

# ARM INSTRUCTION FORMATS

# COUNTING IN BINARY

Decimal Numbers - Base-10

$$3417 = 3 * 10^3 + 4 * 10^2 + 1 * 10^1 + 7 * 10^0$$

Binary Numbers — Base-2

$$11101 = 1 * 2^4 + 1 * 2^3 + 1 * 2^2 + 0 * 2^1 + 1 * 2^0$$

Translating from binary to  
decimal:  $2^0 = 1$

$$2^1 = 2$$

$$2^2 = 4$$

$$2^3 = 8$$

$$2^4 = 16$$

$$11101_2 = 16 + 8 + 4 + 1 = 29_{10}$$

# COUNTING IN BINARY

Translating from decimal to binary: 78

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Largest power of 2 that fits =  $64 = 2^6$

So our binary number will have 7 digits

1xxxxxx

$78 - 64 = 14$

32 doesn't fit, and 16 doesn't fit

so 100xxxx

8 fits in 14

1001xxx

$14 - 8 = 6$

4 fits in 6

10011xx

$6 - 4 = 2$

2 fits in 2

100111x

$2 - 2 = 0$

1001110

$$1001110_2 = 64 + 8 + 4 + 2 = 78_{10}$$

# Hexadecimal Format

**Binary is “tiresome”**

**Hex is a convenient way to convert a binary number to something smaller**

Hexadecimal	Binary	Hexadecimal	Binary	Hexadecimal	Binary	Hexadecimal	Binary
0 <sub>hex</sub>	0000 <sub>two</sub>	4 <sub>hex</sub>	0100 <sub>two</sub>	8 <sub>hex</sub>	1000 <sub>two</sub>	c <sub>hex</sub>	1100 <sub>two</sub>
1 <sub>hex</sub>	0001 <sub>two</sub>	5 <sub>hex</sub>	0101 <sub>two</sub>	9 <sub>hex</sub>	1001 <sub>two</sub>	d <sub>hex</sub>	1101 <sub>two</sub>
2 <sub>hex</sub>	0010 <sub>two</sub>	6 <sub>hex</sub>	0110 <sub>two</sub>	a <sub>hex</sub>	1010 <sub>two</sub>	e <sub>hex</sub>	1110 <sub>two</sub>
3 <sub>hex</sub>	0011 <sub>two</sub>	7 <sub>hex</sub>	0111 <sub>two</sub>	b <sub>hex</sub>	1011 <sub>two</sub>	f <sub>hex</sub>	1111 <sub>two</sub>

**Example: convert 10001010101010001000100010000101 to hex**

**Step 1: 1000 1010 1010 1000 1000 1000 1000 0101**

**Step 2: 0x8AA88885**

# Hexadecimal Format

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3 <sub>hex</sub>	0011 <sub>two</sub>	7 <sub>hex</sub>	0111 <sub>two</sub>	b <sub>hex</sub>	1011 <sub>two</sub>	f <sub>hex</sub>	1111 <sub>two</sub>

**Example: convert 11000100010000101 to hex**

**Step 1: 1 1000 1000 1000 0101**

**Step 2: 0001 1000 1000 1000 0101**

**Step 2: 0x18885**

# ASSEMBLY TO MACHINE CODE

SUB X11, X12, X13

11001011000 01101 000000 01100 01011

1100 1011 0000 1101 0000 0001 1000 1011

0xCB0D018B

# ASSEMBLY TO MACHINE CODE

SUB X11, X12, X13

Opcode: 11001011000

Rm: 01101

shamt: 000000

Rn: 01100

Rd: 01011

11001011000 01101 000000 01100 01011

1100 1011 0000 1101 0000 0001 1000 1011

0xCB0D018B

# MACHINE CODE TO ASSEMBLY

0xB5000889

1011 0101 0000 0000 0000 1000 1000 1001

10110101 0000000000001000100 01001

CBNZ X9, #68

CBNZ X9, MYLABEL

# MACHINE CODE TO ASSEMBLY

0xB5000889

1011 0101 0000 0000 0000 1000 1000 1001

10110101000000000000100010001001

10110101 0000000000001000100 01001

CBNZ X9, #68

LDUR X13, [X12, #0]

11111000010 000000000 00 01100 01101

1111 1000 0100 0000 0000 0001 1000 1101

0xF840018D