Started on	Saturday, 28 October 2023, 9:00 PM
State	Finished
Completed on	Saturday, 28 October 2023, 9:19 PM
Time taken	19 mins 24 secs
Grade	**10.00** out of 10.00 (**100**%)

Question **1**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the channel estimation model for the multiple transmit antenna system given by $\bar{\mathbf{y}} = \mathbf{X}\bar{\mathbf{h}} + \bar{\mathbf{v}}$, where $\mathbf{X}$ denotes the pilot matrix and the noise samples $\bar{\mathbf{v}}$ are zero-mean i.i.d. Gaussian. Let the number of pilot symbols be greater than the number of transmit antennas. The ML estimate of the channel $\bar{\mathbf{h}}$ is

Select one:

- $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\bar{\mathbf{y}}$ ✔
- $\mathbf{X}^{-1}\bar{\mathbf{y}}$
- $(\mathbf{X}\mathbf{X}^T)^{-1}\mathbf{X}^T\bar{\mathbf{y}}$
- $(\mathbf{X}^T\mathbf{X})^{-1}\bar{\mathbf{y}}$

Your answer is correct.

The correct answer is: $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\bar{\mathbf{y}}$

Question **2**

Correct

Mark 1.00 out of 1.00

Flag question

Consider a multi-antenna channel estimation scenario with the pilot matrix given as

$$\mathbf{X} = \begin{bmatrix} -1 & -1 \\ 1 & -1 \\ -1 & 1 \\ 1 & 1 \end{bmatrix}$$

The pilot matrix $\mathbf{X}$ for this scenario satisfies the property that

Select one:

- It has orthogonal columns ✔
- It is invertible
- It has identical columns
- None of these

Your answer is correct.

The correct answer is: It has orthogonal columns

Question **3**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the channel estimation model for the multiple transmit antenna system given by $\bar{\mathbf{y}} = \mathbf{X}\bar{\mathbf{h}} + \bar{\mathbf{v}}$, with the pilot matrix $\mathbf{X}$ given as below

$$\mathbf{X} = \begin{bmatrix} -1 & -1 \\ 1 & -1 \\ -1 & 1 \\ 1 & 1 \end{bmatrix}$$

The number of pilot vectors in the system is

Select one:

- 3
- 1
- 2
- 4 ✔

Your answer is correct.

The correct answer is: 4

Question **4**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the channel estimation model for the multiple transmit antenna system given by $\bar{\mathbf{y}} = \mathbf{X}\bar{\mathbf{h}} + \bar{\mathbf{v}}$, where the pilot matrix $\mathbf{X}$ is given below

$$\mathbf{X} = \begin{bmatrix} -1 & -1 \\ 1 & -1 \\ -1 & 1 \\ 1 & 1 \end{bmatrix}$$

The pseudo-inverse of the pilot matrix $\mathbf{X}$ is

Select one:

- $\frac{1}{4}\begin{bmatrix} -1 & -1 \\ 1 & -1 \\ -1 & 1 \\ 1 & 1 \end{bmatrix}$
- $\begin{bmatrix} -\frac{1}{4} & \frac{1}{4} & -\frac{1}{4} & \frac{1}{4} \\ -\frac{1}{4} & -\frac{1}{4} & \frac{1}{4} & \frac{1}{4} \end{bmatrix}$ ✔
- $\begin{bmatrix} \frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} & \frac{1}{4} \\ \frac{1}{4} & \frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} \end{bmatrix}$
- $\begin{bmatrix} \frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} & \frac{1}{4} \\ -\frac{1}{4} & \frac{1}{4} & -\frac{1}{4} & \frac{1}{4} \end{bmatrix}$

Your answer is correct.

The correct answer is: $\begin{bmatrix} -\frac{1}{4} & \frac{1}{4} & -\frac{1}{4} & \frac{1}{4} \\ -\frac{1}{4} & -\frac{1}{4} & \frac{1}{4} & \frac{1}{4} \end{bmatrix}$

Question **5**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the channel estimation model for the multiple transmit antenna system given by $\bar{\mathbf{y}} = \mathbf{X}\bar{\mathbf{h}} + \bar{\mathbf{v}}$, where the pilot matrix $\mathbf{X}$ is

$$\mathbf{X} = \begin{bmatrix} -1 & -1 \\ 1 & -1 \\ -1 & 1 \\ 1 & 1 \end{bmatrix}$$

Let the noise variance $\sigma^2 = \frac{1}{2}$. The error covariance of the ML estimate of $\bar{\mathbf{h}}$ is,

Select one:

- $\begin{bmatrix} \frac{1}{16} & 0 \\ 0 & \frac{1}{16} \end{bmatrix}$
- $\begin{bmatrix} \frac{1}{8} & \frac{1}{8} \\ \frac{1}{8} & \frac{1}{8} \end{bmatrix}$
- $\frac{1}{8}$
- $\begin{bmatrix} \frac{1}{8} & 0 \\ 0 & \frac{1}{8} \end{bmatrix}$ ✔

Your answer is correct.

The correct answer is: $\begin{bmatrix} \frac{1}{8} & 0 \\ 0 & \frac{1}{8} \end{bmatrix}$

Question **6**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the fading channel estimation problem where the output symbol $y(k)$ is $y(k) = hx(k) + v(k)$, with h, $x(k)$, $v(k)$ denoting the *real* channel coefficient, pilot symbol and noise sample respectively. Let $\bar{\mathbf{x}} = [x(1) \quad x(2) \quad \dots \quad x(N)]^T$ denote the vector of transmitted pilot symbols and $\bar{\mathbf{y}} = [y(1) \quad y(2) \quad \dots \quad y(N)]^T$ denote the corresponding received symbol vector. Let $v(k)$ be independent Gaussian noise with zero-mean and variance σ_k^2. The likelihood function is

Select one:

- $\left(\frac{1}{\sqrt{2\pi \sum_{k=1}^{N} \sigma_k^2}}\right) e^{-\frac{1}{2}\left(\sum_{k=1}^{N}(y(k)-hx(k))^2\right)\left(\sum_{k=1}^{N}\frac{1}{\sigma_k^2}\right)}$
- $\left(\frac{1}{\sqrt{2\pi \sum_{k=1}^{N} \frac{1}{\sigma_k^2}}}\right) e^{-\frac{1}{2}\frac{\left(\sum_{k=1}^{N}(y(k)-hx(k))^2\right)}{\left(\sum_{k=1}^{N}\frac{1}{\sigma_k^2}\right)}}$
- $\left(\prod_{k=1}^{N} \frac{1}{\sqrt{2\pi\sigma_k^2}}\right) e^{-\frac{1}{2}\sum_{k=1}^{N}\frac{(y(k)-hx(k))^2}{\sigma_k^2}}$ ✔
- $\frac{1}{\sqrt{2\pi \sum_{k=1}^{N} \frac{1}{\sigma_k^2}}} e^{-\frac{1}{2}\left(\sum_{k=1}^{N}(y(k)-hx(k))^2\right)\left(\sum_{k=1}^{N}\frac{1}{\sigma_k^2}\right)}$

Your answer is correct.

The correct answer is: $\left(\prod_{k=1}^{N} \frac{1}{\sqrt{2\pi\sigma_k^2}}\right) e^{-\frac{1}{2}\sum_{k=1}^{N} \frac{(y(k)-hx(k))^2}{\sigma_k^2}}$

Question **7**

Correct

Mark 1.00 out of 1.00

Flag question

MIMO is a key technology in

Select one:

- All of these ✔
- Only 4G
- Only 5G
- Only WiFi

Your answer is correct.

The correct answer is: All of these

Question **8**

Correct

Mark 1.00 out of 1.00

Flag question

Consider a MIMO system with r receive antennas and t transmit antennas. The channel matrix is of size

Select one:

- $t \times r$
- $rt \times rt$
- $(r+t) \times (r+t)$
- $r \times t$ ✔

Your answer is correct.

The correct answer is: $r \times t$

Question **9**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the MIMO channel estimation problem with pilot matrix

$$\mathbf{X} = \begin{bmatrix} -1 & 1 & -1 & 1 \\ -1 & -1 & 1 & 1 \end{bmatrix}$$

The output matrix is

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

The size of the MIMO system is,

Select one:

- 3×3
- 2×2
- 3×2
- 2×3

Your answer is correct.

The correct answer is: 3×2

Question **10**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the MIMO channel estimation problem with pilot matrix $\mathbf{X}$ and output matrix $\mathbf{Y}$ as defined in the lectures. The pseudo-inverse of the pilot matrix is

Select one:

- $(\mathbf{X}\mathbf{X}^T)^{-1}\mathbf{X}^T$
- $\mathbf{X}^T(\mathbf{X}\mathbf{X}^T)^{-1}$
- $\mathbf{X}^T(\mathbf{X}^T\mathbf{X})^{-1}$
- $(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T$

Your answer is correct.

The correct answer is: $\mathbf{X}^T(\mathbf{X}\mathbf{X}^T)^{-1}$

Finish review