EE909 Final Exam

Venkateswar Reddy Melachervu | 03 Dec 2023

Test Name::

EE909 Final Exam

Overall Status: Completed Detailed Status: Test-taker Completed | Test Finish Time: December 03, 2023 01:00:03 PM IST

VR

Venkateswar Reddy Melachervu

vmela23@iitk.ac.in

Test-Taker ID: - 126313076

Credibility Index: LOW

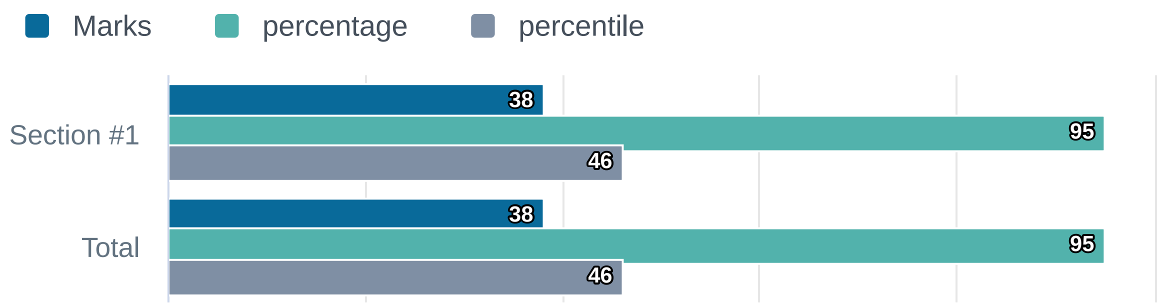
Profile Picture Snapshot

Identity Card Snapshot

Overall Summary

38 Marks Scored out of 40	95 % 46.15 percentile out of 13 Test Takers	2h 58m 26s Time taken of 3hr

Marks Scored



Attempt Summary

Distribution of questions attempted in a total of 40 question(s).

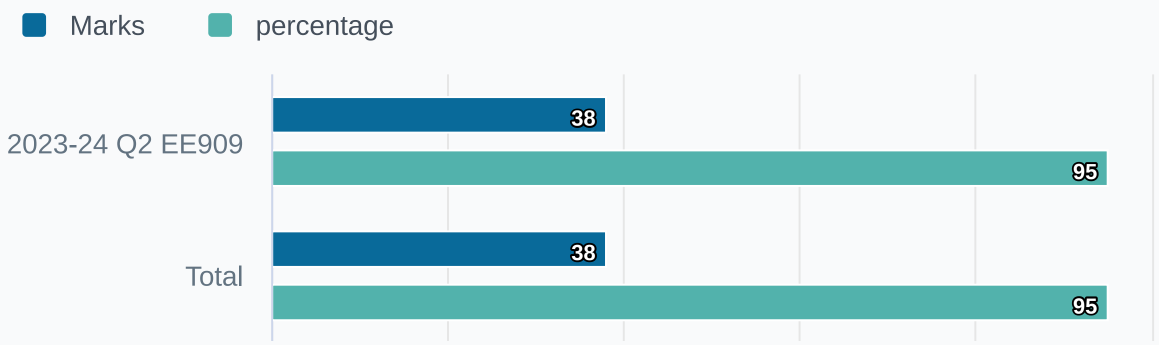
This shows the correctness of questions attempted by the test taker

Correct	38 Ques	38/38 Marks
Incorrect	2 Ques	0/2 Marks
Partially Correct	0 Ques	0/0 Marks
Not Attempted	0 Ques	0/0 Marks

Section-Wise Details

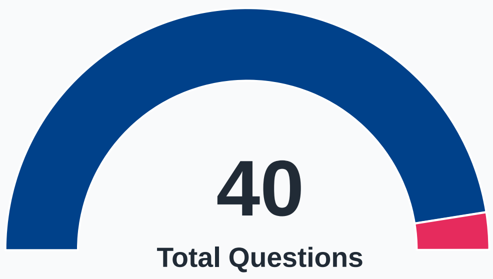
Section 1	question(s)	Time taken	Marks Scored
Section #1	40 Q.	2h 58m 26s (Untimed)	38 / 40

Marks Scored



Attempt Summary

Distribution of questions attempted in a total of 40 question(s).



This shows the correctness of questions attempted by the test taker

Correct	38 Ques	38/38 Marks
Incorrect	2 Ques	0/2 Marks

Question-Wise Details

Section 1
Section #1

40	2h 58m 26s	38/40
question(s)	Time taken	Marks Scored

Q. 1

Question 1

Time taken: 22s

Marks Scored: 1/1

The unknown quantity that is to be estimated is termed the

Response:

OPTIONS	RESPONSE	ANSWER
Variable		
Parameter	✔	✔
Gaussian		
Random		

Q. 2

Question 2

Time taken: 1m 5s

Marks Scored: 1/1

Consider the fading channel estimation problem $\bar{x}$ denotes the complex vector of transmitted pilot symbols and $\bar{y}$ denotes the corresponding received symbol vector. Let $v(k)$ be v i.i.d. symmetric complex Gaussian noise with zero-mean and variance σ^2. The maximum likelihood estimate $\hat{h}$ is

Response:

OPTIONS	RESPONSE	ANSWER
$\frac{\bar{\mathbf{x}}^H\bar{\mathbf{y}}}{\bar{\mathbf{x}}^H\bar{\mathbf{x}}}$	✔	✔
$h\bar{\mathbf{x}}^H\bar{\mathbf{y}}$		
$\bar{\mathbf{x}}^T\bar{\mathbf{y}}$		
$\frac{\bar{\mathbf{x}}^T\bar{\mathbf{y}}}{\bar{\mathbf{x}}^T\bar{\mathbf{x}}}$		

Q. 3

Question 3

Time taken: 4m 9s | Marks Scored: 1/1

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

Response:

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

Q. 4

Question 4

Time taken: 5m 39s | Marks Scored: 1/1

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 $\bar{x}$ = [x(1)   x(2) ... x(N)] ^{T} denote the vector of transmitted pilot symbols and $\bar{y}$ = [y(1)   y(2) ... y(N)] ^{T} denote the corresponding received symbol vector. Let $v(k)$ be independent Gaussian noise with zero-mean and variance $\sigma^2{}_k$. The ML estimate of h is

Response:

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

Q. 5

Question 5

Time taken: 20s

Marks Scored: 1/1

ISI in a wireless system results when

Response:

OPTIONS	RESPONSE	ANSWER
Symbol duration is very large		
Symbol duration is very small	✔	✔
Velocity of the mobile is large		
Velocity of the mobile is small		

Q. 6

Question 6

Time taken: 1m 32s

Marks Scored: 1/1

Consider a two tap frequency selective channel with channel taps $h(0), h(1)$. Let $x(l)$, $0 \leq l \leq 3$ denote the samples obtained via IFFT. These are transmitted over the channel after addition of a cyclic prefix of length 2 symbols. Let $v(l)$ denote the noise sample at time l. The received symbol y(1) at time $l = 1$ is

Response:

OPTIONS	RESPONSE	ANSWER
h(0) x(0) + v(0)		
h(0) x(0) + h(1) x(1) + v(0)		
h(0) x(1) + h(1) x(0) + v(1)	✔	✔
h(0) x(0) + h(1) x(3) + v(0)		

Q. 7

Question 7

Time taken: 41s | Marks Scored: 1/1

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

Response:

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

Q. 8

Question 8

Time taken: 2m 19s | Marks Scored: 1/1

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

Response:

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

Q. 9

Question 9

Time taken: 1m 49s

Marks Scored: 1/1

Consider the wireless sensor network (WSN) estimation scenario described in lectures with each observation $y(k)=h+v(k)$, for $1\leq k\leq N$, i.e. number of observations is N and i.i.d. real Gaussian noise samples of variance σ^2. The likelihood $p(\bar{\mathbf{y}};h)$ of the parameter h, where is $\bar{y}=[(y(1)\ y(2)\ \ldots y(N)]^T$

Response:

OPTIONS	RESPONSE	ANSWER
$\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{1}{2\sigma^2}\sum_{k=1}^{N}(y(k)-h)}$		
$\left(\frac{1}{2\pi\sigma}\right)^{\frac{N}{2}} e^{-\frac{1}{2\sigma^2}\left(\sum_{k=1}^{N}(y(k)-h)\right)^2}$		
$\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{1}{2\sigma^2}\left(\sum_{k=1}^{N}y(k)-h\right)^2}$		
$\left(\frac{1}{2\pi\sigma^2}\right)^{\frac{N}{2}} e^{-\frac{1}{2\sigma^2}\sum_{k=1}^{N}(y(k)-h)^2}$	✔	✔

Q. 10

Question 10

Time taken: 2m 17s

Marks Scored: 1/1

Consider the wireless sensor network (WSN) estimation scenario described in lectures with each observation $y(k)=h+v(k)$, for $1\leq k\leq 4$, with the observations given as $y(1)=-1,\ y(2)=-2,\ y(3)=1,\ y(4)=3.$ What is the maximum likelihood estimate of the unknown parameter h ?

Response:

OPTIONS	RESPONSE	ANSWER
$-\frac{1}{4}$		
$\frac{1}{4}$	✔	✔
$\frac{3}{4}$		
$-\frac{3}{2}$		

Q. 11

Question 11

Time taken: 6m 40s

Marks Scored: 1/1

Consider the fading channel estimation problem with □□ = [1 − □ −1 − □ −1 + □ 1 − □] □ and □□ = [□ −1 −□ 1] □. The maximum likelihood estimate of the channel coefficient □ is,

Response:

OPTIONS	RESPONSE	ANSWER
$\frac{1}{4}j$	✔	✔
$\frac{1}{4}+\frac{1}{4}j$		
$-\frac{1}{2}j$		
$-\frac{1}{2}$		

Q. 12

Question 12

Time taken: 1m 46s

Marks Scored: 1/1

The Fisher information □(□) for estimation of a parameter □ given the likelihood □(□□; □) is

Response:

OPTIONS	RESPONSE	ANSWER
$E\left\{\left(\frac{\partial}{\partial h}\ln p(\bar{\mathbf{y}};h)\right)^2\right\}$	✔	✔
$\frac{1}{E\left\{\left(\frac{\partial}{\partial h}\ln p(\bar{\mathbf{y}};h)\right)^2\right\}}$		
$E\left\{\frac{\partial}{\partial h}p(\bar{\mathbf{y}};h)\right\}$		
$E\left\{\left(\frac{\partial}{\partial h}p(\bar{\mathbf{y}};h)\right)^2\right\}$		

Q. 13

Question 13

Time taken: 53s

Marks Scored: 1/1

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 □ for this scenario satisfies the property that

Response:

OPTIONS	RESPONSE	ANSWER
It is invertible		
It has orthogonal columns	✔	✔
It has identical columns		
None of these		

Q. 14

Question 14

Time taken: 6m 27s

Marks Scored: 1/1

Consider the channel estimation model for the multiple transmit antenna system given by □□ = □□□+ □□, with the pilot matrix □ and receive vector □□ 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 $\bar{h}$ is,

Response:

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

Q. 15

Question 15

Time taken: 1m 45s | Marks Scored: 1/1

Consider the MIMO channel estimation problem with pilot matrix □ and output matrix □. The pseudo-inverse of the pilot matrix is

Response:

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

Q. 16

Question 16

Time taken: 2m 19s | Marks Scored: 1/1

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,

Response:

OPTIONS	RESPONSE	ANSWER
3×4		
4×4		
3×3	✔	✔
4×3		

Q. 17 Question 17

Time taken: 1m 48s | Marks Scored: 1/1

Consider an Inter Symbol Interference channel □(□) = □(□) + $\frac{1}{3}$ □(□ − 1) + □(□). Let an □ = 2 tap channel equalizer be designed for this scenario based on symbols □(□), □(□ + 1) to detect □(□). Let the equalizer vector be denoted by □□. The least squares problem for estimation of □□ is,

Response:

OPTIONS	RESPONSE	ANSWER
$\left\Vert \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ \frac{1}{3} & 1 \\ 0 & \frac{1}{3} \end{bmatrix} \bar{\mathbf{c}} \right\Vert^2$		
$\left\Vert \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ \frac{1}{3} & 1 \\ 0 & \frac{1}{3} \end{bmatrix} \bar{\mathbf{c}} \right\Vert^2$	✔	✔
$\left\Vert \begin{bmatrix} 0 \\ 1 \end{bmatrix} - \begin{bmatrix} \frac{1}{3} & 1 & 0 \\ 0 & \frac{1}{3} & 1 \end{bmatrix} \bar{\mathbf{c}} \right\Vert^2$		
$\left\Vert \begin{bmatrix} 0 \\ 1 \end{bmatrix} - \begin{bmatrix} 1 & \frac{1}{3} \\ 1 & \frac{1}{3} \end{bmatrix} \bar{\mathbf{c}} \right\Vert^2$		

Q. 18 Question 18

Time taken: 34s | Marks Scored: 1/1

In an OFDM system, after addition of the cylic prefix, which of the following statements is true

Response:

OPTIONS	RESPONSE	ANSWER
The output symbols across the subcarriers are a linear convolution between the channel filter and the time-domain transmit samples obtained after IFFT		
The output symbols across the subcarriers are a circular convolution between the channel filter and the transmit symbols loaded on the subcarriers		
The output time-domain samples are a multiplication of the FFT coefficients of the channel filter and the time-domain transmit samples obtained after IFFT		
The output time-domain samples are a circular convolution between the channel filter and the time-domain transmit samples obtained after IFFT	✔	✔

Q. 19

Question 19

Time taken: 4m 16s

Marks Scored: 1/1

Consider an □ = 4 subcarrier OFDM system with **conventional** channel estimation i.e. pilot symbols transmitted on all the subcarriers. The ISI channel has □ = 2 taps, denoted by □(0), □(1). The received samples □(□) for □ = 0, 1, 2, 3 are respectively −1, $-\frac{1}{2}$ □, $\frac{1}{2}$ □,1. The symbol □(2) received on subcarrier □ = 2 in the frequency domain is

Response:

OPTIONS	RESPONSE	ANSWER
−2 + □	✔	✔
−2 − □		
2 + □		
2 − □		

Q. 20

Question 20

Time taken: 1m 49s

Marks Scored: 1/1

Consider the multiple transmit antenna channel estimation model given by □□ = □□□+ □□, with, □, □□ denoting the pilot matrix, output vector, respectively and □□ denoting the additive noise vector comprising of zero-mean i.i.d. Gaussian noise samples of variance □ 2 . The channel coefficients are zero-mean i.i.d. Gaussian with variance □□ 2 . The covariance matrix □□□ of the output vector y is

Response:

OPTIONS	RESPONSE	ANSWER
$\sigma_h^2\mathbf{X}^T\mathbf{X} + \sigma^2\mathbf{I}$		
$\sigma_h^2\bar{\mathbf{h}}\bar{\mathbf{h}}^T + \mathbf{I}$		
$\sigma_h^2\mathbf{I} + \sigma^2\mathbf{X}\mathbf{X}^T$		
$\sigma_h^2\mathbf{X}\mathbf{X}^T + \sigma^2\mathbf{I}$	✔	✔

Q. 21

Question 21

Time taken: 1m 27s | Marks Scored: 1/1

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

Response:

OPTIONS	RESPONSE	ANSWER
□{□□}		
□{□□|□□}	✓	✓
□{□□|□□}		
□{□□|□□}		

Q. 22

Question 22

Time taken: 4m 34s | Marks Scored: 1/1

Consider a multi-antenna channel estimation scenario with □ = 4 pilot vectors, with the pilot matrix □ 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 $□^2_□$ = 1 and noise variance $□^2$ = 2. The error covariance of the LMMSE estimate of $\hat{\mathbf{h}}$ is,

Response:

OPTIONS	RESPONSE	ANSWER
$\begin{bmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{2} \end{bmatrix}$		
$\begin{bmatrix} \frac{1}{3} & 0 \\ 0 & \frac{1}{3} \end{bmatrix}$	✓	✓
$\begin{bmatrix} 1 & \frac{1}{3} \\ \frac{1}{3} & 1 \end{bmatrix}$		
$\begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$		

Q. 23

Question 23

Time taken: 8m 29s

Marks Scored: 1/1

Consider the fading channel estimation problem where the output symbol □(□) is □(□) = □□(□) + □(□), with □, □(□), □(□) denoting the *real* channel coefficient, pilot symbol and noise sample respectively. Let □□ = [1 1 −1] □ denote the vector of transmitted pilot symbols by time instant □ = 3 and □□ = [−3 −2 1] □ denote the corresponding received symbol vector. Let the transmitted and received symbols respectively at time □ + 1 = 4 be □(4) = 1, □(4) = −2 respectively. What is the prediction error □(4)?

Response:

OPTIONS	RESPONSE	ANSWER
0	✔	✔
-4		
-2		
2		

Q. 24

Question 24

Time taken: 7m 12s

Marks Scored: 1/1

Consider the observation model □□ = □□□+ □□, with □□ comprising of i.i.d. Gaussian noise samples of variance □ ^{2} = 3 dB and □, □□ 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 □ = 5 is given as □(5) = −2, corresponding to the pilot vector □□(5) = $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$. Determine the Gain at time □ + 1 = 5

Response:

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

Q. 25

Question 25

Time taken: 42s

Marks Scored: 1/1

Consider the wireless sensor network (WSN) estimation scenario described in lectures with each observation □(□) = □ + □(□), for 1 ≤ □ ≤ □, i.e. number of observations is □. The ML estimate given by the sample mean has the following property.

Response:

OPTIONS	RESPONSE	ANSWER
All of the these	✔	✔
It is unbiased		
Gaussian distributed		
Variance decreases as $\frac{1}{N}$, where □ is number of observations		

Q. 26

Question 26

Time taken: 6m 1s

Marks Scored: 1/1

Consider the wireless sensor network (WSN) estimation scenario described in lectures with each observation □(□) = □ + □(□), for 1 ≤ □ ≤ 4, i.e. number of observations □ = 4 and IID Gaussian noise samples of standard deviation □ = 4. What is the variance of the maximum likelihood estimate $\hat{h}$ of the unknown parameter □ ?

Response:

OPTIONS	RESPONSE	ANSWER
$\frac{1}{2}$		
$\frac{1}{4}$		
1		
4	✔	✔

Q. 27

Question 27

Time taken: 1m 56s

Marks Scored: 1/1

Let □□ = [−1 1 1 −1] □ denote the vector of transmitted pilot symbols and □□ = [1 2 1 3] □ denote the corresponding received symbol vector. The maximum likelihood estimate of the channel coefficient □ is,

Response:

OPTIONS	RESPONSE	ANSWER
$-\frac{1}{4}$	✔	✔
$-\frac{1}{2}$		
$-\frac{3}{4}$		
$\frac{1}{8}$		

Q. 28

Question 28

Time taken: 57s

Marks Scored: 1/1

The Cramer-Rao Bound (CRB) is a

Response:

OPTIONS	RESPONSE	ANSWER
Upper bound on variance of parameter estimation		
Lower bound on variance of parameter estimation	✔	✔
Lower bound on mean of parameter estimate		
Upper bound on mean of parameter estimate		

Q. 29

Question 29

Time taken: 4m 18s

Marks Scored: 1/1

Consider the channel estimation model for the multiple transmit antenna system given by □□ = □ □□+ □□, with the pilot matrix □ given as below

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

The number of transmit antennas in the system is

Response:

OPTIONS	RESPONSE	ANSWER
3		
4		
2	✓	✓
1		

Q. 30

Question 30

Time taken: 5m 39s

Marks Scored: 1/1

Consider the channel estimation model for the multiple transmit antenna system given by □□ = □□□+ □□, where the pilot matrix □ is

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

Let the noise variance □ $^2 = \frac{1}{2}$. The MSE of the ML estimate of $\overline{h}$ is,

Response:

OPTIONS	RESPONSE	ANSWER
$\begin{bmatrix} \frac{1}{4} & 0 \\ 0 & \frac{1}{4} \end{bmatrix}$		
$\frac{1}{4}$	✔	✔
$\frac{1}{8}$		
$\begin{bmatrix} \frac{1}{8} & 0 \\ 0 & \frac{1}{8} \end{bmatrix}$		

Q. 31

Question 31

Time taken: 32m 59s

Marks Scored: 0/1

Consider the fading channel estimation problem where the output symbol □(□) is □(□) = □□(□) + □(□), with □, □(□), □(□) denoting the real channel coefficient, pilot symbol and noise sample respectively. Let □□ = [□(1) □(2) … □(5)] □ denote the vector of transmitted pilot symbols and □□ = [□(1) □(2) … □(5)] □ denote the corresponding received symbol vector. Let □(□) be independent Gaussian noise with zero-mean and variance □. The likelihood function is

Response:

OPTIONS	RESPONSE	ANSWER
$\frac{1}{\sqrt{30\pi^5}} e^{-\frac{1}{30}\sum_{k=1}^{5}(y(k)-hx(k))^2}$	✔	
$\left(\frac{1}{\sqrt{15\pi^5}}\right) e^{-\frac{1}{30}\sum_{k=1}^{5}(y(k)-hx(k))^2}$		
$\frac{1}{\sqrt{32\pi^5}} \times \frac{1}{120} e^{-\frac{1}{120}\sum_{k=1}^{N}(y(k)-hx(k))^2}$		
$\frac{1}{\sqrt{3840\pi^5}} e^{-\frac{1}{2}\sum_{k=1}^{5}\frac{(y(k)-hx(k))^2}{k}}$		✔

Q. 32

Question 32

Time taken: 8m 46s

Marks Scored: 1/1

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

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

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

Response:

OPTIONS	RESPONSE	ANSWER
$\frac{1}{4}\begin{bmatrix} -2 & 0 \\ 1 & 1 \end{bmatrix}$		
$\frac{1}{4}\begin{bmatrix} -8 & 0 \\ 1 & 1 \end{bmatrix}$	✔	✔
$\frac{1}{4}\begin{bmatrix} -8 & 0 \\ 1 & -2 \end{bmatrix}$		
$\frac{1}{4}\begin{bmatrix} -8 & 0 \\ -1 & 1 \end{bmatrix}$		

Q. 33

Question 33

Time taken: 3m 25s

Marks Scored: 1/1

Consider an Inter Symbol Interference channel □(□) = □(0)□(□) + □(1)□(□ − 1) + □(□). Let an □ = 2 tap channel equalizer be designed for this scenario based on symbols □(□), □(□ + 1) to detect □(□). Let the effective channel matrix for this scenario be denoted by □. The projection matrix $□_{□}$ of $□^{□}$ is,

Response:

OPTIONS	RESPONSE	ANSWER
$□^{□}(□^{□}□)^{-1}□$		
$(□^{□}□)^{-1}$		
$□^{□}(□□^{□})^{-1}□$	✔	✔
$□(□^{□}□)^{-1}□^{□}$		

Q. 34

Question 34

Time taken: 33s | Marks Scored: 1/1

Consider an Inter Symbol Interference channel $y(k) = h(0)x(k) + h(1)x(k-1) + v(k)$. Let an $r = 2$ tap channel equalizer be designed for this scenario based on symbols $y(k), y(k+1)$ to detect $x(k)$. Let the equalizer vector be denoted by $\mathbf{c}$ and the effective channel matrix by $\mathbf{H}$. The matrix $\mathbf{H}$ for this scenario is

Response:

OPTIONS	RESPONSE	ANSWER
$\begin{bmatrix} h(0) & h(1) & 0 \\ 0 & h(0) & h(1) \end{bmatrix}$	✓	✓
$\begin{bmatrix} h(0) & h(1) \\ h(1) & h(0) \end{bmatrix}$		
$\begin{bmatrix} h(1) & h(0) & 0 \\ 0 & h(1) & h(0) \end{bmatrix}$		
$\begin{bmatrix} h(0) & h(1) \\ h(0) & h(1) \end{bmatrix}$		

Q. 35

Question 35

Time taken: 4m 33s | Marks Scored: 1/1

Consider a two tap frequency selective channel with channel taps □(0), □(1). Let □(□), 0 ≤ □ ≤ 3 denote the samples obtained via IFFT. Then, the channel coefficient □(3) across subcarrier □ = 3 is

Response:

OPTIONS	RESPONSE	ANSWER
□(0) + □(1)		
□(0) − □□(1)		
□(0) − □(1)		
□(0) + □□(1)	✓	✓

Q. 36

Question 36

Time taken: 4m 29s

Marks Scored: 1/1

Consider an □ = 4 subcarrier OFDM system with **conventional** channel estimation i.e. pilot symbols transmitted on all the subcarriers. The ISI channel has □ = 2 taps, denoted by □(0), □(1). The transmit samples □(□), □ = 0, 1, 2, 3 obtained after IFFT are respectively □,1,−□, 1. The received samples □(□) for □ = 0, 1, 2, 3 are respectively −1, −□,−□,1. The noise samples are zero-mean i.i.d. Gaussian and the cyclic prefix is of length one symbol. The estimate $\widehat{H}(0)$ of the channel coefficient across subcarrier □ = 0 is

Response:

OPTIONS	RESPONSE	ANSWER
-j	✓	✓
j		
-1		
1		

Q. 37

Question 37

Time taken: 6m 22s

Marks Scored: 1/1

Consider a multi-antenna channel estimation scenario with □ = 4 pilot vectors, with the pilot matrix □ and receive vector □□ given below

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

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

Response:

OPTIONS	RESPONSE	ANSWER
$\frac{1}{4}\begin{bmatrix} 1 \\ -1 \end{bmatrix}$		
$\frac{1}{4}\begin{bmatrix} -1 \\ 2 \end{bmatrix}$		
$\frac{1}{4}\begin{bmatrix} -2 \\ 1 \end{bmatrix}$		
$\frac{1}{4}\begin{bmatrix} 2 \\ -1 \end{bmatrix}$	✓	✓

Q. 38

Question 38

Time taken: 17m 37s | Marks Scored: 0/1

Consider the fading channel estimation problem where the output symbol is □(□) = □□(□) + □(□), with □, □(□), □(□) denoting the real channel coefficient, pilot symbol and noise sample respectively. Let □□ = [−1 1 1 −1] □ denote the pilot vector of transmitted pilot symbols and □□ = [−2 1 2 −3] □denote the corresponding received symbol vector. Let □(□) be IID Gaussian noise with zero-mean and variance □ ^{2} = 2. Let the channel coefficient □ be Gaussian with mean □□ = 1 and variance □ ^{2} $_□$ = 1. The MMSE estimate $\widehat{h}$of the channel coefficient h is

Response:

OPTIONS	RESPONSE	ANSWER
$\frac{7}{5}$		
$\frac{3}{2}$	✓	
$\frac{5}{3}$		✓
$\frac{1}{3}$		

Q. 39

Question 39

Time taken: 2m 5s | Marks Scored: 1/1

Consider the multi-antenna channel estimation problem. The expression for the error covariance □(□ + 1)at time □ + 1 is

Response:

OPTIONS	RESPONSE	ANSWER
(□ − □□(□ + 1)□□ □ (□ + 1)□(□))		
□ − □□ □ (□ + 1)□(□)□□(□ + 1))		
(□ − □□(□ + 1)□□ □ (□ + 1)) □(□)	✓	✓
(□ − □□ □ (□ + 1)□□(□ + 1)) □(□)		

Q. 40

Question 40

Time taken: 7m 33s

Marks Scored: 1/1

Consider the observation model □□ = □□□+ □□, with □□ comprising of i.i.d. Gaussian noise samples of variance □ ^{2} = 3 dB and □, □□ given as below

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

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

Response:

OPTIONS	RESPONSE	ANSWER
$-\frac{1}{2}$		
$\frac{3}{2}$	✔	✔
-2		
$\frac{1}{2}$		

Test Log

3rd Dec 2023

10:01 AM Started the test with Section #1

10:01 AM Candidate gave us right to the following feeds
- camera : HP TrueVision FHD RGB-IR (064e:3401)
- microphone : Default - Microphone (USB PnP Audio Device) (0c76:153f)

10:03 AM Candidate Looking Away from Screen

10:05 AM Away from test window for 01 min

10:06 AM Additional person there

10:06 AM Candidate Looking Away from Screen

10:06 AM Away from test window

10:07 AM Candidate Looking Away from Screen

10:09 AM Candidate Looking Away from Screen

10:09 AM Away from test window for 01 min

10:10 AM Away from test window

10:12 AM Candidate Looking Away from Screen

10:13 AM Candidate Looking Away from Screen

10:14 AM Candidate Looking Away from Screen

10:15 AM Additional person there

10:18 AM Candidate Looking Away from Screen

10:19 AM Candidate Looking Away from Screen

10:20 AM Candidate Looking Away from Screen

10:20 AM Away from test window

10:20 AM Away from test window

10:20 AM Candidate Looking Away from Screen

10:21 AM Away from test window

10:21 AM Candidate Looking Away from Screen for 02 mins

10:24 AM Candidate Looking Away from Screen for 01 min

10:27 AM Candidate Looking Away from Screen

10:28 AM Away from test window

10:28 AM Candidate Looking Away from Screen

10:29 AM Candidate Looking Away from Screen

10:31 AM Candidate Looking Away from Screen

10:32 AM Candidate Looking Away from Screen

10:32 AM Candidate Looking Away from Screen

10:33 AM Additional person there

10:34 AM Candidate Looking Away from Screen

10:35 AM	Away from test window for 04 mins
10:35 AM	Candidate Looking Away from Screen for 02 mins
10:36 AM	Away from test window
10:37 AM	Candidate Looking Away from Screen
10:38 AM	Candidate Looking Away from Screen
10:40 AM	Candidate Looking Away from Screen
10:42 AM	Candidate Looking Away from Screen for 01 min
10:45 AM	Away from test window
10:45 AM	Candidate Looking Away from Screen
10:46 AM	Candidate Looking Away from Screen
10:47 AM	Candidate Looking Away from Screen
10:48 AM	Candidate Looking Away from Screen
10:49 AM	Away from test window
10:49 AM	Candidate Looking Away from Screen
10:51 AM	Candidate Looking Away from Screen
10:52 AM	Candidate Looking Away from Screen
10:52 AM	Candidate Looking Away from Screen
10:55 AM	Candidate Looking Away from Screen for 01 min
10:57 AM	Candidate Looking Away from Screen
10:58 AM	Candidate Looking Away from Screen for 02 mins
11:02 AM	Away from test window for 03 mins
11:03 AM	Candidate Looking Away from Screen
11:04 AM	Candidate Looking Away from Screen
11:05 AM	Candidate Looking Away from Screen for 02 mins
11:12 AM	Candidate Looking Away from Screen
11:13 AM	Candidate Looking Away from Screen
11:13 AM	Away from test window for 01 min
11:14 AM	Candidate Looking Away from Screen for 01 min
11:15 AM	Away from test window
11:15 AM	Away from test window
11:15 AM	Candidate Looking Away from Screen
11:16 AM	Candidate Looking Away from Screen
11:18 AM	Away from test window
11:18 AM	Away from test window
11:19 AM	Candidate Looking Away from Screen
11:20 AM	Away from test window
11:21 AM	Candidate Looking Away from Screen
11:23 AM	Candidate Looking Away from Screen

11:23 AM	Away from test window for 01 min
11:25 AM	Candidate Looking Away from Screen for 01 min
11:28 AM	Candidate Looking Away from Screen
11:28 AM	Away from test window for 03 mins
11:29 AM	Candidate Looking Away from Screen
11:29 AM	Away from test window
11:30 AM	Candidate Looking Away from Screen
11:33 AM	Away from test window
11:33 AM	Candidate Looking Away from Screen
11:34 AM	Candidate Looking Away from Screen for 01 min
11:35 AM	Away from test window
11:36 AM	Candidate Looking Away from Screen
11:37 AM	Candidate Looking Away from Screen for 02 mins
11:40 AM	Candidate Looking Away from Screen for 01 min
11:42 AM	Candidate Looking Away from Screen for 02 mins
11:45 AM	Away from test window for 07 mins
11:46 AM	Mobile Phone Detected
11:46 AM	Candidate Looking Away from Screen
11:46 AM	Away from test window
11:47 AM	Candidate Looking Away from Screen
11:48 AM	Candidate Looking Away from Screen
11:49 AM	Away from test window for 01 min
11:49 AM	Candidate Looking Away from Screen for 03 mins
11:51 AM	Away from test window
11:53 AM	Candidate Looking Away from Screen
11:54 AM	Candidate Looking Away from Screen
11:55 AM	Candidate Looking Away from Screen
11:56 AM	Candidate Looking Away from Screen
11:57 AM	Candidate Looking Away from Screen
11:58 AM	Candidate Looking Away from Screen
11:58 AM	Candidate Looking Away from Screen for 05 mins
12:05 PM	Candidate Looking Away from Screen
12:06 PM	Candidate Looking Away from Screen
12:07 PM	Candidate Looking Away from Screen for 04 mins
12:12 PM	Candidate Looking Away from Screen for 01 min
12:15 PM	Candidate Looking Away from Screen for 01 min
12:16 PM	Candidate Looking Away from Screen for 01 min
12:19 PM	Candidate Looking Away from Screen
12:20 PM	Candidate Looking Away from Screen for 01 min

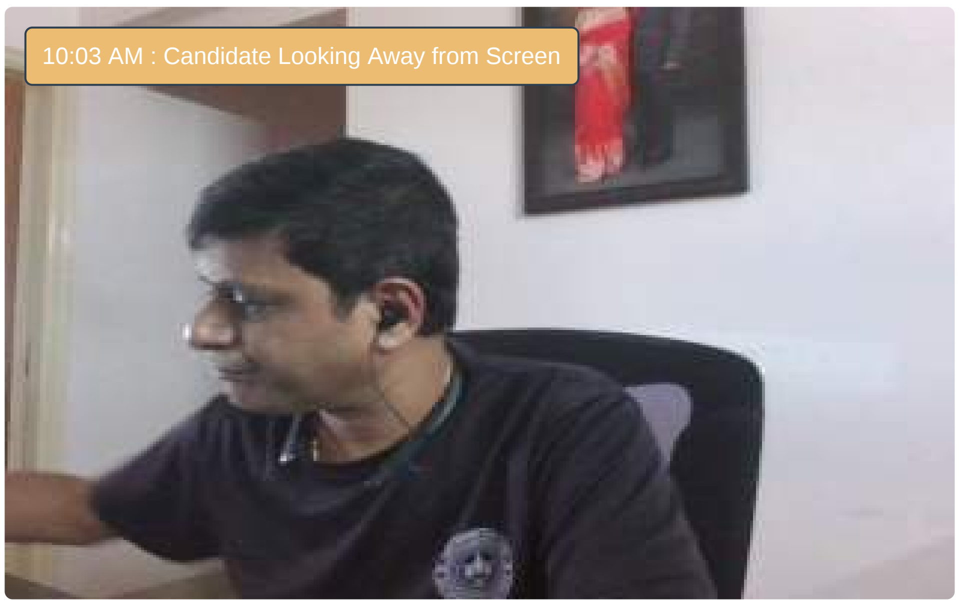
12:22 PM	Away from test window for 15 mins
12:22 PM	Candidate Looking Away from Screen
12:23 PM	Candidate Looking Away from Screen
12:25 PM	Candidate Looking Away from Screen for 01 min
12:27 PM	Away from test window
12:27 PM	Candidate Looking Away from Screen for 01 min
12:29 PM	Candidate Looking Away from Screen for 01 min
12:31 PM	Candidate Looking Away from Screen
12:31 PM	Away from test window for 04 mins
12:33 PM	Candidate Looking Away from Screen
12:34 PM	Away from test window
12:35 PM	Candidate Looking Away from Screen
12:36 PM	Away from test window
12:37 PM	Candidate Looking Away from Screen
12:38 PM	Candidate Looking Away from Screen for 01 min
12:40 PM	Candidate Looking Away from Screen
12:41 PM	Away from test window for 05 mins
12:41 PM	Candidate Looking Away from Screen
12:42 PM	Candidate Looking Away from Screen
12:43 PM	Candidate Looking Away from Screen
12:44 PM	Candidate Looking Away from Screen for 01 min
12:46 PM	Candidate Looking Away from Screen for 01 min
12:48 PM	Candidate Looking Away from Screen
12:49 PM	Away from test window
12:49 PM	Away from test window
12:50 PM	Candidate Looking Away from Screen
12:53 PM	Away from test window
12:53 PM	Candidate Looking Away from Screen
12:54 PM	Candidate Looking Away from Screen
12:55 PM	Candidate Looking Away from Screen
12:59 PM	Away from test window
01:00 PM	Finished the test

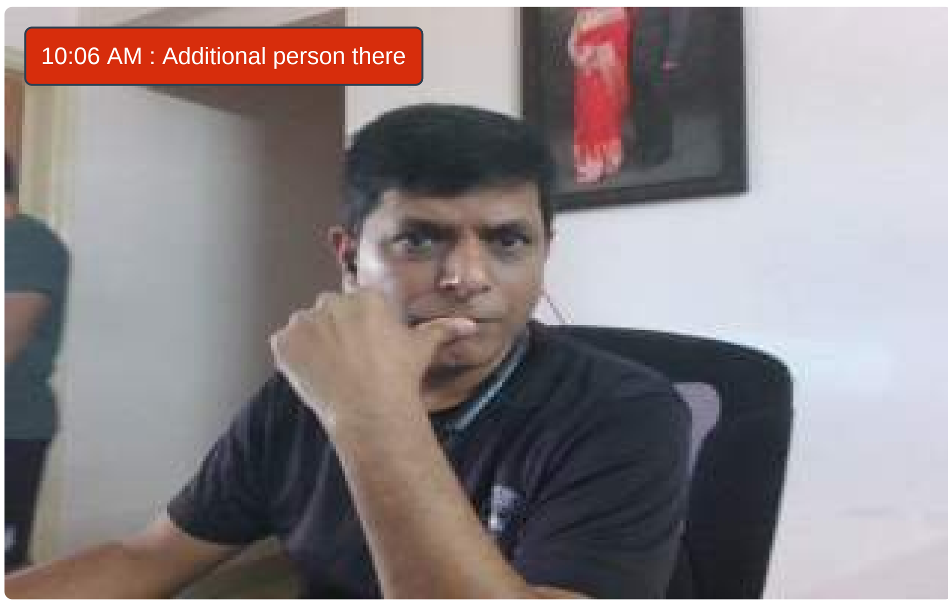
Credibility Index: LOW

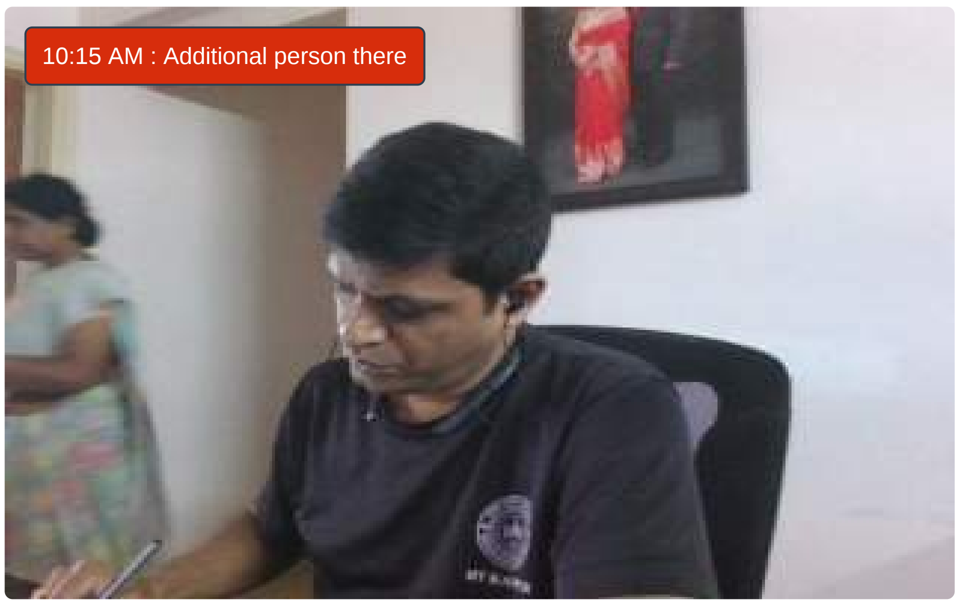
Profile Picture Snapshot

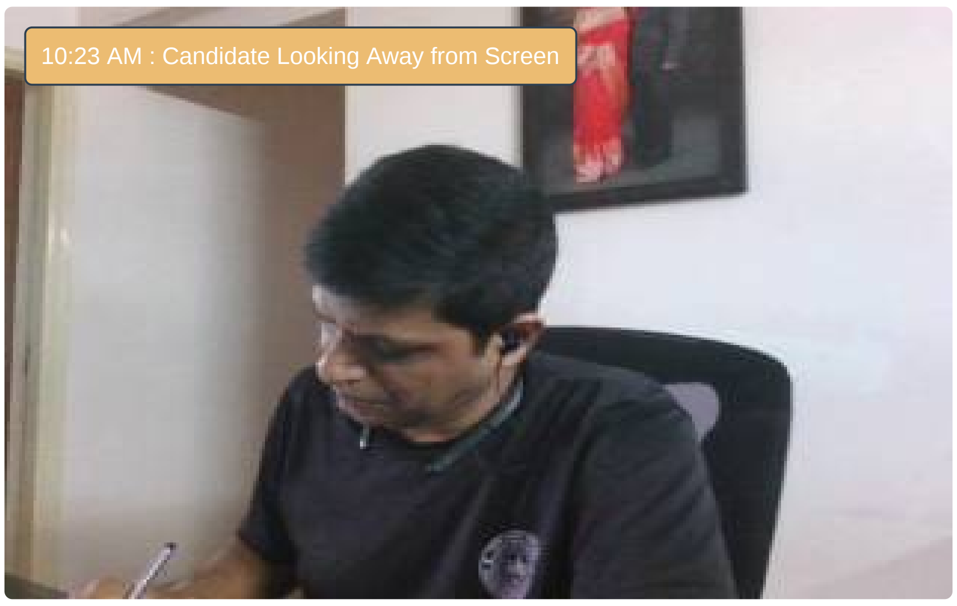
Identity Card Snapshot

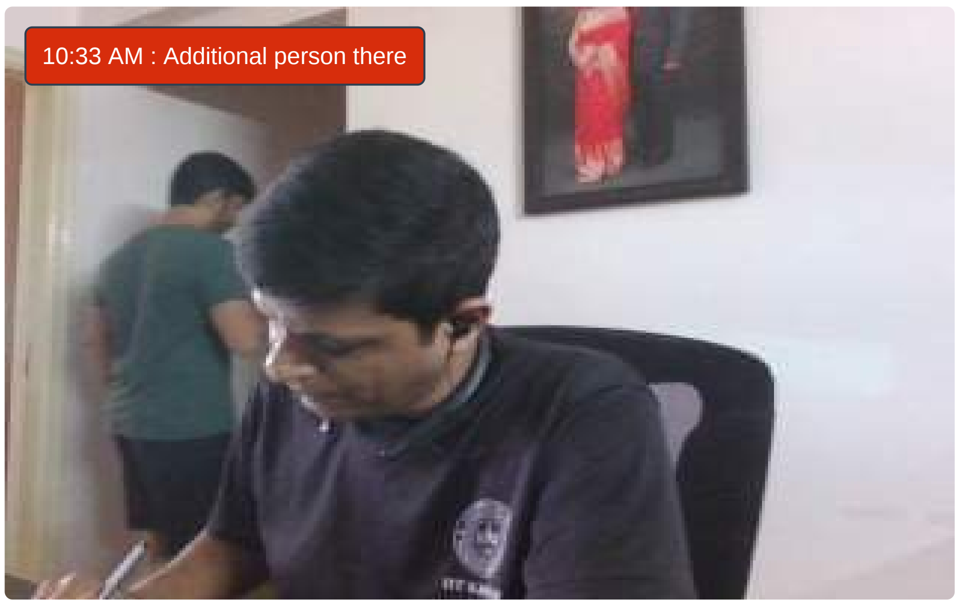
Images of Test-Taker

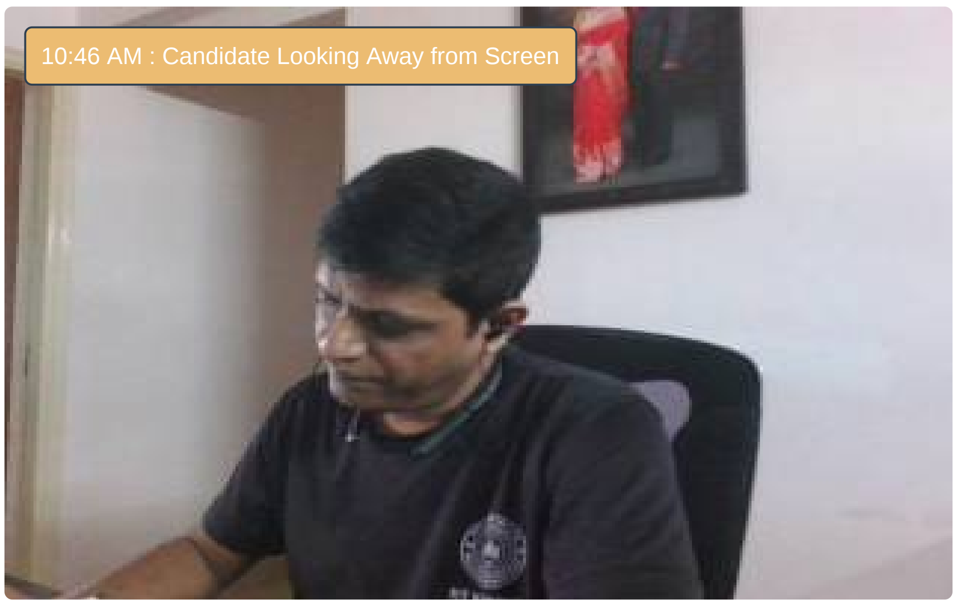


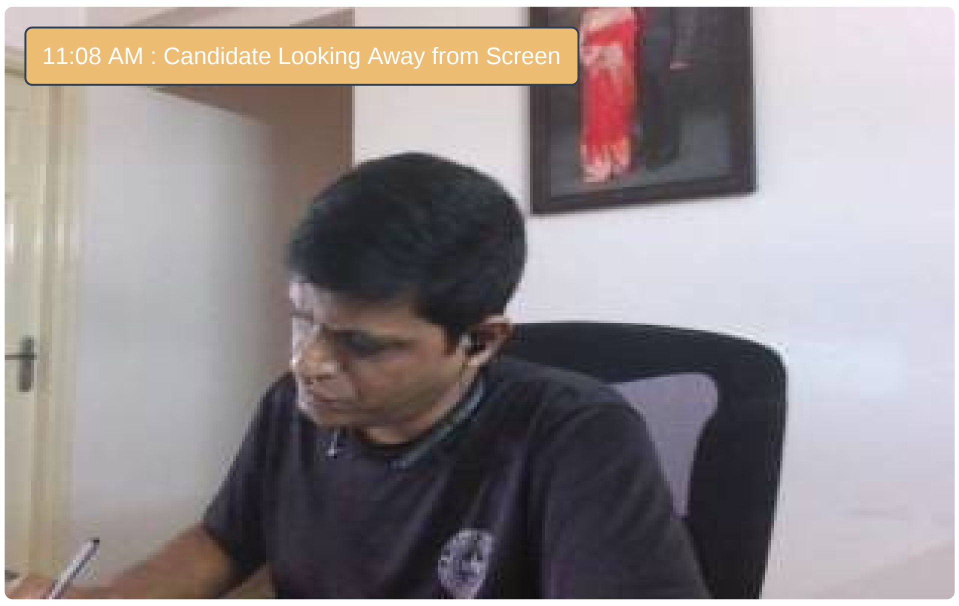


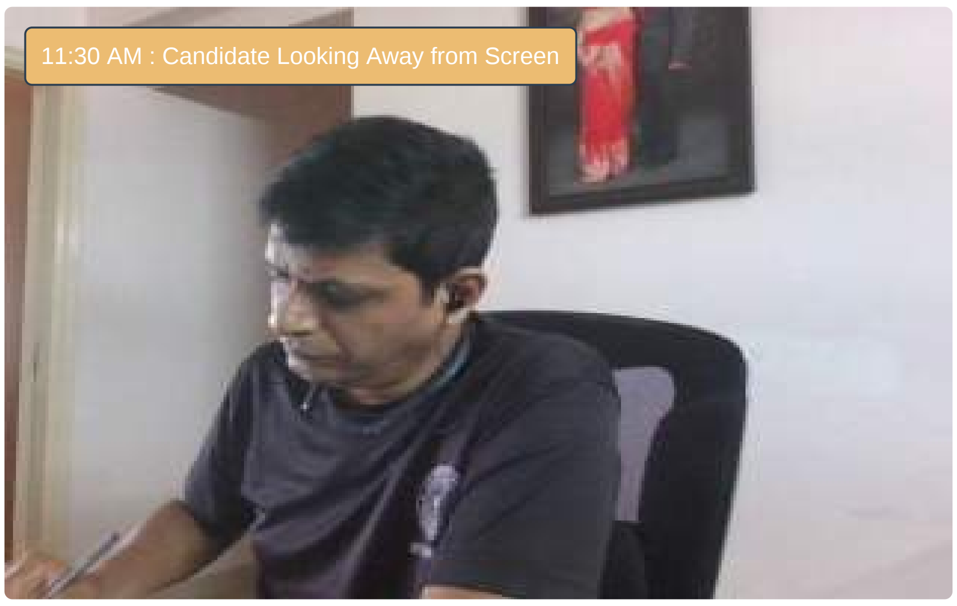


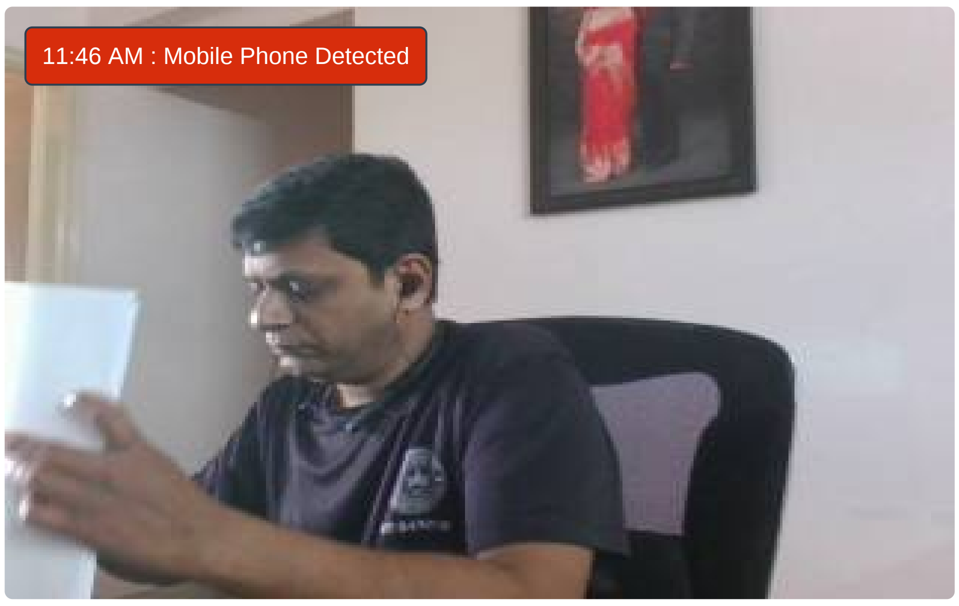


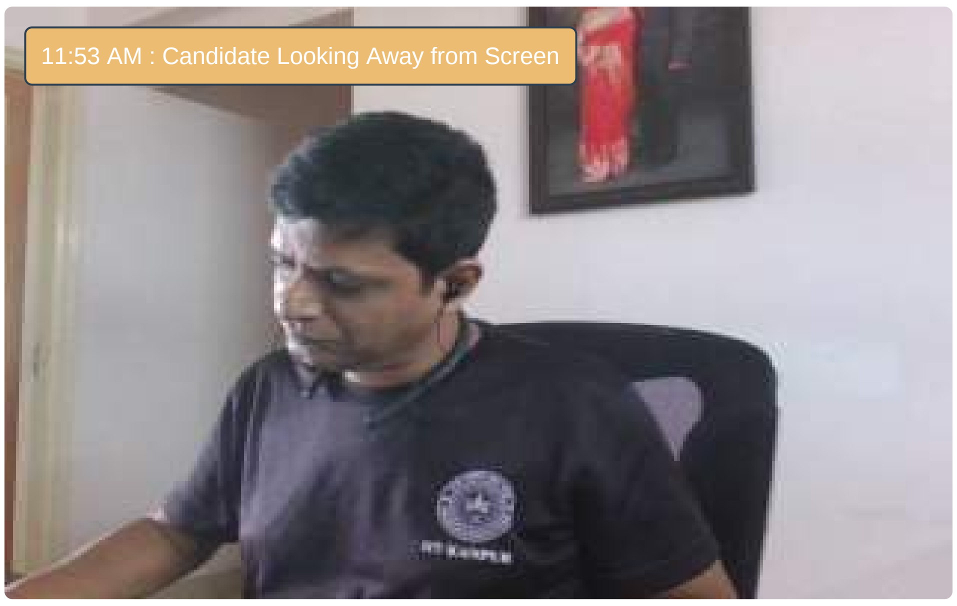


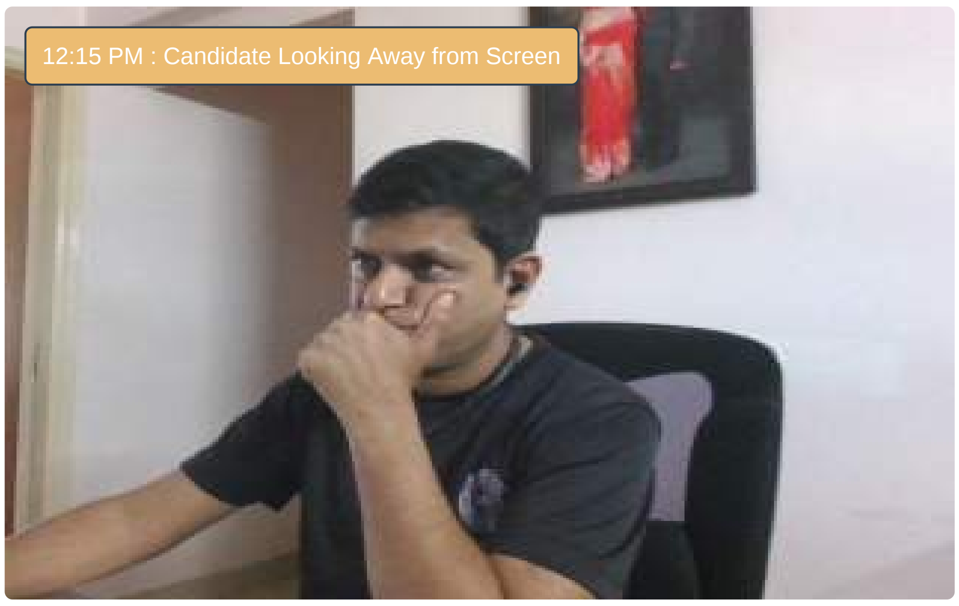


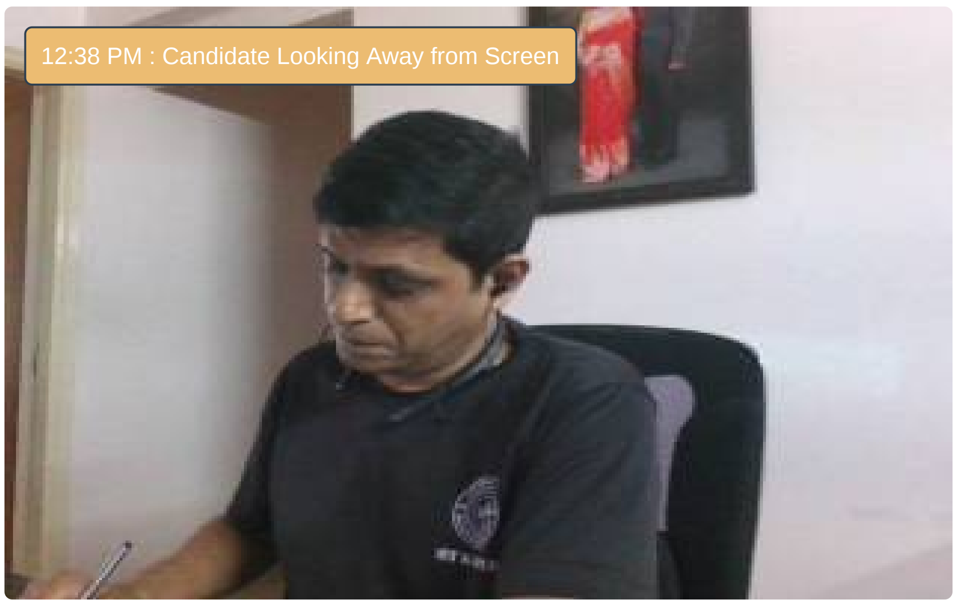

11:08 AM : Candidate Looking Away from Screen


11:30 AM : Candidate Looking Away from Screen


11:46 AM : Mobile Phone Detected


11:53 AM : Candidate Looking Away from Screen


12:15 PM : Candidate Looking Away from Screen


12:38 PM : Candidate Looking Away from Screen

About the Report