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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, APRIL/MAY 2018

Branch:Electronics & Communication

Stream(s):

1. ***Signal Processing***
2. ***Microwave & Television Engineering***
3. ***Telecommunication Engineering***

Course Code & Name:

01EC6302, ESTIMATION AND DETECTION THEORY

Answer *any two full* questions from *each* part

Limit answers to the required points.

Max. Marks: 60 Duration: 3 hours

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PART A

1. Consider the signal detection problem in which change in variance is used for Hypothesis testing. 9

H_0: $x[n] \sim N(0, \sigma_0^2)$, $n = 0, 1, \ldots, N-1$

H_1: $x[n] \sim N(0, \sigma_1^2)$, $n = 0, 1, \ldots, N-1$

Derive the detection rule for Neyman-Pearson (NP) detector

2. Consider the multiple hypothesis testing problem 9

$H_0 : x[n] = -A + w[n], n = 0, 1, \ldots, N-1$

$H_1 : x[n] = w[n], n = 0, 1, \ldots, N-1$

$H_2 : x[n] = A + w[n], n = 0, 1, \ldots, N-1$

where w[n] is white Gaussian noise with variance σ 2 . Find the detection rule for minimum probability of error detector.

3. Consider the detection problem of DC level in noise with unknown variance. 9

$H_0 : x[n] = w[n], n = 0, 1, \ldots, N-1$

$H_1 : x[n] = A + w[n], n = 0, 1, \ldots, N-1$.

A is known and A >0. Derive Generalized Likelihood Ratio Test (GLRT) for the for the detection problem

PART B

4. a Define unbiased estimator. Give an example. 3

   b Give the expression for Cramer- Rao Lower bound foe vector parameter estimation. In this context, explain the regularity condition to be satisfied by the PDF p(x, θ) for the existence of Cramer-Rao bound. Also, define Fisher information matrix. 6

5. Observed data samples { x[0], x[1], ...,x[N-1]} are IID under Laplacian PDF $p(x[n],\mu) = 1/2 \exp(-|x[n]-\mu|)$. Find Best Linear Unbiased Estimator (BLUE) of the mean μ. 9

6. We observe N IID data samples from Gaussian PDF with unit variance and unknown mean. Obtain maximum likelihood estimator (MLE) for the unknown parameter. 9

PART C

7. Show that Wiener filter can be used for predicting the data sample x[n] from N-1 previous observations {x[n-1], x[n-2], ..., x[n-N+1]}. Derive the expression for Wiener filter coefficients. 12

8. Consider the scalar state equation s[n] = a s[n-1] + u[n], and scalar observation equation x[n] = s[n] + w[n] where u[n] is zero mean Gaussian noise with independent samples with variance σ^2_u and w[n] is zero mean Gaussian noise with independent samples with variance σ^2_w. Derive the expression for Kalamn Gain for estimating s[n] from x[n]. 12

9. Discuss the applications of matched filter Estimators in Communication receivers. 12