COURSE NAME:

Signal Processing for mm Wave communication for 5G and beyond

Assignment- week 9

Type of Questions: MCQ

Number of Questions: 10 Total Marks:10*1=10

1. The baseband equalizer in mmwave MIMO system data detection is not required for
   a) ML based detection algorithm.
   b) LMMSE based equalizer design.
   c) Least square based equalizer design.
   d) MRC based equalizer design.
   Correct option: a)
   Detailed solution: lecture 48.
2. Which of the following is not a design parameter?
   a) Digital precoder in transmitter.
   b) RF equalizer in the receiver.
   c) RF precoder in the transmitter.
   d) Wireless channel parameters between transmitter antenna and receiver antenna. Correct Option: d)
   Detailed Solution: lecture 47
3. The parameters in mm wave channel estimation are
   a) Angle of arrival.
   b) Angle of departure.
   c) Channel coefficients in a particular beam.
   d) All of the above.
   Correct option: d)
   Detailed solution: lecture 47.
4. Suppose we are sending a digital data stream **s** .The elements of **s** vector is coming from 5 different independent input data source. The diagonal entries of covariance matrix $\mathbf{R}_{ss}$ are
   a) 1.
   b) 0.
   c) Inner product of $\mathbf{ss}^{T}$**.**
   d) 5.

   Correct option: b)

Detailed solution: lecture 47

5. For a MIMO system, the data model is **y=Hx+w,** where **H** is the channel matrix. **Y,x,w** are respectively received signal vector, input signal vector and AWGN noise vector. $\mathbf{H^p}$ denotes the pseudo inverse of the channel matrix. $\mathbf{R_{yy}}$,$\mathbf{R_{xx}}$ and $\mathbf{R_{xy}}$ is the respective covariance matrix denoted by the vectors.The LMMSE based equalizer depends on
   a) $\mathbf{R_{yy}}$. and $\mathbf{H^p}$.
   b) $\mathbf{R_{xy}}$. and $\mathbf{H^p}$.
   c) $\mathbf{R_{yy}}$. and $\mathbf{R_{xy}}$.
   d) $\mathbf{R_{yy}}$. and $\mathbf{R_{xx}}$.

   Correct option: c)

   Detailed solution: Lecture 47

6. Which of the following is true for MSE?
   a) We are minimizing the cost function based on 2- norm only.
   b) We are minimizing the cost function which is the expectation value of 2 norm cost function.
   c) We are minimizing the expected value of 2 norm with the assumption that the estimated value will be a linear function of observed value.
   d) None of the above.
   Correct Option: b)
   Detailed solution: lecture 48.
7. What is the unit of channel capacity for unit bandwidth?
   i) Bits.
   ii) Bits/hertz.
   iii) (Bits/second)/hertz.
   iv) Bits*hertz.

   Correct option: iii)

   Detailed solution:

   Channel capacity= data rate/bandwidth= (Bits/second)/Hertz.

   Unit of data rate=Bits/second . Unit of Bandwidth=Hertz.

8. For a MIMO system, the data model is **y=Hx+w,** where **H** is the channel matrix of dimension 5×4. **y,x,w** are respectively received signal vector, input signal vector and AWGN noise vector. $\mathbf{H^p}$ denotes the pseudo

inverse of the channel matrix. $\mathbf{R_{yy}}$,$\mathbf{R_{xx}}$ and $\mathbf{R_{xy}}$ is the respective covariance matrix denoted by the vectors.The least square based equalizer depends on

a) $\mathbf{H^{-1}}$.
b) $\mathbf{H^{p}}$.
c) $\mathbf{R_{yy}}$. and $\mathbf{H^{p}}$.
d) $\mathbf{R_{yy}}$. and $\mathbf{R_{xx}}$.

Correct option:b)

Detailed solution: H matrix is rank deficient matrix, so for least square (a non Bayesian equalizer) it only depends on pseudo inverse as inverse does not exist.

For a MIMO system, the data model is **y=Hx+w,** where **H** is the channel matrix. **y,x,w** are respectively received signal vector, input signal vector and AWGN noise vector. . $\mathbf{R_{yy}}$,$\mathbf{R_{xx}}$,$\mathbf{R_{xy}}$ and $\mathbf{R_{ww}}$ is the respective covariance matrix denoted by the vectors.

9. The covariance matrix R_{xy} depends on
   a) R_{xx} ,R_{ww} and H.
   b) R_{ww} and H.
   c) R_{xx} and H.
   d) R_{ww} and R_{xx}.
   Correct Option: c)
   Detailed solution: $R_{xy}=E[x(Hx+w)^*]=R_{xx}H^*$.
10. The covariance matrix R_{yy} depends on

    a) R_{xx} ,R_{ww} and H.

    b) R_{ww} and H.

    c) R_{xx} and H.

    d) R_{ww} and R_{xx}.

    Correct option: a)

    Detailed solution: $R_{yy}=E[(Hx+w)(Hx+w)^*]$. Calculate the expectation to see all the terms in option **a)** are in the covariance matrix.