M1

Math

chapter 4

Quantization :

Spring 24 3-(9)

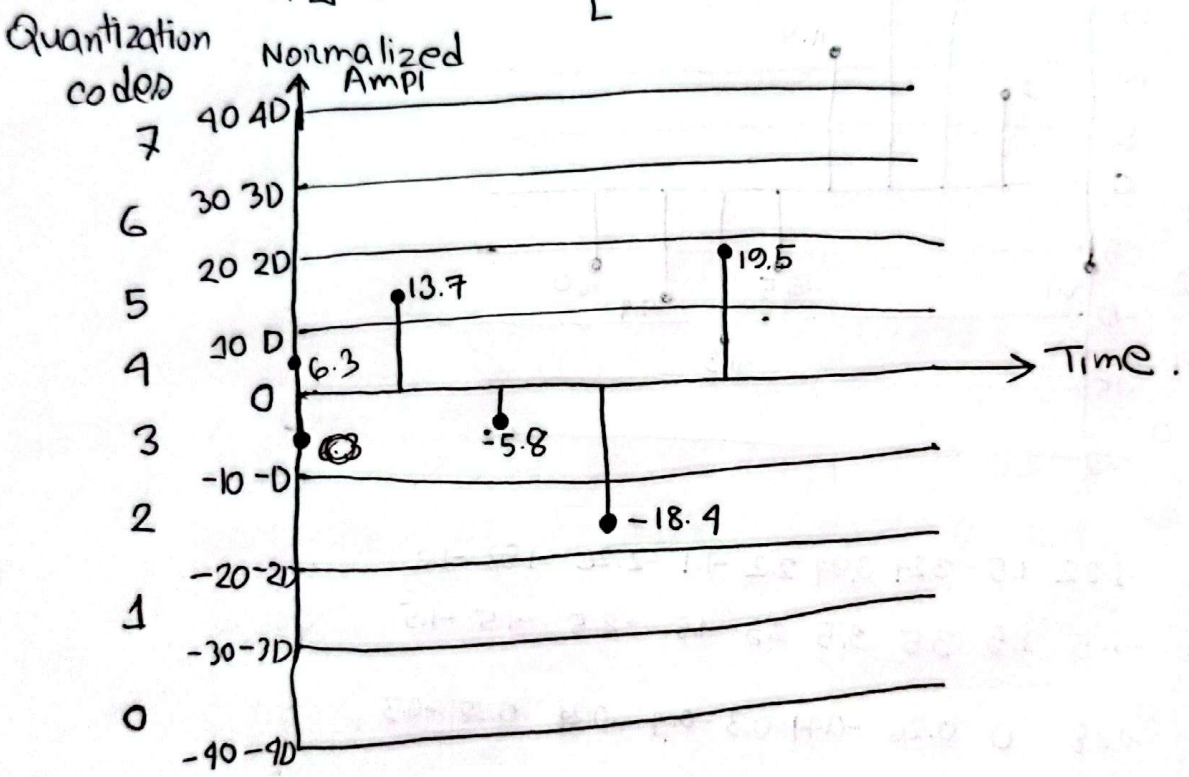
$n_b = \log_2^L = 3$

$\Rightarrow L = 8$

$V_{MAX} = +40$

$V_{MIN} = -40$

$\therefore \Delta = \frac{V_{MAX} - V_{MIN}}{L} = 20$



PAM Value	0.63	1.37	-0.58	-1.84	1.95
Quantized Val	0.5	1.5	-0.5	-1.5	1.5
Error	-0.13	0.13	0.08	0.34	-0.45
Quantization Code	4	5	3	2	5
Encoded Words	100	101	011	010	101

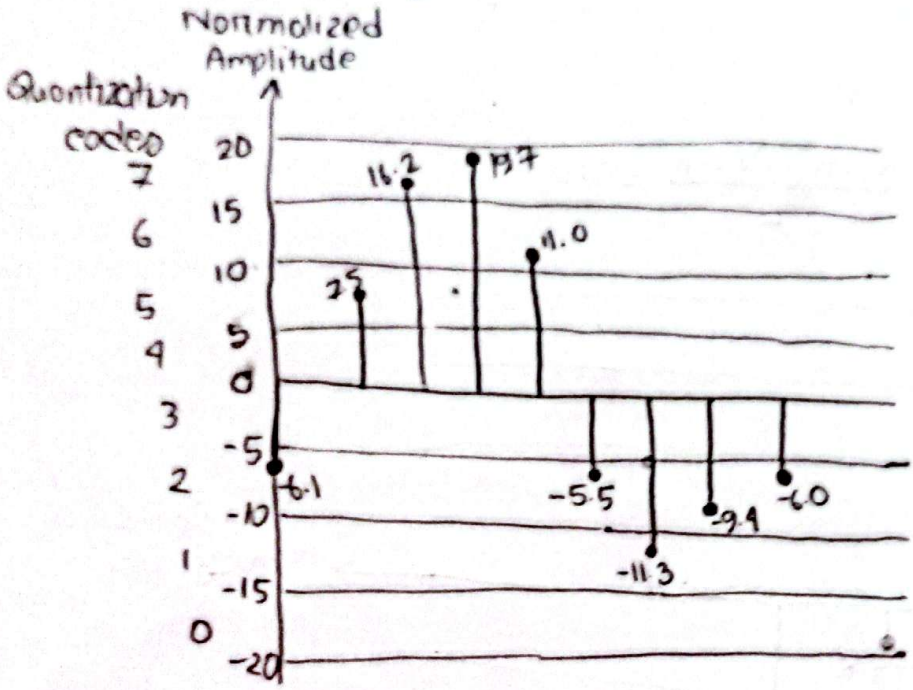
Spring 23 (3f):

$L = 8$ $\quad n_b = 3$

$V_{MAX} = 20V$

$V_{MIN} = -20$

$\Delta = 5$



Quan. PAM	-1.22	1.5	3.24	3.94	2.2	-1.1	-2.26	-1.88	-1.2
Quantized	-1.5	1.5	3.5	3.5	2.5	-1.5	-2.5	-1.5	-1.5
Error	-0.28	0	0.26	-0.44	0.3	-0.4	-0.24	0.38	-0.3
Quratization codes	2	5	7	7	6	2	1	2	2
Encoded words	010	101	111	111	110	010	001	010	010

M2

chapter 8

We need a three stage Division switch with N=100
We use 10 crossbar at first and third stage
calculate the total number of crosspoint.

(i) 4 crossbar at the middle stage
(ii) 6 crossbar at the middle stage.
(iii) N=100 using clos criteria.

(i)

N = 100

n = 10

K = 4

crossbar = 10(4x10) + 4(10x10) + 10(10x4)

= 1200

(ii) crossbar = 10(6x10) + 6(10x10) + 10(10x6)

= 1800

(iii) $n = \left(\frac{N}{2}\right)^{\frac{1}{2}} = \sqrt{50} = 7.07 \approx 8$ $\therefore \frac{N}{n} = 12.5 \approx 13$

K = 2n-1 = 16-1 = 15

crossbar = 13(8x15) + 15(13x13) + 13(15x8)

= 5655

Spring24 (3f)

First: $\frac{3200\,km}{2\times10^8\,m/s} + (3+20+20)\,ms = 59\,ms$

Second: $\frac{11200\,km}{2\times10^8\,m/s} + (3+10+20) = 91.5\,ms$

Third: $\frac{12200\,km}{2\times10^8\,m/s} + (3+10+20+20) = 114\,ms$

Fourth: $\frac{10200}{2\times10^8} + (3+7+20) = 81\,ms$

Fifth: $\frac{10700}{2\times10^8} + (3+7+20+20) = 103.5\,ms$

Order of arrival: $3 \rightarrow 5 \rightarrow 2 \rightarrow 4 \rightarrow 1$

M3

chapter 10

Hamming code :

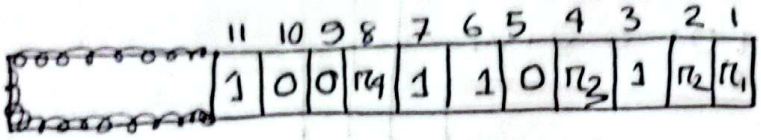
Fall 23 (3b) Half

Adding redundency bit to 1001101

$$2^r \geq m+r+1$$

$$2^4 = 16 \geq 7+4+1$$

$$\therefore r = 4$$



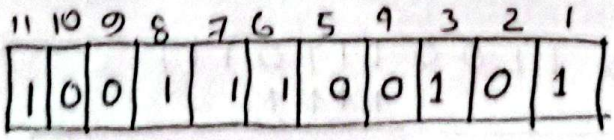
$r_1 = (1,3,5,7,9,11)$
$= (1,0,1,0,1)$
$= 1$

$r_2 = (2,3,6,7,10,11)$
$= (1,1,1,0,1)$
$= 0$

$r_3 = (4,5,6,7)$
$= (0,1,1)$
$= 0$

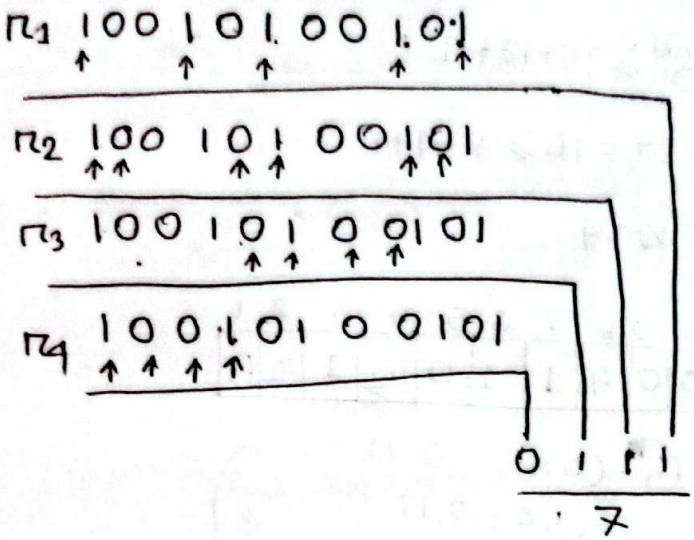
$r_4 = (8,9,10,11)$
$= (0,0,1)$
$= 1$

even parity



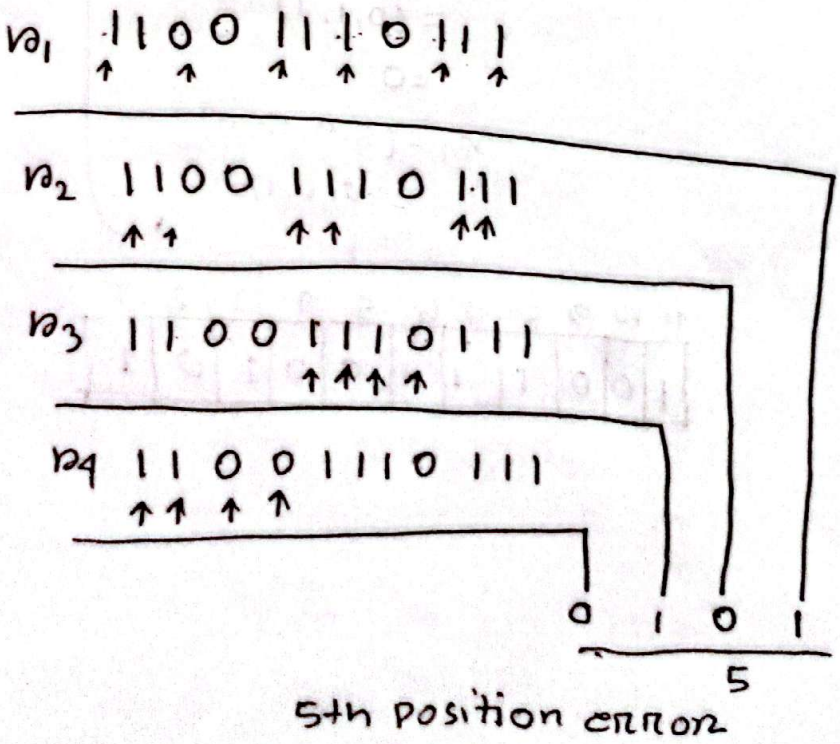
Detecting error bit position:

10010100101



position 7 error.

Spring 24 (3b):



5th position error

Corrected: 11001100111

MQ

chapter 10

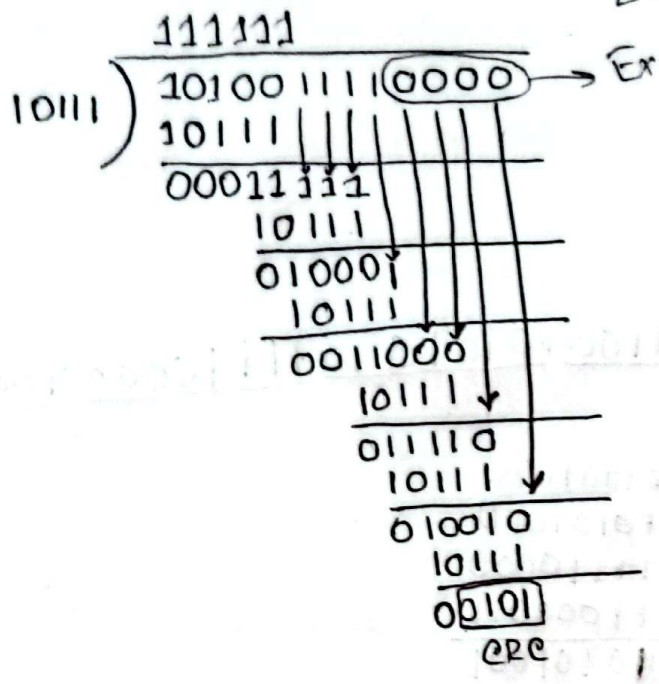
CRC

Spring 24 (3e) / Fall 23 (3e) → same

Dataword : 10100111 1

Divisor : 10111

Divisor = 5 bit
Extra Bit = 5-1 = 4
Extra CRC = 4

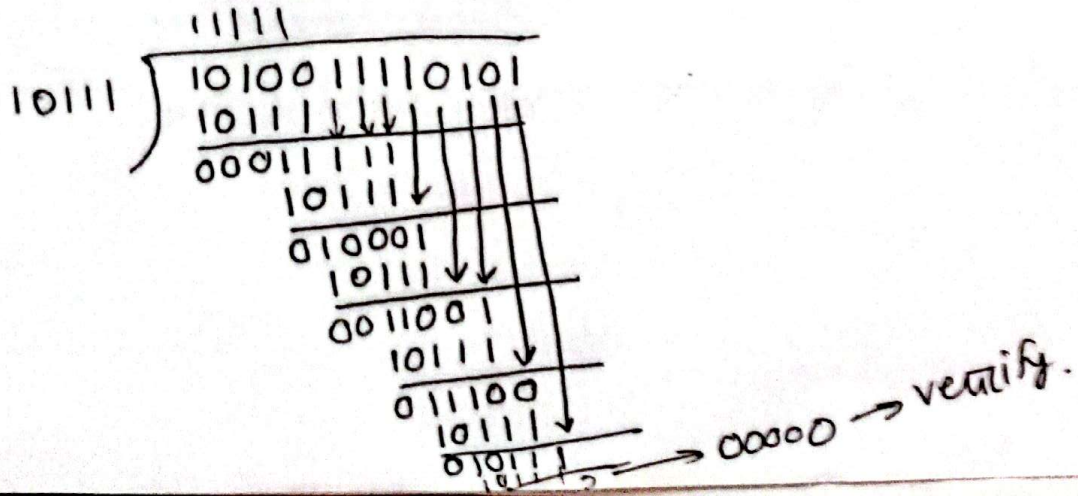


∴ Generation of the CRC codeword,

~~ed~~ Dataword + CRC → 101001111 0101

Verify:

Generation code (divide) divisor = remainder (0)



Fall 23 (3e)

Dataword = 10011101

polynomial = x^3+1

$= x^3.1 + x^2.0 + x.0 + 1$

∴ Divisor = 1001

Then same as before.

Checksum

Fall 23 (3f)

0 100 1100 1010 1010 1111 0000 1100 0011

1 0 0 1 1 0 0
1 0 1 0 1 0 1 0
1 1 1 1 0 0 0 0
+ 1 1 0 0 0 0 1 1
1 0 0 1 0 1 0 0 1
1 0
1 0 1 0 1 0 1 1
(0 1 0 1 0 1 0 0) Extra

(3d) Just have to convert all Hex → Bin and same process

MT

Chapter 5

FSK → n = 1

ASK → n = 1

QPSK → n = 2

64-QAM → n = 6

BPSK → n = 1

16-QAM → n = 4

FSK → B = (1+d)S + 2Δf

for except all,

$n_b = (1+d)S$

Baud rate

FSK

$n = \log_2^2 = 1 \quad S = \frac{2000}{n} = \frac{2000}{1} = 2\text{kbauds}$

ASK

$n = \log_2^2 = 1 \quad S = \frac{4000}{1} = 4\text{kbauds}$

QPSK

$n = \log_2^4 = 2 \quad S = \frac{6000}{2} = 3\text{kbauds}$

64-QAM

$n = \log_2^{64} = 6 \quad S = \frac{36000}{6} = 6\text{kbauds}$

Number of bits per baud.

Ask with four diff amplitude $= \log_2^4 = 2$

FSK " eight " frequency $= \log_2^8 = 3$

PSK " four " phases $= \log_2^4 = 2$

QAM with a constellation of 128 point $= \log_2^{128} = 7$

similar book exercise Q5-6

Required Bandwidth:

$N = 4000bps$

$d = 1$

ASK

$B = (1+d)S$

$= 2S = 2 \times \frac{N}{1} = 2 \times N = 2 \times 4000$

$= 8000Hz$

FSK with $2\Delta f = 4kHz$

$B = (1+d)S + 2\Delta f$

$= 2S + 2\Delta f$

$= 2 \times \frac{N}{1} + 2\Delta f$

$= 2 \times 4000 + 4kHz$

$= 8kHz + 4kHz$

$= 12kHz$

QPSK

$B = (1+d) \times S$

$= 2 \times \frac{N}{2}$

$= 2 \times \frac{4000}{2}$

$= 4kHz$

16QAM

$B = (1+d)S$

$= 2 \times \frac{N}{4}$

$= 2 \times \frac{4000}{4} = 2kHz$

P5-9 Spring 23 (2d), Spring 24 (3c), Fall 22 (2d)
corporation

Bandwith for each channel = $\frac{1\,MHz}{10} = 100\,kHz$

Here, $d = 0$

$B = (1+d)S$

$\Rightarrow B = S$

$\Rightarrow B = \frac{N}{n}$

$\Rightarrow n = \frac{N}{B} = \frac{(\,?\,)}{100kHz} = \square$ → bit per baud

$L = 2^n = \square$ → Number of points in the constelation diagram

5-10
Cable company

64-QAM

$\therefore n = \log_2 64 = 6$

$B = (1+d)S \quad [d=0]$

$\Rightarrow B = \frac{N}{n}$

$\Rightarrow N = B \times n = 6 \times 6 = 36\,Mbps.$

Fall 22 (2e)

$B = (1+d)S \quad [d=0]$

$B = S$

$B = \frac{N}{n}$

(i) 64QAM, $n = 6$ $\therefore N = 4kHz \times 6 = 24\,kbps$

(ii) QPSK, $n = 2$ $\therefore N = 4kHz \times 2 = 8\,kbps.$ Ans.

M7

chapter 6

P6-1

(a) Size of an output frame = 20+1 = 21 bit

(b) frame rate = 100000 fps

(c) output frame duration = $\frac{1}{100000}$ s

= 10 μs

(d) output data rate = 100000 × 21

= 2.1 Mbps

(e) $\frac{20}{21} \times 100 = 95.23\%$

P6-5

(a) 40+1 = 41 bit

(b) 50000 fps

(c) $\frac{1}{50000}$

(d) 50000 × 41 = 2.05 Mbps

(e) $\frac{40}{41} \times 100 = 97.56\%$

Spring 24 BQ

six 200 kbps input
four 400 kbps input

By multilevel multiplexing,

seven @ 400 kbps input

Size of a frame = 400 x 1000 fpo
= 400000 fpo

Frame rate @ $\frac{1}{400000}$ so = Duration of a frame

frame size = 7 bit

output Data rate = 400000 x 7
= 2800000
= 2.8 Mbps.

example

Fall 23 (3b) → Book ~~exercise~~ → 6.9

(3c) → Book exercise → Pg-9