# CSci 304 Assignment 1

Due: Thursday, 9/19/19
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1. (15 points) Convert the following decimal values to 12-bit two's complement binary, octal, and hexadecimal.

   (a) 367
   (b) 1492
   (c) -773
   (d) -1619
   (e) -2044

   Solution:

Table 1: Conversion to decimal work

| **decimal** | **-2048** | **1024** | **512** | **256** | **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 367 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 1492 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| -773 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| -1619 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 |
| -2044 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

Table 2: Binary, Octal, Hexadecimal

| **Decimal** | **Binary** | **Octal** | **Hexa** |
|---|---|---|---|
| 367 | 000101101111 | 0557 | 16F |
| 1492 | 010111010100 | 2724 | 5D4 |
| -773 | 110011111011 | 6373 | CFB |
| -1619 | 100110101101 | 4655 | 9AD |
| -2044 | 100000000100 | 4004 | 804 |

   For Octal, I grouped up the binary into groups of 3 and then saw what number came out for each group – same with hex but in groups of 4 *did not have a good way of showing work for it *

2. (15 points) Convert the following to decimal.

   (a) 1100 1010 (8-bit two's complement)
   (b) $4DAC_{16}$ (unsigned)
   (c) $377_8$ (9-bit two's complement)
   (d) $4211_5$ (12-bit two's complement)
   (e) 1001 0011 0010 (12-bit two's complement)

   Solution:

   (a) 0(1) + 1(2) + 0(4) + 1(8) + 0(16) + 0(32) + 1(64) + 1(-128) = -54

(b) D = 13, A = 10, C = 12 – 12(1) + 10(16) + 13(256) + 4(4096) = 19884

(c) convert to binary: 3 = 011, 7 = 111, 7 = 111
1(1) + 1(2) + 1(4) + 1(8) + 1(16) + 1(32) + 1(64) + 1(128) + 0(-256) = 255

(d) 4(125) + 2(25) + 1(5) + 1(1) = 556

(e) 0(1) + 1(2) + 0(4) + 0(8) + 1(16) + 1(32) + 0(64) + 0(128) + 1(256) + 0(512) + 0(1024) + 1(-2048) = -1742

3. (15 points) For a computer with word size of 10 bits using two's complement, compute the following system values in both binary and decimal.

   (a) Number of values
   (b) Min unsigned integer
   (c) Max unsigned integer
   (d) Min integer
   (e) Max integer

   Solution: *Used the table in question 1 to get the values for powers of 2

   (a) $2^{10}$ = 1024
   (b) 00000 00000 = 0
   (c) 11111 11111 = 1023
   (d) 10000 0000 = -512
   (e) 01111 11111 = 511

4. (20 points) Suppose a = 1101 1001 0101, b = 1010 1110 1001, c = 0010 0011 1101. Compute the following using binary operations assuming 12-bit two's complement. Express your final an- swers in both binary and hexadecimal.

   (a) $\tilde{}(a \ \& \ a)$
   (b) $a|b|c$
   (c) $(a \ \& \ c)|b$
   (d) $\tilde{}a \hat{} b$
   (e) $\tilde{}((a \ \& \ b) \hat{} (b \mid c))$

   Solution: $a = \{0,2,4,7,8,10,11\}$ $b = \{0,3,5,6,7,9,11\}$ $c = \{0,2,3,4,5,9\}$

   (a) $\{1,3,5,6,9\}$ = 0010 0110 1010 = 26A
   (b) $\{0,2,3,4,5,6,7,8,9,10,11\}$ = 1111 1111 1101 = FFD
   (c) $\{0,2,4\}|\{0,3,5,6,7,9,11\}$ = $\{0,2,3,4,5,6,7,9,11\}$ = 1010 1111 1101 = AFD
   (d) $\{1,3,5,6,9\}\hat{}\ \{0,3,5,6,7,9,11\}$ = $\{0,1,7,11\}$ = 1000 1000 0011 = 883
   (e) $\tilde{}\{\{0,7,11\}\hat{}\{0,2,3,4,5,6,7,9,11\}\}$ = $\tilde{}\{2,3,4,5,6,9\}$ = $\{0,1,7,8,10,11\}$ = 1101 1000 0011 = D83

5. (20 points) Assuming a, b, and c from problem 4, compute the following using binary opera- tions assuming 12-bit two's complement, and arithmetic shift where necessary. Express your final answers in both binary and hexadecimal. Also, state whether each involves a positive overflow, a negative overflow, or no overflow.

   (a) a+b
   (b) (a<<6)+c
   (c) (c>>3)+b
   (d) b−c
   (e) (c−a)<<4

   Solution:

   (a) 1101 1001 0101
   + 1010 1110 1001
   1 1000 0111 1110 = 1000 0111 1110 hex: 87E no overflow
   (b) 0101 0100 0000
   + 0010 0011 1101
   0111 0111 1101 hex: 77D no overflow
   (c) 0000 0100 0111
   + 1010 1110 1001
   1011 0011 0000 hex: B30 no overflow
   (d) 1010 1110 1001
   -0010 0011 1101
   1000 1010 1100 = 8AC no overflow
   (e) 0010 0011 1101 - 1101 1001 0101 is the same as writing
   0010 0011 1101
   + 0010 0110 1011 *i just converted the number to the opposite in order to change the sign
   0100 1010 1000 << 4 = 1010 1000 0000 hex: A80 no overflow

6. (15 points) Assuming a, b, and c from problem 4, evaluate the following C boolean expres- sions using binary operations that assume 12-bit two's complement, and logical shift where necessary.

   (a) $(a > 0)||(a\ \&\ b)$
   (b) $(b < 0)\&\&c$
   (c) $(c < 0)||!(a\&\&b)$
   (d) $(\tilde{}a\hat{}b)\&\&!(\tilde{}c\&c)$
   (e) $(a >> 11)\&\&(b << 11)$

   Solution:

   (a) $0||\{0,7,11\}$ = 1 =TRUE
   *second arguement is nonzero therefore true
   (b) $1\&\&\{0,2,3,4,5,9\}$ = 1 =TRUE
   *second arguement is nonzero therefore true

(c) $0||!(1) = 0||0$ = FALSE
*a and b were nonzero therefore second arguement was true but because of the '!' became false

(d) $\{1,3,5,6,9\}\hat{}\{0,3,5,6,7,9,11\}\&\&!(0) = \{1,7,11\}\&\&1 = 1$ = TRUE
*first arguement is nonzero therefore true

(e) 1111 1111 1111 && 1000 0000 0000 = 1 = TRUE
* both arguements are nonzero therefore true