

EEC 382 - Introduction to Digital Communication

Information Theory MCQ Questions



Taha Ahmed

MCQ Questions

1. Q Which of the following describes an information source in the context of communication systems?

- (a) A physical medium used for signal transmission
- (b) The destination that reproduces the information output
- (c) A device that generates messages to one or more destinations
- (d) The statistical distribution of the transmitted signal

1. A (c)

2. Q What does a communication channel do in a communication system?

- (a) Generates messages to be transmitted
- (b) Determines the statistical distribution of the transmitted signal
- (c) Corrupts the transmitted signal in a random manner
- (d) Reproduces the information output at the destination

2. A (c)

3. Q What is the main objective of a communication engineer in designing a transmitter and receiver?

- (a) Controlling the information stores
- (b) Decreasing the resistance of the transmitted signal to destination noise
- (c) Matching the output of the channel to the destination
- (d) Increase the performance of the system by decreasing the channel noise

3. A (c)

4. Q What is the main objective of information theory?

- (a) Analyzing physical sources and physical channels
- (b) Finding the fundamental limits of communication
- (c) Reproducing messages at one point from another point
- (d) Compressing the source to minimize the required number of bits

4. A (b)

5. Q What does Shannon's concept of entropy in information theory?

- (a) The minimum rate at which the source can be compressed and still be recoverable from c
- (b) The maximum rate at which information can be reliably transmitted
- (c) The amount of information the source has
- (d) The fundamental problem in communication

5. A (a)

6. Q What does channel capacity represent in information theory?

- (a) The maximum rate at which information can be compressed
- (b) The minimum rate at which the source can be recovered from a compressed version
- (c) The fundamental problem in communication
- (d) The maximum rate at which information can be reliably transmitted

6. A (d)

7. Q If the information source is predictable, then

- Ⓐ No need to transmit the information
- Ⓑ Entropy is maximum
- Ⓒ Compression is not possible
- Ⓓ All of the above

7. A (a)

8. Q The entropy for the fair coin

- Ⓐ 0
- Ⓑ $\frac{1}{2}$
- Ⓒ 1
- Ⓓ 2

8. A (c)

9. Q The entropy for a completely biased coin

- Ⓐ 0
- Ⓑ $\frac{1}{2}$
- Ⓒ 1
- Ⓓ 2

9. A (a)

10. Q Can we send the output of an information source through a channel?

- (a) Yes, if the entropy is less than the capacity
- (b) Yes, if the entropy is greater than the capacity
- (c) No, regardless of the entropy
- (d) It depends on the specific characteristics of the information source

10. A (a)

11. Q The impossible event needs at least a/an number of bits to be encoded

- (a) zero
- (b) 1
- (c) depends on the probabilities of the other events
- (d) infinity

11. A (d)

12. Q What does the entropy of a discrete random variable measure in information theory?

- (a) The expected value of self-information for all symbols
- (b) The maximum rate at which information can be reliably transmitted
- (c) The amount of information can the channel transmit
- (d) None of the above

12. A (a)

13. Q How does the information content relate to the probability of an event?

- (a) It remains constant regardless of the probability
- (b) It decreases as the probability decreases
- (c) It increases as the probability decreases
- (d) It is a discrete function of probabilities

13. A (c)

14. Q Entropy is a function of

- (a) probability but not of realization
- (b) realization but not of probability
- (c) both probability and realization
- (d) neither probability nor realization

14. A (a)

15. Q Maximum uncertainty is symmetric channel occurs when

- (a) $P_e = 0$
- (b) $P_e = 0.5$
- (c) $P_e = 1$
- (d) $P_e = H_b(1)$

15. A (b)

16. Q $P_e = 1$ means that probability of error equals 1, hence recovery of the original message is impossible.

- (a) True
- (b) False

16. A (b)

17. Q What does the joint entropy $H(X, Y)$ represent?

- (a) Uncertainty on the vector X plus the uncertainty on the vector Y
- (b) Total certainty on the vectors (X, Y) together
- (c) Total uncertainty on the vectors (X, Y) together
- (d) Mutual information between X and Y

17. A (c)

18. Q What is the equation for joint entropy $H(X, Y)$?

- (a) $H(X, Y) = \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2 p(x, y)$
- (b) $H(X, Y) = \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2(1 + p(x, y))$
- (c) $H(X, Y) = - \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2 p(x, y)$
- (d) $H(X, Y) = - \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2(1 + p(x, y))$

18. A (c)

19. Q If X and Y are independent random variables, what is the relationship between their joint entropy $H(X, Y)$ and their individual entropies $H(X)$ and $H(Y)$?

- (a) $H(X, Y) = H(X) - H(Y)$
- (b) $H(X, Y) = H(X) + H(Y)$
- (c) $H(X, Y) = H(X) \cdot H(Y)$
- (d) $H(X, Y) = \log_2(H(X) + H(Y))$

19. A (b)

20. Q What property does entropy have for independent sources?

- (a) It is subtractive
- (b) It is multiplicative
- (c) It is additive
- (d) It is logarithmic

20. A (c)

21. Q What does the conditional entropy measure?

- (a) Uncertainty on the vector X plus the uncertainty on the vector Y
- (b) Total certainty on the vectors (X, Y) together
- (c) The remaining uncertainty of random variable Y after observing random variable X
- (d) Mutual information between X and Y

21. A (c)

22. Q What is the equation for conditional entropy $H(Y|X)$?

- Ⓐ $H(Y|X) = \sum_{x \in X} \sum_{y \in Y} p(x|y) \log_2 p(y, x)$
- Ⓑ $H(Y|X) = \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2 p(y|x)$
- Ⓒ $H(Y|X) = - \sum_{x \in X} \sum_{y \in Y} p(x|y) \log_2 p(y, x)$
- Ⓓ $H(Y|X) = - \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2 p(y|x)$

22. A (d)

23. Q What is the equation used to calculate entropy in information theory?

- Ⓐ $H(x) = - \sum_{x \in \chi} P(x) \log P(x)$
- Ⓑ $H(x) = \sum_{x \in \chi} P(x) \log P(x)$
- Ⓒ $H(x) = \sum_{x \in \chi} P(x) / \log P(x)$
- Ⓓ $H(x) = - \sum_{x \in \chi} P(x) / \log P(x)$

23. A (a)

24. Q Find the entropy of the random variable X with PMF

$$P(x) = \begin{cases} \frac{1}{2} & x = 1 \\ \frac{1}{4} & x = 2 \\ \frac{1}{4} & x = 3 \end{cases}$$

- Ⓐ 1 bit
- Ⓑ 1.5 bit
- Ⓒ 2 bit
- Ⓓ 2.5 bit

24. A (b)

$$H(x) = - \sum_{x \in \mathcal{X}} P(x) \log P(x) = - \left(\frac{1}{2} \log_2 \frac{1}{2} + \frac{1}{4} \log_2 \frac{1}{4} + \frac{1}{4} \log_2 \frac{1}{4} \right) = 1.5 \text{ bits}$$

25. Q Find the entropy of the random variable X with PMF $P(x) = 2^{-x}$ for $x \in \{1, 2, 3, \dots\}$

- Ⓐ 1 bit
- Ⓑ 1.5 bit
- Ⓒ 2 bit
- Ⓓ 2.5 bit

25. A (c)

$$H(x) = - \sum_{x \in \chi} P(x) \log P(x) = - \sum_{x=1}^{\infty} 2^{-x} \log_2 2^{-x}$$

$$\sum_{x=1}^{\infty} x \left(\frac{1}{2}\right)^x = \frac{\frac{1}{2}}{\left(1 - \frac{1}{2}\right)^2} = 2 \text{ bits}$$

Note :

$$\sum_{x=0}^{\infty} r^x = \frac{1}{1-r} \quad (1)$$

$$\sum_{x=0}^{\infty} x r^x = \frac{r}{(1-r)^2} \quad (2)$$

26. Q $H(x)$ is when X is uniformly distributed, and equals

- (a) maximum, $\log_2 M$
- (b) maximum, $1/M \log_2 1/M$
- (c) minimum, $\log_2 M$
- (d) minimum, $1/M \log_2 1/M$

26. A (a)

27. Q When the source is deterministic, the entropy equals

- (a) 0
- (b) 1
- (c) $\log_2 M$
- (d) $\log_2 M$

27. A (a)

28. Q In binary symmetric channels, the minimum entropy is 0. and happens when $P(x) = \dots\dots\dots$

- (a) 0
- (b) 1
- (c) $\frac{1}{2}$
- (d) (a) and (b)

28. A (d)

29. Q In binary symmetric channels, the maximum entropy is $\dots\dots\dots$ and happens when $P(x) = \dots\dots\dots$

- (a) 1, 0
- (b) $1, \frac{1}{2}$
- (c) 2, 0
- (d) $2, \frac{1}{2}$

29. A (b)

30. Q

$$P(x) = \begin{cases} \frac{1}{2} & x = a \\ \frac{1}{4} & x = b \\ \frac{1}{8} & x = c \\ \frac{1}{8} & x = d \end{cases}$$

is 1.75 bits, what of the following considered an efficient code

- (a) a = 0, b = 111, c = 110, d = 101
- (b) a = 0, b = 10, c = 110, d = 111
- (c) a = 10, b = 101, c = 110, d = 011
- (d) a = 101, b = 11, c = 10, d = 111

30. A (b)

Calculate the average length of each code, the only code of length matches the entropy is (b)

$$\mathbb{E}[L] = \sum P_i \ell_i = \frac{1}{2} \times 1 + \frac{1}{4} \times 2 + \frac{1}{8} \times 3 + \frac{1}{8} \times 3$$

31. Q Which of these are true ?

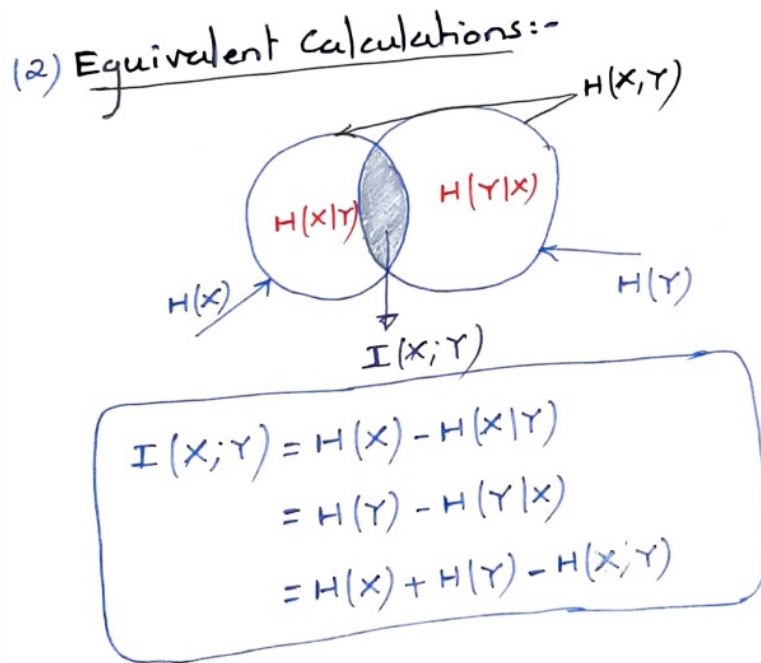
- (a) $H(Y|X) \neq H(X|Y)$
- (b) $H(Y|X) = H(X|Y)$

31. A (a)

32. Q What does the chain rule in information theory state?

- (a) $H(X, Y) = H(X) + H(Y)$
- (b) $H(X, Y) = H(X) \cdot H(Y)$
- (c) $H(X, Y) = H(Y|X) \cdot H(Y)$
- (d) $H(X, Y) = H(X) + H(Y|X)$

32. A (d)



33. Q What does the source coding theorem establish?

- (a) The maximum number of bits the channel can transmit without error
- (b) The minimum number of bits the channel can transmit without error
- (c) The maximum number of bits required to represent a source
- (d) The minimum number of bits required to represent a source

33. A (d)

34. Q What does L_T represent in the source coding theorem equation $R = \frac{L_T}{n}$?

- (a) The total length of the codeword
- (b) The number of source symbols
- (c) The error probability in source coding
- (d) The minimum error probability in source coding

34. A (a)

35. Q What is the condition for encoding the source output with an arbitrarily small error probability?

- (a) $R \geq H(X)$
- (b) $R \leq H(X)$
- (c) $R = H(X)$
- (d) $R = 0$

35. A (a)

36. Q The source coding theorem specifies a practical algorithm for source coding.

- (a) True
- (b) False

36. A (b)

37. Q What defines typical sequences in information theory?

- (a) Sequences that have a high probability of occurrence
- (b) Sequences that have a low probability of occurrence
- (c) Sequences whose empirical distribution matches their statistical distribution
- (d) Sequences whose empirical distribution is greater than their statistical distribution

37. A (c)

38. Q if $P(X_n = 1) = 0.1$, then 1000101101 is, while 0000100000 is

- (a) non typical sequence, non typical sequence
- (b) non typical sequence, typical sequence
- (c) typical sequence, non typical sequence
- (d) typical sequence, typical sequence

38. A (b)

39. Q All sequences from the source are typical as

- (a) $n \rightarrow \infty$
- (b) $n \rightarrow 0$
- (c) $n \rightarrow 1$
- (d) $n \rightarrow H(X)$

39. A (a)

40. Q A good designer of a source encoder should design a code that is uniquely decodable, average codeword length is maximum and the code is binary.

- (a) True
- (b) False

40. A (b)

41. Q What does the average codeword length in a source coding scheme depend on?

- (a) The entropy of the original message
- (b) The probability of each message
- (c) The efficiency of the code
- (d) The number of source symbols

41. A (b)

42. Q What does the efficiency of a code measure?

- (a) The minimum length of the codeword divided by the entropy of the codeword
- (b) The average length of the codeword divided by the entropy of the codeword
- (c) The average length of the codeword divided by the minimum length of the codeword
- (d) The minimum length of the codeword divided by the average length of the codeword

42. A (d)

43. Q What is unique decodability in coding theory?

- Ⓐ The ability to uniquely identify each source symbol
- Ⓑ The property of having a one-to-one correspondence between codewords and messages
- Ⓒ The requirement for only one way to parse the encoded binary sequence
- Ⓓ The guarantee of error-free transmission in the decoding process

43. A (c)

44. Q What is the advantage of instantaneous codes in source coding problems?

- Ⓐ They minimize the delay in the decoding process
- Ⓑ They ensure error-free transmission of the decoded sequence
- Ⓒ They allow for unique decodability of the original message
- Ⓓ They reduce the average codeword length in the coding scheme

44. A (a)

45. Q What type of codes are necessary to achieve instantaneous coding?

- Ⓐ Prefix codes
- Ⓑ Suffix codes
- Ⓒ Variable-length codes
- Ⓓ Fixed-length codes

45. A (a)

46. Q Instantaneous codes are not necessarily for the useless source coding problems, however they are a nice property to have.

- ☐ a True
- ☐ b False

46. A (a)

47. Q What property defines a prefix code?

- ☐ a All codewords have the same length
- ☐ b Each codeword is a prefix of another codeword
- ☐ c No codeword is a prefix of any other codeword
- ☐ d All codewords have the same number of ones and zeros

47. A (c)

48. Q 0, 10, 110, 111 is a prefix code.

- ☐ a True
- ☐ b False

48. A (a)

49. Q A Huffman code is instantaneous prefix code, uniquely decodable, with minimum average codeword length.

- ☐ a True
- ☐ b False

49. A (a)

50. Q Huffman code is unique .

- (a) True
- (b) False

50. A (b)

51. Q If the designer of a communication system has a small memory in the decoder, it is better while designing the huffman code to

- (a) combined symbol is placed as high as possible, to decrease the variance of the codeword length
- (b) combined symbol is placed as low as possible, to decrease the variance of the codeword length
- (c) combined symbol is placed as high as possible, to increase the variance of the codeword length
- (d) combined symbol is placed as low as possible, to increase the variance of the codeword length
- (e) No matter where the combined symbol is placed, the variance of the codeword length will remain the same

51. A (a)

52. Q What does the channel coding theorem characterize?

- (a) The maximum rate of information that can be communicated over a noisy channel
- (b) The minimum rate of information that can be communicated over a noisy channel
- (c) The maximum error probability of communication over a noisy channel
- (d) The minimum error probability of communication over a noisy channel

52. A (a)

53. Q The first step a good designer of a channel encoder should do is to reduce the probability of error of the channel.

- ☐ (a) True
- ☐ (b) False

53. A (b)

54. Q The compact disc (CD) is a valid example on a channel .

- ☐ (a) True
- ☐ (b) False

54. A (a)

55. Q What is the channel capacity?

- ☐ (a) The minimum error probability of a noisy channel
- ☐ (b) The maximum error probability of a noisy channel
- ☐ (c) The minimum rate of information that can be communicated over a noisy channel
- ☐ (d) The maximum rate of information that can be communicated over a noisy channel

55. A (d)

56. Q According to the channel coding theorem, reliable communication is possible if and only if:

- (a) The rate of the code is greater than the channel capacity
- (b) The rate of the code is equal to the channel capacity
- (c) The rate of the code is less than the channel capacity
- (d) The rate of the code is equal to the entropy

56. A (c)

57. Q For a noisy channel, the probability of error P_e will be always bounded away from zero.

- (a) True
- (b) False

57. A (b)

The channel coding theorem states that for a noisy channel, reliable communication is possible if and only if the rate of the code is less than the channel capacity. $R < C$

58. Q The noisy typewriter problem involves a typewriter that produces errors when typing characters. Which of the following statements accurately describes the relationship between the code rate and the error probability in this problem?

- (a) Increasing the code rate reduces the error probability.
- (b) Increasing the code rate increases the error probability.
- (c) Introducing more symbols to represent the input reduces the error probability.
- (d) Symbols with higher entropy can be affected during the transmission more than symbols with lower entropy

58. A (b)

59. Q Which statement best describes the essence of the channel coding theorem?

- (a) Using identical inputs for channel coding achieves lower error probability.
- (b) Choosing inputs with overlapping output sequences ensures reliable communication.
- (c) Using inputs with disjoint output sequences helps achieve lower error probability.
- (d) Choosing inputs that are close together under channel operations guarantees reliable communication.

59. A (c)

60. Q How is the transmission rate defined in a coding system?

- (a) The ratio of message bits to codeword bits
- (b) The number of bits in the codeword
- (c) The maximum number of messages that can be transmitted over the channel
- (d) The optimal probability distribution for message transmission

60. A (a)

$$R = \frac{k}{n}$$

61. Q What does the term “optimization problem” refer to in the context of capacity calculation?

- (a) Finding the maximum reliable rate by choosing the best probability distribution
- (b) Minimizing the number of bits in the codeword relative to the average codeword length
- (c) Maximizing the number of messages that can be transmitted
- (d) Selecting the optimal channel extension for maximum capacity

61. A (a)

62. Q What does the capacity calculation in a discrete memoryless system focus on?

- (a) Optimizing the number of bits in the codeword
- (b) Selecting the optimal channel extension for maximum capacity
- (c) Maximizing the entropy of messages that can be transmitted
- (d) Choosing the best probability distribution for message transmission

62. A (d)

63. Q Which equation represents the capacity of an AWGN channel?

- (a) $C = \frac{1}{2} \log_2(1 + \frac{P}{\sigma_n^2})$
- (b) $C = \frac{1}{2} \log_2(2\pi e \sigma^2)$
- (c) $h(x) \leq \frac{1}{2} \log_2(2\pi e \sigma^2)$
- (d) $R = \frac{k}{n}$

63. A (a)

64. Q What is the maximum value of the differential entropy for a continuous random variable X with zero mean and variance σ^2 ?

- (a) $\frac{1}{2} \log_2(2\pi e \sigma^2)$
- (b) $\log_2(\sigma^2)$
- (c) $\frac{1}{2} \log_2(e)$
- (d) $\frac{1}{2} \log_2(\sigma^2)$

64. A (a)

65. Q What happens to the capacity of a bandlimited AWGN channel as the transmitted power (P) increases without any power constraints?

- (a) The capacity remains constant.
- (b) The capacity decreases.
- (c) The capacity increases.
- (d) The capacity approaches zero.

65. A (c)

66. Q What is the relationship between the capacity (C) and the bandwidth of the channel (W) in a bandlimited AWGN channel?

- (a) Capacity is inversely proportional to the bandwidth.
- (b) Capacity is directly proportional to the bandwidth.
- (c) Capacity is independent of the bandwidth.
- (d) Capacity is exponentially related to the bandwidth.

66. A (b)

67. Q Which of the following equations represents the Signal-to-Noise Ratio (SNR) in the context of a bandlimited AWGN channel?

- (a) $\text{SNR} = \frac{WP}{N_0}$
- (b) $\text{SNR} = \frac{N_0}{WP}$
- (c) $\text{SNR} = \frac{WN_0}{P}$
- (d) $\text{SNR} = \frac{P}{N_0W}$

67. A (d)

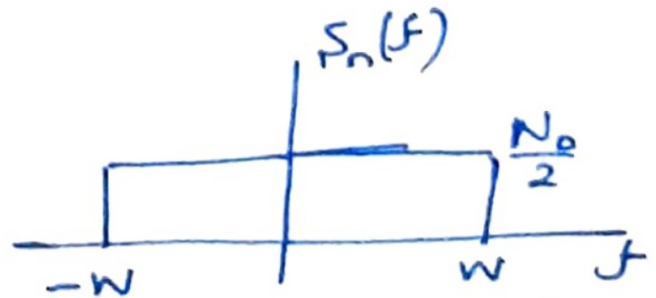
68. Q What is the equation for the capacity (C) of a bandlimited AWGN (Additive White Gaussian Noise) channel?

- (a) $C = W \log_2(1 + \frac{PW}{N_0})$
- (b) $C = W \log_2(1 + \frac{N_0}{PW})$
- (c) $C = W \log_2(1 + \frac{P}{N_0 W})$
- (d) $C = W \log_2(1 + \frac{N_0 W}{P})$

68. A (c)

69. Q In the following figure, the noise power per sample

- (a) $\frac{N_0}{W}$
- (b) $\frac{2N_0}{W}$
- (c) $N_0 W$
- (d) $\frac{N_0}{W2}$



69. A (c)

70. Q What is the formula for spectral efficiency (η) in terms of the code rate (R) and the bandwidth of the channel (W)?

Ⓐ $\eta = \frac{W}{H(x)}$

Ⓑ $\eta = \frac{H(x)}{W}$

Ⓒ $\eta = \frac{R}{W}$

Ⓓ $\eta = \frac{W}{R}$

70. A (c)

71. Q What is the formula for the spectral efficiency of an AWGN channel?

Ⓐ $\eta = \log_2 \left(1 + \frac{\text{SNR}}{RW} \right)$

Ⓑ $\eta = \log_2 \left(1 - \frac{\text{SNR}}{RW} \right)$

Ⓒ $\eta = \log_2(1 + \text{SNR})$

Ⓓ $\eta = \log_2(1 - \text{SNR})$

71. A (c)

72. Q What happens to the spectral efficiency as the bandwidth of the channel increases?

- (a) Spectral efficiency increases
- (b) Spectral efficiency decreases
- (c) Spectral efficiency remains constant
- (d) Spectral efficiency is unrelated to bandwidth

72. A (b)

73. Q What happens to the capacity as the transmitted power increases?

- (a) Capacity increases
- (b) Capacity decreases
- (c) Capacity remains constant
- (d) Capacity is unrelated to power

73. A (a)

74. Q How does the increase in capacity behave as the power increases?

- (a) The increase in capacity is linear
- (b) The increase in capacity is logarithmic and fast
- (c) The increase in capacity is logarithmic and slow
- (d) There are no increase in capacity

74. A (c)

75. Q When the bandwidth increases in AWGN channel

- (a) SNR decreases and rate decreases
- (b) SNR decreases and rate increases
- (c) SNR increases and rate decreases
- (d) SNR increases and rate increases

75. A (b)

76. Q Reliable data transmission occurs when

- (a) transmission rate $<$ channel capacity
- (b) transmission rate $>$ channel capacity
- (c) transmission rate $=$ channel capacity
- (d) No relation between transmission rate and channel capacity

76. A (a)

77. Q Shannon paper gives us a way to compress information till the entropy of the source

- (a) True
- (b) False

77. A (b)

78. Q What does the term “coding gain” represent in communication systems?

- (a) The improvement in signal quality achieved by using coding techniques
- (b) The ratio of energy per bit (E_b) to noise power spectral density (N_0)
- (c) The difference in bandwidth between coded and uncoded signals
- (d) The number of errors corrected by the code

78. A (a)

79. Q How is the coding gain calculated?

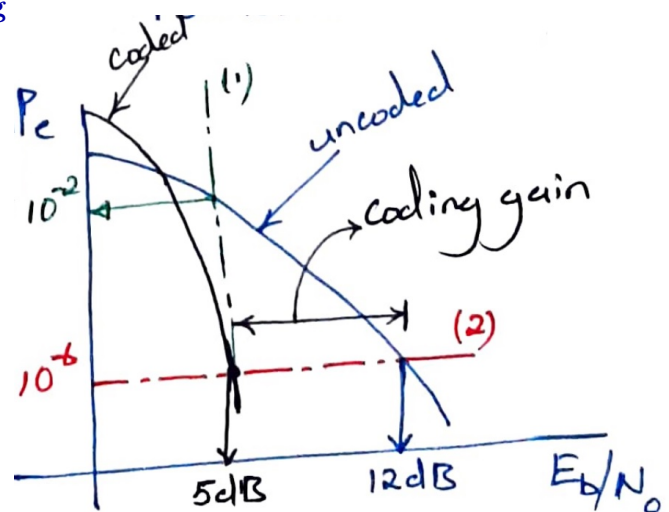
- (a) $\frac{E_b}{N_0}$
- (b) $\frac{E_b}{N_0} + 1$
- (c) $\left. \frac{E_b}{N_0} \right|_{\text{uncoded}} - \left. \frac{E_b}{N_0} \right|_{\text{coded}}$
- (d) $\left. \frac{E_b}{N_0} \right|_{\text{coded}} - \left. \frac{E_b}{N_0} \right|_{\text{uncoded}}$

79. A (c)

80. Q In the following figure, the coding gain is

- (a) 7 dB at $P_e = 10^{-6} W$
- (b) 5 dB at $P_e = 10^{-2} W$
- (c) 12 dB at $P_e = 10^{-6} W$
- (d) 17 dB at $P_e = 10^{-2} W$

80. A (a)



81. Q In linear block codes, the mapping of a message block is independent of all previous message blocks. This means that the encoder:

- (a) Has memory of previous blocks and their mappings
- (b) Encodes each message block based on the current message block only
- (c) Requires feedback from the decoder for encoding
- (d) Cannot correct errors in the received codeword

81. A (b)

82. Q One of the channel coding advantages while one of its disadvantages

- (a) Increasing required transmitted power , Higher bandwidth
- (b) Higher bandwidth , smaller antenna size
- (c) Decreasing required transmitted power , Higher bandwidth
- (d) Higher bandwidth , bigger antenna size

82. A (c)

83. Q In encoding, addition can be calculated with the gate, while multiplication can be calculated with gate

- (a) OR, AND
- (b) AND, OR
- (c) OR, XOR
- (d) XOR, AND

83. A (d)

84. Q In modulo two arithmetic $P + P = \dots\dots\dots$

- (a) $2P$
- (b) 0
- (c) 1

84. A (b)

85. Q $C = \{0000, 10100, 01111, 11011\}$, therefore

- (a) C is a linear block code
- (b) C is not a linear block code

85. A (a)

86. Q $C = \{0000, 11100, 01111, 11011\}$, therefore

- (a) C is a linear block code
- (b) C is not a linear block code

86. A (b)

87. Q $C = \{ 11100, 01111, 11011, 01100, 10001, 01000, 11111, 10010, 00001, 00101\}$, therefore

- (a) C is a linear block code
- (b) C is not a linear block code

87. A (b)

88. Q What does the code rate represent in information theory?

- (a) The expansion factor of the bandwidth
- (b) The ratio between the length of the input block and the length of its output block
- (c) The amount of information contained in the input block
- (d) The uncertainty of the random variable

88. A (b)

89. Q What does the equation $\Delta w = \left(\frac{1}{R_c} - 1 \right) w$ represent in information theory?

- (a) The ratio between the length of the input block and the length of its output block
- (b) The expansion factor of the bandwidth
- (c) The amount of information contained in the input block
- (d) The uncertainty of the random variable

89. A (b)

90. Q In coding theory, what is a systematic code?

- (a) A code that has a replica of the message at the end of each codeword
- (b) A code that length is the entropy
- (c) A code that has a random sequence at the beginning of each codeword
- (d) A code that has a random sequence at the end of each codeword

90. A (a)

91. Q What is the definition of Hamming weight in coding theory?

- (a) The number of zeros in a vector
- (b) The number of ones in a vector
- (c) The number of bits in a vector
- (d) The number of positions in which two vectors differ

91. A (b)

92. Q In a systematic code, the relative position of message bits and parity bits is:

- (a) The message bits must be before the parity bits
- (b) Not important and has no impact on the decoding process
- (c) The message bits must be after the parity bits
- (d) Decided based on the length of the codeword

92. A (b)

93. Q What is the aim of hard decision decoding in error correction?

- (a) To convert the received codeword into a binary representation
- (b) To find the closest codeword given the received codeword in the Hamming distance sense
- (c) To estimate the probability of error in the received codeword
- (d) To correct errors in the received codeword based on probabilistic calculations

93. A (b)

94. Q What does the Hamming distance measure in coding theory?

- (a) The number of zeros in a vector
- (b) The number of ones in a vector
- (c) The number of bits in a vector
- (d) The number of positions in which two vectors differ

94. A (d)

95. Q If $C = 11011$ then the Hamming weight of C is

- (a) 1
- (b) 2
- (c) 4
- (d) 5

95. A (c)

96. Q if $C_1 = 1001101$ and $C_2 = 1000110$ then the Hamming distance between C_1 and C_2 is

- (a) 1
- (b) 2
- (c) 3
- (d) 4

96. A (c)

97. Q If $w(c)$ is the hamming weight and $d(c, m)$ is the hamming distance between c and m , therefore $w(c)$ and $d(c, m)$ are equal when

- (a) $c = m$
- (b) $c = 0$
- (c) $m = 0$
- (d) $m = 1$

97. A (c)

98. Q What does the minimum distance measure in coding theory?

- (a) The number of ones in a vector
- (b) The maximum weight of a linear block code
- (c) The maximum Hamming distance between any two codewords in the code
- (d) The error correcting capability of the code

98. A (d)

99. Q What does the Singleton bound state for a linear block code?

- (a) The maximum distance separable code
- (b) The upper bound on the minimum distance of the code
- (c) The minimum distance of the code
- (d) The maximum weight of a linear block code

99. A (b)

100. Q If a linear block code attains the Singleton bound, what is it called?

- Ⓐ A maximum distance separable code
- Ⓑ A systematic code
- Ⓒ A minimum distance code
- Ⓓ A huffman code

100. A (a)

101. Q A good communication system designer aims to

- Ⓐ decrease the hamming distance between any two pairs, and make the minimum distance as high as possible
- Ⓑ decrease the hamming distance between any two pairs, and make the minimum distance as low as possible
- Ⓒ increase the hamming distance between any two pairs, and make the minimum distance as high as possible
- Ⓓ increase the hamming distance between any two pairs, and make the minimum distance as low as possible

101. A (c)

102. Q What is the condition for error detection in a linear block code with minimum distance d_{\min} ?

- (a) $\ell \leq d_{\min}$
- (b) $\ell \leq d_{\min} - 1$
- (c) $\ell \leq \left\lfloor \frac{d_{\min}}{2} \right\rfloor$
- (d) $\ell \leq \left\lfloor \frac{d_{\min} - 1}{2} \right\rfloor$

102. A (b)

103. Q What is the condition for error correction in a linear block code with minimum distance d_{\min} ?

- (a) $\ell \leq d_{\min}$
- (b) $\ell \leq d_{\min} - 1$
- (c) $\ell \leq \left\lfloor \frac{d_{\min}}{2} \right\rfloor$
- (d) $\ell \leq \left\lfloor \frac{d_{\min} - 1}{2} \right\rfloor$

103. A (d)

104. Q The generator matrix of a linear block code is obtained by:

- (a) Concatenating the encoder outputs of the codewords
- (b) Concatenating the encoder outputs of the basis vectors
- (c) Concatenating the message bits and parity bits of the codewords
- (d) Concatenating the message bits and parity bits of the basis vectors

104. A (b)

105. Q The syndrome of a linear block code:

- (a) Depends only on the transmitted codeword
- (b) Depends only on the error pattern
- (c) Depends on both the transmitted codeword and the error pattern
- (d) Depends on the size of the generator matrix

105. A (b)

106. Q Two codewords in a linear block code will have the same syndrome if:

- (a) They have the same message bits
- (b) They have the same parity bits
- (c) They experience the same error pattern
- (d) They are encoded using the same generator matrix

106. A (c)

107. Q What is the minimum distance of a Hamming code?

- (a) 1
- (b) 2
- (c) 3
- (d) 4

107. A (c)

108. Q How many errors can a Hamming code with parameters $n = 2^m - 1$ and $d = 3$ correct?

- (a) $t \leq 1$
- (b) $t \leq 2$
- (c) $t \leq 3$
- (d) $t \leq 4$

108. A (a)

109. Q What is the code rate (R_c) of a Hamming code in terms of the parameter m ?

- (a) $1 - \frac{m}{2^m - 1}$
- (b) $1 - \frac{m + 1}{2^m - 1}$
- (c) $\frac{m + 1}{2^m - 1}$
- (d) $\frac{m}{2^m - 1}$

109. A (a)

110. Q What happens to the code rate (R_c) of a Hamming code as the parameter m approaches infinity?

- (a) R_c approaches 1
- (b) R_c approaches 0
- (c) R_c remains constant
- (d) R_c becomes undefined

110. A (a)

Watch

<https://www.youtube.com/playlist?list=PL6bBF5Hte-BBicb16EnLI6wfoQnWN58Pb>

<https://www.youtube.com/playlist?list=PL6bBF5Hte-BD5ysv3BpYBqHxr2G7lPs3>