

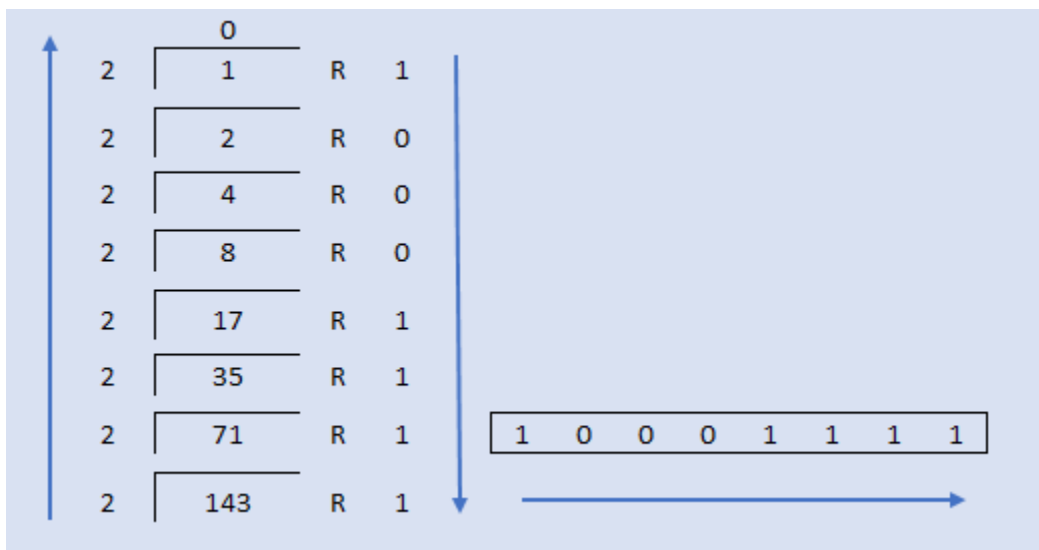
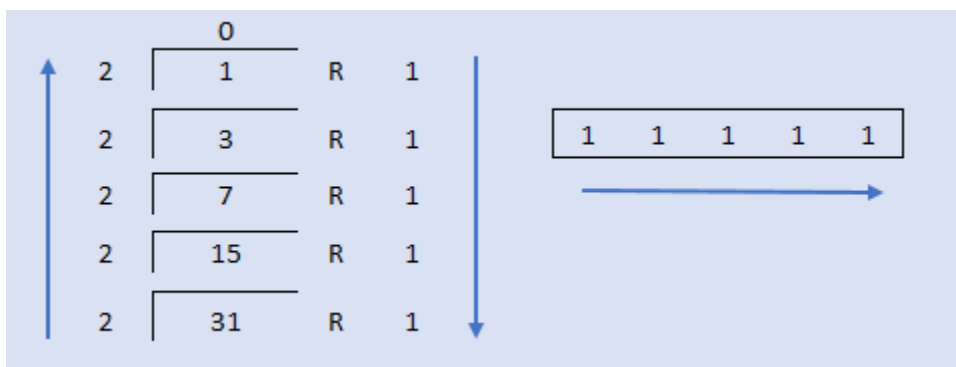
Assignment Three Lecture: Operations in bases other than 10
 Due: 8:25am Tuesday, September 27, 2016
 100 points

1. Perform the following operation in base 2.

$$31 + 9(8 + 11) - 143 + (17 - 11)(10 + 12)$$

Solution:

First we convert all numbers to binary. Below conversion for 31 and 143 is demonstrated. The rest follow similar approach.



		2 ⁰	2 ¹	2 ²		2 ³				2 ⁴							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0	1	10	11	100	101	110	111	1000	1001	1010	1011	1100	1101	1110	1111	10000	10001

Decimal - Binary Numbers

So the statement in binary is:

$$11111 + 1001 (1000 + 1011) - 10001111 + (10001 - 1011) (1010 + 1100)$$

We begin by finding the values in the parentheses:

$$\begin{array}{r} 1 \\ + \quad 1\ 0\ 0\ 0 \\ \hline 1\ 0\ 0\ 1\ 1 \end{array}$$

$$\begin{array}{r} 1 \\ + \quad 1\ 0\ 1\ 0 \\ \hline 1\ 1\ 0\ 0 \\ + \quad 1\ 1\ 0\ 0 \\ \hline 1\ 0\ 1\ 1\ 0 \end{array}$$

$$\begin{array}{r} 1\ 0\ 0\ 0\ 1 \\ - \quad 1\ 0\ 1\ 1 \\ \hline 1\ 1\ 1 \\ \hline 0\ 0\ 1\ 1\ 0 \end{array}$$

Replacing the values:

$$11111 + 1001 (10011) - 10001111 + (110) (10110)$$

Performing multiplications:

$$\begin{array}{r} \\ x \\ \hline \\ \\ \\ \\ \\ \hline 1\ 0\ 0\ 1\ 1 \\ \hline 1\ 0\ 1\ 0\ 1\ 0\ 1\ 1 \end{array}$$

$$\begin{array}{r} \\ x \\ \hline \\ \\ \hline \\ \hline 1\ 0\ 0\ 0\ 0\ 1\ 0\ 0 \end{array}$$

Replacing the values:

$$11111 + 10101011 - 10001111 + 10000100$$

Adding the positive values:

$$\begin{array}{r}
 \\
 \\
 \\
 + \\
 + \\
 \hline
 1 0 0 0 1 1 0
 \end{array}$$

And perform the subtraction:

$$101001110 - 10001111$$

$$\begin{array}{r}
 1 1 0 1 1 1 \\
 - 1 0 0 1 1 \\
 \hline
 1 \\
 \hline
 0 0 1 1 1 1
 \end{array}$$

We can test our final answer to make sure we did it correctly:

$$31 + 9 (8 + 11) - 143 + (17 - 11) (10 + 12) = 191$$

Testing our results:

512	256	128	64	32	16	8	4	2	1	
0	0	1	0	1	1	1	1	1	1	
0	0	128	0	32	16	8	4	2	1	191

←

←

Base 2
Number

Equivalent Decimal

Alternatively, you can use DEC2BIN or BIN2DEC functions in EXCEL for verification.

2. Perform the following operation in base 4.

Your student ID # - Year of your birth + (Day of your birth) (Month of your birth)

Solution:

Let's use these numbers:

Your student ID #: 435106 → 1222032202 in base 4

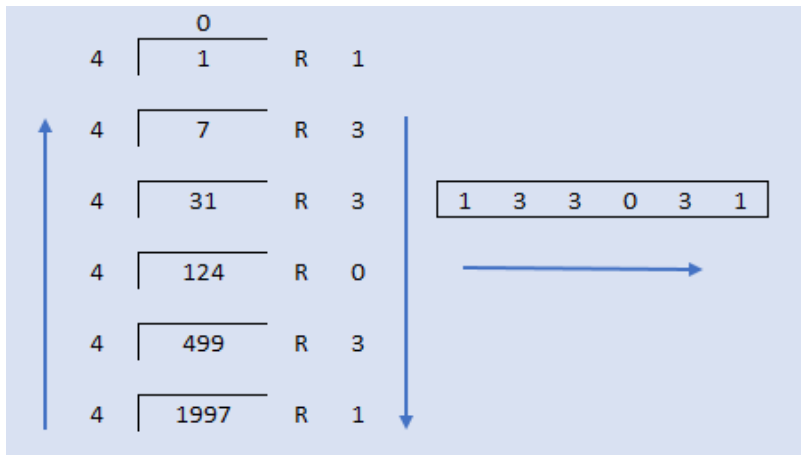
Year of your birth: 1997 → 133031 in base 4

Day of your birth: 15 → 33 in base 4

Month of your birth: 8 → 20 in base 4

4^0				4^1				4^2									
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0	1	2	3	10	11	12	13	20	21	22	23	30	31	32	33	100	101
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
102	103	110	111	112	113	120	121	122	123	130	131	132	133	200	201	202	203

Decimal - Base 4 Numbers



3. Perform the following operation in base 8.

$$9 (8) + 11 - 10 + 17 (6)$$

Solution:

- 9 in base 10 → 11 in base 8
- 8 in base 10 → 10 in base 8
- 11 in base 10 → 13 in base 8
- 10 in base 10 → 12 in base 8
- 17 in base 10 → 21 in base 8
- 6 in base 10 → 6 in base 8

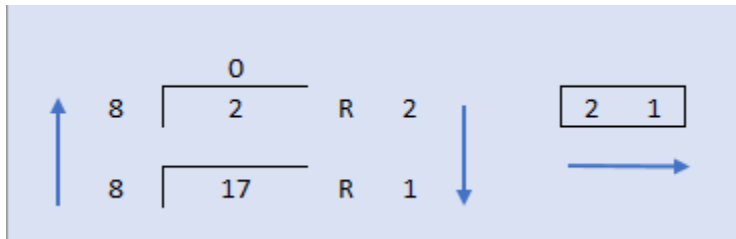
$$9 (8) + 11 - 10 + 17 (6) = 175$$

8^0								8^1									
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17	20	21

18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
22	23	24	25	26	27	30	31	32	33	34	35	36	37	40	41	42	43

Decimal - Base 8 Numbers

Sample calculation:



The statement in base 8 is $11 \cdot 10 + 13 - 12 + 21 \cdot 6$

Perform Multiplications:

		1	1
x		1	0
<hr/>			
		0	0
	1	1	
<hr/>			
	1	1	0



		2	1
x			6
<hr/>			
	1		
		4	6
<hr/>			
	1	4	6

Perform addition and subtractions:

$$\begin{array}{r}
 1 \\
 1 \ 4 \ 6 \\
 + \ 1 \ 1 \ 0 \\
 + 1 \ 3 \\
 \hline
 2 \ 7 \ 1
 \end{array}$$

$$\begin{array}{r}
 2 \ 7 \ 1 \\
 - 1 \ 2 \\
 \hline
 2 \ 5 \ 7
 \end{array}$$

Testing the solution:

4096	512	64	8	1	 Base 8  Number Equivalent Decimal
0	0	2	5	7	
0	0	128	40	7	

4. Perform the following operation in base 16.

$$82 (11) + 194 - 25 (8)$$

Solution:

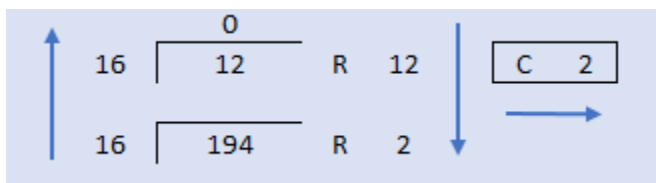
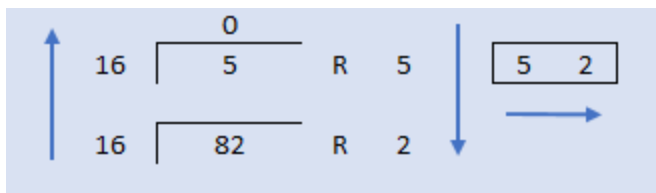
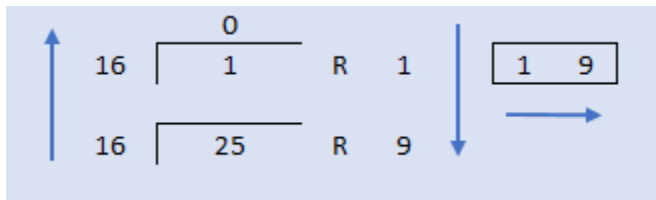
- 82 in base 10 → 52 in base 16
- 11 in base 10 → b in base 16
- 194 in base 10 → c2 in base 16
- 25 in base 10 → 19 in base 16
- 8 in base 10 → 8 in base 16

$$82 (11) + 194 - 25 (8) = 896 \text{ in decimal}$$

$$52 (b) + c2 - 19 (8) = ? \text{ in base 16?}$$

16^0													16^1				
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f	10	11
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
12	13	14	15	16	17	18	19	1a	1b	1c	1d	1e	1f	20	21	22	23
36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
24	25	26	27	28	29	2a	2b	2c	2d	2e	2f	30	31	32	33	34	35

Decimal - Base 16 Numbers



Performing multiplications:

$$\begin{array}{r}
 52 \\
 \times \quad b \\
 \hline
 1 \\
 376 \\
 \hline
 386
 \end{array}$$



$$\begin{array}{r}
 19 \\
 \times \quad 8 \\
 \hline
 4 \\
 88 \\
 \hline
 c8
 \end{array}$$

Performing addition and subtraction:

$$\begin{array}{r}
 1 \\
 386 \\
 + \quad c2 \\
 \hline
 448
 \end{array}$$

$$\begin{array}{r}
 448 \\
 - \quad c8 \\
 \hline
 1 \\
 380
 \end{array}$$

Testing the solution:

65536	4096	256	16	1	 Base 16  Number Equivalent Decimal
0	0	3	8	0	
0	0	768	128	0	