ECE124: Discussion

Discussion #2

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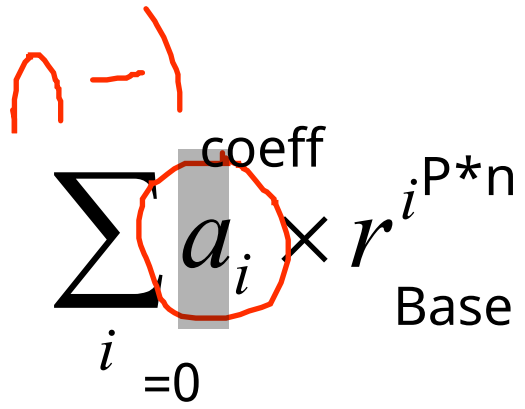
Number Systems

Decimal	*Binary*	*Hex*	*Octal*
00	00000	00	00
01	00001	01	01
02	00010	02	02
03	00011	03	03
04	00100	04	04
05	00101	05	05
06	00110	06	06
07	00111	07	07
08	01000	08	10
09	01001	09	11
10	01010	0A	12
11	01011	0B	13
12	01100	0C	14
13	01101	0D	15
14	01110	0E	16
15	01111	0F	17

Image from:
http://pirun.ku.ac.th/~fscinrn/Nuclear%20Instrument/node119.html

Conversions between number systems



- Conversion from base *r* to decimal

3 digits out# (a2a1a0)8

=(a0*8^0)+(a0*8^1)+(a0*8^2)=(?)10

- Conversion from decimal to base *r*
  - Divide number and successive quotients by *r*
  - Sequence of remainders is base *r* number

1.9 Express the following numbers in different number systems.

(a) $(10110.0101)_2$

Decimal	Binary	Hex	Octal
00	00000	00	00
01	00001	01	01
02	00010	02	02
03	00011	03	03
04	00100	04	04
05	00101	05	05
06	00110	06	06
07	00111	07	07
08	01000	08	10
09	01001	09	11
10	01010	0A	12
11	01011	0B	13
12	01100	0C	14
13	01101	0D	15
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1.) Decimal

(1x2^4)+1x2^2+1x2^1+1x2^-2+1x2^-4=(?)10 <-- dont have to find on the test, just use formula

2.) octal

010 110 . 010 100
2 6 . 2 4

3.) Hex

0001 0110 . 0101
1 6 . 5

1.9 Express the following numbers in different number systems.

(c) $(26.24)_8$

Binary
26.24
010 110 . 010 100

what if (26.24)16
0010 0110 . 0010 0100

Decimal	*Binary*	*Hex*	*Octal*
00	00000	00	00
01	00001	01	01
02	00010	02	02
03	00011	03	03
04	00100	04	04
05	00101	05	05
06	00110	06	06
07	00111	07	07
08	01000	08	10
09	01001	09	11
10	01010	0A	12
11	01011	0B	13
12	01100	0C	14
13	01101	0D	15
14	01110	0E	16
15	01111	0F	17

1.9 Express the following numbers in different number systems.

(d) $(DABA.B)_{16}$

Binary
1101 1010 1011 1010 . 1011

octal
15 12 13 12 . 13

(25.6875)10
to binary

10011.1011

25/2 =12R1 1 <- LSB
12/2 = 6
6/2=3
3/2=1R1 1
1/2=0R1 1

.6875*2 = 1+.375 <-MSB
.375*2 = 0+.75
.75*2 = 1 + .5
.5*2 = 1 +.0

Decimal	Binary	Hex	Octal
00	00000	00	00
01	00001	01	01
02	00010	02	02
03	00011	03	03
04	00100	04	04
05	00101	05	05
06	00110	06	06
07	00111	07	07
08	01000	08	10
09	01001	09	11
10	01010	0A	12
11	01011	0B	13
12	01100	0C	14
13	01101	0D	15
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15	01111	0F	17

signed(101)2 = (-1)10

- **Computer arithmetic of signed numbers**

  signed magnitude --> left most (MSB)

- **N's complement**
  - Given a number **N** in base **r** having **n** digits, the **(r–1)'s complement** of N is defined as:

    $(r^n - 1) - N$
  - Given a number **N** in base **r** having **n** digits, the **(r)'s complement** of N is defined as:

    $(r^n) - N$

-(1*2^2)+(1*2^1)+(1*2^0)

Signed Numbers with Complements

101 =(-1)10

- 3-bit representations of positive and negative numbers:

(111)2
= -(001)2

Decimal		2's Complement	1's Complement	Signed Magnitude
011	+3	011	011	011
010	+2	010	010	010
001	+1	001	001	001
000	0	000	000	000
	-0	X	111	100
	-1	111	110	101
	-2	110	101	110
	-3	101	100	111
	-4	100	X	X

011100
100100

3 = 011
-3 = 101

2 =010
-2 =110

- Bit sequence does not reveal coding—context matters!
- Left most bit is sign bit in 2's complement—automatically!

1.14 Obtain the 1's and 2' complements of the following binary numbers:

(d) 10101010

01010101

01010110

(e) 10100101

01011010

01011011

(f) 11111111

00000000

00000001

- Convert the following decimal numbers to 8-bit signed binary numbers and represent them in 8-bit 2's complement representation.

(a) −27

11100101

27/2 = 13R1
13/2=6R1
6/2=3
3/2=1R1
1/2=0R1

(b) 27

00011011

(c) −52

00110100

11001100

52/2=26 <--LSB
26/2=13
13/2=6R1
6/2=3
3/2=1R1
1/2=0R1

1.18 Perform subtraction on the given unsigned binary numbers using the 2's complement of the subtrahend. Where the result should be negative, find its 2's complement and affix a minus sign.

(a) 10011 - 10010

19-18 = 1

```
  010011
+ 101110
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  000001
```

(c) 1001 - 110101

00001001 00110101

```
  00001001
+ 11001011
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  11010100  ->  -00101100
```