JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKANAGHAT
END SEMESTER EXAMINATION, JUNE 2016
M.Tech (ECE, 2nd Semester)

Course Code: 10M11EC211   MAX.MARKS:35

Course Name: ADVANCED DIGITAL SIGNAL PROCSSING   MAX.TIME: 2Hrs

Course Credit: 3

Note: Attempt all questions, marks are indicated against each question.

Q 1) The autocorrelation matrix for a signal consisting of a complex exponentials in white noise is given as

$$\begin{bmatrix} 3 & -2j & -2 \\ 2j & 3 & -2j \\ -2 & 2j & 3 \end{bmatrix}$$

Use the MUSIC method to determine the frequencies and the powers of the complex exponential and the variance of the additive noise. [6 Marks]

Q 2) What is the effect of padding zeros to the given *finite duration discrete data* record on its power spectrum (periodogram using DFT)? What factors determine frequency resolution in the spectral estimate (periodogram using DFT) of the *finite duration discrete data* record? Give one difference between MUSIC and periodogram methods of spectrum estimation. [3 Marks]

Q 3) Prove or disprove that DFT of $x^*(n)$ is $X^*(N-k)$, where $x(n)$ is time domain signal and $X(k)$ is its N −point DFT [2 Marks]

Q 4) For the given sequence

$$x(n) = \begin{cases} \cos(n\pi), & \forall \ 0 \leq n \leq 7 \\ 0, & \text{elsewhere} \end{cases}$$

Obtain the DFT using radix-2 decimation in time FFT algorithm. (Draw the signal flow graph and signal values at every stage). [3 Marks]

Q 5) Use the Yule-Walker equations to determine the autocorrelation coefficients of the following AR models, assume that $w(n) = WN(0,1)$. What is the variance σ_x^2 of the resulting process? [5 marks]

$$x(n) = 0.5x(n-1) + w(n)$$

Q 6) The probability density function of a random variable X is given by

$$f_X(x) = \begin{cases} k & a \leq x \leq b \\ 0 & \text{otherwise} \end{cases}$$

Determine the value of k. [2 marks]

Q 7)
a) Comment on the correctness of the following two statements:[2]
   i. The Pisarenko harmonic decomposition exploits the orthogonality of two subspaces (noise subspace and signal subspace).
   ii. Eigen-decomposition methods for spectral estimation are the best at low SNR.
b) What would be the autocorrelation function for a white noise process? [2 Mark]
c) In general, the area under the power spectral density curve represents _____. [1 Marks]
d) *"A random process X(t) is called strict-sense stationary if its statistical properties are variant with time"*. Comment on the validity of the statement. [1 Mark]

e) Which of the following is/are the nonparametric method for power spectrum estimation[1 Mark]
   i.   Bartlett
   ii.   Blackman and Tukey
   iii. Welch

f) Which of the following is/are the parametric method for power spectrum estimation[1 Mark]
   i.   Yule-Walker Method
   ii.   Burg Method
   iii. Unconstrained Least-Square method

Q 8) Suppose that we are given the autocorrelation values $\gamma_{yy}(0) = 3, \gamma_{yy}(1) = 1,$ and $\gamma_{yy}(2) = 0$ for a process consisting of a single sinusoid in additive white noise. Determine the frequency, its power, and the variance of the additive noise. (use Pisarenko Harmonic Decomposition method) [6 Marks]

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