EEC 382 - Introduction to Digital Communication

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) $\mathbf{0}$

(b) $\mathbf{\frac{1}{2}}$

(c) $\mathbf{1}$

(d) $\mathbf{2}$

8. A **(c)**

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

(a) $\mathbf{0}$

(b) $\mathbf{\frac{1}{2}}$

(c) $\mathbf{1}$

(d) $\mathbf{2}$

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)

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)

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)

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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 $H(Y|X)$?

(a) $H(Y|X) = \sum_{x \in X} \sum_{y \in Y} p(x|y) \log_2 p(y,x)$

(b) $H(Y|X) = \sum_{x \in X} \sum_{y \in Y} p(x,y) \log_2 p(y|x)$

(c) $H(Y|X) = -\sum_{x \in X} \sum_{y \in Y} p(x|y) \log_2 p(y,x)$

(d) $H(Y|X) = -\sum_{x \in X} \sum_{y \in Y} p(x,y) \log_2 p(y|x)$

22. A (d)

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

(a) $H(x) = -\sum_{x \in \chi} P(x) \log P(x)$

(b) $H(x) = \sum_{x \in \chi} P(x) \log P(x)$

(c) $H(x) = \sum_{x \in \chi} P(x) / \log P(x)$

(d) $H(x) = -\sum_{x \in \chi} P(x) / \log P(x)$

23. A (a)

$\boxed{24.\ Q}$ Find the entropy of the random variable X with PMF

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

(a) 1 bit

(b) 1.5 bit

(c) 2 bit

(d) 2.5 bit

$\boxed{24.\ A}$ (b)

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

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

(a) 1 bit

(b) 1.5 bit

(c) 2 bit

(d) 2.5 bit

$\boxed{25.\ A}$ (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 :

$$\sum_{x=0}^{\infty} r^x = \frac{1}{1-r} \tag{1}$$

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

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26. Q **$H(x)$ is .... when X is uniforamlly 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)

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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)

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

(a) **0**

(b) **1**

(c) $\frac{1}{2}$

(d) **(a) and (b)**

28. A (d)

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

(a) **1, 0**

(b) **1,** $\frac{1}{2}$

(c) **2 , 0**

(d) **2,** $\frac{1}{2}$

29. A (b)

$\boxed{30.\ Q}$

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

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`

$\boxed{30.\ A}$ (b)

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

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

$\boxed{31.\ Q}$ Which of these are true ?

(a) $H(Y|X) \neq H(X|Y)$

(b) $H(Y|X) = H(X|Y)$

$\boxed{31.\ A}$ (a)

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

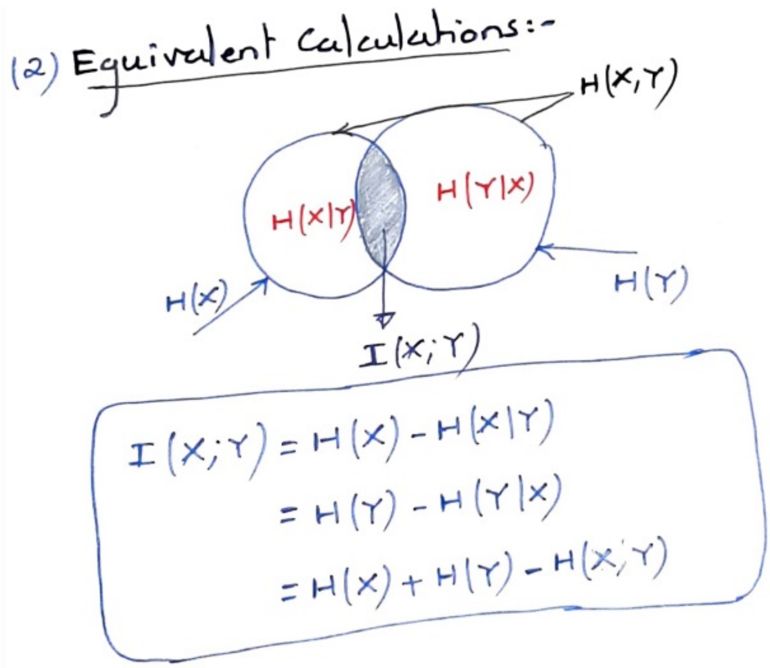
(a) $H(X, Y) = H(X) + H(Y)$

(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 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)

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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) $n \to \infty$

(b) $n \to 0$

(c) $n \to 1$

(d) $n \to H(X)$

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?**

(a) **The ability to uniquely identify each source symbol**

(b) **The property of having a one-to-one correspondence between codewords and messages**

(c) **The requirement for only one way to parse the encoded binary sequence**

(d) **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?**

(a) **They minimize the delay in the encoding process**

(b) **They ensure error-free transmission of the encoded sequence**

(c) **They allow for unique decodability of the original message**

(d) **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?**

(a) **Prefix codes**

(b) **Suffix codes**

(c) **Variable-length codes**

(d) **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 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)

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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)

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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)

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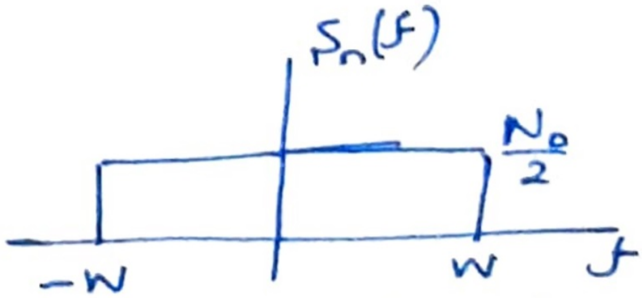
69. Q In the following figure, the noise power per sample ....



(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)?**

(a) $\eta = \dfrac{W}{H(x)}$

(b) $\eta = \dfrac{H(x)}{W}$

(c) $\eta = \dfrac{R}{W}$

(d) $\eta = \dfrac{W}{R}$

70. A (c)

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

(a) $\eta = \log_2\left(1 + \dfrac{\mathrm{SNR}}{RW}\right)$

(b) $\eta = \log_2\left(1 - \dfrac{\mathrm{SNR}}{RW}\right)$

(c) $\eta = \log_2(1 + \mathrm{SNR})$

(d) $\eta = \log_2(1 - \mathrm{SNR})$

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)

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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 (b)

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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 (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) $\frac{E_b}{N_0}$

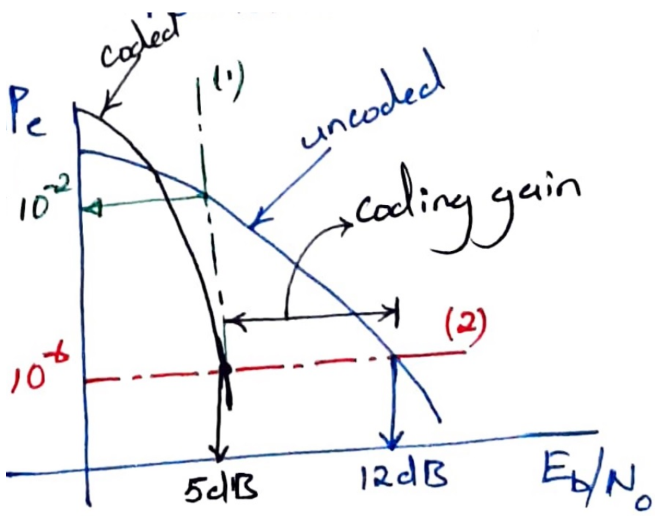
(b) $\frac{E_b}{N_0} + 1$

(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)

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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)

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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)

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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 $P + P =$ ....**

(a) $\mathbf{2P}$

(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) **A maximum distance separable code**

(b) **A systematic code**

(c) **A minimum distance code**

(d) **A huffman code**

100. A (a)

---

101. Q **A good communication system designer aims to ....**

(a) **decrease the hamming distance between any two pairs, and make the minimum distance as high as possible**

(b) **decrease the hamming distance between any two pairs, and make the minimum distance as low as possible**

(c) **increase the hamming distance between any two pairs, and make the minimum distance as high as possible**

(d) **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) $1 - \dfrac{m}{2^m - 1}$

(b) $1 - \dfrac{m+1}{2^m - 1}$

(c) $\dfrac{m+1}{2^m - 1}$

(d) $\dfrac{m}{2^m - 1}$

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

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