ENCS 2340 Notes Chapter 1

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How Computers represent digits ?

* Using electric voltage

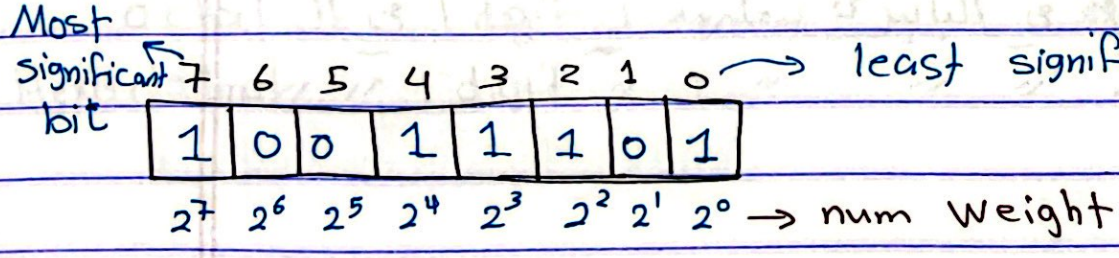
high voltage = 1 Low voltage = 0

* Using electric charge
  * used in memory cells.
  charged memory cell = 1 discharged = 0

* Using magnetic feild
  * used in magnetic disk

* Using light:
  used in optical disks

Binary Numbers



Decimal value $= (d_{n-1} * 2^{n-1}) + \dots + (d_1 \times 2^1) + (d_0 \times 2^0)$

* Binary $(10011101)_2 = (1 * 2^7) + (0 * 2^6) + (0 * 2^5) + \dots$

$= 2^7 + 2^4 + 2^3 + 2^2 + 1 = 157$

Kb = 10^3 = 1000 (kilo bit)

kib = 2^{10} = 1024 (kilo binary)

Roman numbers | X = 10 V = 5 I = 1

XXVII = 10 + 10 + 5 + 1 + 1 = 27

Binary to decimal

$(11011)_2 = 1 \times 2^4 + 1 \times 2^3 + 0 + 1 \times 2^2 + 1 = 27$

$(2051)_4 = 4^3 \times 2 + 0 \times 4^2 + 5 \times 4^1 + 1 \times 4^0 = 149$

هاد عاط كون عنا رقم 5 وهو أقل من 4

كل 3 digits في البايري بتعلزهن بـ 1 digit في ال octal

Hexadecimal " 1 digit " " " " 4 "

Convert Decimal to Binary.

* Convert 37_{10} to binary.

Division	Quotient	Remainder	
37/2	18	1	→ least
18/2	9	0	
9/2	4	1	
4/2	2	0	$\therefore 37 = (100101)_2$
2/2	1	0	
1/2	0	1	→ Most

Easy way to convert binary to decimal

128 64 32 16 8 4 2 1

0 1 0 0 1 1 0 1

64 + 8 + 4 + 1 = 77

Popular Number System

* Binary Number system → (0, 1) — Radix = 2 (2 digits)
* Octal Number system → (0-7) — Radix = 8 (8 digits)
* Decimal Number system → (0 → 9) — Radix = 10 (10 digits)
* Hexadecimal Number system — Radix = 16 (16 digits)

starts from zero

→ 0, 1, 2, ..., 8, 9, A, B, C ....., F

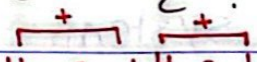
A = 10 B = 11 C = 12 F = 15

decimal	binary
0	0 0 0 0
1	0 0 0 1
2	0 0 1 0
3	0 0 1 1
4	0 1 0 0
5	0 1 0 1
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1
10	1 0 1 0
11	1 0 1 1
12	1 1 0 0
13	1 1 0 1
14	1 1 1 0
15	1 1 1 1

* طريقة سهلة للتحويل من octal الى binary

* ناخذ 3 ارقام ثم نكتب فوقها 4 2 1
الرقم اللي بيكونه فوقه ال 1 نكتبه واذا كانه في الرقم
اكثر من 1 نجمع الرقمين او اكثر

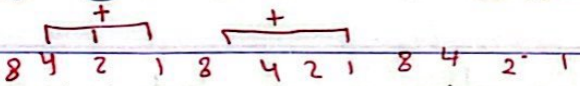
مثال: 1 0 1 1 0 1 0 1



7 5 5 2

* وللتحويل من Hexadecimal الى binary
نفس الطريقة فوقه بكتب تزيد تزله قطع 8 4 2 1

مثل 0 1 1 1 1 0 1 0 1 0 0



7 9 4

Fraction

$(126.3)_7 = 1\times7^2 + 2\times7^1 + 6\times7^0 + 3\times7^{-1}$

$(826.42)_{10} = 8\times10^2 + 2\times10^1 + 6\times10^0 + 4\times10^{-1} + 2\times10^{-2}$

$(362.31)_6$ Not allowed

ممنوع هاد نس الرقم تحت

To Find largest value for Radix $r = r^3 - 1$

Ex

$(111)_2 = 2^3 - 1$

$(777)_8 = 8^3 - 1$

$(999)_{10} = 10^3 - 1$

To Find possible values for Radix $r = r^n - 1$

Number with fractions

* $(2409.87)_{10} = 2\times10^3 + 4\times10^2 + 9\times10^0 + 8\times10^{-1} + 7\times10^{-2}$

* $(1101.101)_2 = 1\times2^3 + 2^2 + 1 + 2^{-1} + 2^{-3}$

* $(263.5)_6$ = Not allowed cuz digit 6 isn't allowed in radix 6

Convert 0.6875 to Radix 2

Multiplication	New fraction	Bit!!
$0.6875 * 2 = 1.375$	.375	1 → First fraction bit
$0.375 * 2 = 0.75$	.75	0
$0.75 * 2 = 1.5$	0.5	1
$0.5 * 2 = 1.0$	0.0	1 → last fraction bit

$\therefore 0.6875 = (0.1011)_2$

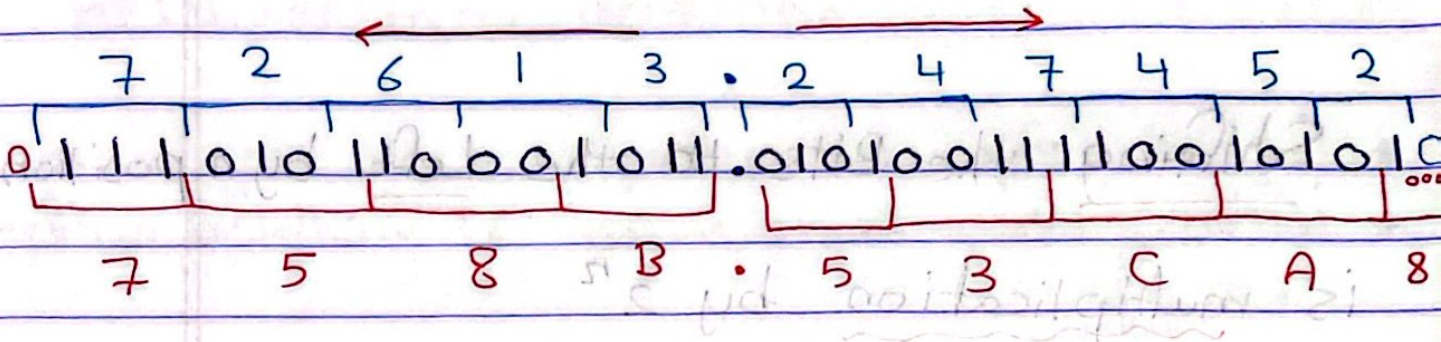
Convert 139.6875 to octal (Radix 8)

*في هاي الحالة نقسم الرقم لعدد صحيح واعشاري العدد الصحيح نقسمه على 8 والاعشاري نضربه في 8 مثل المثال السابق

Division	Quotient	Reminder
139/8	17	3
17/8	2	1
2/8	0	2

Multip	New fraction	Digit
$0.6875 * 8 = 5.5$	0.5	5
$0.5 * 8 = 4.0$	0.0	4

$\therefore 139.6875 = (213.54)_8$



* العدد الصحيح نحوله من اليمين لليسار اما الاعشاري من اليسار لليمين

Largest fraction value = $1 - 2^{-m}$

in general for any radix $1 - r^{-m}$

Convert $(299.8195)_{10}$ to $(\ )_{12}$

299 / 12	24	B
24 / 12	2	0
2 / 12	0	2 ↑

0.8195 * 12 = 9.834	0.834	9 ↓
0.834 * 12 = 10.008	0.008	A

$\therefore (299.8195)_{10} = (20B.9A)_{12}$

Shifting the Bits to the Left by n position is multiplication by 2^n

* if shift to the left by 1 position multi by 2
" " " " " 2 " multi by 4

Shifting bits to the right by n position is division by 2^n

before 00100110 = 38 ⇒ div by 2
after 00010011 = 19
r = 0
the reminder

before 00100110 = 38 div by 4
after 00001001 = 9
r = 2

Hexadecimal addition

* نجمع اول شيء من جهة اليمين
* اذا المجموع للرقمين اكبر او يساوي 16 فان الناتج هو الرقم -16 والـ Carry = 1

Ex

```
    1  1  1
  9C372865
+ 1395E84B
----------
  AFCD10B0
```

5 + B = 16
∴ sum = 16 - 16 = 0
and carry = 1

Hexadecimal subtraction

* نبدأ من جهة اليمين
* اذا كان طرح الرقمين سالب نجمع الرقم لـ 16 والفرق.

borrow = -1

Ex

```
  -1    -1
  9C372865
- 1395E84B
----------
  88A2401A
```

5 - B = -6
∴ 16 - 6 = 10
borrow = -1

When $r = 10$ we have 9's complement

* for decimal ($r = 10$) number N $n = 6$ 9's complement

* 9's comp of $547600 = 999999 - 547600 = 452399$

* For binary ($r = 2$) number N $n = 7$ 1's complement

* 1's comp of $1011000 = 1111111 - 1011000 = 0100111$

* 1'S comp of $0101101 = 1111111 - 0101101 = 1010010$
  ↳ Change 0 to 1 and 1 to 0

* For octal ($r = 8$) number N $n = 5$ 7's complement

7's comp of $15372 = 77777 - 15372 = 62405$

7's comp of $01746 = 77777 - 01746 = 76031$

For decimal ($r = 10$) number N $n = 6$ 10's comp

10's comp of 546700 = 1000000 − 546700 = 453300

10's comp of 012398 = 1000000 − 012398 = 987602

For binary ($r = 2$) number N $n = 7$ 2's comp

2's comp of 1011000 = 10000000 − 1011000 = 1001000

01001000 → Easy method to convert

نكتب الاصفار قبل اول 1 ثم بعدها
نقلب ال 1 لصفر والصفر لـ 1

2's comp of 0101101 is 1010011

For octal ($r = 8$) number N $n = 5$ 8's comp

8's comp of 15372 = 100000 − 15372 = 62406

$$\begin{array}{r} {}^{7}{}^{7}{}^{7}{}^{7}{}^{8} \\ 1\,0\,0\,0\,0\,0 \\ -\;1\,5\,3\,7\,2 \\ \hline 6\,2\,4\,0\,6 \end{array}$$

8's comp of 01746 = 100000 − 01746 = 76032

$$\begin{array}{r} {}^{7}{}^{7}{}^{7}{}^{7}{}^{8} \\ 1\,0\,0\,0\,0\,0 \\ -\;0\,0\,1\,7\,4\,6 \\ \hline 7\,6\,0\,3\,2 \end{array}$$

نقلب الارقام بس

1's comp of 10110.00 is 01001.11

2's comp of 01101.101 is 10010.011

= نبدأ نقلب

متى نزيد ال Carry على الجواب

في 1's comp لا نجمع اما في 2's comp نجمع

Signed Numbers :-

this is +45 → 0 010 1101 (0 = sign)

this is -45 → 1 0101101 (1 = sign)

the 1's comp for a num make it negative

Ex: 1's comp
- 00001001 this is +9
- 11110110 this is -9

No represent for zero

The range of values is $-(2^{n-1}-1) \rightarrow (2^{n-1}-1)$

if n = 8 bits the the range -127 to 127

Also the 2's comp for a num make it negative

Ex: 2's comp

$A = (00101100)_2 = +44$

$A = (11010100)_2 = -44$

The range of values is -2^{n-1} to $+(2^{n-1}-1)$

if n = 8 bits then the range is -128 to 127

There is only one zero = $(00\ldots000)_2$ all bits are zero

1 0 1 1 0 1 0 0 $\Rightarrow$ $-128+32+16+4=-76$

-128 64 32 16 8 4 2 1

Convert Subtraction into addition

1) take the 2's comp of the sec num and change the subtract into addition with ignoring the carry.

Overflow happen when :-

1) Adding 2 positive num & the sum is negative

2) Adding 2 negative num and the sum is positive

Minimum Number of bits required :-

$$2^{n-1} < M \leq 2^n$$

$$n = \lceil \log_2 M \rceil$$

Ex : How many bits required to represent 10 decimal digits with a binary Code?

Ans $\lceil \log_2 10 \rceil = 4$ bits

Conversion and Coding.

$13_{10} = (1101)_2$ This is Conversion

$13 \Longleftrightarrow (0001\ 0011)_{BCD}$ This is Coding

So Coding requires more bits than Conversion

* A number with n decimal digits is coded with $(4 \times n)$ bits in BCD

BCD Addition

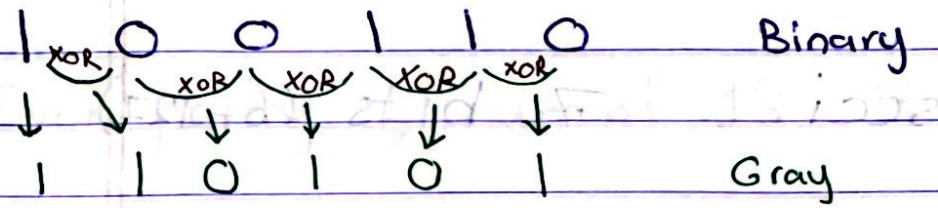
$$\begin{array}{r} 1000 \\ +\ 0101 \\ \hline 1101 \end{array} \qquad \begin{array}{r} +\ 8 \\ 5 \\ \hline 13 > 9 \end{array}$$

if the answer is Larger than 9 then we add 6 to it

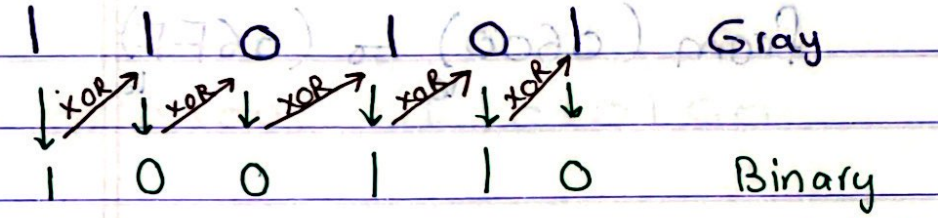
So

$$\begin{array}{r} 1000 \\ +\ 0101 \\ \hline 1101 \\ +\ 0110 \\ \hline 10011 \end{array} \qquad \begin{array}{r} +\ 8 \\ 5 \\ \hline 13 > 9 \\ +\ 6 \\ \hline 19 \end{array} \quad (\text{Carry} + 3)$$

Binary to gray



Gray to Binary



Character Codes :-

Coracter sets :-

* Standard Ascci — 7 bits (0-127)
* Extended Ascii — 8 bits (0-225)
* Unicode — 16 bits (0-65.535)
* UTF — from $(0600)_{16}$ to $(06FF)_{16}$

ASCII Code table

Control characters →

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2																
3																
4																
5																
6																
7																

Parity bit → Used to make num of 1 even or odd

* Even parity → num of 1's is even

* odd parity → num. of 1's are odd

	Even Parity	odd Parity
A = 1000001	0 1000001	1 1000001
B = 1010100	1 1010100	0 1010100

<u>Ex</u> A system uses 1-parity bit scheme for error detection, the receiver receives a byte represented in hexadecimal as "D3" without error, the parity scheme used is ___________ (even/odd) parity

D 3
1101 0011 → عادي و طلع بدون error وعدد ال 1 هو odd .

∴ odd parity

Some Notes :-

* Extension

	0101	1101
* unsigned	000101	001101
* Signed magnitude	000101	100101
* Signed 1's	000101	111101
* signed 2's	000101	111101

⇓

الرقم الموجب يبقى كما هو
بالسالب ؟

* Represent (-13) using (8 bit) signed 2's Complement

$$(00001101)_2 \Rightarrow (13)_{10}$$

~~(11110011)~~ ← $(-13)_{10}$

this is 2's comp to find the 8 bit signed 2's comp
we find - (2's comp of 11110011)

$$\Rightarrow -(00001101) \Rightarrow -(13)$$

* لما نوجد ال Complement للارقام كالآتي

* find 10's comp $(935)_{11}$
r-1 لا

* في هذه الحالة نطرح كل رقم من 10 مباشرة .

so the answer is $(175)_{10}$

* 12's comp $(789)_{13}$

also same here n the answer is $(543)_{12}$

but in this case → find 13's comp → $(789)_{13}$

↳ فقط نطرح اول رقم من اليمين من 13 وباقي المنازل من 12

∴ the answer is $(544)_{13}$

واذا كان اول ارقام من اليمين اصفار تبقى اصفار ونطرح اول رقم بعدها من ال 13 حسب المثال وباقي الارقام من 12
(نطرح اول رقم بعد الصفر من r وباقي الارقام من r-1)

Ex

the 13's comp for $(A3900)_{13}$ is $(29400)_{13}$

