

# Unit 6 - Week 5 - BER Performance in Fading Channels

**Course outline**

- How to access the portal
- Overview of Cellular Evolution and Wireless Technologies
- Wireless Propagation and Cellular Concepts
- Cellular System Design, Capacity, Handoff, and Outage
- Week 4 - Multipath Fading Environment
- Week 5 - BER Performance in Fading Channels
  - Coherent versus Differential Detection
  - Review of Lec 1-19
  - Coherent vs Differential Detection - Part II and BER in Fading
  - BER in Fading - Part II, Ricean Fading
  - Ricean and Nakagami Fading, Moment Generating Function (MGF)
  - Lec20\_notes
  - Lec21\_notes
  - Lec21b\_notes
  - Lec22\_notes
  - Lec23\_notes
  - Week 5 Feedback : Introduction to Wireless and Cellular Communications
  - Assignment 5 Solutions
  - Quiz : Assignment 5
- Week 6 - Wide Sense Stationary Uncorrelated Scattering (WSSUS) Channel Model
- Week 7 - Computer simulation of Rayleigh fading, Antenna Diversity
- Week 8 - Fading Channels - Diversity and Capacity
- Week 9 - Capacity and Introduction to CDMA
- Week 10 - Introduction to CDMA
- Week 11 - CDMA Receivers
- Week 12
- Text Transcription
- DOWNLOAD VIDEOS

## Assignment 5

The due date for submitting this assignment has passed. **Due on 2019-09-04, 23:59 IST.**  
 As per our records you have not submitted this assignment.

- A mobile communication system uses a DBPSK modulation scheme (Tx sends 0 at the beginning of the transmission). Bit 0 is transmitted with phase 1 point and Bit 1 is transmitted with phase. If the following binary stream of data 0,0,1,1,0,1,1 has to be conveyed to the receiver. Which of the following is the correct bit stream that is sent to the transmitter after the Differential modulation?

0,0,0,1,0,0,1  
 0,0,0,1,0,1,1  
 1,1,1,0,1,1,0  
 1,1,1,0,1,0,0

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: 0,0,0,1,0,0,1
- Consider a system that uses coherent QPSK modulation and detection scheme with 20 us symbol period for communication. The channel has a coherence time of 10 ms. If 100 symbols are being used for the purpose of channel estimation find the data rate?

160 kbps  
 100 kbps  
 80 kbps  
 40 kbps

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: 80 kbps
- Which of the following can result in catastrophic error propagation?

Coherent modulation and coherent detection.  
 Differential modulation and differential detection.  
 Differential detection and coherent modulation.  
 Coherent modulation and differential detection.

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: Coherent modulation and differential detection.
- In QPSK, assuming  $E_b/N_0 = 8dB$ , evaluate  $P_b$  (BER) using exact expression. In QPSK, assuming  $E_b/N_0 = 8dB$ , evaluate  $P_b$  (BER) using exact expression.

$3.17 \times 10^{-5}$   
  $1.92 \times 10^{-4}$   
  $2.87 \times 10^{-7}$   
  $8.16 \times 10^{-4}$

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers:  $1.92 \times 10^{-4}$
- In the previous question, find the  $P_s$  (SER) using exact expression. One QPSK symbol consists of two BPSK bits. Use this definition and probability concepts to calculate the Symbol error rate.

$6.34 \times 10^{-5}$   
  $3.84 \times 10^{-4}$   
  $5.74 \times 10^{-7}$   
  $1.63 \times 10^{-3}$

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers:  $3.84 \times 10^{-4}$
- If  $P_e$  denotes the probability of bit error then the probability of bit correctly recovered is  $(1 - P_e)$ . What is the probability that two independent bits are recovered without any error?

$1 - P_e^2$   
  $1 - 2P_e$   
  $P_e(1 - P_e)$   
  $(1 - P_e)^2$

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers:  $(1 - P_e)^2$
- Calculate the BER of Differential BPSK if SNR = 8 dB. Assume only AWGN with no fading.

$8.5 \times 10^{-4}$   
  $1.92 \times 10^{-4}$   
  $9.1 \times 10^{-4}$   
  $1.5 \times 10^{-2}$

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers:  $9.1 \times 10^{-4}$
- Calculate the BER of Coherent BPSK if average SNR = 10dB. Assume Rayleigh fading environment.

0.015  
 0.044  
 0.050  
  $7.83 \times 10^{-4}$

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: 0.044
- What is the Rice factor (k) for a channel with no Line of Sight (LOS) component?

0  
 1  
 2  
 3

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: 0
- How does the Rice factor (k) change with a decrease in the power of Line of Sight (LOS) component?

Increase  
 Decrease  
 Remains constant  
 Cannot say

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: Decrease
- Which of the following gives rise to statistics similar to that of a Rayleigh pdf?

a) Rician distribution with rice factor (k) = 0  
 b) Rician distribution with rice factor (k) = 1  
 c) Nakagami-m distribution with m = 1/2  
 d) Both (a) and (c)

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: a) Rician distribution with rice factor (k) = 0
- What is the most appropriate multipath model for cellular transmission, where a dominant line-of-sight plus many weak reflections are present?

Rayleigh fading  
 Rician fading  
 Nakagami fading  
 None of the above

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: Rician fading
- Consider a GMSK system with SNR = 15 dB. What should be the SNR in dB of a BPSK system such that the Bit Error Rate remains same as that of the GMSK system? Assume AWGN channel.

8.45  
 9.65  
 10.21  
 15

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: 10.21
- An  $m \times n$  interleaver takes  $mn$  bits as input (code-bits), inserts them column-wise into an  $m \times n$  matrix, and the output bits (Tx bits) are produced by reading the elements of this matrix row-wise. Consider a  $4 \times 5$  interleaver at the transmitter. Which of the following blocks can deinterleave (reverse-process of interleaving) the Tx bits at the receiver.

Any  $i \times j$  interleaver such that  $ij = 20$   
  $4 \times 5$  interleaver  
  $5 \times 4$  interleaver  
 None of the above

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers:  $5 \times 4$  interleaver
- Let's say 12 code-bits (c0, c1, c2, ..., c11) are passed through a  $3 \times 4$  interleaver and the output bits (t0, t1, t2, ..., t11) are transmitted using BPSK modulation. Due to momentary bad-channel condition, bits t2, t3, t4 are corrupted by the channel. What are the code-bits that are obtained incorrectly at the receiver after deinterleaving?

c2, c3, c4  
 c1, c4, c8  
 c1, c4, c7  
 c6, c9, c1

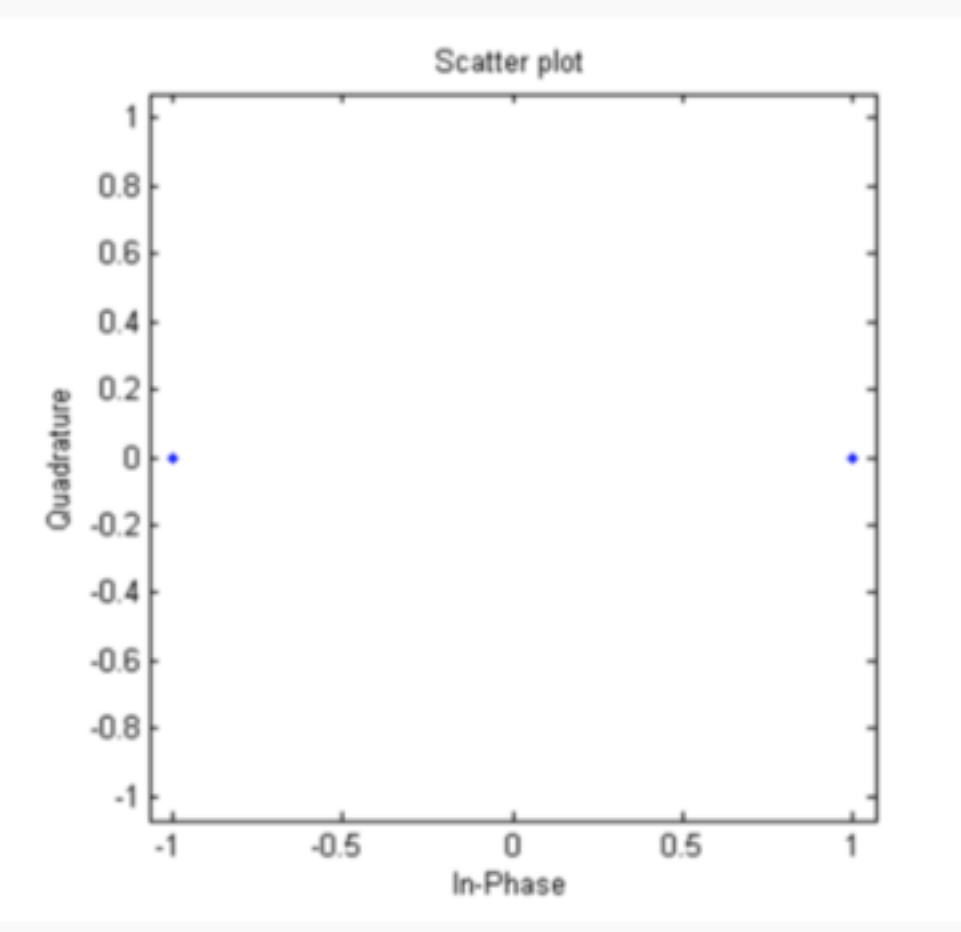
No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: c6, c9, c1
- A 1-error correcting (n, k) FEC (Forward Error Correction) decoder takes in 'n' code-bits at a time and corrects upto '1' bit errors, if present in the n-bit codeword. An m-bit burst error occurs when the channel occasionally goes into a fading below acceptable level, corrupting m consecutive bits. Consider a 2-error correcting (7, 4) FEC decoder at the receiver. Let's say 28 bits were transmitted into the channel and received at the receiver. What is the maximum length of burst error that can be definitely corrected at the receiver, if there is no interleaver?

28  
 8  
 14  
 2

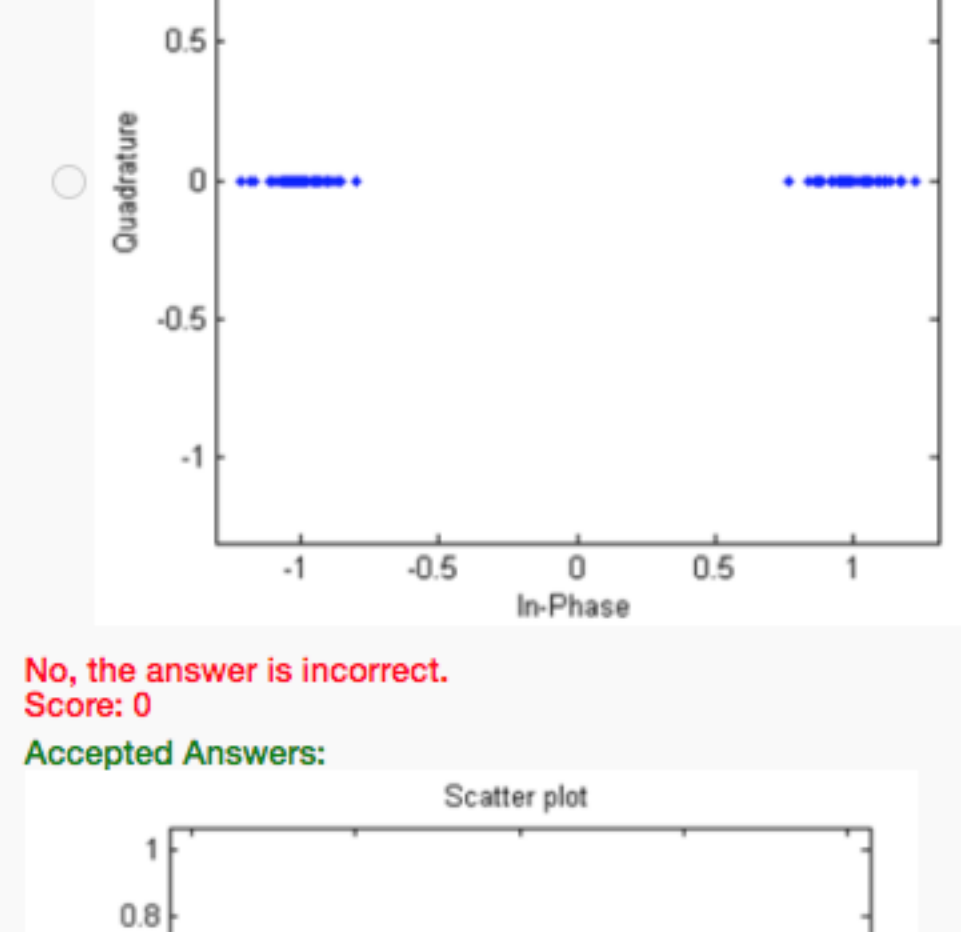
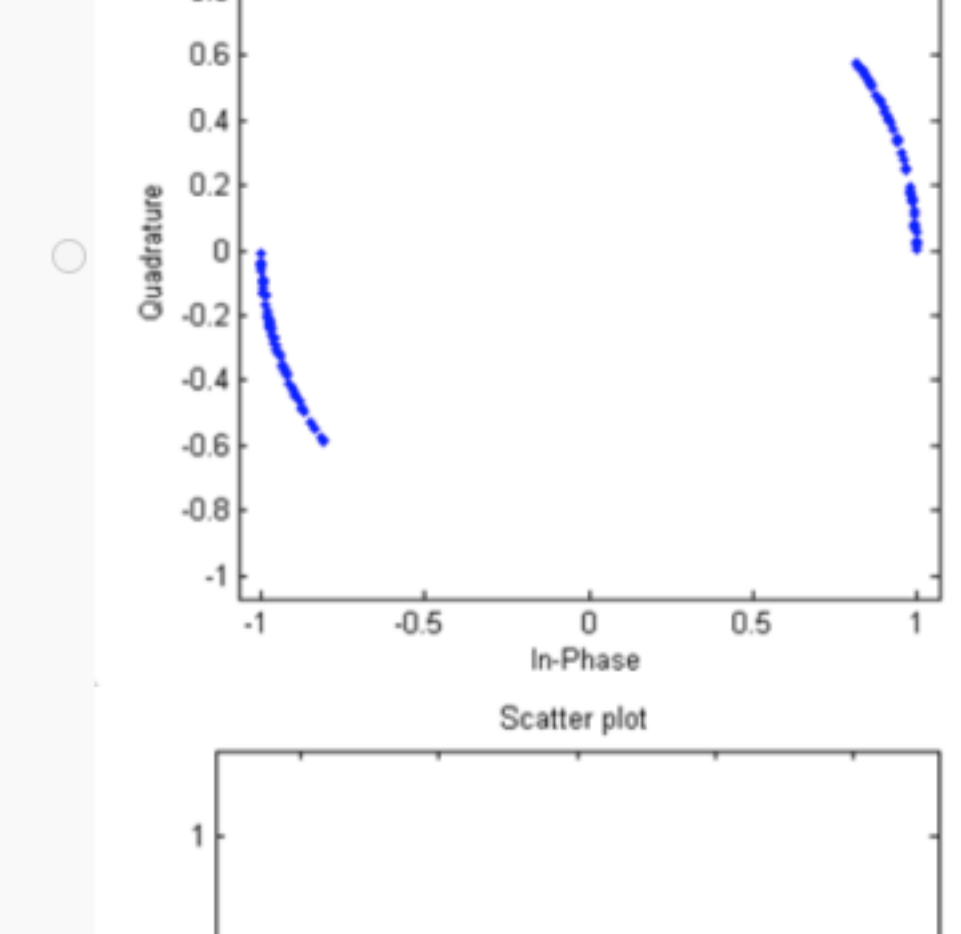
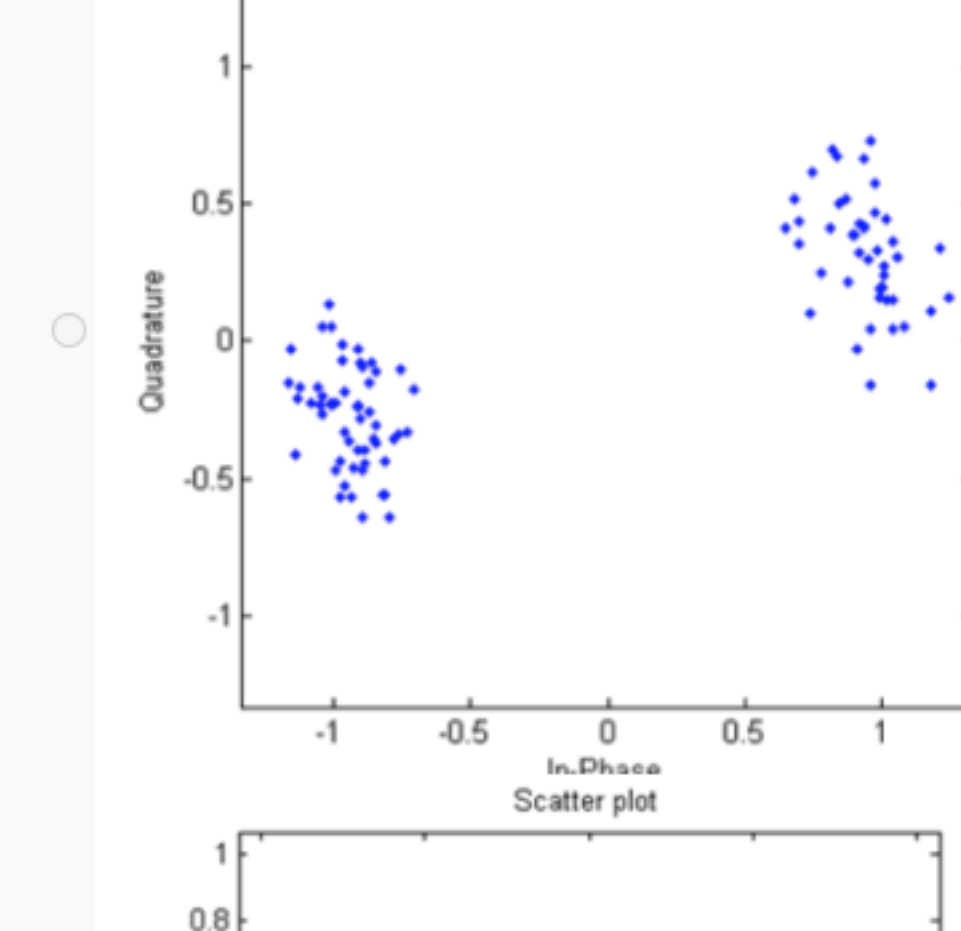
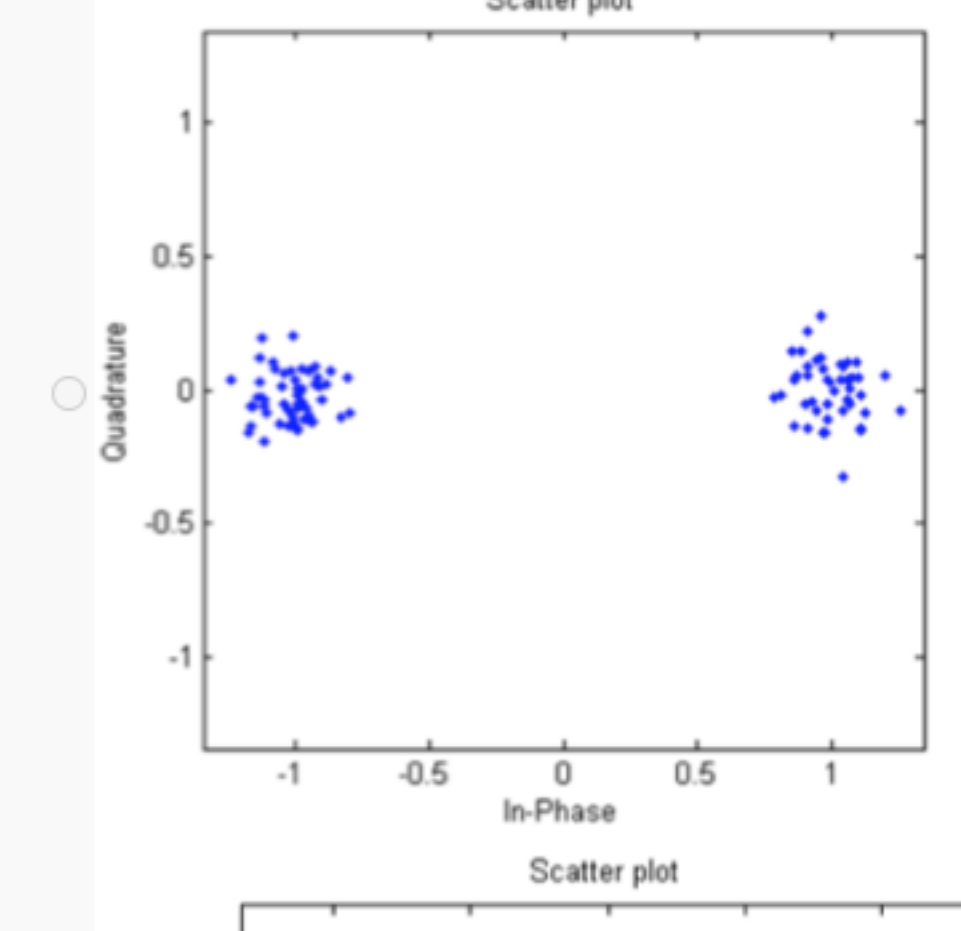
No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: 2
- How will the answer change for the above question if we introduce a  $7 \times 4$  interleaver at the transmitter and corresponding deinterleaver at the receiver? What will be the maximum length of burst error that can surely be corrected at the Rx now?

28  
 8  
 14  
 2

No, the answer is incorrect.  
 Score: 0  
 Accepted Answers: 8
- A BPSK modulation transmits a symbol '+1' or '-1' in one period. A constellation diagram is a plot of the complex modulated symbols in the complex z-plane (real-part/In-Phase vs imaginary-part/Quadrature). Shown below is the constellation of 100 BPSK symbols (+1,-1,-1,+1,-1, ...) that were sent into the channel at the transmitter.



How will this constellation look for the 100 symbols at the receiver, if these BPSK symbols are affected by a Doppler shift? (Assume that Doppler shift is the only impairment => No channel/other impairments, not even path-loss!). Which of the below plots best represents the effect of Doppler shift on BPSK?



No, the answer is incorrect.  
 Score: 0  
 Accepted Answers:

