NPTEL Online Certification Courses

Indian Institute of Technology Kharagpur

Course: Signal Processing for mm Wave communication for 5G and beyond

Assignment:

Week -6

TYPE OF QUESTION: MCQ/MSQ

Number of questions: 10 **Total mark: 10 X 1 = 10**

Q.1 Which of the following technique may be used for creating pencil (sharp) beam at the antenna?

a. Increasing the number of antennas.
b. Decrease the number of antennas.
c. Use non-uniform spacing of antenna.
d. Increase signal power continuously.

Answer: a. Increasing the number of antennas.
Explanation: For pencil beam, high number of antennas are recommended with uniform antenna spacing. Signal power cannot be increased continuously for different restrictions. See, lecture 32 for details.

Q.2 A vector $r = [\,1\ 2\ \sqrt{11}]$ makes azimuth angle of 30^0, and elevation angle of 45^0. The y component of the vector is given by

a. 4
b. 1.41
c. 3.46
d. 2.44

Answer: b. 1.41
Explanation: The y component is given by $|r|sin\theta\ sin\phi$. See, lecture 33.

Q.3 a ULA is set up on z-axis. The antenna spacing is $0.5\ mm$. The position vector of 4th antenna element is given by (assume that the reference antenna is placed at the origin)

a. (0, 0, 2)
b. (2, 0, 0)
c. (0, 0, 1.5)
d. (0,0,0.5)

Answer: c. (0, 0, 1.5)
Explanation: The position vector for 4th antenna element on z-axis is (0,0, 3d). See, Lecture 35 for details.

Q.4 Consider a 2×2 multi-antenna system, where the transmitting-antenna are placed on x-axis, and received antenna are placed on z-axis. The AOD is (θ^1, ϕ^1) and AOA is (θ^2, ϕ^2). Assuming channel attenuation factor (α) be unity, and antenna spacing is $\frac{\lambda}{2}$ for both transmitter and receiver. The receiver side steering vector is given by

a. $a^r = [1\ e^{j\,\pi\cos(\theta^1)}]$
b. $a^r = [1\ e^{j\,\pi\cos(\theta^2)}]$
c. $a^r = \left[1\ e^{j\,\pi\cos(\theta^1)\sin(\phi^1)}\right]$
d. $a^r = [1\ e^{j\,\pi\cos(\theta^2)\sin(\phi^2)}]$

Answer: b. $a^r = [1\ e^{j\,\pi\cos(\theta^2)}]$

Explanation: See, lecture 35 for beam forming with array processing.

Q.5 Given the following set up as

	Transmitting antenna size	Receiving antenna size
Set up 1	4 (placed on xy plane)	8 (x-plane)
Set up 2	8 (z-plane)	4 (xy-plane)
Set up 3	4 ($x - plane$)	4 (z-plane)

The channel matrix for set up 2, is given by

a. $H_{4\times4}$
b. $H_{8\times4}$
c. $H_{4\times8}$
d. $H_{8\times8}$

Answer: c. $\boldsymbol{H_{4\times8}}$
Explanation: See, lecture 35.

Q.6 The steering matrix formed at the receiver side of a 3x3 antenna system is given by

$$A = \begin{bmatrix} 1 & e^{j\theta_1} & e^{j\theta_2} \\ 1 & e^{2j\theta_1} & e^{2j\theta_2} \\ 1 & e^{3j\theta_1} & e^{3j\theta_2} \end{bmatrix}.$$

The above structure of the matrix is called

a. Toeplitz matrix

b. Vandermonde matrix
c. Unitary matrix
d. Wishart matrix

Answer: b. Vandermonde matrix.
Explanation: The above structure is the structure of Vandermonde matrix, and it has interesting applications in array processing.

Q.7 The resolving power of an array depends on

a. Number of antennas
b. Spatial extent
c. Aperture
d. All of the above

Answer: d. All of the above.
Explanation: The resolving power depends on spatial extent, aperture and number of antennas.

Q.8 A communication signal model is given by $y = Ax + w$. The spatial correlation matrix is given by

a. $R = E(yy^*)$
b. $R = E(xx^*)$
c. $R = A^+$(pseudo-inverse)
d. $R = E(ww^*)$

Answer: a. $\boldsymbol{R} = \boldsymbol{E}(\boldsymbol{yy}^*)$
Explanation: spatial correlation matrix is formed by the received signal vector.

Q.9 Find the odd one

a. Beam-forming helps in the improvement of SNR
b. AoA and AoD is same for LOS communication
c. Far-filed assumption ensures parallel rays for AoA/AoD
d. AoA and AoD cannot be distinguished by placing reflectors.

Answer: d. AoA and AoD cannot be distinguished by placing reflectors.

Explanation: In presence of reflectors, the AoA and AoD can be different.

Q.10 A channel matrix is given by

$$H = \begin{bmatrix} 1 & 0.25 \\ 0.25 & 1 \end{bmatrix}.$$

Eigenvalue of the channel matrix can be represented in diagonal form (as if single tap), with the tap values

a. 1 and 0.25
b. 1.25 and 0.25
c. 1.25 and 0.75
d. 0.75 and 0.25

Answer: c. 1.25 and 0.75
Explanation: Compute the eigenvalues for H.