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: $\mathbf{x} \sim \mathbf{N}(\mathbf{0}, \sigma_0^2\ \mathbf{I})$ and H_1: $\mathbf{x} \sim \mathbf{N}(\mathbf{0}, \sigma_1^2\ \mathbf{I})$; where $\sigma_1^2 > \sigma_0^2$. The observation vector contains N samples. Mark the decision regions.	**4**
	Answer b or c	
b	Design the Maximum Aposteriory Probability Detector 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, find the Probability of error if $p(\mathbf{H_0}) = ¼$, $p(\mathbf{H_1}) = ¾$, A = 3, $\sigma^2 = 4$ and N = 10.	**5**
c	Explain minimax detector. Derive the expression for minimum risk.	**5**

Q. no.	Module 2	Marks
2a	Explain sequential detection.	**4**
	Answer b or c	
b	Show that the matched filter output has maximum SNR.	**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	Find Maximum Likelihood 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,A).	**4**
	Answer b or c	
b	Derive Best Linear Unbiased estimator. Find BLUE for a DC level A in white noise with variance σ^2.	**5**
c	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 $T(\bar{x}) = \sum_{n=0}^{N-1} x[n]$	**5**

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Q. no.	Module 4	Marks
4a	Derive the Linear Least Square Estimator for a scalar parameter.	**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 $0 \le n \le N-1$ 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	Derive Linear MMSE estimator. Also derive an expression for minimum Bayesian error.	**5**
	Answer b or c	
b	Explain the application of Wiener filter for smoothing a noisy signal. Also give the filtering interpretation of it.	**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 AR parameter estimation of ARMA model.	**5**
	Answer b or c	
b	Explain the active sonar/radar detection application of GLRT.	**7**
c	Explain the application of CRLB in range estimation.	**7**