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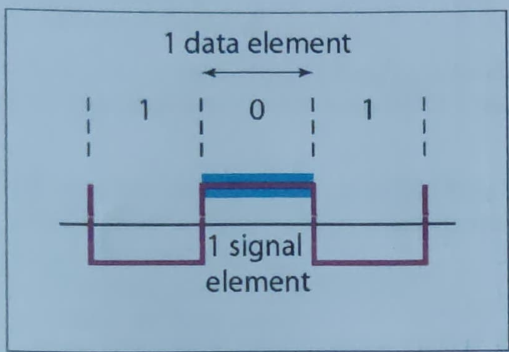
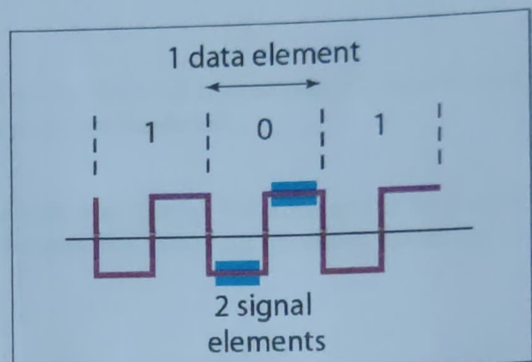
Assignment No. 2
Computer Networks

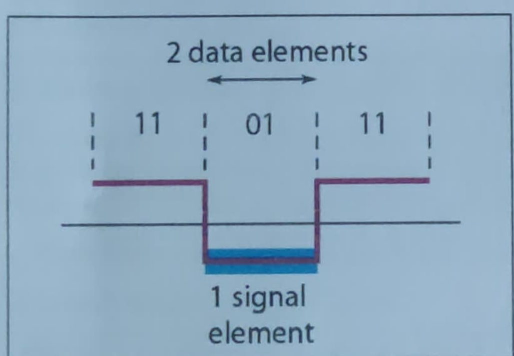
Q.No. 1 Calculate the value of the signal rate (Baud rate) for each case in Figure below, if the data rate is 1 Mbps and c = 1/2.



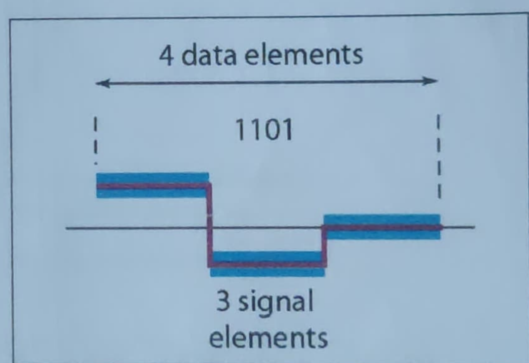
a. One data element per one signal element (r = 1)



b. One data element per two signal elements $\left(r = \frac{1}{2}\right)$



c. Two data elements per one signal element (r = 2)



d. Four data elements per three signal elements $\left(r = \frac{4}{3}\right)$

Q.No. 2 What is the Nyquist sampling rate for each of the following signals?
a. A low-pass signal with bandwidth of 200 KHz?
b. A band-pass signal with bandwidth of 200 KHz if the lowest frequency is 100 KHz?

Q.No. 3 We have sampled a low-pass signal with a bandwidth of 200 KHz using 1024 levels of quantization.
a. Calculate the bit rate of the digitized signal.
b. Calculate the SNR_{dB} for this signal.
c. Calculate the PCM bandwidth of this signal.

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Q.No. 4 Calculate the baud rate for the given bit rate and type of modulation.

a. 2000 bps, FSK
b. 4000 bps, ASK
c. 6000 bps, QPSK
d. 36,000 bps, 64-QAM

Q.No. 5 Calculate the bit rate for the given baud rate and type of modulation.

a. 1000 baud, FSK
b. 1000 baud, ASK
c. 1000 baud, BPSK
d. 1000 baud, 16-QAM

Q.No. 6 Assume that a voice channel occupies a bandwidth of 4 kHz. We need to multiplex 10 voice channels with guard bands of 500 Hz using FDM. Calculate the required bandwidth.

Q.No. 7 Ten sources, six with a bit rate of 200 kbps and four with a bit rate of 400 kbps are to be combined using multilevel TDM with no synchronizing bits. Answer the following questions about the final stage of the multiplexing:

a. What is the size of a frame in bits?
b. What is the frame rate?
c. What is the duration of a frame?
d. What is the data rate?

Q.No. 8 Find the minimum Hamming distance for the following cases:

a. Detection of two errors.
b. Correction of two errors.
c. Detection of 3 errors or correction of 2 errors.
d. Detection of 6 errors or correction of 2 errors.

Q.No. 9 Given the dataword 1011011010 and the divisor 11101,

a. Show the generation of the codeword at the sender site (using binary division).
b. Show the checking of the codeword at the receiver site (assume no error).

c. Show the checking of the codeword at the receiver site (assume one-bit error).

Q.No. 10 Byte-stuff the data in Figure below.

ESC			FLAG			ESC	ESC	ESC		FLAG	

Q.No. 11 A sender sends a series of packets to the same destination using 5-bit sequence numbers. If the sequence number starts with 0, what is the sequence number after sending 100 packets?

Q.No. 12 a. Compare space-division and time-division switches.

b. What is TSI and its role in a time-division switching?
c. Define blocking in a switched network.

1. formula $\Rightarrow S = C \times N \times \frac{1}{r}$

(a) $r = 1$

$$S = (1/2) \times (1\,\text{Mbps}) \times \frac{1}{1} = 500\,\text{kbaud}.$$

(b) $r = 1/2$

$$S = (1/2) \times (1\,\text{Mbps}) \times \frac{1}{1/2} = 1\,\text{Mbaud}.$$

(c) $r = 2$

$$S = \left(\frac{1}{2}\right) \times (1\,\text{Mbps}) \times \frac{1}{2} = 250\,\text{kbaud}.$$

(d) $r = 4/3$

$$S = (1/2) \times (1\,\text{Mbps}) \times \frac{1}{4/3} = 375\,\text{kbaud}.$$

2. In a low-pass signal the minimum frequency 0.

(a) therefore, we have

$$f_{max} = 0 + 200 = 200\,\text{kHz} \rightarrow f_s = 2 \times 200{,}000 = 400000\ \text{sam/s}.$$

(b) In a bandpass signal, the maximum frequency is equal to the minimum frequency plus the bandwidth. Therefore we have

$$f_{max} = 100 + 200 = 300\,\text{kHz} \rightarrow f_s = 2 \times 300000 = 600000\ \text{sam/s}$$

3.

(a) In a lowpass signal, the min. frequency is 0. Therefore, we can say $f_{max} = 0 + 200 = 200\,\text{kHz}$

$fs = 2 \times 200{,}000 = 400{,}000$ samples. The number of bits per sample and the bit rate are $nb = \log_2 1024$ $= 10$ bits/sample

$$N = 400\,KHz \times 10 = \underline{4\,Mbps}$$

(c) The value of $nb = 10$. The minimum bandwidth can calculated as $B_{PCM} = nb \times B_{analog} = 10 \times 200\,KHz = 2\,MHz$.

(4) formula ⇒ $S = (1/r) \times N$.

(a) $r = \log_2 2 = 1$

$$S = (1/1) \times (2000\,bps) = 2000\,baud.$$

(b) $r = \log_2 2 = 1$.

$$S = (1/1) \times (4000\,bps) = 4000\,baud$$

(c) $r = \log_2 4 = 2$

$$S = (1/2) \times (6000\,bps) = 3000\,baud.$$

(d) $r = \log_2 64 = 6$.

$$S = (1/6) \times (36000\,bps) = 6000\,baud.$$

(5) formula $= r \times N$

(a) $r = 1 \rightarrow N = 1 \times 1000\,bps = 1000\,bps$

(b) $r = 1 \rightarrow N = 1 \times 1000\,bps = 1000\,bps$

(c) $r = 1 \rightarrow N = 1 \times 1000\,bps = 1000\,bps$

(d) $r = 4 \rightarrow N = 4 \times 1000\,bps = 4000\,bps$

(6) To multiplex 10 voice channels, we need to nine guard bands. The required bandwidth is men

$B = (4 KHz) \times 10 + (500 kHz) \times 9 = \underline{44.5 KHz}.$

(7) We combine six-200-kbps sources into three 400-kbps. Now we have seven 400kbps channels.

(a) each output frame carries 1 bit from each of the seven 400 kbps line. Frame size $= 7 \times 1 = 7$ bits.

(b) Each frame carries 1 bit from each 400-kbps source. Frame rate = 400,000 frame/sec.

(c) Frame duration = (1/frame rate) = 1/400 000 = 2.5 μs.

(d) output data rate = (400 000 frames/sec) x (7 bits/frame) =

$\underline{\underline{2.8 \text{ mbps}}}$

(8)

(a) Detection of two errors = $d+1 = 2+1 = 3$

(b) Correction of two errors = $2d+1 = 2 \times 2+1 = 5$

(c) Detection of 3 errors or correction of 2 errors =

$d+1$ or $2d+1 = 3+1$ or $2 \times 2+1 = 4$ or 5.

(d) Detection of 6 errors or correction of 2 errors

$= \underline{7 \text{ or } 5}$

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(9) dataword = 1011011010 , div = 11101

4bit = 5

n = bit - 1

= 4

adding 4 zeroes

(a)

```
          1111101011
11101 ) 10110110100000
        11101
        010111
         11101
         010101
          11101
          010000
           11101
           011011
            11101
            001100
             00000
             011000
              11101
              001010
               00000
               010100
                11101
                010010
                 11101
                 01111
```

$\boxed{\text{codeword} = 10110110101111}$

(b)

```
              1111101011
      11101 ) 10110110101111
              11101
              ------
              010111
               11101
               ------
               010101
                11101
                ------
                010000
                 11101
                 ------
                 011011
                  11101
                  ------
                  001100
                   00000
                   ------
                   011001
                    11101
                    ------
                    001001
                     00000
                     ------
                     010011
                      11101
                      ------
                      011101
                       11101
                       ------
                       00000
```

→ Codeword at the reciever site

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(c) assuming 1 bit error.

```
            1111101101
11101 ) 1011011110111 1
        11101
        010111
         11101
        010101
          11101
          010001
           11101
           011001
            11101
            001000
             00000
             010001
              11101
              011001
               11101
               001001
                00000
                010011
                 11101
                 01110
```

remainder = 01110 → when assuming 1 bit error

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(10)

ESC	ESC			ESC	FLAG			ESC	ESC	ESC	ESC	ESC	ESC	

ESC	FLAG	

(11) A five bit sequence number can create sequence numbers from 0 to 31. The sequence number in the Nth packet is (N mod 32). This means that the 101th packet has the sequence number (101 mod 32) or 5.

(12) (a) In a space-division switch, the path from one device to another is spatially separate from other paths. The inputs and the outputs are connected using a grid of electronic microswitches. In a time-division switch, the inputs are divided in time using TDM. A control unit sends the input to the correct output device.

(b) TSI (Time slot interchange) is the most popular technology in a time-division switch. It used random access memory with several memory locations. The RAM fills up with incoming data from time slots in the order recieved - slots are then sent out in an order based on the decisions of a control unit.

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(c) Blocking refers to the times when one input cannot be connected to an output because there is no path available between them - all the possible intermediates switches are occupied.