Wajid

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -2 EXAMINATION- 2016

M.Tech (ECE) 2nd Semester

COURSE CODE: 10M11EC211 MAX. MARKS: 25

COURSE NAME: Advanced Digital Signal Processing

COURSE CREDITS: 03 MAX. TIME: 1.5 HR

Note: *All questions are compulsory.*

Carrying of mobile phone during examinations will be treated as case of unfair means.

Write your assumptions clearly, if it is required.

JUIT TEST-2 APRIL 2016

1. Consider a narrowband spatially propagating signal with a speed of propagation c. The signal impinges on an $M = 2$ element ULA from an angle $\emptyset = 0^o$ with spacing d between the elements. For illustration purposes, let the temporal content of the signal be a pulse.[5 marks]
    a. Let the time of arrival of the pulse at the first sensor be $t = 0$. At what time does the signal arrive at the second sensor?
    b. Do any other angles $\emptyset$ produce the same delay between the sensors? Why?
    c. Suppose now that we only have single sensor. Can we determine the angle from which a signal impinges on this sensor?

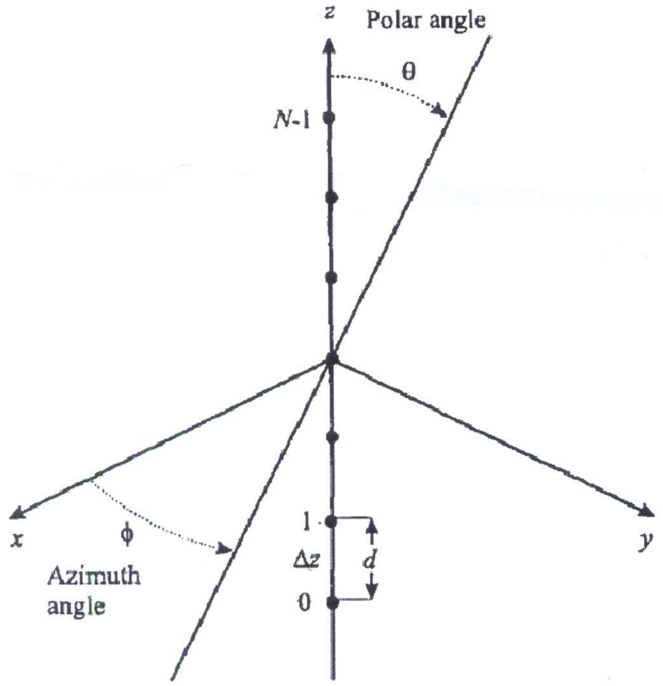
2. An ARMA process has an autocorrelation $\{\gamma_{xx}(m)\}$ whose z-transform is given as

$$\Gamma_{xx}(z) = 9\frac{\left(z-\frac{1}{3}\right)(z-3)}{\left(z-\frac{1}{2}\right)(z-2)}, \qquad \frac{1}{2} < |z| < 2$$

    a. Determine the filter $H(z)$ for generating $\{x(n)\}$ from a white noise input sequence. Is $H(z)$ unique? Explain.
    b. Determine a stable linear whitening filter for the sequence $\{x(n)\}$. [6 marks]

3. Fill in the blank spaces[3 Marks]
    a. The spatial part of the processor is an aperture (or antenna) for the continuous space domain and an ___________ for the discrete space domain.
    b. The array configuration consists of two parts. The first part is the _________ ________ of the individual elements and the second part is the ___________ _____________.

4. Assume a uniform linear array given below where N is even.



Use the relationships

$$B_{\Psi}(\Psi) = 2Re[\boldsymbol{w}_1^H \boldsymbol{v}_{\Psi 1}(\Psi)]$$

to derive the beam pattern of a uniformly weighted uniform linear array i.e.

$$B_{\Psi}(\Psi) = \frac{1}{N}\left[\frac{\sin\left(\frac{N}{2}\Psi\right)}{\sin\left(\frac{\Psi}{2}\right)}\right] \qquad -\frac{2\pi d}{\lambda} \leq \Psi \leq \frac{2\pi d}{\lambda}$$

Where $\boldsymbol{v}_{\Psi}$ is the array manifold vector , $\boldsymbol{w}_1$ contains the first half elements of weighing vector $\boldsymbol{w}$ and $\Psi = \frac{2\pi}{\lambda}\cos(\theta)\, d$. [6 marks]

5. Let τ_{ij} is the time delay of arrival between the i^{th} and j^{th} element for a planar wave propagating along the unit vector **a**. Assume $\mathbf{r}_i$ and $\mathbf{r}_j$ are the position vectors of the i^{th} and j^{th} element respectively, and c is the speed of propagation of the wave. Derive and express the τ_{ij} in terms of the position vectors of the elements.[5 Marks]

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