Монгол Улсын Их Сургууль

Мэдээллийн технологи, электроникийн сургууль

Мэдээлэл, компьютерийн ухааны тэнхим

“Компьютерийн зохион байгуулалт ба архитектур” хичээлийн 1-р лабораторийн тайлан

“Программ хангамж” хөтөлбөрийн 2-р түвшний оюутан:

Э.Түвшин-Эрдэнэ/23b1num0869/

Улаанбаатар хот

2025 он

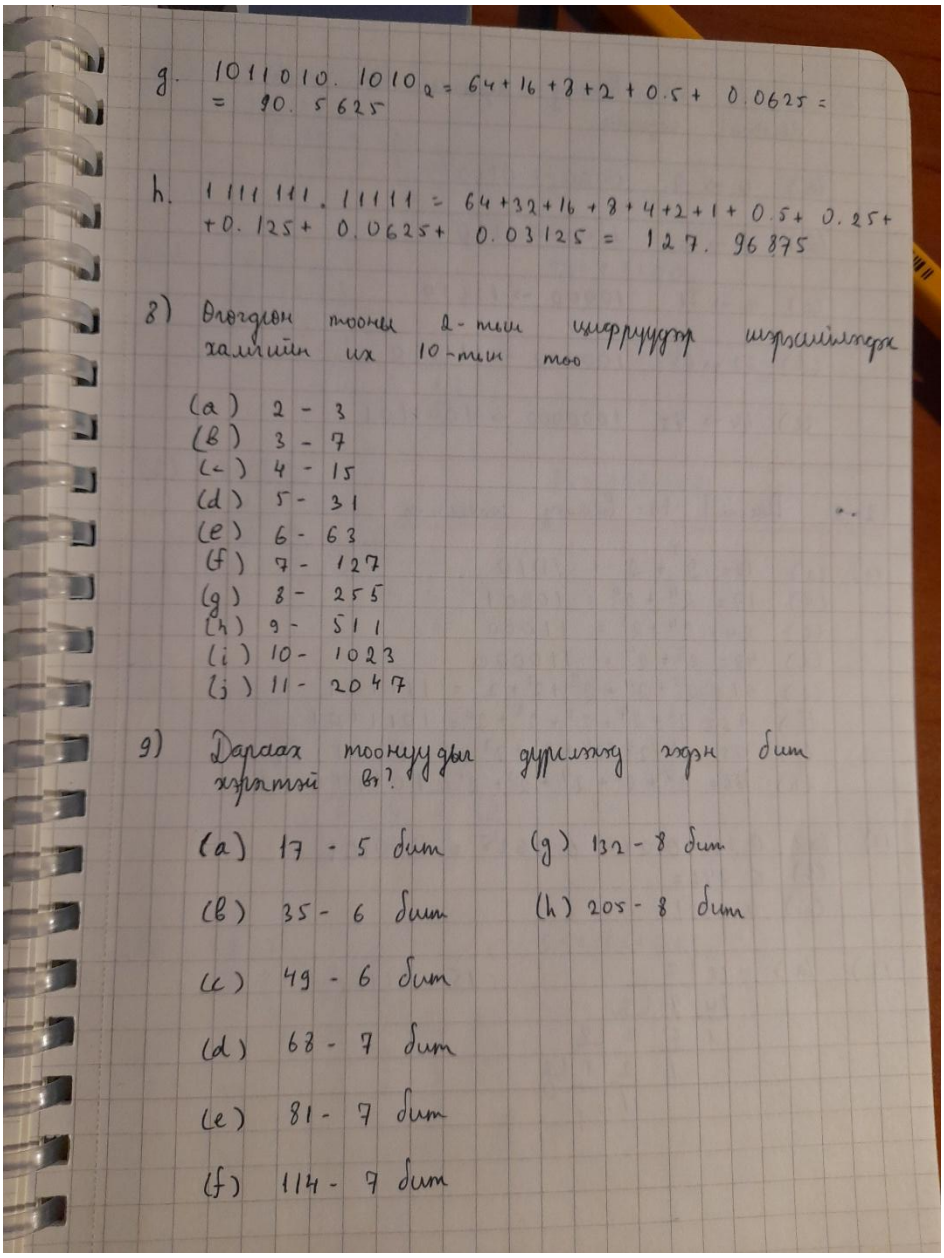
Lab 1

2-2 (binary numbers)

5) a. $11_2 = 3$
b. $100_2 = 4$
c. $111_2 = 7$
d. $1000_2 = 8$
e. $1001_2 = 9$
f. $1100_2 = 12$
g. $1011_2 = 11$
h. $1111_2 = 15$

6) a. $1110_2 = 14$
b. $1010_2 = 10$
c. $11100_2 = 28$
d. $10000_2 = 16$
e. $10101_2 = 21$
f. $11101_2 = 16+8+4+1 = 29$
g. $10111_2 = 16+4+2+1 = 23$
h. $11111 = 16+8+4+2+1 = 31$

7) a. $110011.11_2 = 32+16+2+1+0.5+0.25 = 51.75$
b. $101010.01_2 = 32+8+2+0.25 = 42.25$
c. $1000001.111 = 64+1+0.5+0.25+0.125 =$
$= 65.875$
d. $1111000.101 = 64+32+16+8+0.5+0.125 =$
$= 120.625$
e. $1011100.10101 = 64+16+8+4+0.5+0.125+$
$+ 0.03125 = 92.65625$
f. $1110001.0001 = 64+32+16+1+0.0625 =$
$= 113.0625$



g. $1011010.1010_2 = 64+16+8+2+0.5+0.0625 = 90.5625$

h. $1111111.11111 = 64+32+16+8+4+2+1+0.5+0.25+0.125+0.0625+0.03125 = 127.96875$

8) Өгөгдсөн тоонуудыг 2-тын цифрүүдээр илэрхийлэхэд хамгийн их 10-тын тоо

(a) 2 - 3
(b) 3 - 7
(c) 4 - 15
(d) 5 - 31
(e) 6 - 63
(f) 7 - 127
(g) 8 - 255
(h) 9 - 511
(i) 10 - 1023
(j) 11 - 2047

9) Дараах тоонуудыг дүрслэхэд ядаж бит хэрэгтэй вэ?

(a) 17 - 5 бит
(b) 35 - 6 бит
(c) 49 - 6 бит
(d) 68 - 7 бит
(e) 81 - 7 бит
(f) 114 - 7 бит
(g) 132 - 8 бит
(h) 205 - 8 бит

10) Generate the binary sequence for each decimal sequence

(a) $0 \rightarrow 7$ $0000 \rightarrow 0110$

(B) $8 \rightarrow 15$ $1000 \rightarrow 1110$

(c) $16 \rightarrow 31$ $10000 \rightarrow 11110$

(d) $32 \rightarrow 63$ $100000 \rightarrow 111110$

(e) $64 \rightarrow 75$ $1000000 \rightarrow 1001101$

2-3 Decimal-to-binary conversion

11) (a) $10 = 2^3 + 2^1 = 1010$

(B) $17 = 2^4 + 2^0 = 10001$

(c) $24 = 2^4 + 2^3 = 11000$

(d) $48 = 2^5 + 2^4 = 110000$

(e) $61 = 2^5 + 2^4 + 2^3 + 2^2 + 2^0 = 111101$

(f) $93 = 2^6 + 2^4 + 2^3 + 2^2 + 2^0 = 1011101$

(g) $125 = 2^6 + 2^5 + 2^4 + 2^3 + 2^2 + 2^0 = 1111101$

(h) $186 = 2^7 + 2^5 + 2^4 + 2^3 + 2^1 = 10111010$

12) (a) $0.32 = 0.25 + 0.0625 = 0.0101$

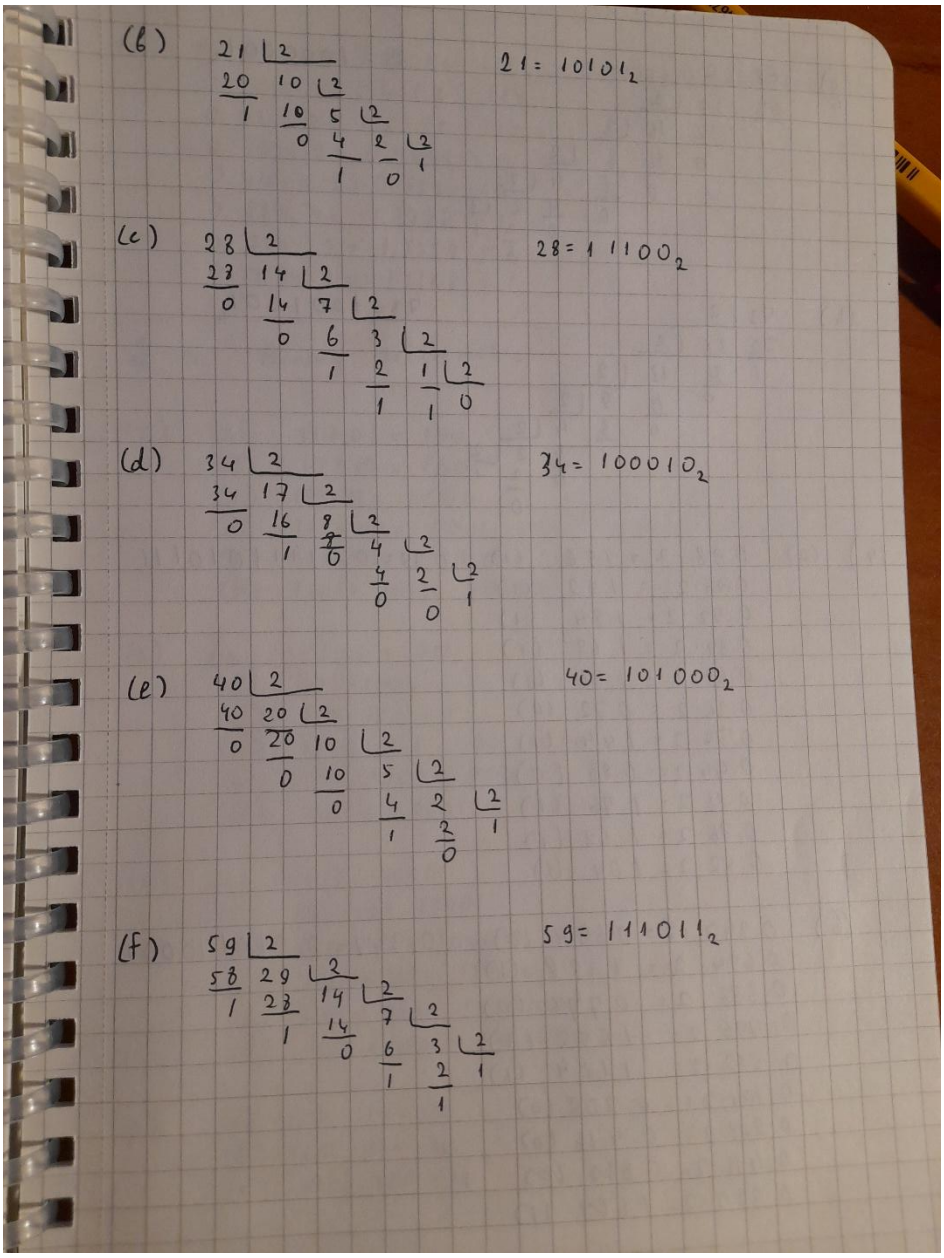
(B) $0.246 =$

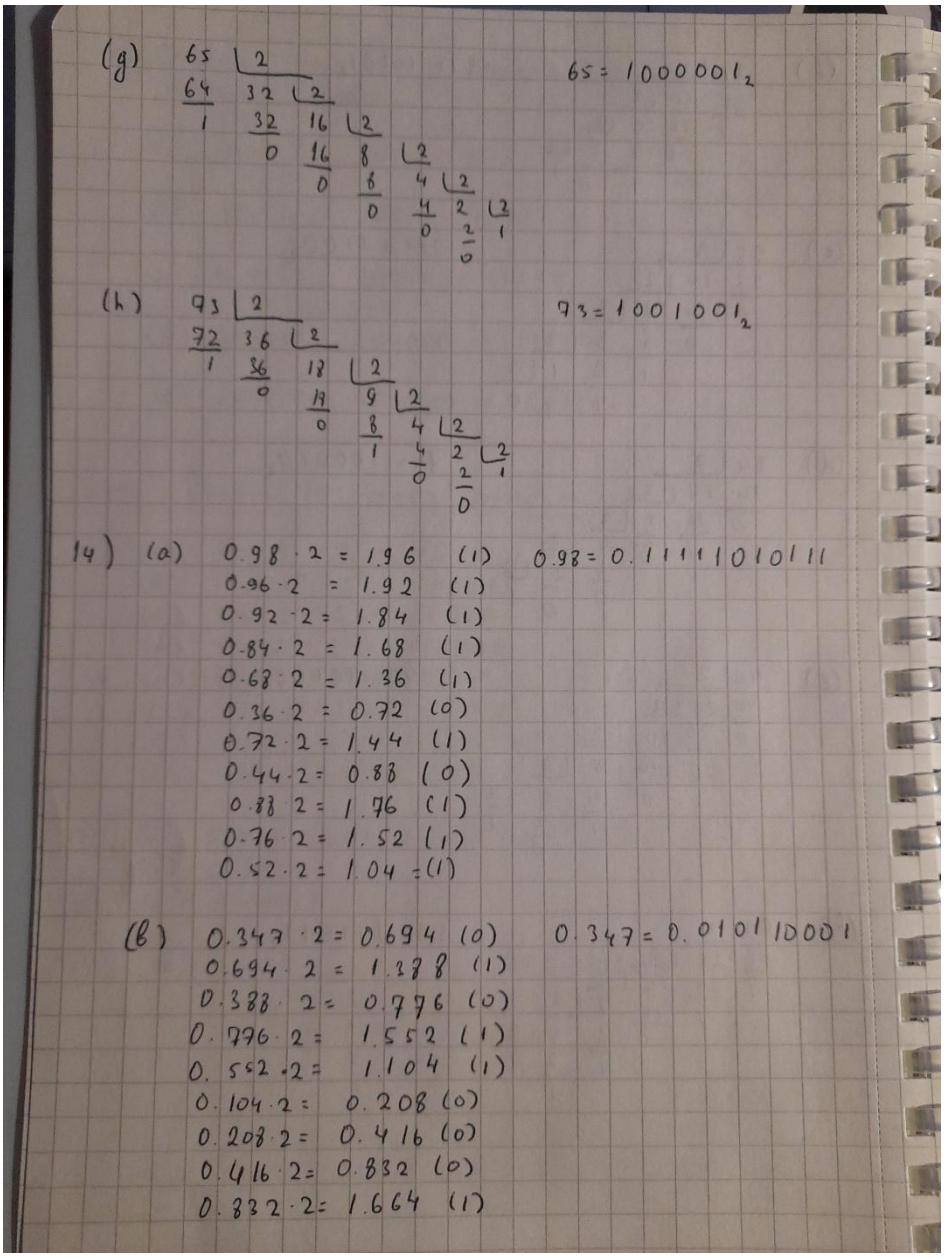
(c) $0.0981 =$

13) (a)

15	2			
14	7	2		
1	6	3	2	
	2	1	2	
	1		0	
		1		

$15 = 1111_2$


(b)
21 = 10101₂
(c)
28 = 11100₂
(d)
34 = 100010₂
(e)
40 = 101000₂
(f)
59 = 111011₂



(g)
65 | 2
64 | 32 | 2
1 | 32 | 16 | 2
0 | 16 | 8 | 2
0 | 8 | 4 | 2
0 | 4 | 2 | 2
0 | 2 | 1
0

$65 = 1000001_2$

(h)
73 | 2
72 | 36 | 2
1 | 36 | 18 | 2
0 | 18 | 9 | 2
0 | 8 | 4 | 2
1 | 4 | 2 | 2
0 | 2 | 1
0

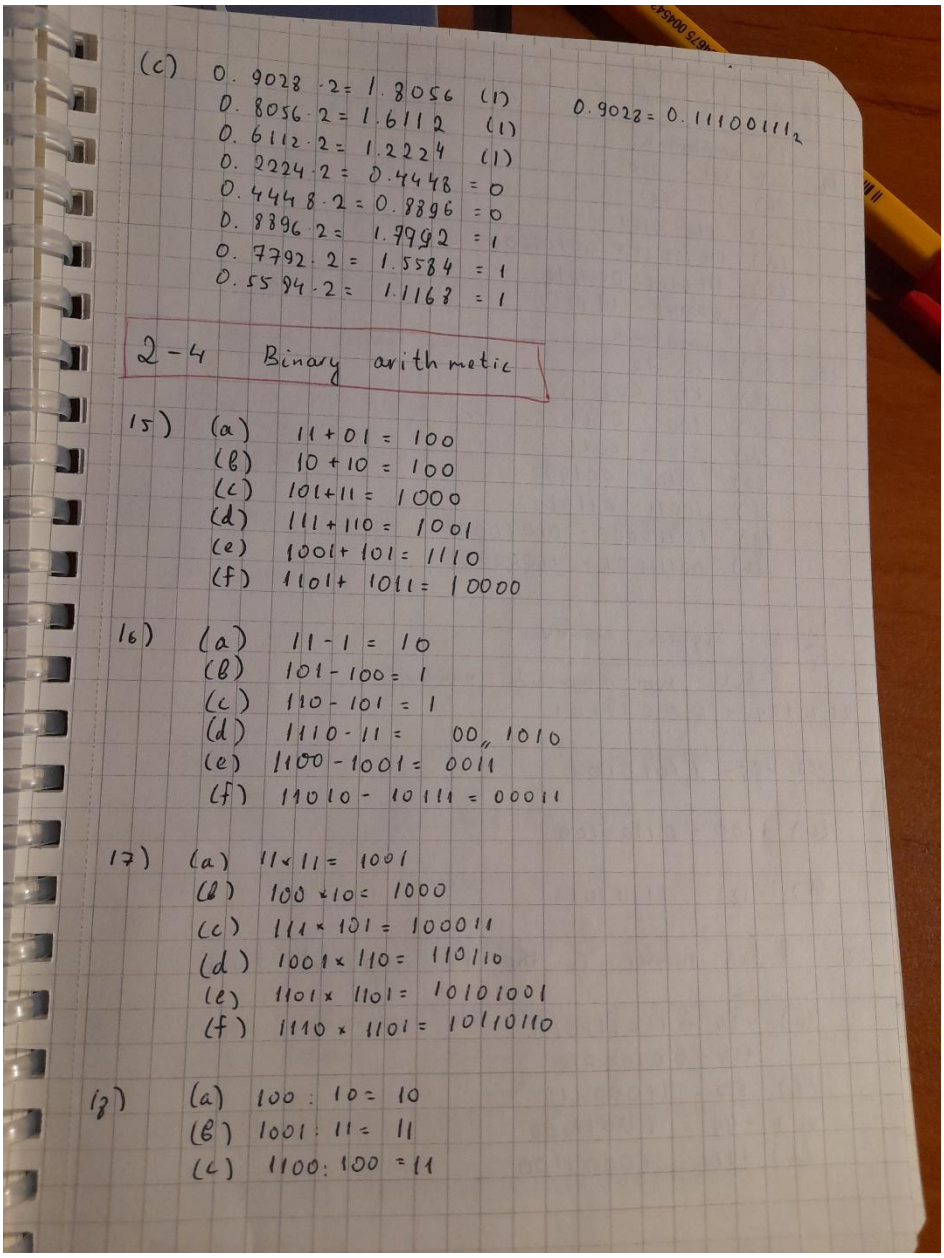
$73 = 1001001_2$

14) (a)
0.98 · 2 = 1.96 (1)
0.96 · 2 = 1.92 (1)
0.92 · 2 = 1.84 (1)
0.84 · 2 = 1.68 (1)
0.68 · 2 = 1.36 (1)
0.36 · 2 = 0.72 (0)
0.72 · 2 = 1.44 (1)
0.44 · 2 = 0.88 (0)
0.88 2 = 1.76 (1)
0.76 2 = 1.52 (1)
0.52 · 2 = 1.04 = (1)

$0.98 = 0.11111010111$

(b)
0.347 · 2 = 0.694 (0)
0.694 · 2 = 1.388 (1)
0.388 · 2 = 0.776 (0)
0.776 · 2 = 1.552 (1)
0.552 · 2 = 1.104 (1)
0.104 · 2 = 0.208 (0)
0.208 2 = 0.416 (0)
0.416 · 2 = 0.832 (0)
0.832 · 2 = 1.664 (1)

$0.347 = 0.0101100011$



(c) $0.9028 \cdot 2 = 1.8056$ (1)
$0.8056 \cdot 2 = 1.6112$ (1)
$0.6112 \cdot 2 = 1.2224$ (1)
$0.2224 \cdot 2 = 0.4448$ = 0
$0.4448 \cdot 2 = 0.8896$ = 0
$0.8896 \cdot 2 = 1.7792$ = 1
$0.7792 \cdot 2 = 1.5584$ = 1
$0.5584 \cdot 2 = 1.1168$ = 1

$0.9028 = 0.11100011_2$

2-4 Binary arithmetic

15) (a) $11 + 01 = 100$
(b) $10 + 10 = 100$
(c) $101 + 11 = 1000$
(d) $111 + 110 = 1001$
(e) $1001 + 101 = 1110$
(f) $1101 + 1011 = 10000$

16) (a) $11 - 1 = 10$
(b) $101 - 100 = 1$
(c) $110 - 101 = 1$
(d) $1110 - 11 = 1010$
(e) $1100 - 1001 = 0011$
(f) $11010 - 10111 = 00011$

17) (a) $11 \times 11 = 1001$
(b) $100 \times 10 = 1000$
(c) $111 \times 101 = 100011$
(d) $1001 \times 110 = 110110$
(e) $1101 \times 1101 = 10101001$
(f) $1110 \times 1101 = 10110110$

18) (a) $100 : 10 = 10$
(b) $1001 : 11 = 11$
(c) $1100 : 100 = 11$

2-5 1's and 2's complements

1's complements

19. (a) 101 - 010
(b) 110 - 001
(c) 1010 - 0101
(d) 11010111 - 00101000
(e) 1110101 - 0001010
(f) 00001 - 11110

2's complements

20. (a) 10 - 10
(b) 111 - 001
(c) 1001 - 0111
(d) 1101 - 0011
(e) 11100 - 00100
(f) 10011 - 01101
(g) 10110000 - 01010000
(h) 00111101 - 11000001

2-6 Signed numbers

8-bit sign-magnitude number

21. (a) +29 - 00011101

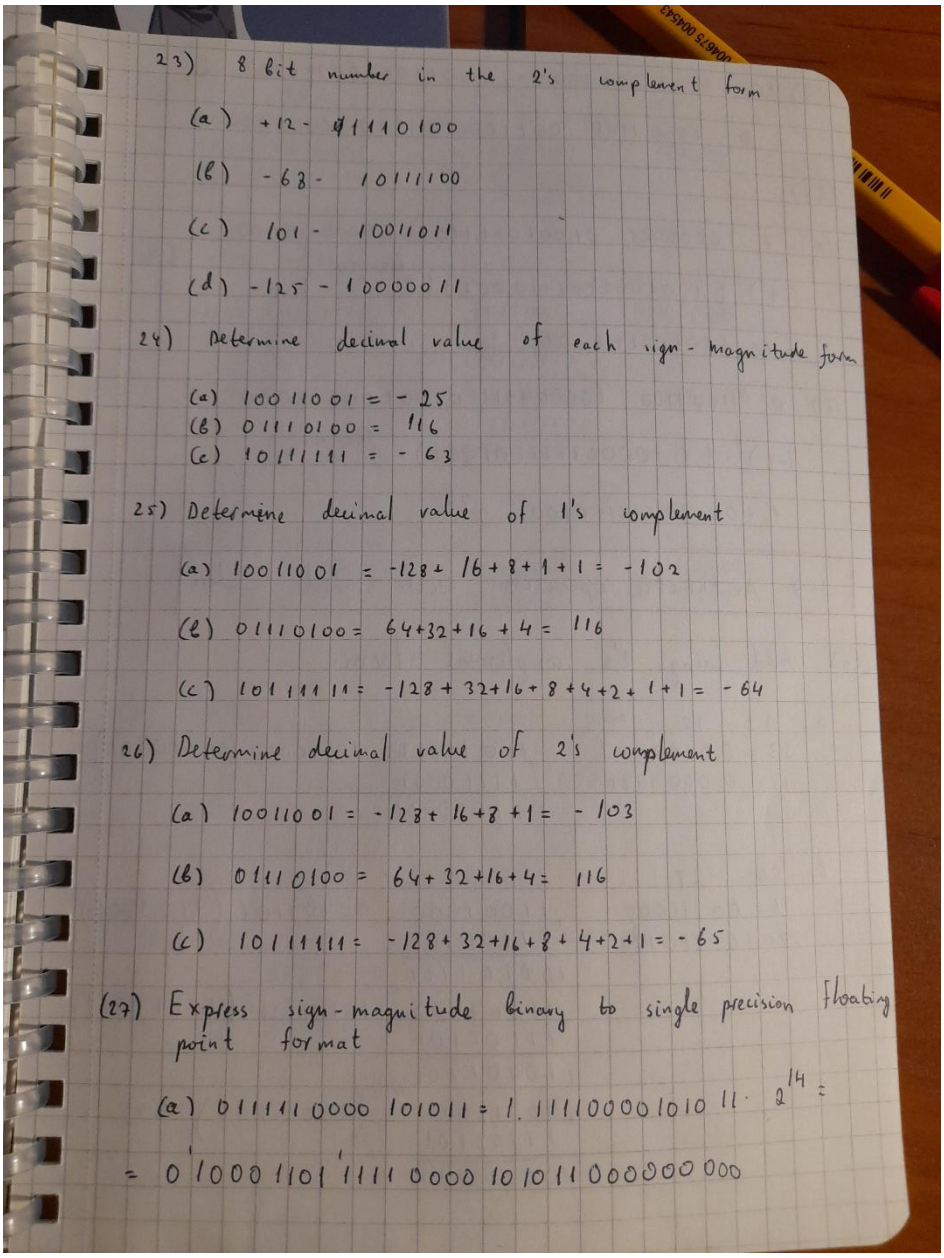
(b) -85 - 11010101

(c) +100 - 01100100

(d) -123 - 11111011

22. 8 bit number in the 1's complement form

(a) -34 - 11011101
+34 - 00100010
(b) 57 - 11000110
(c) -99 - 10011100
(d) +115 - 10001100



23) 8 bit number in the 2's complement form

(a) +12 - 01110100

(b) -68 - 10111100

(c) 101 - 10011011

(d) -125 - 10000011

24) Determine decimal value of each sign-magnitude form

(a) 10011001 = -25
(b) 01110100 = 116
(c) 10111111 = -63

25) Determine decimal value of 1's complement

(a) 10011001 = -128 + 16 + 8 + 1 + 1 = -102

(b) 01110100 = 64 + 32 + 16 + 4 = 116

(c) 10111111 = -128 + 32 + 16 + 8 + 4 + 2 + 1 + 1 = -64

26) Determine decimal value of 2's complement

(a) 10011001 = -128 + 16 + 8 + 1 = -103

(b) 01110100 = 64 + 32 + 16 + 4 = 116

(c) 10111111 = -128 + 32 + 16 + 8 + 4 + 2 + 1 = -65

(27) Express sign-magnitude binary to single precision floating point format

(a) 01111100001010111 = 1.11110000101011 · 2^{14} =

= 0 10001101 11110000101011000000000

(b) $1001\ 1000.0011\ 1000 = 1.0011\ 0000\ 0111\ 000 \cdot 2^{14}$

$= 0\ \ 1000\ 1101\ \ 0011\ 0000\ 0111\ 0000\ 0000\ 0000$

(28)

(a) $1\ \ 10000001\ \ 01001001110001\ 00000000$

$(-1)^1 (1.01001001110001)(2^{128-127}) =$

-10.1001001110001

(b) $0\ \ 11001100\ \ 10000111110100100000000$

$(-1)^0 \cdot (1.10000111110100100) \cdot 2^{204-127} =$

$1.10000111110100100 \cdot 2^{77}$

2-7 Arithmetic operations with signed numbers

(29) Add using 2's complement form:

a. 33, 15

$33 = 00100001$

$15 = 00001111$

11011111
$+\ 11110001$
$\overline{111010000}$

$11010000\ (00110000)$

b. 56, -27

$56 = 00111000$

$-27 = 10011011$

11001000
$+\ 01100101$
$\overline{100101101}$

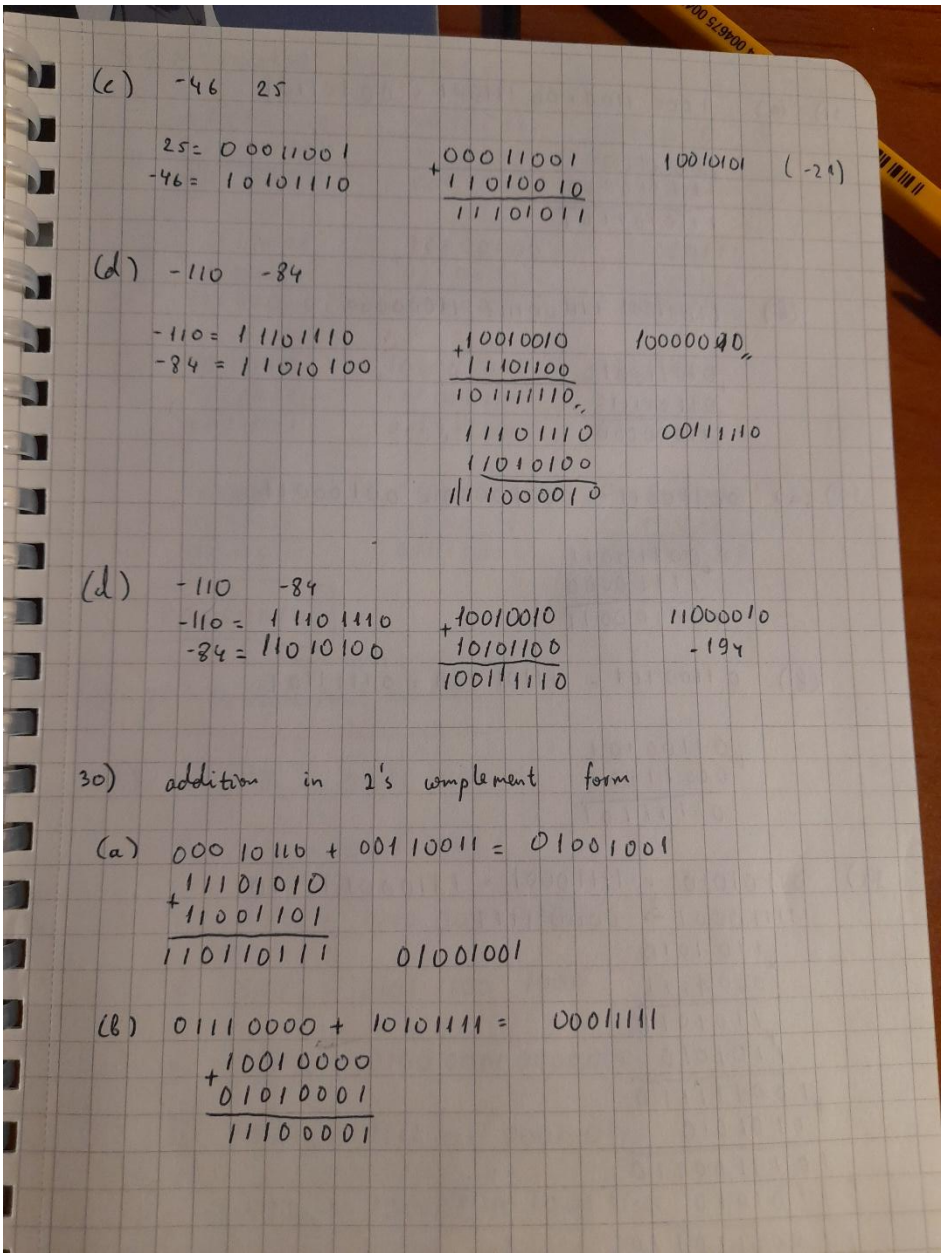
$00101101\ (11010010)$

11001000
$+\ 11100101$
$\overline{110101101}$

$10101101\ (01010011)$

00111000
$+\ 11100101$
$\overline{100011101}$

$(00011101) = 29$



(c) -46 25

25 = 00011001
-46 = 10101110

00011001
+ 11010010
11101011

10010101 (-21)

(d) -110 -84

-110 = 11101110
-84 = 11010100

10010010
+ 11101100
101111110

10000010

11101110
11010100
111000010

00111110

(d) -110 -84

-110 = 11101110
-84 = 11010100

10010010
+ 10101100
100111110

11000010
-194

30) addition in 2's complement form

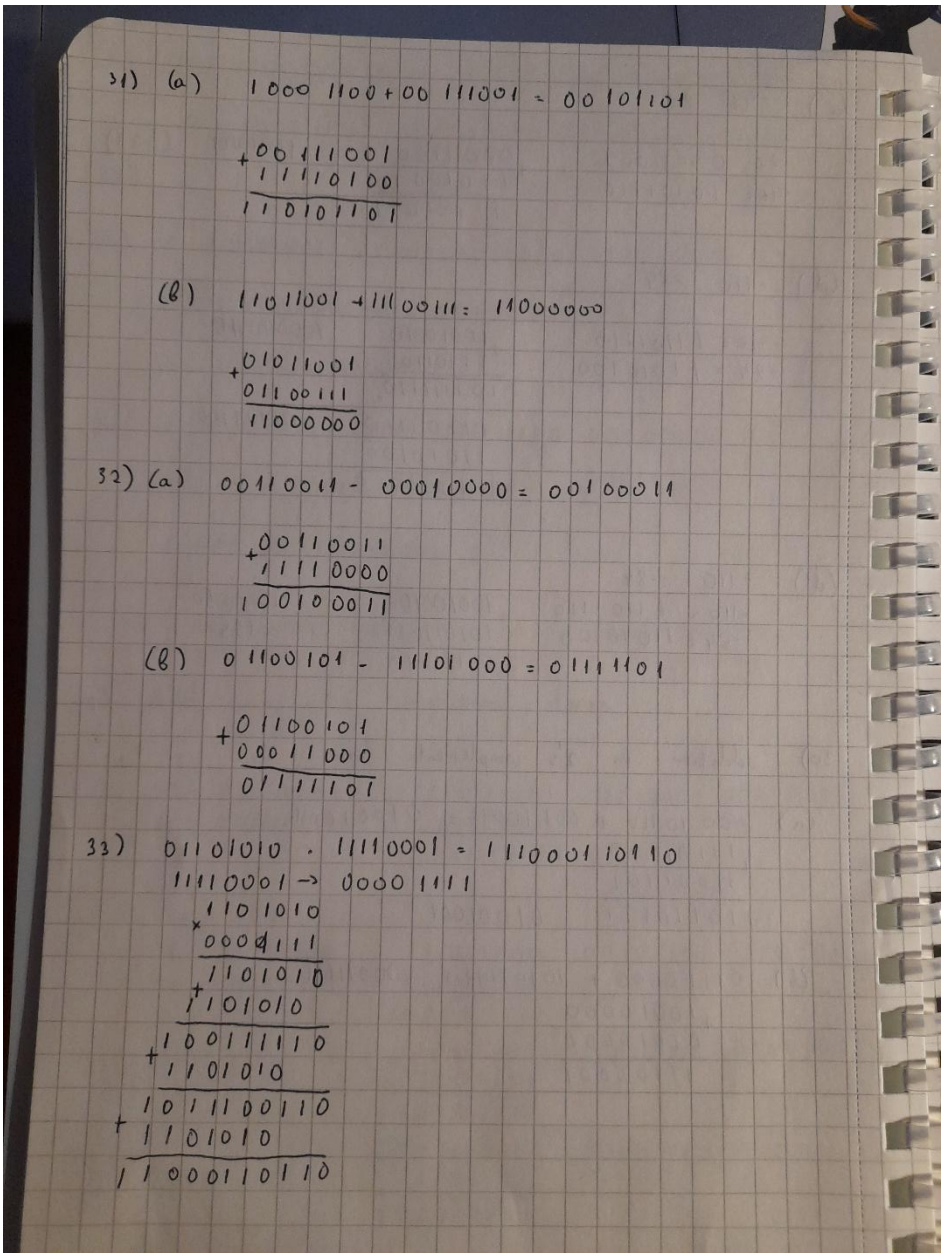
(a) 00010110 + 00110011 = 01001001

11101010
+ 11001101
111010111

01001001

(b) 01110000 + 10101111 = 00011111

10010000
+ 01010001
111000001



31) (a) 1000 1100 + 00 111001 = 00 101101

```
  00111001
+ 11110100
-----------
  11010101
```

(b) 11011001 + 01100111 = 11000000

```
  01011001
+ 01100111
-----------
  11000000
```

32) (a) 00110011 - 00010000 = 00100011

```
  00110011
+ 11110000
-----------
  00100011
```

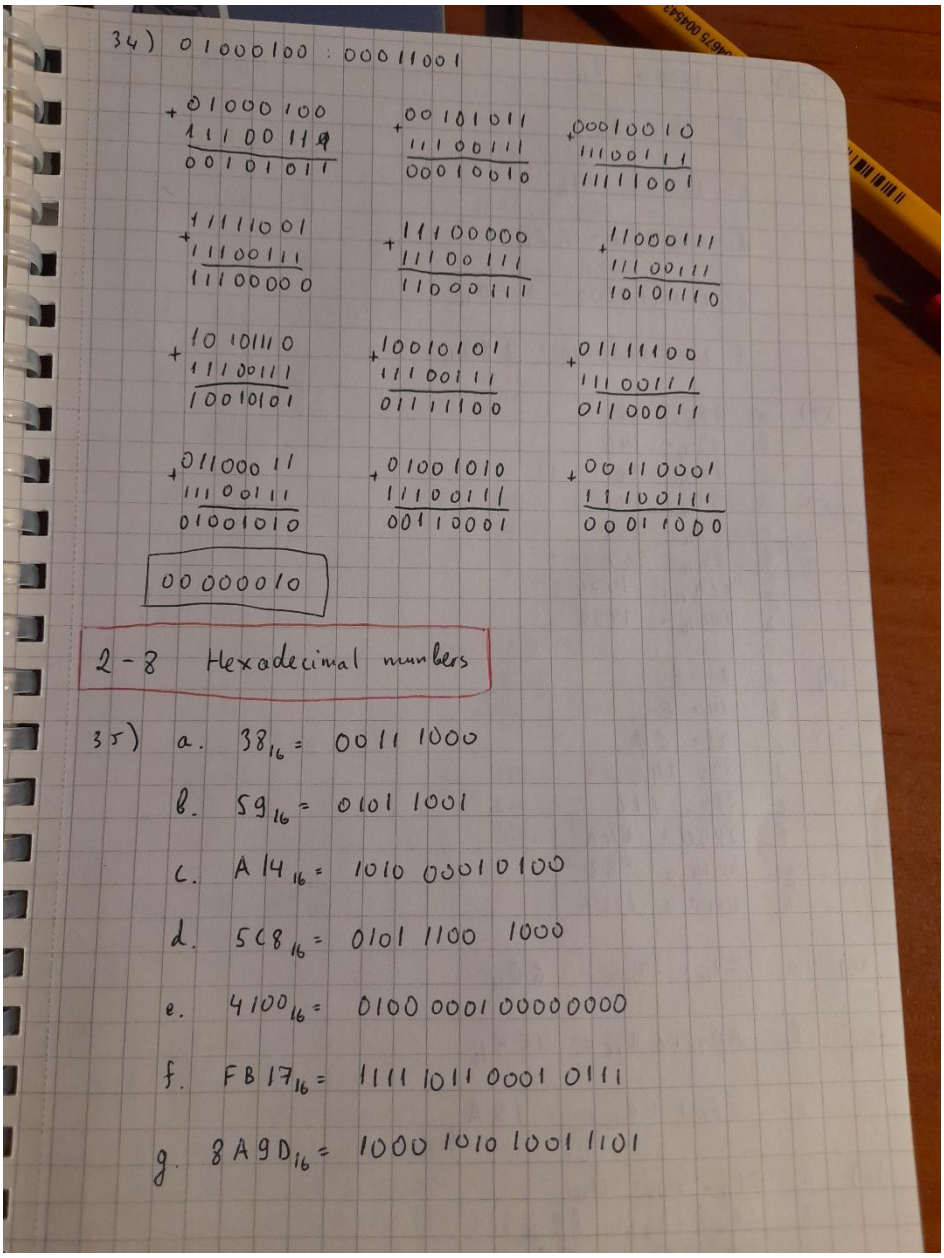
(b) 01100101 - 11101000 = 01111101

```
  01100101
+ 00011000
-----------
  01111101
```

33) 01101010 . 11110001 = 1110001101110

11110001 → 00001111

```
    1101010
  x 00001111
  -----------
    1101010
   1101010
  ---------
  100111110
+ 1101010
  ---------
  101110110
+ 1101010
  ---------
  110001101110
```



34) 01000100 : 00011001

01000100 + 11100110 = 00101011

00101011 + 11100111 = 00010010

00010010 + 11100111 = 11111001

11111001 + 11100111 = 11100000

11100000 + 11100111 = 11000111

11000111 + 11100111 = 10101110

10101110 + 11100111 = 10010101

10010101 + 11100111 = 01111100

01111100 + 11100111 = 01100011

01100011 + 11100111 = 01001010

01001010 + 11100111 = 00110001

00110001 + 11100111 = 00011000

00000010

2-8 Hexadecimal numbers

35) a. 38_{16} = 0011 1000

b. 59_{16} = 0101 1001

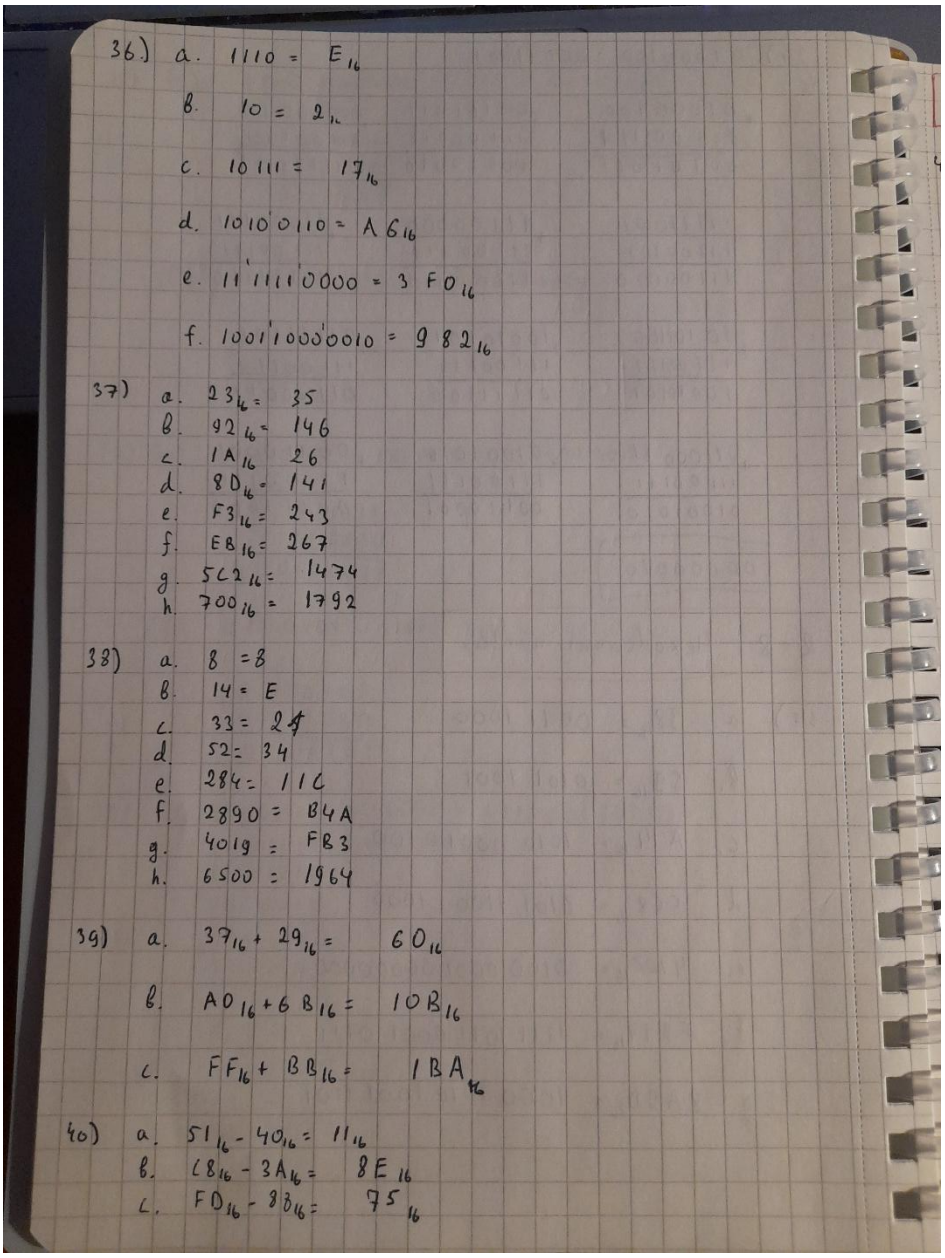
c. $A14_{16}$ = 1010 00010100

d. $5C8_{16}$ = 0101 1100 1000

e. 4100_{16} = 0100 0001 00000000

f. $FB17_{16}$ = 1111 1011 0001 0111

g. $8A9D_{16}$ = 1000 1010 1001 1101



36.) a. $1110 = E_{16}$

b. $10 = 2_{16}$

c. $10111 = 17_{16}$

d. $10100110 = A6_{16}$

e. $1111'0000 = 3F0_{16}$

f. $1001'1000'0010 = 982_{16}$

37) a. $23_{16} = 35$
b. $92_{16} = 146$
c. $1A_{16}$ 26
d. $8D_{16} = 141$
e. $F3_{16} = 243$
f. $EB_{16} = 267$
g. $5C2_{16} = 1474$
h. $700_{16} = 1792$

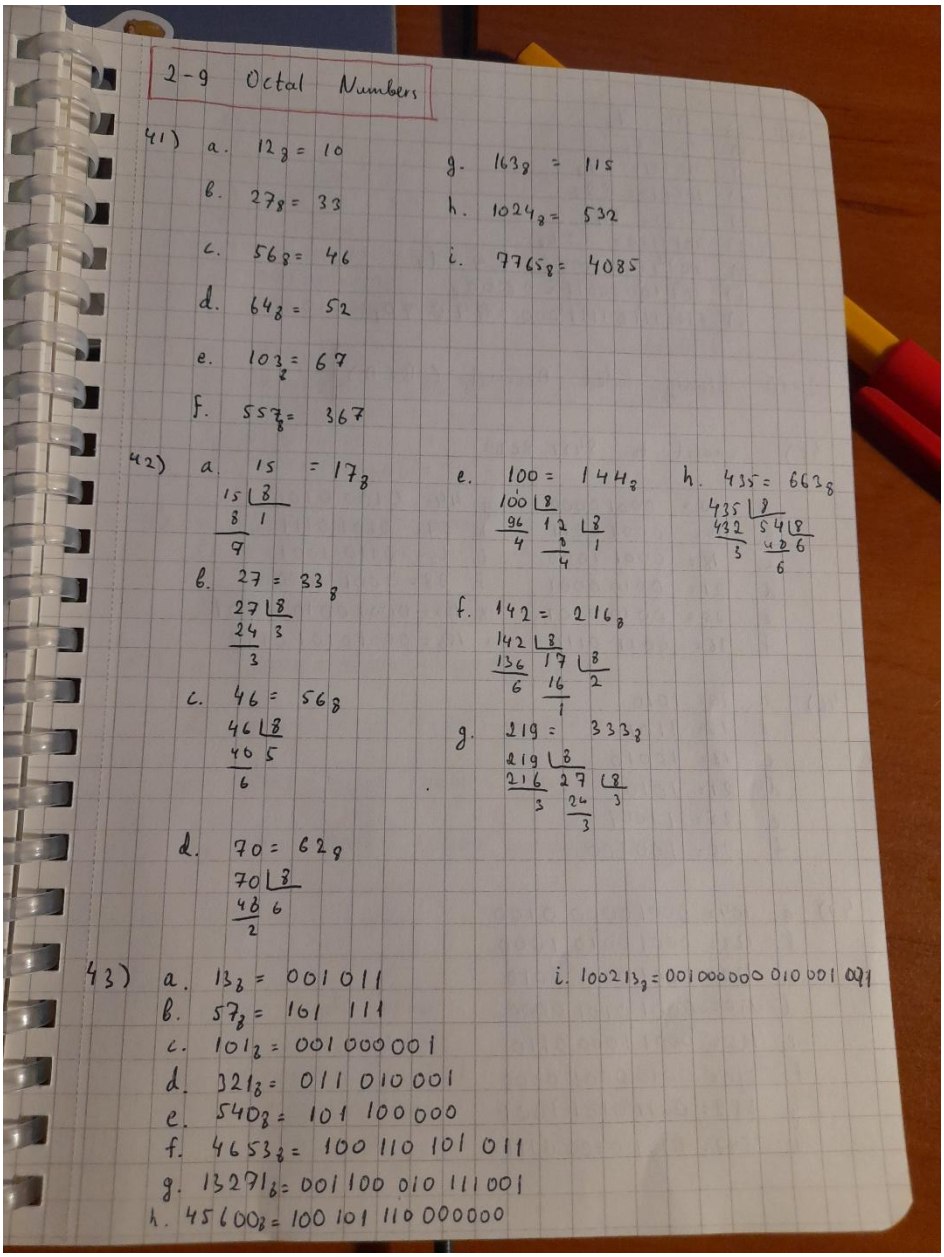
38) a. $8 = 8$
b. $14 = E$
c. $33 = 21$
d. $52 = 34$
e. $284 = 11C$
f. $2890 = B4A$
g. $4019 = FB3$
h. $6500 = 1964$

39) a. $37_{16} + 29_{16} = 60_{16}$

b. $AD_{16} + 6B_{16} = 10B_{16}$

c. $FF_{16} + BB_{16} = 1BA_{16}$

40) a. $51_{16} - 40_{16} = 11_{16}$
b. $C8_{16} - 3A_{16} = 8E_{16}$
c. $FD_{16} - 88_{16} = 75_{16}$



2-9 Octal Numbers

41) a. $12_8 = 10$

b. $27_8 = 33$

c. $56_8 = 46$

d. $64_8 = 52$

e. $103_8 = 67$

f. $557_8 = 367$

g. $163_8 = 115$

h. $1024_8 = 532$

i. $7765_8 = 4085$

42) a. $15 = 17_8$

15 ⌊8
8 1
7

b. $27 = 33_8$

27 ⌊8
24 3
3

c. $46 = 56_8$

46 ⌊8
40 5
6

d. $70 = 62_8$

70 ⌊8
48 6
2

e. $100 = 144_8$

100 ⌊8
96 12 ⌊8
4 8 1
4

f. $142 = 216_8$

142 ⌊8
136 17 ⌊8
6 16 2
1

g. $219 = 333_8$

219 ⌊8
216 27 ⌊8
3 24 3
3

h. $435 = 663_8$

435 ⌊8
432 54 ⌊8
3 48 6
6

43) a. $13_8 = 001\ 011$

b. $57_8 = 101\ 111$

c. $101_8 = 001\ 000\ 001$

d. $321_8 = 011\ 010\ 001$

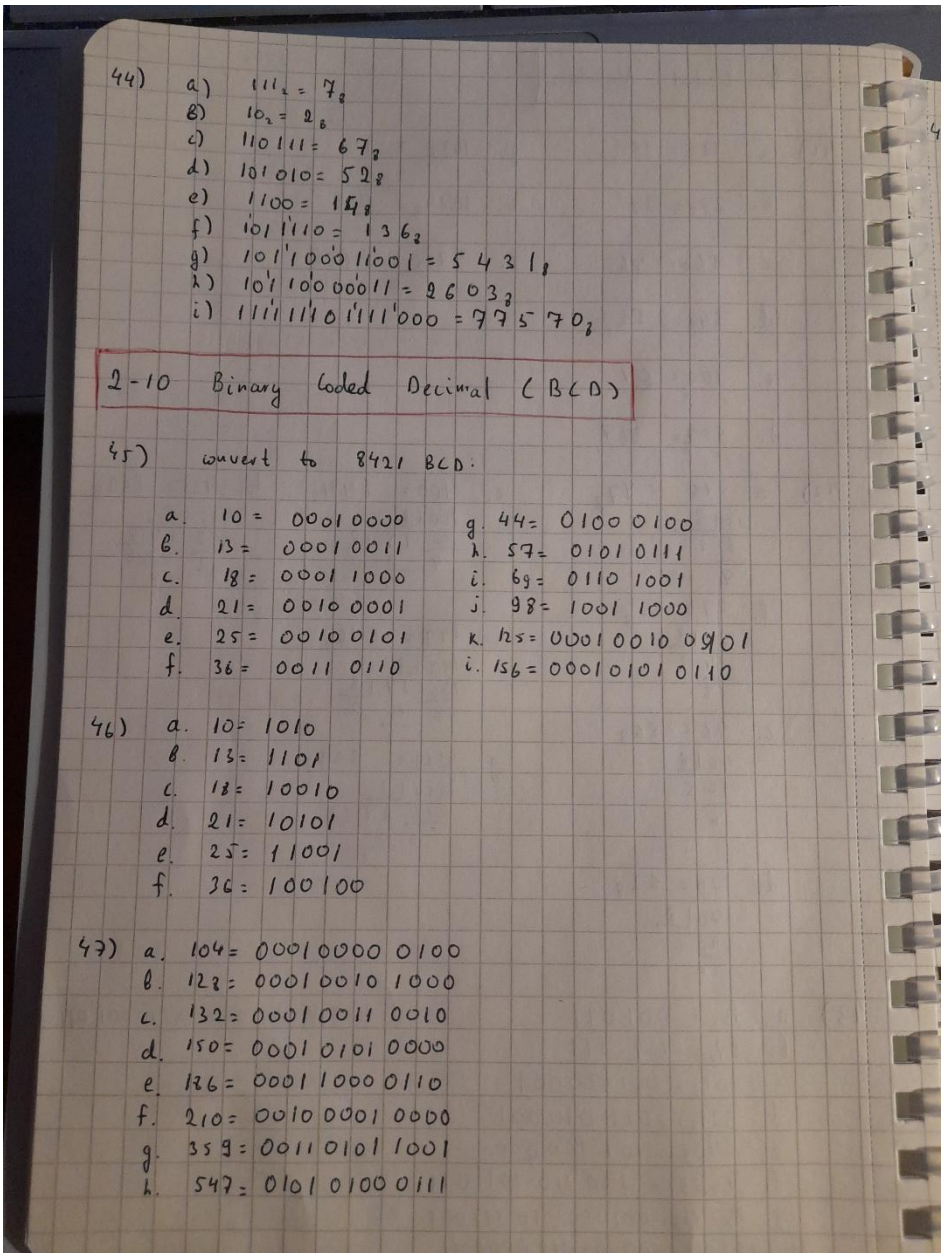
e. $540_8 = 101\ 100\ 000$

f. $4653_8 = 100\ 110\ 101\ 011$

g. $13271_8 = 001\ 100\ 010\ 111\ 001$

h. $45600_8 = 100\ 101\ 110\ 000\ 000$

i. $100213_8 = 001\ 000\ 000\ 010\ 001\ 011$



44) a) $111_2 = 7_8$
b) $10_2 = 2_8$
c) $110111 = 67_8$
d) $101010 = 52_8$
e) $1100 = 14_8$
f) $101\,1110 = 136_8$
g) $101\,1000\,1001 = 5431_8$
h) $101\,100\,000\,011 = 2603_8$
i) $1111\,1110\,1111\,000 = 77570_8$

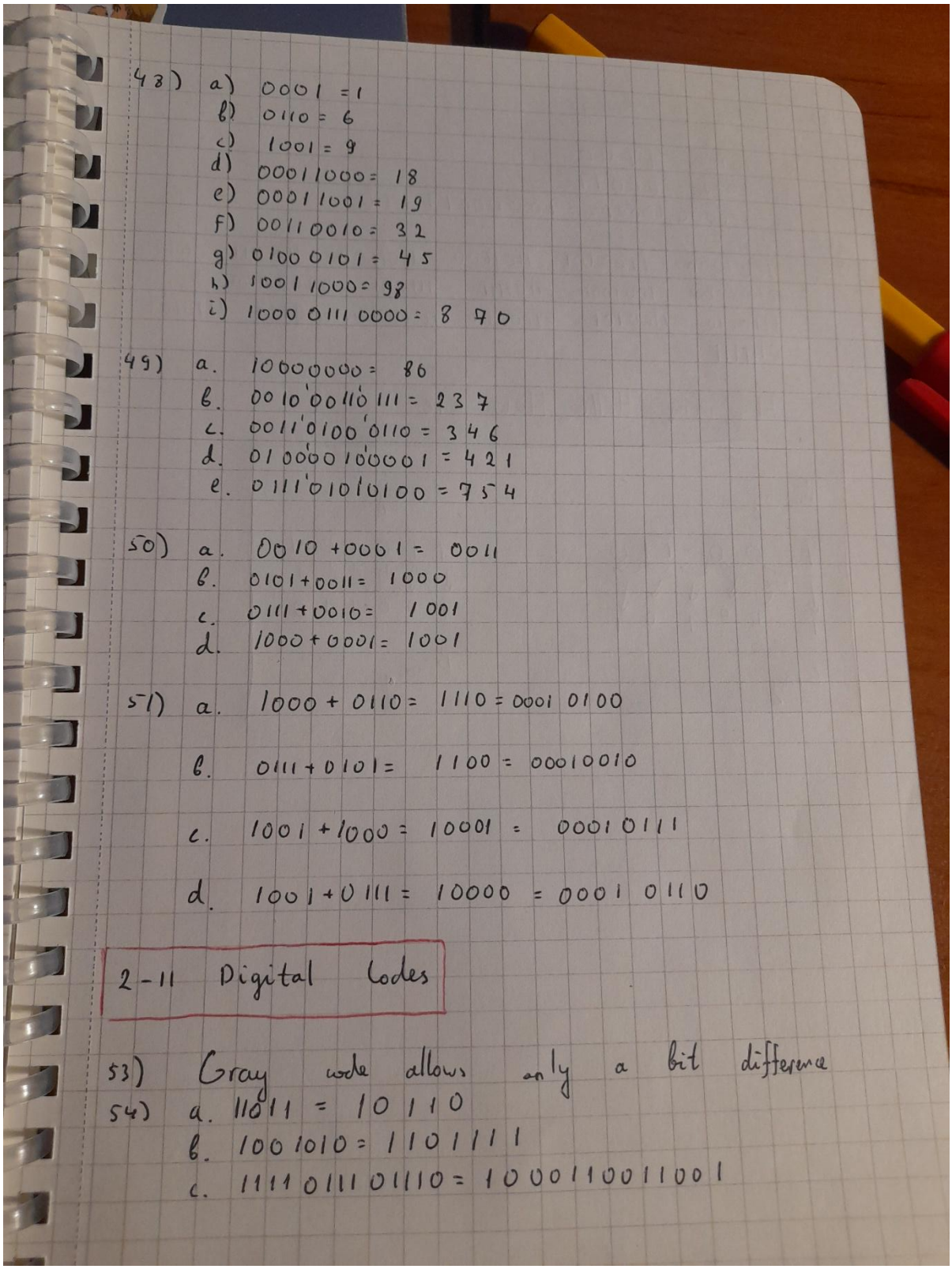
2-10 Binary Coded Decimal (BCD)

45) convert to 8421 BCD.

a. 10 = 0001 0000
b. 13 = 0001 0011
c. 18 = 0001 1000
d. 21 = 0010 0001
e. 25 = 0010 0101
f. 36 = 0011 0110
g. 44 = 0100 0100
h. 57 = 0101 0111
i. 69 = 0110 1001
j. 98 = 1001 1000
k. 125 = 0001 0010 0101
l. 156 = 0001 0101 0110

46) a. 10 = 1010
b. 13 = 1101
c. 18 = 10010
d. 21 = 10101
e. 25 = 11001
f. 36 = 100100

47) a. 104 = 0001 0000 0100
b. 128 = 0001 0010 1000
c. 132 = 0001 0011 0010
d. 150 = 0001 0101 0000
e. 136 = 0001 1000 0110
f. 210 = 0010 0001 0000
g. 359 = 0011 0101 1001
h. 547 = 0101 0100 0111



48) a) 0001 = 1
b) 0110 = 6
c) 1001 = 9
d) 00011000 = 18
e) 00011001 = 19
f) 00110010 = 32
g) 01000101 = 45
h) 10011000 = 98
i) 1000 0111 0000 = 870

49) a. 10000000 = 80
b. 0010 0011 0111 = 237
c. 0011 0100 0110 = 346
d. 0100 0010 0001 = 421
e. 0111 0101 0100 = 754

50) a. 0010 + 0001 = 0011
b. 0101 + 0011 = 1000
c. 0111 + 0010 = 1001
d. 1000 + 0001 = 1001

51) a. 1000 + 0110 = 1110 = 0001 0100

b. 0111 + 0101 = 1100 = 00010010

c. 1001 + 1000 = 10001 = 0001 0111

d. 1001 + 0111 = 10000 = 0001 0110

2-11 Digital Codes

53) Gray code allows only a bit difference
54) a. 11011 = 10110
b. 1001010 = 1101111
c. 1111 0111 01110 = 1000110011001

55. Gray to binary

a. 1010 = 1100
b. 00010 = 00011
c. 110000 10001 = 100000111110

58. 1001000 1100101 1101100 1101100 1101111 0101110
0100000 1001000 1101111 1110111 0100000 1100001
1110010 1100101 0100000 1111001 1101111 1110101
0111111

Hemm, Hello_How are you?

Binary

1 0 0 1 1 0
xor
1 1 0 1 0 1

Gray

Gray

1 1 0 1 0 1
xor
1 0 0 1 1 0

Binary