\mathbf{0}, 9\mathbf{I})$, and $\mathbf{P_{FA}} = 10^{-2}$,(i) determine $\mathbf{P_D}$ if observation vector contains N=10 samples. (ii) determine N to get a $\mathbf{P_D} \geq 0.9$.	**5**
c	Explain Receiver Operator Characteristics. State its properties.	**5**

Q. no.	**Module 2**	**Marks**
2a	Show that the performance of a matched filter does not depend on signal shape but on its energy only.	**4**
	Answer b or c	
b	What is Generalized Likelihood Ratio Test? Use GLRT to determine a detector for an unknown DC Level in white Gaussian noise.	**5**
c	What is a sign detector? Derive the expression for $\mathbf{P_D}$ of a sign detector.	**5**

Q. no.	Module 3	Marks
3a	State Rao-Blackwell-Lehmann-Schefe theorem for scalar parameter. Using it, find the MVU estimator for a DC value A in white Gaussian noise w[n] from the observation x[n] = A + w[n]; n = 0,1,.., N-1; w[n] ~ N(0,σ^2). Take $\tilde{A} = x[0]$ and $T(\bar{x}) = \sum_{n=0}^{N-1} x[n]$	**4**
	Answer b or c	
b	Derive Best Linear Unbiased estimator. Find BLUE for a DC level in white noise with variance σ^2.	**5**
c	Show that, unbiased phase estimator which attains CRLB does not exist.	**5**

PTO

Q. no.	Module 4	Marks
4a	Give the geometric interpretation of Linear Least Square Estimator.	**4**
	Answer b or c	
b	Determine the Minimum Mean Square Estimator of a DC value A in white Gaussian noise w[n] from the observation, x[n] = A + w[n]; n = 0, 1, …., N-1; w[n] ~ N(0,σ^2). Assume A is uniformly distributed in the range [-A_0, A_0].	**5**
c	Determine the MAP estimator of θ. Given x[n]'s are conditionally independent and identically distributed for 0 ≤ n ≤ N-1 and $p(x[n]/\theta) = \begin{cases} \theta \exp(-\theta x[n])\,; & x[n] > 0 \\ 0 & ; x[n] < 0 \end{cases}$, $p(\theta) = \begin{cases} \lambda \exp(-\lambda\theta)\,; & \theta > 0 \\ 0 & ; \theta < 0 \end{cases}$	**5**

Q. no.	Module 5	Marks
5a	Explain the application of Wiener filter for smoothing a noisy signal.	**5**
	Answer b or c	
b	Derive Linear MMSE estimator. Determine the LMMSE estimator for a DC level in white Gaussian noise with uniform prior pdf.	**7**

c	Given $s[n] = \frac{1}{2}s[n-1] + u[n],\ n \geq 0$; s[-1] ~N(0, 2); $\sigma_u^2 = 1$; x[n] = s[n] + w[n]; w[n]~ N(0, σ_n^2); $\sigma_n^2 = (1/2)^n$; w[n] is independent of s[-1] and u[n] for $n \geq 0$. Find $\hat{s}[1/1]$, $\hat{s}[2/2]$, $\hat{s}[3/3]$, using Kalman Filter.	**7**

Q. no.	**Module 6**	**Marks**
6a	Explain the application of maximum likelihood estimation in estimating the range.	**5**
	Answer b or c	
b	Derive the expression for minimum probability of error in the ML receiver for binary signal detection.	**7**
c	Explain the active sonar/radar detection application of GLRT.	**7**