Computer Architecture and Logic Design

Number Systems and Conversions

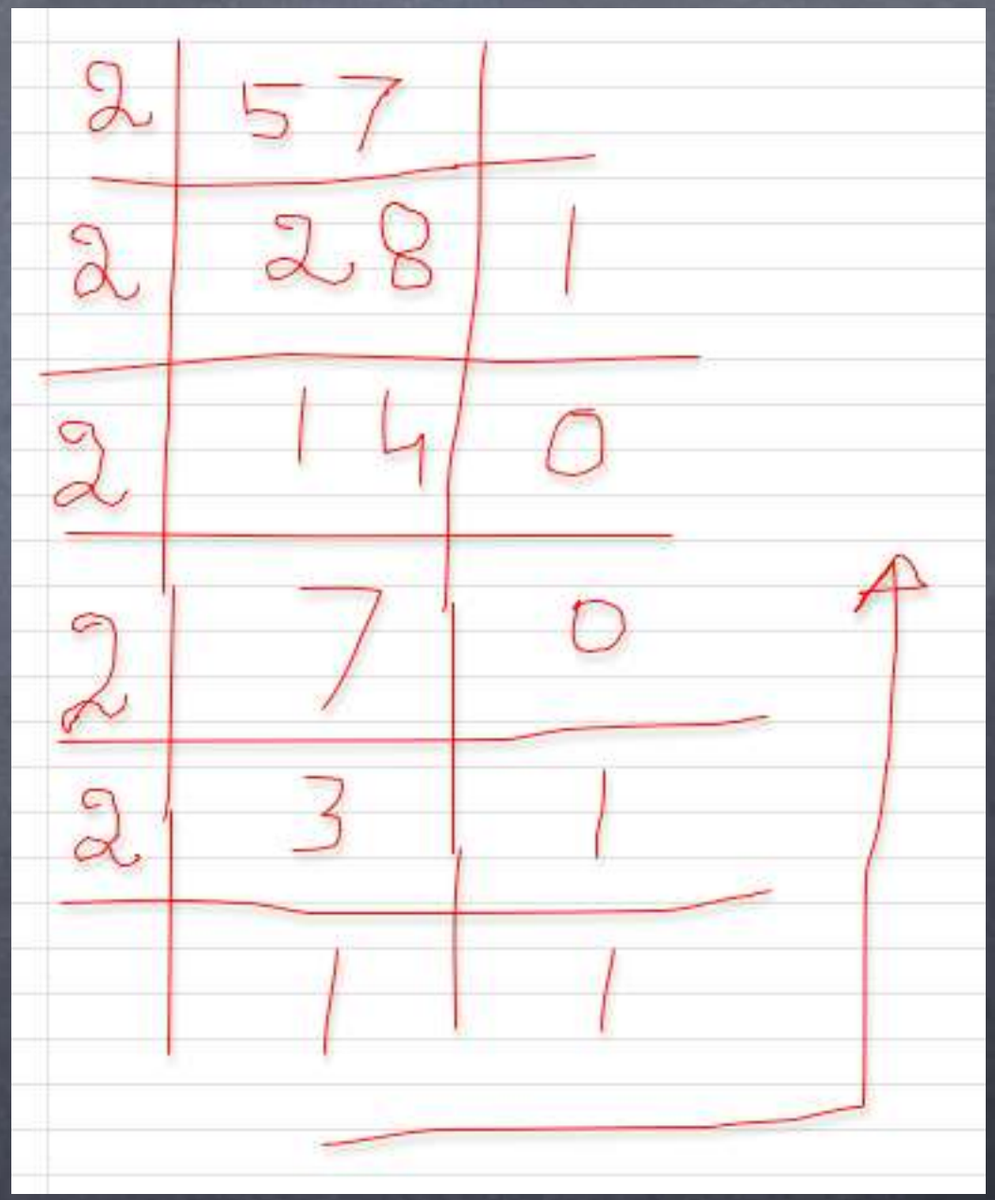
By Rimsha

Decimal to Base r Conversion

Convert Decimal 57.625 to Binary

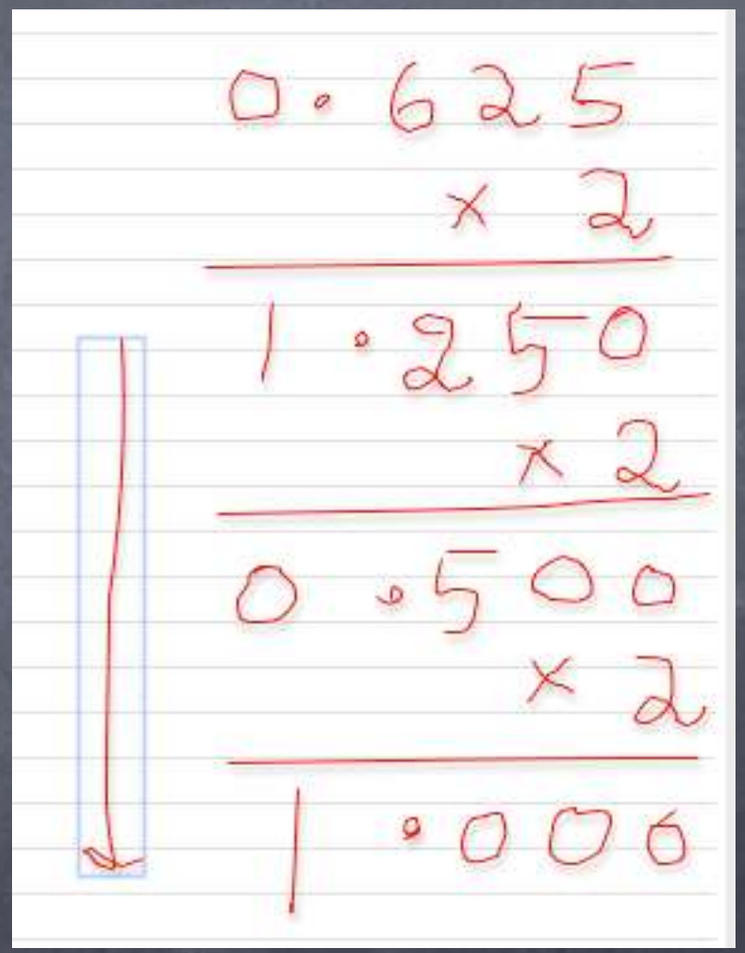
Use **repeated division** for integer part

$(57)_{10} = (111001)_2$



Decimal to Base r Conversion Contd..

Convert Decimal 57.625 to Binary



Use **repeated multiplication** for decimal part

$(0.625)_{10} = (0.101)_2$

$(57.625)_{10} = (111001.101)_2$

Conversion Between two Bases

However, it is generally easier to convert base A to its decimal equivalent and then convert the decimal value to base B.

- Base A → Decimal → Base B

Power Series Expansion

Repeated Division, Repeated Multiplication

Conversion between binary and Octal

It can be carried out by inspection.

- Each octal digit corresponds to 3 bits

$(101\ 110\ 010\ .\ 011\ 001) =_2 (5\ 6\ 2\ .\ 3\ 1)_8$

$(010\ 011\ 100\ .\ 101\ 001)_2 = (2\ 3\ 4\ .\ 5\ 1)_8$

$(7\ 4\ 5\ .\ 3\ 2)_8 = (111\ 100\ 101\ .\ 011\ 010)_2$

$(3\ 0\ 6\ .\ 0\ 5)_8 = (011\ 000\ 110\ .\ 000\ 101)_2$

Conversion between binary and hexadecimal

Each hexadecimal digit corresponds to 4 bits

$(1001\ 1010\ 0110\ .\ 1011\ 0101)_2 = (9\ A\ 6\ .\ B\ 5)_{16}$

$(1100\ 1011\ 1000\ .\ 1110\ 0111)2 = (C\ B\ 8\ .\ E\ 7)_{16}$

$(E\ 9\ 4\ .\ D\ 2)_{16} = (1110\ 1001\ 0100\ .\ 1101\ 0010)_2$

$(1\ C\ 7\ .\ 8\ F)_{16} = (0001\ 1100\ 0111\ .\ 1000\ 1111)_2$

- Note that the hexadecimal number system requires additional characters to represent its 16 values.

Your Turn

Find Decimal Equivalent of the following:-

$(1011.11)_2$

$(147.3)_8$

$(A2F)_{16}$

$(3301.13)_6$

$(5476)_8$ Convert to Base 16

Your Turn Solution

Find Decimal Equivalent of the following:-

$(1011.11)_2 = (11.75)_{10}$

$(147.3)_8 = (103.375)_{10}$

$(A2F)_{16.} = (2607)_{10}$

$(3301.13)_6 = (757.25)_{10}$

($(5476)_8$ Convert to Base 16. Ans $(B3E)_{16}$

Your Turn

Convert the Decimal Number 244 into a Binary Number

Division of Decimal Number by 2	Quotient	Remainder	Binary
244/2	122	0	0 (LSB)
122/2	61	0	0
61/2	30	1	1
30/2	15	0	0
15/2	7	1	1
7/2	3	1	1
3/2	1	1	1
1/2	0	1	1 (MSB)

Your Turn

Convert the Decimal Number 145 into a Binary Number

Division of Decimal Number by 2	Quotient	Remainder	Binary
145/2	72	1	1 (LSB)
72/2	36	0	0
36/2	18	0	0
18/2	9	0	0
9/8	4	1	1
4/2	2	0	0
2/2	1	0	0
1/2	0	1	1 (MSB)

Hence, $145_{10} = 10010001_2$

Conversion between different bases

Find the equivalent octal form of $C1_{16}$

$C1_{16} = (C \times 16^1) + (1 \times 16^0)$

$= C \times 16 + 1 \times 1$

$=12 \times 16 + 1$

$= 192 + 1$

$C1_{16}$ =193 (Decimal form)

Now we have to convert this decimal to octal number;

8 | 193
8 | 24 -- 1
8 | 3 -- 0
8 | 0 --3

The octal number is 301_8

Hence, $C1_{16} = 301_8$

Practice Problem

- Please write numbers from 0 to 20 in decimal, binary, Octal, Hexadecimal

Practice Problem Solution

Decimal	Binary	Octal	Hexadecimal
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	6	6
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10
17	10001	21	11
18	10010	22	12
19	10011	23	13
20	10100	24	14

The End