

## Unit 8 - Principles of MIMO Wireless Communication (Continued)

### Course outline

#### How to Access the Portal ?

#### Introduction to Wireless Systems

#### Performance in Fading wireless channels

#### Multiple Antenna Wireless Systems and Diversity

#### Wireless Channel Characterization - Delay Spread and Doppler

#### Principles of CDMA Wireless Communication

#### Principles of CDMA and MIMO Wireless Communication

#### Principles of MIMO Wireless Communication (Continued)

 MIMO Receivers

 BER Performance of ZF Receiver

 Transmit Beamforming in MISO Systems

 Alamouti Code and Space-Time Block Codes

 BER of Alamouti Coded System

 Singular Value Decomposition (SVD)

 SVD in MIMO

 Quiz : Assignment-7

 Assignment - 7 Solution

#### Principles of OFDM Wireless Communication

#### Text Transcription

#### Unit-0

## Assignment-7

The due date for submitting this assignment has passed.  
As per our records you have not submitted this assignment.

**Due on 2019-10-16, 23:59 IST.**

1) Consider the channel matrix  $H = \begin{bmatrix} 1 & 2 \\ 1 & -2 \end{bmatrix}$ . The matrix  $U$  in the SVD of this channel matrix is given as, 1 point

$\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{bmatrix}$

$\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$

$\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$

$\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$

2) Consider total transmit power  $P = 9$  dB, noise power =  $-3$  dB in a  $2 \times 2$  MIMO channel with channel matrix  $H = \begin{bmatrix} 1 & 2 \\ 1 & -2 \end{bmatrix}$ . The 1 point

optimal power value for the second channel is,

 8 dB

 6.121 dB

 4.948 dB

 5.9176 dB

No, the answer is incorrect.

Score: 0

Accepted Answers:

5.9176 dB

3) The special case of a MIMO system with a single receive antenna and multiple transmit antennas is termed as 1 point

 MIMO – Multiple Input Multiple-Output

 MISO – Multiple Input Single Output

 SIMO – Single Input Multiple Output

 SISO – Single Input Single Output

No, the answer is incorrect.

Score: 0

Accepted Answers:

MISO – Multiple Input Single Output

4) In a  $3 \times 2$  MIMO system with IID noise elements and dB noise variance  $\sigma^2 = -6$  dB, the noise covariance is given as 1 point

  $0.25 \mathbf{I}_{3 \times 3}$ 
  $0.25 \mathbf{I}_{2 \times 2}$ 
  $0.50 \mathbf{I}_{3 \times 3}$ 
  $0.50 \mathbf{I}_{2 \times 2}$ 

No, the answer is incorrect.

Score: 0

Accepted Answers:

$0.25 \mathbf{I}_{3 \times 3}$

5) Consider the MIMO channel matrix  $H = \begin{bmatrix} 1 & -1 \\ 2 & 2 \\ -1 & 3 \end{bmatrix}$ . The corresponding zero-forcing receiver matrix is, 1 point

$\begin{bmatrix} 1 & -1 \\ 2 & 2 \\ -1 & 3 \end{bmatrix}$

  $\mathbf{I}_{3 \times 3}$ 

$\begin{bmatrix} \frac{1}{6} & \frac{1}{3} & -\frac{1}{6} \\ -\frac{1}{14} & \frac{1}{7} & \frac{3}{14} \end{bmatrix}$

$\begin{bmatrix} \frac{1}{6} & \frac{2}{3} & -\frac{1}{6} \\ -\frac{1}{14} & \frac{2}{7} & \frac{1}{14} \end{bmatrix}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\begin{bmatrix} \frac{1}{6} & \frac{1}{3} & -\frac{1}{6} \\ -\frac{1}{14} & \frac{1}{7} & \frac{3}{14} \end{bmatrix}$

6) Consider a  $5 \times 4$  MIMO channel with zero-forcing receiver. The dB SNR required for a given BER is 1 point

$5 \times \log \left( \frac{3}{4 \times BER} \right)$

$10 \times \log \left( \frac{5}{4 \times BER} \right)$

$10 \times \log (-2 \times \ln(2 \times BER))$

$10 \times \log (BER)$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$5 \times \log \left( \frac{3}{4 \times BER} \right)$

7) Consider a  $1 \times 2$  MISO channel with coefficients  $h_1 = 1 + 2j$  and  $h_2 = 2 - j$ . The effective  $2 \times 2$  matrix at the receiver for the Alamouti Scheme is given as, 1 point

$\begin{bmatrix} 1 + 2j & 2 - j \\ 2 + j & -1 + 2j \end{bmatrix}$

$\begin{bmatrix} -1 + 2j & 2 - j \\ 2 - j & -1 + 2j \end{bmatrix}$

$\begin{bmatrix} 1 + 2j & 2 - j \\ 2 + j & 1 + 2j \end{bmatrix}$

$\begin{bmatrix} 1 + 2j & 2 + j \\ 2 + j & -1 + 2j \end{bmatrix}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\begin{bmatrix} 1 + 2j & 2 - j \\ 2 + j & -1 + 2j \end{bmatrix}$

8) In MIMO Singular Value Decomposition of  $\mathbf{H}$  for  $r > t$ , as described in the class lecture, the matrix  $U$  satisfies 1 point

  $\mathbf{U}\mathbf{U}^H = \mathbf{I}$  only

  $\mathbf{U}^H\mathbf{U} = \mathbf{I}$  only

  $U$  is a unitary matrix

  $U$  is a square matrix

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\mathbf{U}^H\mathbf{U} = \mathbf{I}$  only

9) Consider dB SNR = 65 dB in a  $1 \times 4$  MISO system. The BER with transmit beamforming is given as, 1 point

$2.1875 \times 10^{-25}$

$5.2835 \times 10^{-26}$

$5.2835 \times 10^{-25}$

$2.1875 \times 10^{-26}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$2.1875 \times 10^{-26}$

10) Consider the MIMO channel matrix  $H = \begin{bmatrix} 3 \\ 4 \end{bmatrix}$ . The singular values of this matrix are given as 1 point

 3, 4

 5

 4, 36

 6

No, the answer is incorrect.

Score: 0

Accepted Answers:

5