Converting Denary Numbers to Binary Numbers

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I suppose teachers would not have any difficulty in explaining the algorithm of converting binary numbers to denary numbers to their students. Say, to convert 1011001_2, we can give a solution as follows:

$$\begin{aligned} & 1011001_2 \\ = \quad & 2^6 + 2^4 + 2^3 + 1 \\ = \quad & 64 + 16 + 8 + 1 \\ = \quad & 89_{10} \end{aligned}$$

However, it is not easy for the other way round. In most textbooks, only the following algorithm, by using short division, was given when demonstrating how to convert 89_{10} to binary. No further explanation on this algorithm was given.

2)	89	
2)	44	1
2)	22	0
2)	11	0
2)	5	1
2)	2	1
	1	0

$\therefore \quad 89_{10} = 1011001_2$.

Very often, students were not convinced even though I told them that this process was just a reverse process of the previous one with multiplication and addition being "reversed" by division and subtraction.

This year, I used a new method to solve the problem and eventually I found out that my method could also be used to explain the short-division algorithm.

My method is simple, to subtract the greatest power of 2 from the given (or remaining) value. The method is illustrated as follows.

	89_{10}	
=	$64 + 25$	($2^6 = 64 < 89$; $2^7 = 128 > 89$; and $89 - 64 = 25$)
=	$64 + 16 + 9$	($2^4 = 16 < 25$; $2^5 = 32 > 25$; and $25 - 16 = 9$)
=	$64 + 16 + 8 + 1$	($2^3 = 8 < 9$; $2^4 = 16 > 9$; and $9 - 8 = 1$)
=	$2^6 + 2^4 + 2^3 + 1$	
=	1011001_2	

Then the short-division algorithm can be easily explained by comparing the following two computations.

2)	89		2)	64 + 16 + 8 + 1	
2)	44	1	2)	32 + 8 + 4	 1
2)	22	0	2)	16 + 4 + 2	 0
2)	11	0	2)	8 + 2 + 1	 0
2)	5	1	2)	4 + 1	 1
2)	2	1	2)	2	 1
	1	0		1	 0

$\therefore \quad 89_{10} = 1011001_2$.

The short-division algorithm is mechanical but not easy to understand its theory behind. My method is straightforward but a bit slow. Students are allowed to use either method in tests and examinations.

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