

EEC 382 - Introduction to Digital Communication

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# Information Theory MCQ Questions

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## MCQ Questions

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**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)

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**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)

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**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)

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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)

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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)

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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)

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**7. Q** If the information source is predictable, then .....

- (a) No need to transmit the information
- (b) Entropy is maximum
- (c) Compression is not possible
- (d) All of the above

**7. A** (a)

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**8. Q** The entropy for the fair coin .....

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

**8. A** (c)

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**9. Q** The entropy for a completely biased coin .....

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

**9. A** (a)

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**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)

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**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)

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**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)

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**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)

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**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)

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**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)

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**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)

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**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)

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**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)

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**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)

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**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)

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**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)



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**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)

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**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)

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**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)

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

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**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)

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**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 = 0, b = 111, c = 110, d = 101
- Ⓑ a = 0, b = 10, c = 01, d = 111
- Ⓒ a = 10, b = 101, c = 110, d = 011
- Ⓓ 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)

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

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**31. Q** Which of these are true ?

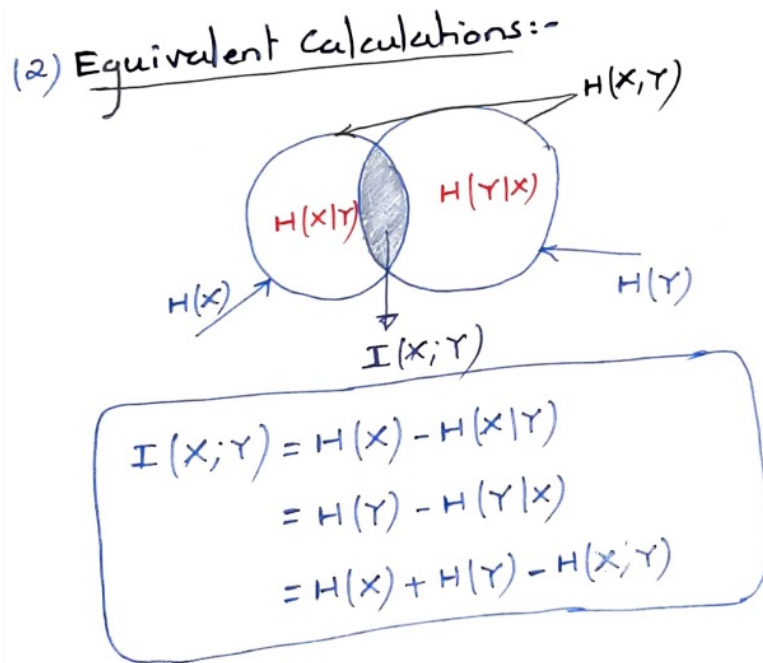
- Ⓐ  $H(Y|X) \neq H(X|Y)$
- Ⓑ  $H(Y|X) = H(X|Y)$

**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)

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

- (a) The average 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)

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**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)

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

- (a) True
- (b) False

**36. A** (b)

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**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)

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**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)

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**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)



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**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)

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**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)

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**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)

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**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)

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

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

**44. A** (a)

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**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)

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**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)

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**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)

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

- ☐ (a) True
- ☐ (b) False

**48. A** (a)

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

- ☐ (a) True
- ☐ (b) False

**49. A** (a)

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**50. Q** Huffman code is unique .

- (a) True
- (b) False

**50. A** (b)

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**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)

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**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)

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**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)

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

- ☐ (a) True
- ☐ (b) False

**54. A** (a)

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**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)

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**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)

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**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.  $R < C$

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**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)

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**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)

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**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)

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

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**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)

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**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)

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**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)

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

- (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)



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**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)

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**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)

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**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)

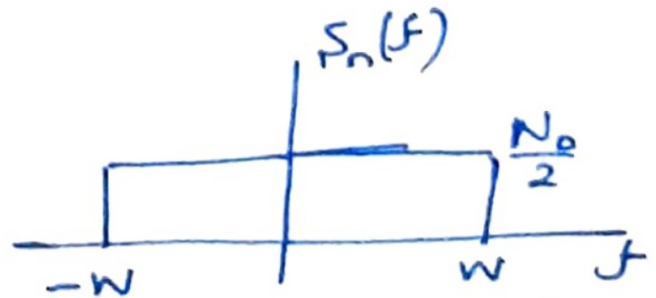
68. Q What is the equation for the capacity ( $C$ ) of a bandlimited AWGN (Additive White Gaussian Noise) channel?

- (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)

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**70. Q** What is the formula for spectral efficiency ( $\eta$ ) 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)

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**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)

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**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)

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**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)

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**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)

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**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** (a)

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**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)

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

- (a) True
- (b) False

**77. A** (a)

**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?

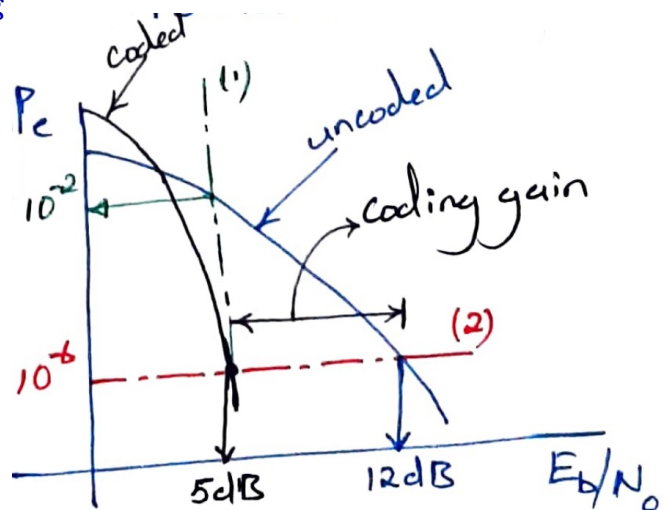
- (a)  $\frac{E_b}{N_0}$
- (b)  $\frac{E_b}{N_0} + 1$
- (c)  $\left. \frac{E_b}{N_0} \right|_{\text{uncoded}} - \left. \frac{E_b}{N_0} \right|_{\text{coded}}$
- (d)  $\left. \frac{E_b}{N_0} \right|_{\text{coded}} - \left. \frac{E_b}{N_0} \right|_{\text{uncoded}}$

**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) AND, XOR
- (d) XOR, OR

**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>