

Section 1.5: Converting Between

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Binary, Octal, and Hexadecimal

converting between binary and octal:

octal	binary
0	0 = 000 ₂
1	1 = 001 ₂
2	10 ₂ = 010 ₂
3	11 ₂ = 011 ₂
4	100 ₂
5	101 ₂
6	110 ₂
7	111 ₂
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6 ₈	110 ₂
3 ₈	011 ₂
4 ₈	100 ₂

so $634_8 = 110\ 011\ 100_2$

nifty, no?

example: convert the following octal numbers to binary:

a) $15_8 = 001\ 101_2 = 1101_2$

b) $703_8 = 111\ 000\ 011_2$

binary \rightarrow octal:

works in the way you'd expect:
group the digits into sets of
three starting from the
right-hand side

$$10101110_2 \rightarrow \text{octal}$$

$$256_8$$

examples: convert from binary to octal:

① $101_2 = 5_8$

② $1011_2 = 13_8$

③ $1111001101110_2 = 17156_8$

octal	binary
0	000_2
1	001_2
2	010_2
3	011_2
4	100_2
5	101_2
6	110_2
7	111_2

hexadecimal works the same way, except that you use groups of 4

hexadecimal	binary	hexadecimal	binary
0	0000 ₂	8	1000 ₂
1	0001 ₂	9	1001 ₂
2	0010 ₂	A ₁₆	1010 ₂
3	0011 ₂	B ₁₆	1011 ₂
4	0100 ₂	C ₁₆	1100 ₂
5	0101 ₂	D ₁₆	1101 ₂
6	0110 ₂	E ₁₆	1110 ₂
7	0111 ₂	F ₁₆	1111 ₂

so $E8_{16} = 11101000_2$

examples: convert to binary:

① $94_{16} = 1001\ 0100_2$

② $FAB_{16} = 1111\ 1010\ 1011_2$

converting octal \leftrightarrow hexadecimal

best way? convert to binary first, then regroup the digits

example: convert 705_8 to hexadecimal

$$705_8 = \begin{array}{|c|c|c|} \hline 111 & 000 & 101 \\ \hline \end{array}_2$$

$$= 1\ 1100\ 0101_2 \quad \leftarrow \text{can skip}$$

$$= 1C5_{16}$$

examples: perform the following conversions:

① $5670_8 \rightarrow$ hexadecimal

② $30D1_{16} \rightarrow$ octal

answer: ① $5670_8 = 101\ 110\ 111\ 000_2$
 $= 1011\ 1011\ 1000_2$
 $= BB8_{16}$

② $30D1 = 0011\ |0000\ 1101\ |0001$
 $= 11\ 000\ 011\ 010\ 001$
 $= 30321_8$

but how does this work for non-integer numbers?
exactly the same way!

example: convert 0.101110_2 to octal

rewrite in groups of 3:

$$0.101110_2 = 0.101\ 110_2$$

$$= 0.56_8$$

example: convert 0.725_8 to hexadecimal:

$$0.725_8 = 0.111\ 010\ 101_2$$

$$= 0.1110\ 1010\ 1000_2$$

← change to groups of 4

$$= 0.EA8_{16}$$

example: convert 11.01_2 to hexadecimal

$$11.01_2 = 0011.0100_2$$

$$= 3.4_{16}$$