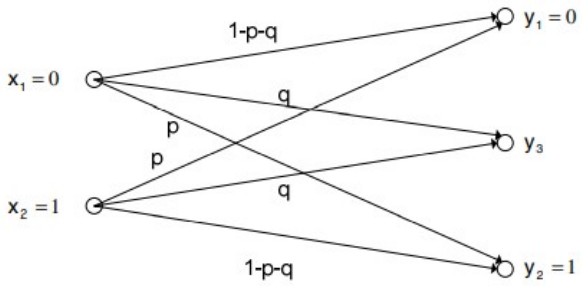

Q1/ The output of a DMS consists of symbols (x_1, x_2, and x_3) with probabilities (0.45, 0.35, and 0.2) respectively. Find the Entropy (H(x)) and the Huffman code for this source. Is this code lossless code?

Q2/ When generating a C(7, 4) Cyclic block code using the polynomial (x^3+x+1);

i. What would be the generated codeword (V) for the data sequence U= 1110?

ii. If the received codeword (r) is 1011010, is it a correct codeword? Check it.

Q3/ For the binary erasure channel (BEC) shown below, find the noise matrix.



Q4/The data is to be transmitted at the rate of 20 kbits/sec over a channel having bandwidth B=3.2 kHz. Determine the required signal to noise ratio in dB.

Q5/ Find the capability of error detection and correction for the following linear block codes:
C = {0000000, 1101000, 0110100, 1110010, 1000001}

Q6/A (6,3) systematic Linear Block Code encodes the information sequence x into codeword c.

1) Determine the generator matrix (G) of this code.

2) Find the parity check matrix (H) for this code.

Q7/ Encode using Huffman binary algorithm the source S:

$$S:\begin{pmatrix} s_1 & s_2 & s_3 & s_4 & s_5 & s_6 \\ 0.3 & 0.25 & 0.15 & 0.15 & 0.10 & 0.05 \end{pmatrix}$$

Q8/ A (7,4) cyclic block code generated by the polynomial $1+x^2+x^3$:

1. What would the generated codewords be for the data sequences 1000 and 1010?
2. Check that these codewords would produce a zero syndrome if received without error.

Q9/ A binary symmetric channel (BSC) with (X_1 and X_2) inputs and (Y_1 and Y_2) outputs has a conditional probability of error $p=10^{-5}$, and the messages 0 and 1 are generated at the source with equal probability. 1)Draw the channel model indicating all the probabilities on it. 2) Write the noise matrix.

Q10/ A 4*4 block interleaver is used in a digital transmission system. Determine the output of this interleaver if the input bit stream is assumed to be "**1 0 1 0 0 0 1 1 0 1 0 1 1 1 0 0**".

Q11/ Which of the following binary codes are linear?
C1 = {00, 01, 10, 11}
C2 = {000, 011, 101, 110}
C3 = {00000, 01101, 10110, 11011}
C4 = {101, 111, 011}

Q12/ For the C(7,4) Linear Block Code, find the sent codeword, if the received codeword is [1010111], when the generator matrix is as shown below:

$$G = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Q13/ A discrete memoryless source with three symbols [x_1, x_2, and x_3], with probability $p(x_1)= p(x_3)$ and $p(x_2)=\alpha$, feeds into discrete memoryless channel. Sketch the variation of H(x) with α, and show the maximum value of H(x) on the sketch.

Q14/ / In a facsimile transmission of a picture, there are about 225x106 picture elements per frame. For good reception, twelve brightness levels are necessary. Assuming all these levels to be equiprobable, calculate the channel bandwidth required to transmit one picture in every three minutes for a signal to noise power ratio of 30 dB. If the S/N ratio requirement increases by 40 dB, calculate the new bandwidth.

Q15/ When generating a (6, 3) Cyclic block code using the polynomial ($1+x+x^3$); i. What would the generated codeword be for the data sequence 101? ii. If the codeword 011010 is corrupted to 101110, what is the syndrome at the receiver? Why?

Q16/ In a digital communication system, if the received convolutional code is: (11 00 10 01 11 10 00). Use the Viterbi decoding process for detecting and correcting the error in this received code, and find the decoder output.

Q17/ For the C(7,4) Linear Block Code, find the sent codeword, if the received codeword is [1010111], when the generator matrix is as shown below:

$$G = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Q18/ How could the capability of error detection and correction be found for linear block codes?

Q19/ Consider a systematic (7, 4) cyclic code generated by $g(x)= x^3 +x +1$.
1. Find the transmitted codeword (v), if the input message is u(x) = x+1.
2. Could $x^3 +1$ be used as a generator polynomial? Why?

Q20/ / Which of the following binary codes are linear?
C1 = {00, 01, 10, 11}
C2 = {000, 011, 101, 110}
C3 = {00000, 01101, 10110, 11011}
C4 = {101, 111, 011}
C5 = {000, 001, 010, 011}
C6 = {0000, 1001, 0110, 1110}

Q21/ Give the standard form of generator matrix G and parity check matrix H of a [15; 11; 3] binary Hamming code. Using these matrices to encode the message u = 11111100000 and decode the message v = 111000111000111.

Q22/ / Below is given a generator matrix in systematic form. What are the values of n and k for the code? What is the parity check matrix?

$$G=\begin{bmatrix}1&1&0&1&1&0&0&0&0&0\\1&0&1&0&0&1&0&0&0&0\\1&1&1&1&0&0&1&0&0&0\\0&1&1&1&0&0&0&1&0&0\\0&1&0&1&0&0&0&0&1&0\\1&1&1&0&0&0&0&0&0&1\end{bmatrix}$$

Q23/ Find the length and minimum distance of the code generated by the polynomial $X^5 + X^3 + X^2 + X + 1$

Q24/ Show that the polynomial $X^4 + X^2 + 1$ can be used to generate a code of length 12. Find the minimum distance and comment on the result.

Q25/ The binary polynomial $X^5 + X^2 + 1$ generates a Hamming code. What are the values of n and k?

Q26/ Consider a telegraph source having two symbols (dot and dash). The dot duration is 0.2 sec; and the dash duration is 3 times of the dot duration. The probability of the dot's occurring is twice that of the dash, and time between symbols is 0.2 sec. Calculate: (a) The Entropy of the source (H). (b) Average symbol rate. (c) Information rate (Bit rate).

Q27/ The data is to be transmitted at the rate of 10000 bits/sec over a channel having bandwidth B=3 kHz. Determine the required signal to noise ratio. If the bandwidth is increased to 10 kHz, then determine the signal to noise ratio. What are your comments?

Q28/

Consider a systematic **(7, 3)** cyclic code generated by $g(x) = x^4 + x^3 + x^2 + 1$.

1. Find the transmitted codeword (***v***), if the input message is $u(x) = x^2 + 1$.
2. If the received codeword (***r***) =**1011000**, find the syndrome.
3. Find the correct codeword using the look-up table shown below:

Error Pattern (e)	Syndrome vector
e_0	1000
e_1	0100
e_2	0010
e_3	0001
e_4	1011

Q29/ / A discrete source emits one of five symbols once every (2 msec) with probabilities [0.5, 0.25, 0.125, 0.0625 and 0.0625 respectively]. Find the source entropy and the information rate.

Q30/ A voice grade telephone channel has a bandwidth of 3.3 kHz. If the signal to noise ratio (S/N) on the channel is 20dB, (A) determine the capacity of the channel. (B) If this channel is to be used to transmit 10.5 kbps of data determine the minimum S/N required on the channel.

Q31/ / The generator matrix of a linear block codes is given by:

$$G = \begin{bmatrix} 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Find:

- Minimum distance.
- Syndrome for single error in the first bit position.
- The sent codeword, if the received codeword is [r=0101010].

Q32/ An analog signal bandlimited to 10 kHz is sampled and then quantized to 8 levels of a PCM system with probabilities of: 1/4, 1/5, 1/5, 1/10, 1/20 and 1/20 respectively. Calculate the Entropy and the Rate of information,

Q33/ A 3*3 block interleaver is used in a digital transmission system. Determine the output of this interleaver if the input bit stream is assumed to be "1 0 1 0 1 1 1 0 0".

Q34/

Consider a systematic **(7, 3)** cyclic code generated by $g(x) = x^4 + x^3 + x^2 + 1$.

1. Find the transmitted codeword (***v***), if the input message is $u(x) = x^2 + 1$.
2. Draw the encoder circuit.
3. If the received codeword (***r***) =**1011000**, find the syndrome.

Q35/ For a (2, 1, 2) convolutional encoder, if the incoming message is:
(11001011100):

1. Find the encoded message.
2. Draw the Trellis diagram indicating the continuous path through it.

Q36/ A transmitter send one of four possible messages. The most likely occurs with a probability of 0.5 and is represented by the value 0. The second most likely occurs with a probability of 0.25 and is given the representation 10. The other two messages each occur with a probability of 0.125 and are given the representations 110 and 111. Find the mean information content of the messages and the mean number of bits transmitted.

Q37/ A block code has d_{min} = 8. Find the maximum guaranteed error detection if maximum error correction is to be carried out. How would this change if only single-error patterns were to be corrected?

Q38/ An 8-bit byte is constructed by taking 7 information bits and adding a parity check to produce an odd number of 1s in the byte (odd parity). Is this a linear code? What are the values of n, k and minimum distance?

Q39/ Below is given a generator matrix in systematic form. What are the values of n and k for the code? What is the parity check matrix? g(x)= x^3 +x+1

Q40/ For a (6,3) systematic linear block code, the codeword comprises I_1, I_2, I_3, P_1, P_2, P_3 where the three parity-check bits are formed from the information bits as follows:

$P_1 = I_1 \oplus I_2$, $P_2 = I_1 \oplus I_3$, $P_3 = I_2 \oplus I_3$

1) Find: (a) the parity check matrix (**H**); (b) the generator matrix (**G**); (c) all possible codewords.

2) Determine: (d) the minimum distance; (e) the error detecting and correcting capability of this code; (f) If the received sequence is 101000, calculate the syndrome and decode the received sequence.

Q41/ The primitive polynomial X^4 + X+ 1 is used to generate a cyclic code. Encode the sequences 10011101001 and 01010000111.

Q42/

Find the length and minimum distance of the code generated by the polynomial $X^5 + X^3 + X^2 + X + 1$

Q43/ A source transmits two independent messages with probabilities of p and (1-p) respectively. Prove that the entropy is maximum when both the messages are equally likely. Plot the variation of entropy (H) as a function of probability 'p' of the message.

Q44/ For a discrete memoryless source there are three symbols with probabilities $p_1=\alpha$ and $p_2= p_3$. Determine the entropy of the source and sketch its variation for different values of α.

Q45/ The data is to be transmitted at the rate of 10000 bits/sec over a channel having bandwidth B=3000 Hz. Determine the S/N ratio required. If the bandwidth is increased to 10000 Hz, then determine the S/N ratio.

Q46/ Construct the addition and multiplication tables of GF(5).

Q47/ The parity check matrix is given below:

$$H=\begin{bmatrix} 1 & 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

1) Determine the generator matrix for this code in the systematic form,
2) How many codewords are in this code? What is the d_{min} for this code?

Q48/ A code C consists of all binary sequences of length 6 and weight 3. Is this code a linear block code? Why?

Q49/ Find the Convolutional codes for the i/p data: [010100], if the code is with (1/2) code rate.

Q50/ A systematic (n,k) block code where n=4, k=2, and the four codewords are:
[0000, 1010, 1101, 0111].
(a) Write down the input messages (in a table form).
(b) How many errors will the code correct?

Q51/ Choose the correct answer/answers:

1- In **Modulo-5 multiplication**, 3 multiplied by 2 equal:
- a) 6
- b) 5
- c) 1

2- In **a linear block code**, if the message consists of " *k* " information digits, then there are:
- a) *k* distinct codewords.
- b) 2^k distinct codewords.
- c) 16 distinct codewords.

3- An information source produces finite set of messages, the **probabilities summation** of these messages must equal:
- a) 2
- b) 1
- c) The number of messages.

4- For the C(8,4) linear block code, the **code rate** (***R***) equal:
- a) 1/2
- b) 8
- c) 4

5- The **minimum distance (*d_{min}*)** for the codes [110011, 010111, 101011] is:
- a) 1
- b) 2
- c) 3

6- For the **(7,3) cyclic code** generated by $g(x)=x^4+x^3+x^2+1$, if the i/p message is [101], the transmitted codeword will be:
- a) 1100101
- b) 0001011
- c) 1000101

7- In communication system, the **signaling rate (R)** must be:
- a) ≥ the channel capacity (**C**).
- b) ≤ the channel capacity (**C**).
- c) = the channel capacity (**C**).

8- Interleaving is the method of:
   a) Channel coding.
   b) Linear block code.
   c) Converting a burst error into a random error structure.

9- The Entropy H(x) has a maximum value when the events are:
   a) Equiprobable.
   b) With probability equal 1.
   c) Memoryless.

10- In a (15,11) Hamming code, there are:
   a) 2^{11} distinct codewords.
   b) 2^{15} distinct codewords.
   c) 16 distinct codewords.

Q52/ A voice grade telephone channel has a bandwidth of 3.5 kHz. If the signal to noise ratio **(*S/N*)** on the channel is **20dB**, **(A)** determine the capacity of the channel. **(B)** If this channel is to be used to transmit **10.5 kbps** of data, determine the minimum ***S/N*** required on the channel.

Q53/ The terminal of a computer used to enter alphanumeric data is connected to the computer through a voice grade telephone line having a usable bandwidth of 3kHz and an output S/N of 10dB. Determine:

1) The capacity of the channel.
2) The maximum rate at which data can be transmitted from the terminal to the computer without error.

Q54/ Below is given a generator matrix in systematic form. What are the values of *n* and *k* for the code? What is the parity check matrix?

$$G=\begin{bmatrix}1&1&0&1&1&0&0&0&0&0\\1&0&1&0&0&1&0&0&0&0\\1&1&1&1&0&0&1&0&0&0\\0&1&1&1&0&0&0&1&0&0\\0&1&0&1&0&0&0&0&1&0\\1&1&1&0&0&0&0&0&0&1\end{bmatrix}$$

Q55/ The generator matrix of a linear block codes is given by:

$$G=\begin{bmatrix}1&0&1&1&0&0&0\\0&1&1&0&1&0&0\\1&1&0&0&0&1&0\\1&1&1&0&0&0&1\end{bmatrix}$$

Find: The code table.

Q56/ For the C(7,4) Linear Block Code, find the sent codeword, if the message is [0011], when the generator matrix is as shown below:

$$G=\begin{bmatrix}1&0&1&1&0&0&0\\0&1&1&0&1&0&0\\1&1&0&0&0&1&0\\1&1&1&0&0&0&1\end{bmatrix}$$

Q57/ When generating a (7, 4) Cyclic block code using the polynomial $(1+x^2+x^3)$;

i. What would be the generated codeword for the data sequence 1111?

ii. If the codeword 1101001 is corrupted to 1001001, what is the syndrome at the receiver? Why?

Q58/ The data is to be transmitted at the rate of 10000 bits/sec over a channel having bandwidth B=3 kHz. Determine the required signal to noise ratio. If the bandwidth is increased to 10 kHz, then determine the signal to noise ratio. What are your comments?

Q59/ The generator matrix of a linear block codes is given by:

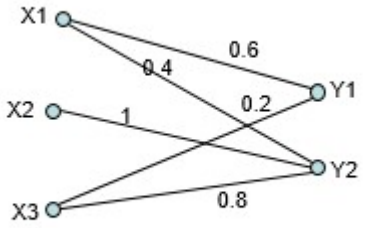
$$G=\begin{bmatrix}1&0&1&1&0&0&0\\0&1&1&0&1&0&0\\1&1&0&0&0&1&0\\1&1&1&0&0&0&1\end{bmatrix}$$

Find: 1) Minimum distance, error detection and correction capabilities.

2) Syndrome for single error in the first bit (LSB) position.

Q60/ Consider a systematic (**7**, 4) cyclic code generated by $g(x)= x^3 +x^2 +1$. Find the transmitted codeword (***v***), if the input message is $u(x) =x^2+x+1$.

Q61/) A discrete memoryless source with three symbols, with probabilities $p(x_1) = p(x_3)$, and $p(x_2)=\alpha$, feeds into discrete memoryless channel shown below. Determine the maximum value of H(x).



Q62/ The terminal of a computer used to enter alphanumeric data is connected to the computer through a voice grade telephone line having a usable bandwidth of 3kHz and an output S/N of 10dB. Determine:

1) The capacity of the channel.
2) The maximum rate at which data can be transmitted from the terminal to the computer without error.

Assume that the terminal has 128 characters and that the data sent from the terminal consists of independent sequences of characters with equal probability.

Q63/ For a (2, 1, 2) convolutional encoder, if the incoming message is: **(11001011)**,

1. Find the encoded message.
2. Draw the Trellis diagram indicating the continuous path through it.

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