METRO STATE UNIVERSITY

ICS 232 Computer Organization & Architecture
Homework 2 - Chapter 2 - 10 points
Due Date: 5/31/2023

Name: Key

Note: Please post your homework to ICS232 D2L on or before the due date.

Chapter 2 – Data Representation

Essential Terms and Concepts

7. What does overflow mean in the context of unsigned numbers?

The result is larger than the largest number. A carry out occurs.

18. What are the three components of a floating-point number?

Sign, exponent, significant (mantissa)

25. Explain the difference between ASCII and Unicode.

ASCII uses 8 bits per character with the lower 128 assigned and the upper 128 changes dependent on the locale. Unicode uses 16 bits per character with all code points assigned by standards.

26. How many bits does a EBCDIC, ASCII and Unicode character require?

ASCII – 8
EBCDIC – 8
Unicode - 16

Exercises

2. Perform the following base conversions using subtraction or division-remainder:

a) 588_{10} = _____ 3
b) 2254_{10} = _____ 5
c) 652_{10} = _____ 7
d) 3104_{10} = _____ 9

a) 210210_3

```
588 / 3 = 196 r 0
```

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```
196 / 3 = 65   r 1
65  / 3 = 21   r 2
21  / 3 = 7    r 0
7   / 3 = 2    r 1
2   / 3 = 0    r 2
```

b) 33004_5

```
2254 / 5 = 450 r 4
450  / 5 = 90  r 0
90   / 5 = 18  r 0
18   / 5 = 3   r 3
3    / 5 = 0   r 3
```

c) 1621_7

d) 4228_9

5. Perform the following base conversions.

a) 20012_3 = _____ 10

b) 4103_5 = _____ 10

c) 3236_7 = _____ 10

d) 1378_9 = _____ 10

a) 167_{10}

b) 528_{10}

```
4*5^3 + 1*5^2 + 0*5^1 + 3*5^0
500   + 25    + 0     + 3 = 528
```

c) 1154_{10}

d) 1043_{10}

8. Convert the following decimal fractions to binary with a maximum of six places to the right of the binary point:

a) 25.84375

b) 57.55

c) 80.90625

d) 84.874023

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a) 11001.11011

```
25 /2 = 12 r 1
12 /2 = 6  r 0
6  /2 = 3  r 0
3  /2 = 1  r 1
1  /2 = 0  r 1

.84375 * 2 = 1.69
.69    * 2 = 1.38
.38    * 2 = 0.76
.76    * 2 = 1.52
.52    * 2 = 1.04
```

b) 111001.100011
c) 1010000.11101
d) 1010100.110111

10. Convert the following binary fractions to decimal:
    a) 10111.1101
    b) 100011.10011
    c) 1010011.10001
    d) 11000010.111

a) 23.8125

```
16 + 4 + 2 + 1 = 23
.1101 = .5 + .25 + .0625 = .0.8125
```

b) 35.59375
c) 83.53125
d) 194.875

15. Convert the hexadecimal number DEAD $BEEF_{16}$ to binary.

DEAD $BEEF_{16}$ = 1101 1110 1010 1101 1011 1110 1110 1111_2

17. Represent the following decimal numbers in binary using 8-bit signed magnitude, one's complement, and two's complement representations:

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a) 60
Signed magnitude: 0011 1100
One's complement: 0011 1100
Two's complement: 0011 1100

b) -60
Signed magnitude: 1011 1100
One's complement: 1100 0011
Two's complement: 1100 0100

c) 20
Signed magnitude: 00010100
One's complement: 00010100
Two's complement: 00010100

d) -20
Signed magnitude: 10010100
One's complement: 11101011
Two's complement: 11101100

22. What decimal value does the 8-bit binary number 1011 0100 have if:
a) it is interpreted as an unsigned number? 180
b) it is on a computer using signed-magnitude representation? -52
c) it is on a computer using one's complement representation? -75
d) it is on a computer using two's complement representation? -76
e) it is on a computer using excess-127 representation? 53

33. Add the following unsigned binary numbers as shown.

```
a)  01000100 b)  01011011  c) 10101100
  + 10111011   + 00011111   + 00100100
    =========    ==========   ==========
    11111111     01111010     11010000
```

44. Using arithmetic shifting, perform the following:

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a) double the value 00010101_2 00101010
b) quadruple the value 01110111_2 error (sign bit changes)
c) divide the value 11001010_2 in half 01100101

52. Show how each of the following floating-point values would be stored using IEEE-754 double precision (be sure to indicate the sign bit, the exponent, and the significand fields):

a) 12.5
b) −1.5
c) 0.75
d) 26.625

a) $12.5 = 1.1001 \times 2^3$ 0 10000000010 1001000...0
3+1023 = 1026 = 10000000010
b) $-1.5 = -1.1 \times 2^0$ 1 01111111111 1000000...0
0 + 1023 = 1023 = 01111111111
c) $0.75 = 1.1 \times 2^{-1}$ 0 01111111110 1000000...0
−1 + 1023 = 1022 = 01111111110
d) $26.625 = 1.1010101 \times 2^4$ 0 10000000011 1010101...0
4 + 1023 = 1027 = 10000000011

55. Given that the ASCII code for A is 0100 0001, what is the ASCII code for J?

If A = 0100 0001, then J = 0100 1010

58. Decode the following ASCII message, assuming 7-bit ASCII characters and no parity:
1001010 1001111 1001000 1001110 0100000 1000100 1001111 1000101

100 1010 = J
100 1111 = O
100 1000 = H
100 1110 = N
010 0000 = space

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100 0100 = D
100 1111 = O
100 0101 = E

X1. Encode the following four characters in Unicode:

0 ∑ @ π(zero, summation, at-sign, pi)

0030 2211 0040 03C0 (hex values)

X2. Perform the following unsigned hexadecimal arithmetic:

```
a)  1AF4   b)  3DE7   c)  F938
  + 3304     + D496     - 395D
    ====       ====       ====
    4DF8      1127D      BFDB
```

X3. Decode the following hexadecimal ASCII message, assuming 8-bit ASCII characters:

54 68 65 20 45 6E 64

The End

On a Windows PC: Install WSL 2

1. Install WSL 2 by following these instructions:
   https://docs.microsoft.com/en-us/windows/wsl/install-win10
   You can install any Linux distribution you like. I used Ubunto.

2. Install GCC compiler by
   a. Use `sudo apt update` to update the package database.
   b. Use `sudo apt upgrade` to make sure all of your packages are current.
   c. Use `sudo apt install gcc` to install the GNU C x86 and x86-x64 compiler.

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d. Use `sudo apt install gcc-multilib` to install the GNU C cross-compilation feature.
e. Use `sudo apt install gdb` to install the GNU debugger.

On a Mac: You may need to install Xcode. Then use a terminal window which will act just like the WSL window.

3. Refer to https://stackoverflow.com/questions/2603489/how-do-i-compile-a-c-file-on-my-mac for more help.

Then either using WSL or the Mac terminal window:

4. Write or copy from the Internet any simple C program and run it. Include the program and the output here. Compile with `gcc <filename.c>` and run with `./a.out`.

Prepare for next class by reading Chapter 3 – Boolean Algebra and Digital Logic