Lecture-6
SDe

classmate
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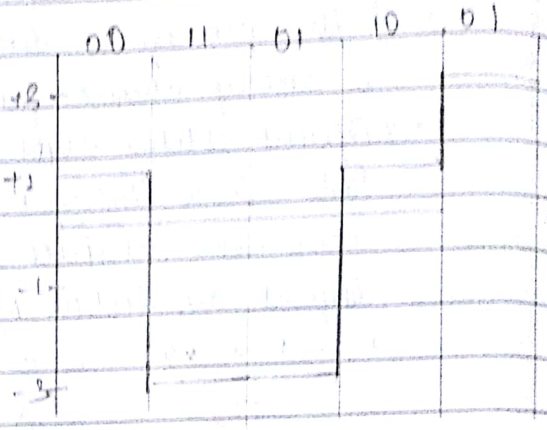
Page

Multilevel - 2B1Q

- 2 bit 1 quaternary coding

Next bits	Next level	Next level
00	+1	-1
01	+3	-3
10	-1	+1
11	-3	+3

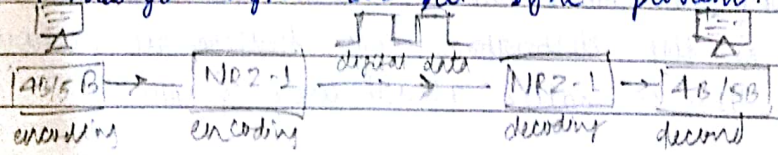


Block coding

- It changes a block of m bits into a block of n bits, where n > m.
- It is referred to as mB/nB encoding technique.
- Normally involves three steps -
  - Division - into m groups
  - Substitution - substitute m bits by n-bit
  - Combination - n bit group are combined.

4B/5B

- Four binary/5 binary.
- Used with NRZ coding.
- NRZ-I has good signal rate but sync problem.



- 4 bits has no more than 1 leading 0 and no more than 2 trailing zeros

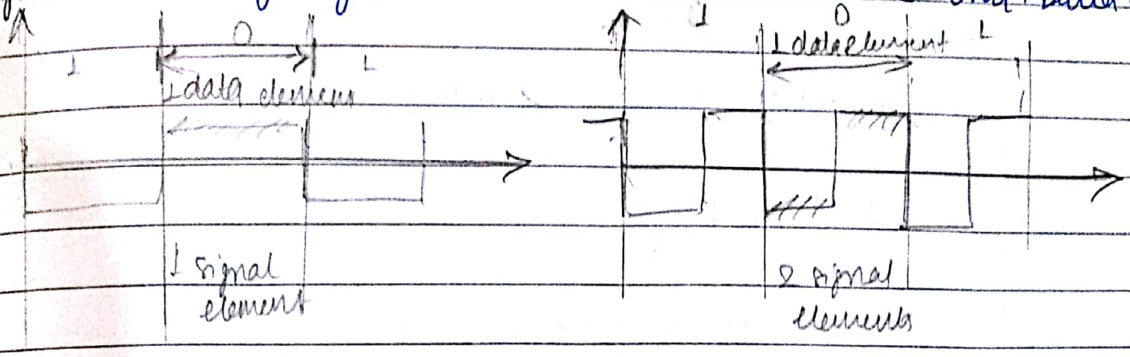
4B/5B mapping codes

Data seq	Encoded seq	Control seq.	Encoded sequence
0000	11110	Q (Quiet)	00000
0001	01001	I (Idle)	11111
0010	10100	H (Halt)	00100
0011	10101	J (Start delim)	11000
0100	01010	K (Start delim)	10001
0101	01011	T (End delim)	01101

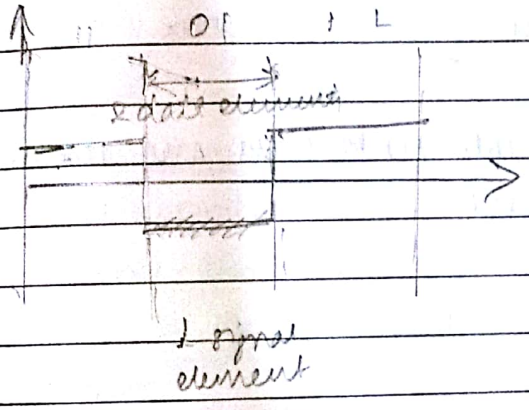
Data rate vs Baud rate

- Data rate - # of data elements (bits) sent in 1 sec. Unit: bps.

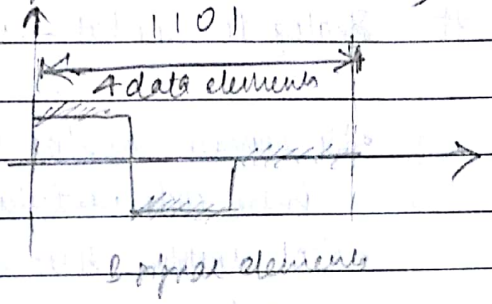
Signal rate - # of signal elements (pulses) sent in 1 sec. Unit: baud.



One data element per one signal element ($r = 1$)



One data element per two signal elements ($r = 1/2$)



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

Four data elements per 3 signal elements ($r = 4/3$)

- Goal of data comm^n is to increase data rate (speed of transmission) while decreasing signal rate (bandwidth requirements)
- r = data rate / signal rate
- Signal rate depends on N (bps), $\frac{1}{r}$ (bit/pulse) and the actual data pattern.

$$S = c \cdot N \cdot \frac{1}{r} \text{ [pulses/sec]}$$

c: case factor

Q. $r = 1$

$N = 100$ kbps

c is b/w 0 and 1. Find signal rate.

Sol^n

$C_{avg} = 0.5$

$\therefore S = \frac{c \cdot N \cdot L}{r}$

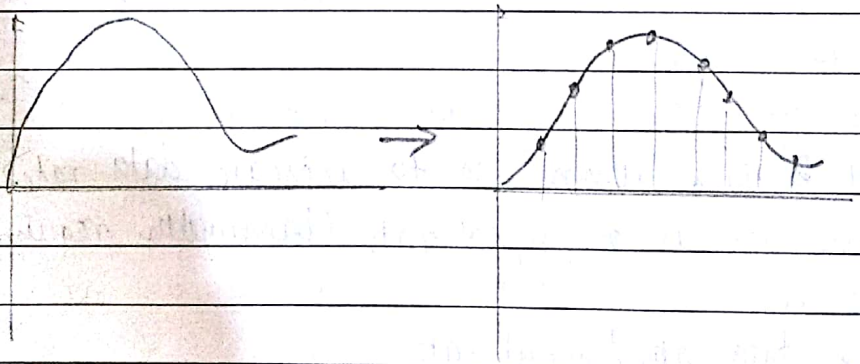
$= 0.5 \times 100000 \times 1$

$= 50000$ pulses/sec $= 50$ kbaud.

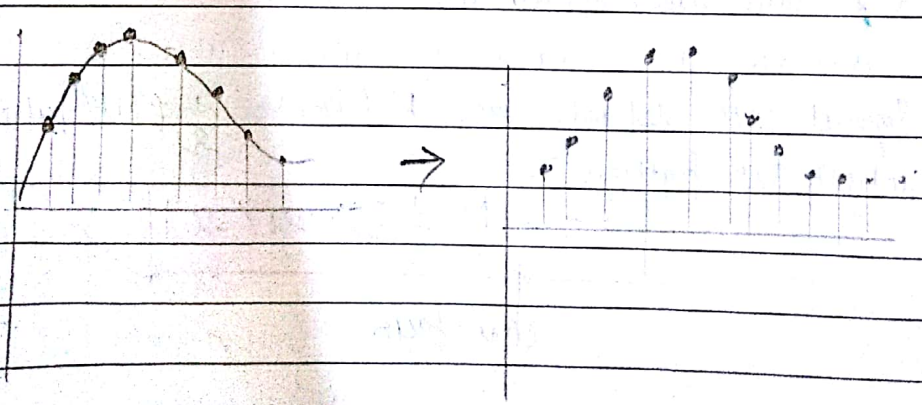
Analog to digital conversion

- To convert analog wave into digital data, we use Pulse code modulation (PCM).
- PCM involves three steps:
  - Sampling
  - Quantization
  - Encoding

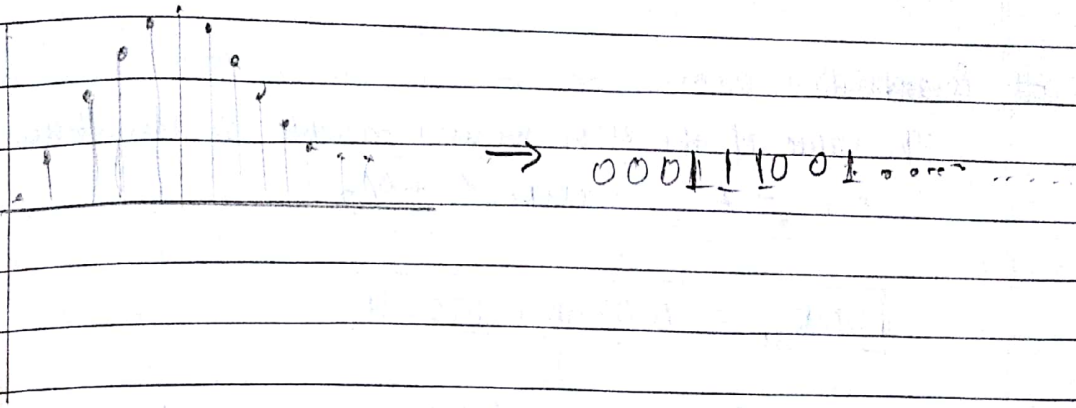
Sampling



Quantization



Encoding



- Sampling
  - Analog signal is sampled every T interval
  - Acc. to Nyquist theorem, the sampling rate must be at least two times the highest frequency of the signal

- Quantization
  - Approximation of instantaneous analog value.
  - Done b/w max. and min amplitude value.

- Encoding
  - Approximated value is converted to binary format.

Quantization steps

- Divide the range into L zones, each of height Δ

$$\Delta = (V_{max} - V_{min}) / L$$

- Assign
  ^ Quantized values of 0 to L-1 to the midpoint of each zone.

- Approximate the value of the sample amplitude to the quantized value.