Started on	Saturday, 21 October 2023, 8:17 AM
State	Finished
Completed on	Saturday, 21 October 2023, 9:36 AM
Time taken	1 hour 18 mins
Grade	**8.00** out of 10.00 (**80**%)

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 in $\bar{\mathbf{v}}$ are zero-mean i.i.d. Gaussian with variance σ^2. The likelihood function for the parameter vector $\bar{\mathbf{h}}$ given the observation vector $\bar{\mathbf{y}}$ is

Select one:

- $\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{\|\bar{\mathbf{y}}-\mathbf{X}\bar{\mathbf{h}}\|^2}{2\sigma^2}}$
- $\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{\|\bar{\mathbf{y}}-\mathbf{X}\bar{\mathbf{h}}\|}{\sigma^2}}$
- $\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{(\bar{\mathbf{y}}-\mathbf{X}\bar{\mathbf{h}})^2}{2\sigma^2}}$
- $\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{|\bar{\mathbf{y}}-\mathbf{X}\bar{\mathbf{h}}|}{\sigma^2}}$

Your answer is correct.

The correct answer is: $\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{\|\bar{\mathbf{y}}-\mathbf{X}\bar{\mathbf{h}}\|^2}{2\sigma^2}}$

Question **2**

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:

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

Your answer is correct.

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

Question **3**

Correct

Mark 1.00 out of 1.00

Flag question

For the multiple transmit antenna channel estimation model given by $\bar{\mathbf{y}} = \mathbf{X}\bar{\mathbf{h}} + \bar{\mathbf{v}}$, the pseudo-inverse of the pilot matrix $\mathbf{X}$, when the number of pilot symbols is greater than the number of transmit antennas, is

Select one:

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

Your answer is correct.

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

Question **4**

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

Your answer is correct.

The correct answer is: It has orthogonal columns

Question **5**

Incorrect

Mark 0.00 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 transmit antennas in the system is

Select one:

- 3
- 4 ✖
- 1
- 2

Your answer is incorrect.

The correct answer is: 2

Question **6**

Incorrect

Mark 0.00 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
- 4
- 1
- 2 ✖

Your answer is incorrect.

The correct answer is: 4

Question **7**

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 pseudo-inverse of the pilot matrix **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 **8**

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 **X** and receive vector $\bar{\mathbf{y}}$ given below

$$\mathbf{X}=\begin{bmatrix}1 & 1\\ -1 & 1\\ -1 & -1\\ 1 & -1\end{bmatrix},\bar{\mathbf{y}}=\begin{bmatrix}3\\ -2\\ -2\\ -1\end{bmatrix}$$

The ML estimate of $\bar{\mathbf{h}}$ is,

Select one:

- $\frac{1}{2}\begin{bmatrix}-2\\ -3\end{bmatrix}$
- $\frac{1}{2}\begin{bmatrix}-1\\ -2\end{bmatrix}$
- $\frac{1}{2}\begin{bmatrix}3\\ 2\end{bmatrix}$ ✔
- $\frac{1}{2}\begin{bmatrix}-2\\ 3\end{bmatrix}$

Your answer is correct.

The correct answer is: $\frac{1}{2}\begin{bmatrix}3\\2\end{bmatrix}$

Question **9**

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 $\mathbf{X}$ is

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

Let the noise variance $\sigma^2 = \frac{1}{4}$. 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: $\begin{bmatrix} \frac{1}{16} & 0 \\ 0 & \frac{1}{16} \end{bmatrix}$

Question **10**

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 $\mathbf{X}$ is

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

Let the noise variance $\sigma^2 = \frac{1}{4}$. The MSE of the ML estimate of $\bar{\mathbf{h}}$ is,

Select one:

- $\frac{1}{16}$

- $\frac{1}{4}$
- $\frac{1}{8}$
- $\begin{bmatrix} \frac{1}{8} & 0 \\ 0 & \frac{1}{8} \end{bmatrix}$

Your answer is correct.

The correct answer is: $\frac{1}{8}$

Finish review