Started on	Sunday, 26 November 2023, 1:15 PM
State	Finished
Completed on	Sunday, 26 November 2023, 1:56 PM
Time taken	41 mins 43 secs
Grade	**8.00** out of 10.00 (**80**%)

Question **1**

Correct

Mark 1.00 out of 1.00

Flag question

The expression for the **MMSE estimate** $\hat{\mathbf{h}}$ is

Select one:

- $E\{\bar{\mathbf{h}}\}$
- $E\{\bar{\mathbf{h}}|\bar{\mathbf{y}}\}$ ✔
- $E\{\bar{\mathbf{y}}|\bar{\mathbf{h}}\}$
- $E\{\bar{\mathbf{h}}|\bar{\mathbf{x}}\}$

Your answer is correct.

The correct answer is: $E\{\bar{\mathbf{h}}|\bar{\mathbf{y}}\}$

Question **2**

Correct

Mark 1.00 out of 1.00

Flag question

For $\bar{\mathbf{h}}, \bar{\mathbf{y}}$, jointly Gaussian, zero-mean, MMSE estimate can be simplified as

Select one:

- $\mathbf{R}_{yy}^{-1}\mathbf{R}_{hy}\bar{\mathbf{y}}$
- $\mathbf{R}_{hy}\mathbf{R}_{yy}\ \bar{\mathbf{y}}$
- $\mathbf{R}_{hy}^{-1}\mathbf{R}_{yy}\ \bar{\mathbf{y}}$
- $\mathbf{R}_{hy}\mathbf{R}_{yy}^{-1}\bar{\mathbf{y}}$ ✔

Your answer is correct.

The correct answer is: $\mathbf{R}_{hy}\mathbf{R}_{yy}^{-1}\bar{\mathbf{y}}$

Question **3**

Incorrect

Mark 0.00 out of 1.00

Flag question

The matrix $\mathbf{R}_{hy}$ is

Select one:

- covariance matrix ✖

variance

standard deviation

cross-covariance matrix

Your answer is incorrect.

The correct answer is:
cross-covariance matrix

Question **4**

Correct

Mark 1.00 out of 1.00

Remove flag

Consider a multi-antenna channel estimation scenario with $N = 4$ pilot vectors, with the pilot matrix $\mathbf{X}$ and receive vector $\bar{\mathbf{y}}$ given below

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

Let the channel coefficients be i.i.d. Gaussian with variance $\sigma_h^2 = 1$ and noise variance $\sigma^2 = 4$. The MMSE estimate of the channel vector $\bar{\mathbf{h}}$ is

Select one:

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

$\frac{1}{4}\begin{bmatrix} -1 \\ 2 \end{bmatrix}$

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

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

Your answer is correct.

The correct answer is: $\frac{1}{4}\begin{bmatrix} -1 \\ 0 \end{bmatrix}$

Question **5**

Correct

Mark 1.00 out of 1.00

Remove flag

Consider a multi-antenna channel estimation scenario with $N = 4$ pilot vectors, with the pilot matrix $\mathbf{X}$ given below

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

Let the channel coefficients be i.i.d. Gaussian with variance $\sigma_h^2 = 1$ and noise variance $\sigma^2 = 4$. The error covariance of the LMMSE estimate of $\bar{\mathbf{h}}$ is,

Select one:

$\begin{bmatrix} \frac{1}{3} & 0 \\ 0 & \frac{1}{3} \end{bmatrix}$

- $\begin{bmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{2} \end{bmatrix}$ ✔
- $\begin{bmatrix} 1 & \frac{1}{3} \\ \frac{1}{3} & 1 \end{bmatrix}$
- $\begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$

Your answer is correct.

The correct answer is: $\begin{bmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{2} \end{bmatrix}$

Question **6**

Correct

Mark 1.00 out of 1.00

Remove flag

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 $\bar{\mathbf{x}} = [-1 \quad 1 \quad -1]^T$ denote the vector of transmitted pilot symbols by time instant $N = 3$ and $\bar{\mathbf{y}} = [-3 \quad -2 \quad 1]^T$ denote the corresponding received symbol vector. Let the transmitted and received symbols respectively at time $N + 1 = 4$ be $x(4) = 1$, $y(4) = -2$ respectively. What is the prediction error $e(4)$?

Select one:

- -4
- -2 ✔
- 0
- 2

Your answer is correct.

The correct answer is: -2

Question **7**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the multi-antenna channel estimation problem. The expression for the gain $\bar{\mathbf{k}}(N+1)$at time $N+1$ is

Select one:

- $\frac{\frac{1}{\sigma^2}\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}{1+\bar{\mathbf{x}}^T(N+1)\frac{1}{\sigma^2}\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}$ ✔
- $\frac{\sigma^2\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}{1+\bar{\mathbf{x}}^T(N+1)\sigma^2\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}$
- $\frac{\sigma^2\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}{1+\mathbf{x}(N+1)\sigma^2\mathbf{P}(N)\bar{\mathbf{x}}^T(N+1)}$
- $\frac{\frac{1}{\sigma^2}\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}{1+\mathbf{x}(N+1)\frac{1}{\sigma^2}\mathbf{P}(N)\bar{\mathbf{x}}^T(N+1)}$

Your answer is correct.

The correct answer is: $\frac{\frac{1}{\sigma^2}\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}{1+\bar{\mathbf{x}}^T(N+1)\frac{1}{\sigma^2}\mathbf{P}(N)\bar{\mathbf{x}}(N+1)}$

Question **8**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the multi-antenna channel estimation problem. The expression for the error covariance $\mathbf{P}(N+1)$at time $N+1$ is

Select one:

- $\left(\mathbf{I}-\bar{\mathbf{k}}(N+1)\bar{\mathbf{x}}^T(N+1)\mathbf{P}(N)\right)$
- $\left(\mathbf{I}-\bar{\mathbf{x}}^T(N+1)\mathbf{P}(N)\bar{\mathbf{k}}(N+1)\right)$
- $\left(\mathbf{I}-\bar{\mathbf{k}}(N+1)\bar{\mathbf{x}}^T(N+1)\right)\mathbf{P}(N)$ ✔
- $\left(\mathbf{I}-\bar{\mathbf{x}}^T(N+1)\bar{\mathbf{k}}(N+1)\right)\mathbf{P}(N)$

Your answer is correct.

The correct answer is: $\left(\mathbf{I}-\bar{\mathbf{k}}(N+1)\bar{\mathbf{x}}^T(N+1)\right)\mathbf{P}(N)$

Question **9**

Correct

Mark 1.00 out of 1.00

Remove flag

Consider the observation model $\bar{\mathbf{y}}=\mathbf{X}\bar{\mathbf{h}}+\bar{\mathbf{v}}$, with $\bar{\mathbf{v}}$ comprising of i.i.d. Gaussian noise samples of variance $\sigma^2 = -3$ dB and $\mathbf{X}, \bar{\mathbf{y}}$ given as below

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

The observation at time $N=5$ is given as $y(5)=-1$, corresponding to the pilot vector $\bar{\mathbf{x}}(5)=\begin{bmatrix}2\\ -2\end{bmatrix}$. Determine the Gain at time $N+1=5$

Select one:

- $\frac{1}{6}\begin{bmatrix}1\\ -1\end{bmatrix}$ ✔
- $\frac{1}{3}\begin{bmatrix}-1\\ 1\end{bmatrix}$
- $\frac{1}{3}\begin{bmatrix}2\\ -1\end{bmatrix}$
- $\frac{1}{3}\begin{bmatrix}1\\ -1\end{bmatrix}$

Your answer is correct.

The correct answer is: $\frac{1}{6}\begin{bmatrix}1\\ -1\end{bmatrix}$

Question **10**

Incorrect

Mark 0.00 out of 1.00

Flag question

Consider the general estimation problem of a zero-mean parameter vector $\bar{\mathbf{h}}$ given a zero mean observation vector $\bar{\mathbf{y}}$, and the two properties P1, P2 below

P1: $\bar{\mathbf{h}}$, $\bar{\mathbf{y}}$ are jointly Gaussian

P2: The input-output model for $\bar{\mathbf{h}}$, $\bar{\mathbf{y}}$ is linear

The LMMSE estimate equals $\mathbf{R}_{hy}\mathbf{R}_{yy}^{-1}\bar{\mathbf{y}}$

Select one:

- Only when P1 and P2 are both true
- when P1 is true but P2 is not necessarily true
- when P2 is true but P1 is not necessarily true ✖
- when neither P1 nor P2 are necessarily true

Your answer is incorrect.

The correct answer is:

when neither P1 nor P2 are necessarily true

Finish review