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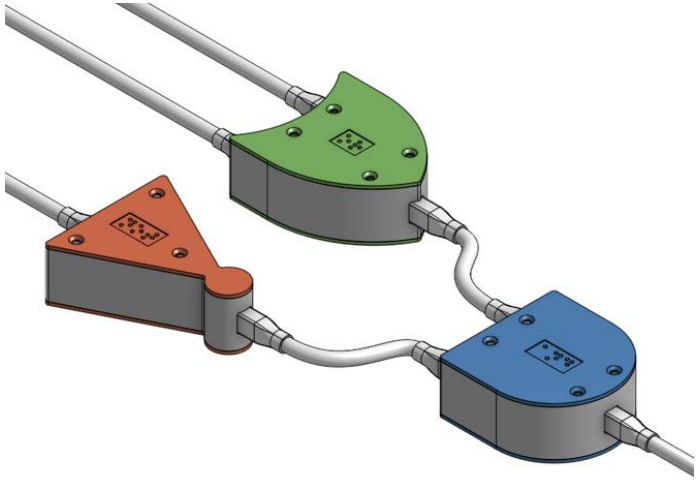

CS 211 - Digital Logic Design
211 عال - تصميم المنطق الرقمي

First Term - 1439/1440
Lecture #2

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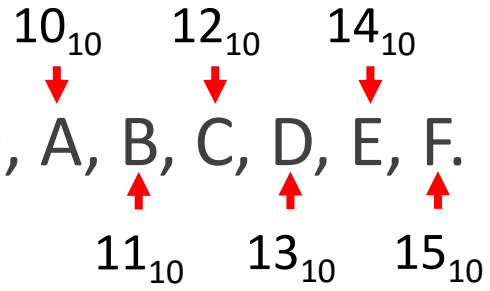
Administrivia

- Course website:
  - Up and running but not fully functional yet!!
  - URL: http://hshehata.github.io/courses/su/cs211/

Hexadecimal Numbers

- Radix/base of system is 16.
  - Sixteen possible values for each digit: 0, 1, 2, …, 9, A, B, C, D, E, F.
  - Example: The number $3D57.F0E_{16}$



- Column weights of hexadecimal num's are powers of 16:

$$\ldots\ 16^3\ 16^2\ 16^1\ 16^0.\ 16^{-1}\ 16^{-2}\ 16^{-3}\ 16^{-4}\ \ldots$$

Conversion: Hexadecimal ➔ Decimal

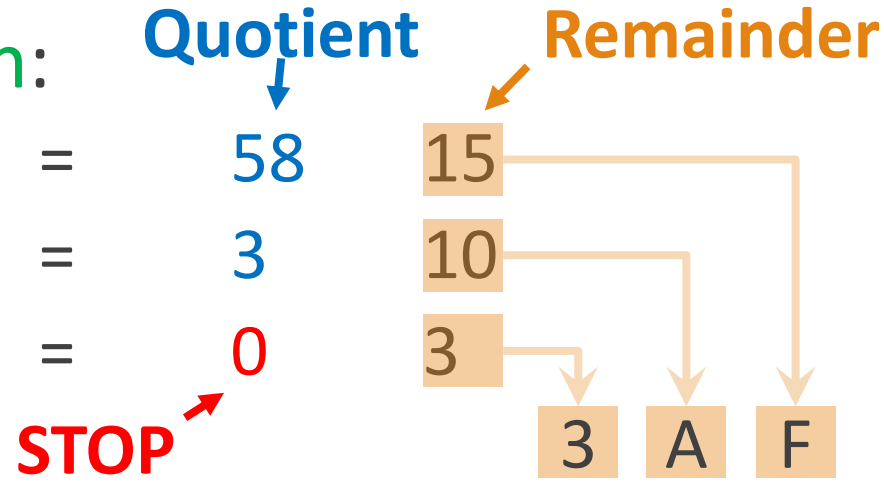
- Method: Sum of weights
- Example: Convert $3FA.4_{16}$ to decimal.
- Solution:

16^2	16^1	16^0	.	16^{-1}
256	16	1	.	1/16
*	*	*		*
3	F	A	.	4
768	+240	+10		+0.25

$= 1018.25_{10}$

Conversion: Decimal ➔ Hexadecimal

- Method:
  - Repeated division-by-16 (for integer)
  - Repeated multiplication-by-16 (for fraction)
- Example: Convert 943_{10} to Hexadecimal.
- Solution:



Conversion: Binary ➔ Hexadecimal

- Method: 4-bit grouping (Break binary num. into 4-bit groups starting from radix point; replace each 4-bit group with the equivalent hexadecimal symbol)
- Example: Convert 10011101010.101111_2 to hexadecimal.
- Solution:

0100 1110 1010 . 1011 1100

4 E A . B C = $4EA.BC_{16}$

NOTE: A zero added to the right of a fraction or the left of an integer, doesn't change its value!!

Conversion: Hexadecimal ➔ Binary

- Method: 4-bit replacement (Replace each hexadecimal symbol with the appropriate four bits)
- Example: Convert $2B9.3A_{16}$ to binary.
- Solution:

2	B	9	.	3	A	=	
0010	1011	1001	.	0011	1010	=	1010111001.0011101_2

NOTE: A zero removed from the right of a fraction or the left of an integer doesn't change its value!!

Octal Numbers

- Radix/base of system is 8.
  - Eight possible values for each digit: 0, 1, 2, …, 7.
  - Example: The number 2407.321_8
- Column weights of octal numbers are powers of 8:

$$\ldots 8^3\ 8^2\ 8^1\ 8^0.\ 8^{-1}\ 8^{-2}\ 8^{-3}\ 8^{-4}\ \ldots$$

Conversion: Octal ⬅➡ Dec./Hex./Bin.

- Methods are similar to hexadecimal; with few changes.
  - Octal ➔ decimal: sum of weights
  - Decimal ➔ octal: repeated division-by-8 and repeated multiplication-by-8
  - Binary ➔ octal: 3-bit grouping
  - Octal ➔ binary: 3-bit replacement

Conversion Methods Summary

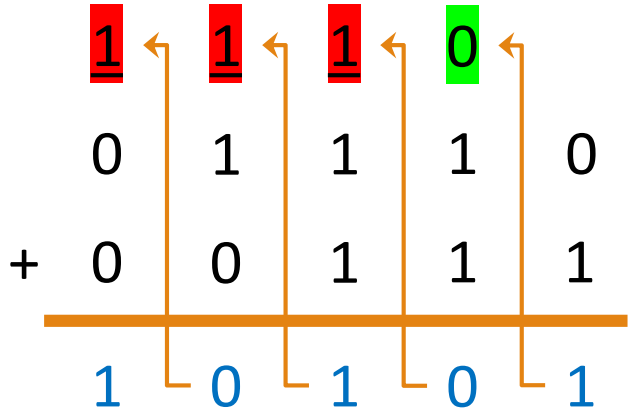
From \ To	Decimal	Binary	Octal	Hexadecimal
Decimal	-	Repeated Div./Mult. By 2	Repeated Div./Mult. By 8	Repeated Div./Mult. By 16
Binary	Sum of Weights	-	3-bit Grouping	4-bit Grouping
Octal	Sum of Weights	3-bit Replacement	-	Oct. ➔ Bin. Bin. ➔ Hex.
Hexadecimal	Sum of Weights	4-bit Replacement	Hex. ➔ Bin. Bin. ➔ Oct.	-

Unsigned Binary Addition

- Eight basic rules for adding binary digits (bits):

When there is no carry (or a carry of 0)	When there is a carry of 1
0 + 0 ➔ Sum = 0, carry = 0	1 + 0 + 0 ➔ Sum = 1, carry = 0
0 + 1 ➔ Sum = 1, carry = 0	1 + 1 + 0 = 10 ➔ Sum = 0, carry = 1
1 + 0 ➔ Sum = 1, carry = 0	1 + 0 + 1 = 10 ➔ Sum = 0, carry = 1
1 + 1 ➔ Sum = 0, carry = 1	1 + 1 + 1 ➔ Sum = 1, carry = 1

- Example:

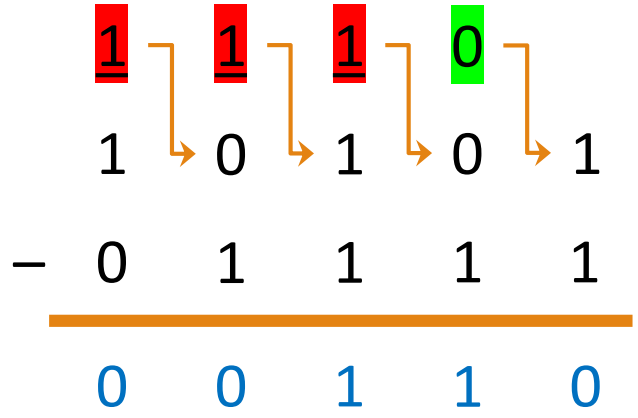


Unsigned Binary Subtraction

- Eight basic rules for subtracting binary digits (bits):

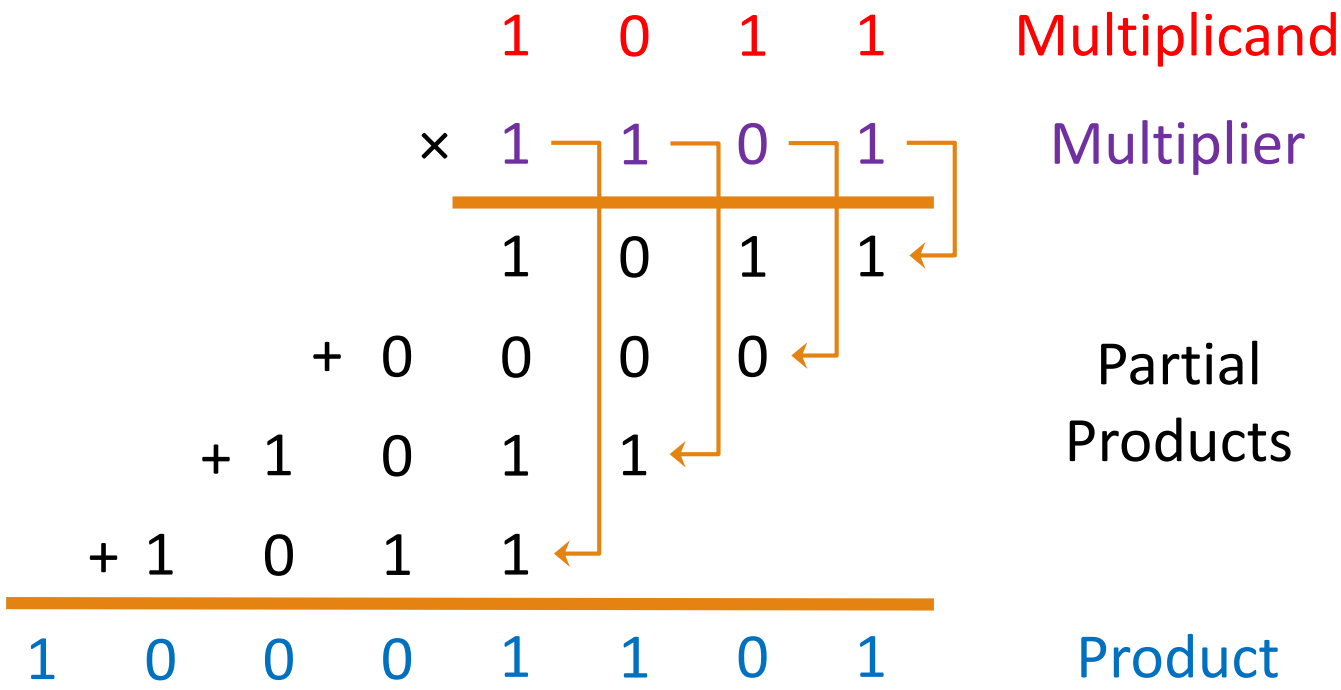
When there is no borrow (or a borrow of 0)	When there is a borrow of 1
0 – 0 ➔ sum = 0, borrow = 0	0 – 0 – 1 ➔ sum = 1, borrow = 1
0 – 1 ➔ sum = 1, borrow = 1	0 – 1 – 1 ➔ sum = 0, borrow = 1
1 – 0 ➔ sum = 1, borrow = 0	1 – 0 – 1 ➔ sum = 0, borrow = 0
1 – 1 ➔ sum = 0, borrow = 0	1 – 1 – 1 ➔ sum = 1, borrow = 1

- Example:



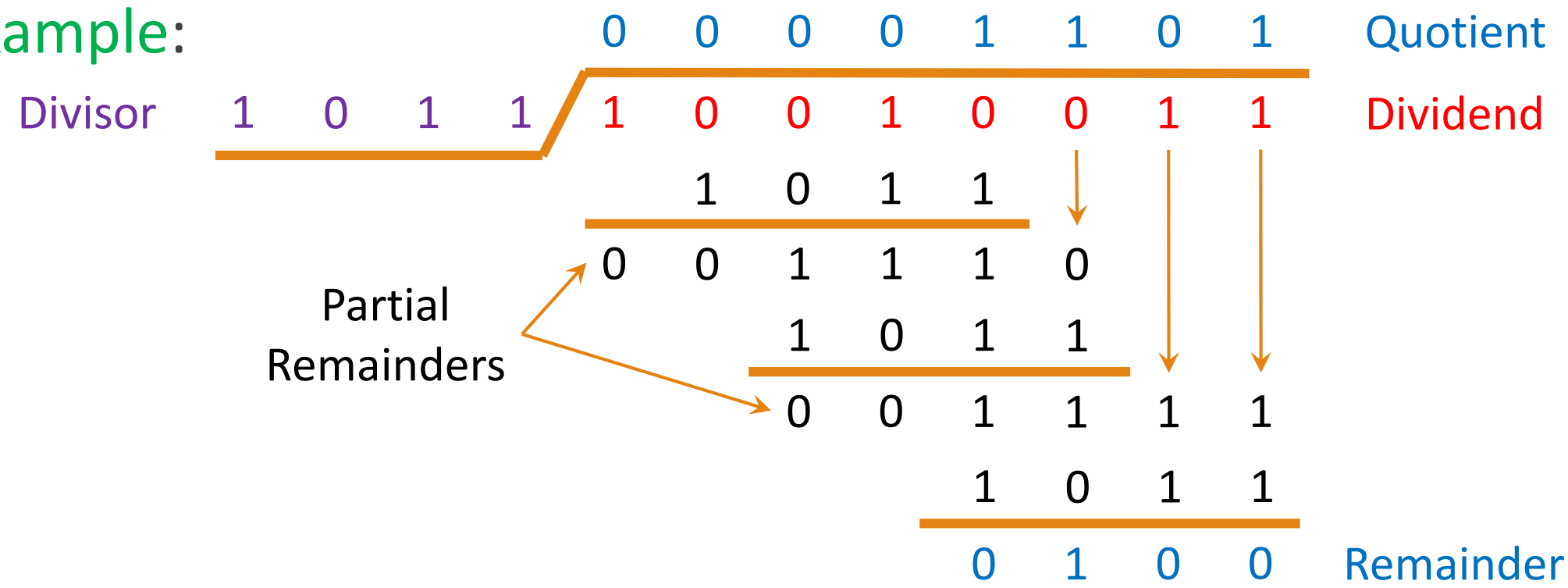
Unsigned Binary Multiplication

- Four basic rules for multiplying binary digits (bits):
  - 0 × 0 = 0, 0 × 1 = 0, 1 × 0 = 0, 1 × 1 = 1
- Example:



Unsigned Binary Division

- Same procedure as decimal division ➔ Long Division
- Example:



Reading Material

- Floyd, Chapter 2:
  - Pages 54 – 57
  - Pages 72 – 82