Started on	Friday, 24 November 2023, 9:03 PM
State	Finished
Completed on	Friday, 24 November 2023, 9:04 PM
Time taken	1 min 6 secs
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 $\bar{\mathbf{x}} = [1 \quad 1 \quad -1]^T$ 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: 0

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 $\bar{\mathbf{x}} = [1 \quad 1 \quad -1]^T$ 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. Let $v(k)$ be IID Gaussian noise with zero-mean and variance $\sigma^2 = 2$. The gain $K(4)$ is

Select one:

- $\frac{1}{4}$ ✔
- $\frac{1}{2}$
- $-\frac{1}{3}$
- -2

Your answer is correct.

The correct answer is: $\frac{1}{4}$

Question **3**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the multi-antenna channel estimation problem. The expression for the prediction error $e(N+1)$ at time $N+1$ is

Select one:

- $y(N+1) - \bar{\mathbf{x}}(N+1)\hat{\mathbf{h}}(N)$
- $y(N+1) - \hat{\mathbf{h}}(N)\bar{\mathbf{x}}^T(N+1)$
- $y(N+1) - \bar{\mathbf{x}}^T(N+1)\hat{\mathbf{h}}(N)$ ✔
- $y(N+1) - \bar{\mathbf{x}}(N+1)\hat{\mathbf{h}}^T(N)$

Your answer is correct.

The correct answer is: $y(N+1) - \bar{\mathbf{x}}^T(N+1)\hat{\mathbf{h}}(N)$

Question **4**

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:

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

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 **5**

Correct

Mark 1.00 out of 1.00

Flag question

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

Select one:

- $\hat{\mathbf{h}}(N+1) = \hat{\mathbf{h}}(N)e(N+1) + \bar{\mathbf{k}}(N+1)$
- $\hat{\mathbf{h}}(N+1) = \hat{\mathbf{h}}(N) + \bar{\mathbf{k}}(N+1)e(N+1)$ ✔
- $\hat{\mathbf{h}}(N+1) = \hat{\mathbf{h}}(N)\bar{\mathbf{k}}^T(N+1) + e(N+1)$

$\hat{\mathbf{h}}(N+1) = \hat{\mathbf{h}}(N) + \frac{\bar{\mathbf{k}}(N+1)}{e(N+1)}$

Your answer is correct.

The correct answer is: $\hat{\mathbf{h}}(N+1) = \hat{\mathbf{h}}(N) + \bar{\mathbf{k}}(N+1)e(N+1)$

Question **6**

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:

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

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 **7**

Correct

Mark 1.00 out of 1.00

Flag question

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

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

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

Select one:

- $-\frac{1}{2}$
- $-\frac{3}{2}$
- -2
- $\frac{1}{2}$ ✔

Your answer is correct.

The correct answer is: $\frac{1}{2}$

Question **8**

Correct

Mark 1.00 out of 1.00

Flag question

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

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

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

Select one:

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

Your answer is correct.

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

Question **9**

Correct

Mark 1.00 out of 1.00

Flag question

Consider the general estimation problem of a parameter vector $\bar{\mathbf{h}}$ given observation vector $\bar{\mathbf{y}}$. The LMMSE estimate equals the MMSE estimate when

Select one:

- $\bar{\mathbf{h}}, \bar{\mathbf{y}}$ are independent
- $\bar{\mathbf{h}}, \bar{\mathbf{y}}$ are zero-mean
- $\bar{\mathbf{h}}, \bar{\mathbf{y}}$ are jointly Gaussian ✔
- $\bar{\mathbf{h}}, \bar{\mathbf{y}}$ contain i.i.d. components

Your answer is correct.

The correct answer is: $\bar{\mathbf{h}}, \bar{\mathbf{y}}$ are jointly Gaussian

Question **10**

Correct

Mark 1.00 out of 1.00

Flag question

. Consider the MIMO channel matrix below

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

The corresponding zero-forcing receiver matrix is

Select one:

$$\begin{bmatrix} \frac{3}{22} & \frac{2}{22} & -\frac{3}{22} \\ \frac{1}{19} & \frac{3}{19} & \frac{3}{19} \end{bmatrix}$$

$$\begin{bmatrix} \frac{3}{22} & \frac{2}{22} & \frac{3}{22} \\ \frac{1}{19} & \frac{3}{19} & -\frac{3}{19} \end{bmatrix}$$

$$\begin{bmatrix} \frac{3}{19} & \frac{2}{19} & \frac{3}{19} \\ \frac{1}{22} & \frac{3}{22} & -\frac{3}{22} \end{bmatrix}$$

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

Your answer is correct.

The correct answer is: $\begin{bmatrix} \frac{3}{22} & \frac{2}{22} & -\frac{3}{22} \\ \frac{1}{19} & \frac{3}{19} & \frac{3}{19} \end{bmatrix}$

Finish review