Started on	Saturday, 28 October 2023, 8:41 AM
State	Finished
Completed on	Saturday, 28 October 2023, 9:20 AM
Time taken	39 mins
Grade	**10.00** out of 10.00 (**100**%)

Question **1**
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:

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

Your answer is correct.

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

Question **2**
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 ML estimate of h is

Select one:

- $\frac{\sum_{k=1}^{N}\frac{1}{\sigma_k^2}x(k)y(k)}{\sum_{k=1}^{N}\frac{1}{\sigma_k^2}x^2(k)}$ ✔
- $\frac{\sum_{k=1}^{N}\frac{1}{\sigma_k}x(k)y(k)}{\sum_{k=1}^{N}\frac{1}{\sigma_k}x^2(k)}$
- $\frac{\left(\sum_{k=1}^{N}x(k)y(k)\right)\left(\sum_{k=1}^{N}\frac{1}{\sigma_k^2}\right)}{\sum_{k=1}^{N}\frac{1}{\sigma_k^2}x^2(k)}$
- $\frac{\sum_{k=1}^{N}\sigma_k^2x(k)y(k)}{\sum_{k=1}^{N}\sigma_k^2x^2(k)}$

Your answer is correct.

The correct answer is: $\frac{\sum_{k=1}^{N}\frac{1}{\sigma_k^2}x(k)y(k)}{\sum_{k=1}^{N}\frac{1}{\sigma_k^2}x^2(k)}$

MIMO is a key technology in

Question **3**

Correct

Mark 1.00 out of 1.00

Flag question

Select one:

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

Your answer is correct.

The correct answer is: All of these

Question **4**

Correct

Mark 1.00 out of 1.00

Flag question

In the MIMO channel model $\bar{\mathbf{y}}(k) = \mathbf{H}\bar{\mathbf{x}}(k) + \bar{\mathbf{n}}(k)$ described in class lectures, the coefficient $h_{i,j}$ of the channel matrix $\mathbf{H}$ denotes

Select one:

- Power gain between receive antenna i and transmit antenna j
- Fading channel coefficient between receive antenna i and transmit antenna j ✔
- Amplitude gain between receive antenna j and transmit antenna i
- Fading channel coefficient between receive antenna j and transmit antenna i

Your answer is correct.

The correct answer is: Fading channel coefficient between receive antenna i and transmit antenna j

Question **5**

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:

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

Your answer is correct.

The correct answer is: $r \times t$

Question **6**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the MIMO channel estimation problem with pilot matrix

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

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 ✔
- 3×2

- 2×2
- 2×3

Your answer is correct.

The correct answer is: 3×3

Question **7**
Correct
Mark 1.00 out of 1.00
Flag question

Consider the MIMO channel estimation problem with pilot matrix $\mathbf{X}$ and output matrix $\mathbf{Y}$. The LS estimate of the MIMO channel matrix is given as,

Select one:

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

Your answer is correct.

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

Question **8**
Correct
Mark 1.00 out of 1.00
Flag question

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

Select one:

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

Your answer is correct.

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

Question **9**
Correct
Mark 1.00 out of 1.00
Flag question

Consider the MIMO channel estimation problem with pilot matrix

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

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

Select one:

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

Your answer is correct.

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

Question **10**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the MIMO channel estimation problem with pilot matrix

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

The output matrix is

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

The least squares or ML estimate of the MIMO channel matrix **H** is

Select one:

- $\frac{1}{4}\begin{bmatrix}-1 & -7 & 3\\ -2 & -1 & -6\\ -3 & 0 & -8\end{bmatrix}$
- $\frac{1}{4}\begin{bmatrix}-1 & -7 & -3\\ -2 & 3 & -6\\ -2 & -1 & -8\end{bmatrix}$
- $\frac{1}{4}\begin{bmatrix}3 & -7 & 3\\ 2 & 0 & 2\\ -2 & 0 & -8\end{bmatrix}$
- $\frac{1}{4}\begin{bmatrix}-1 & -7 & 3\\ -2 & 0 & -6\\ -2 & 0 & -8\end{bmatrix}$ ✔

Your answer is correct.

The correct answer is: $\frac{1}{4}\begin{bmatrix}-1 & -7 & 3\\ -2 & 0 & -6\\ -2 & 0 & -8\end{bmatrix}$

Finish review