

CMSI 284 Encoding Exercise or, the Joy of Hex

Submitted by: _____

Instructions

Do all of these problems *without* the aid of a computer. The purpose of these exercises is for you to develop “manual” encoding skills, which you will need in the event that a zombie apocalypse wipes out all known systems technology on the planet.

You may submit this assignment in one of these ways. With *both* options, make sure to show your work where work needed to be done. This provides evidence that you did not use a computer to determine the answers.

- If you know \LaTeX sufficiently, copy the *source file* of this exercise and add your solutions to this copy. Commit and push the file to your GitHub repository. *Advantage:* Drop-dead clear, sharp, unambiguous presentation. *Disadvantage:* Intermediate computations may be harder to write down.
- Alternatively, you may *print* the PDF version of this exercise and do your work on paper. Submit this printout with your *name* in the designated blank up top. *Advantage:* More convenient for showing your work. *Disadvantage:* Handwritten answers may be harder to read.

Mapping to Outcomes and Proficiencies

The overall assignment covers outcomes *1a*, *1b*, *4d*, and *4f*. Each question will pertain specifically to either *1a* or *1b* and will be given a score ranging from 0 to 4 based on the correctness of the answer. The average score for a given outcome, rounded, determines the final proficiency for the assignment. e.g., If your numeric encoding answers attain an average of 3.2, then *1a* will get a proficiency of 3.

Outcome *4d* will be determined by how well you use the information given in class to compute the requested answers, and how accurately you follow the instructions in this assignment.

Outcome *4f* will be determined by whether you submit the assignment on time.

1 Integers

Outcome 1a, 30 answers: Assuming a 16-bit storage word, choose a value in the requested encoding and specification, then provide its corresponding values for the other encodings:

1. Signed decimal < -31000 , not divisible by 2:

- (a) Unsigned decimal:
- (b) Hexadecimal:
- (c) Binary:

2. Hexadecimal between A234 and DFFF inclusive, no zeroes:

- (a) Unsigned decimal:
- (b) Signed decimal:
- (c) Binary:

3. Hexadecimal between 0111 and 01FF inclusive, two zeroes max:

- (a) Unsigned decimal:
- (b) Signed decimal:
- (c) Binary:

4. Binary with high-order bits 1011 and at least 5 1s:

- (a) Unsigned decimal:
- (b) Signed decimal:
- (c) Hexadecimal:

5. Hexadecimal between 8000 and A000 *exclusive*, one zero max:

- (a) Unsigned decimal:
- (b) Signed decimal:

- (c) Binary:
6. Unsigned decimal between 48000 and 65000 inclusive, not divisible by 4:
-
- (a) Signed decimal:
(b) Hexadecimal:
(c) Binary:
7. Unsigned decimal between 80 and 1024 *exclusive*, not divisible by 4:
-
- (a) Signed decimal:
(b) Hexadecimal:
(c) Binary:
8. Signed decimal between -69 and -192 inclusive, not divisible by 2:
-
- (a) Unsigned decimal:
(b) Hexadecimal:
(c) Binary:
9. Binary with high-order bits 0001 and at least 7 1s:
-
- (a) Unsigned decimal:
(b) Signed decimal:
(c) Hexadecimal:
10. Hexadecimal between 284C and 789A *exclusive*, one zero max:
-
- (a) Unsigned decimal:
(b) Signed decimal:
(c) Binary:

2 Negation

Outcome 1a, 5 answers: Choose 16-bit signed words according to the given specifications, then compute their negatives, expressing your answers in hex as well. You may have a maximum of eight hex 0 digits among your chosen values:

1. x in [9876...CDEF] = _____; $-x$ = _____
2. y in [D219...EDEE] = _____; $-y$ = _____
3. z is odd, in [8087...9191] = _____; $-z$ = _____
4. w is even, in [3BB0...5FFE] = _____; $-w$ = _____
5. m in [010A...020B] = _____; $-m$ = _____

3 Signed Arithmetic

Outcome 1a, 28 answers: Choose 16-bit addends with the given specifications and compute the requested sums and states using **signed** arithmetic. You may have a maximum of twelve hex 0 digits among your chosen values (not including the ones already given):

1. 2 8 _ _ + 5 A _ _
 - (a) Sum, saturated:
 - (b) Sum, modular:
 - (c) Carry (y/n):
 - (d) Overflow (y/n):
2. 7 0 _ _ + E 7 _ _
 - (a) Sum, saturated:
 - (b) Sum, modular:
 - (c) Carry (y/n):
 - (d) Overflow (y/n):
3. B B _ _ + 8 A _ _
 - (a) Sum, saturated:
 - (b) Sum, modular:
 - (c) Carry (y/n):
 - (d) Overflow (y/n):

4. $A1\text{ -- } + 9A\text{ -- }$

- (a) Sum, saturated:
- (b) Sum, modular:
- (c) Carry (y/n):
- (d) Overflow (y/n):

5. $A2\text{ -- } + 2A\text{ -- }$

- (a) Sum, saturated:
- (b) Sum, modular:
- (c) Carry (y/n):
- (d) Overflow (y/n):

6. $58\text{ -- } + 0F\text{ -- }$

- (a) Sum, saturated:
- (b) Sum, modular:
- (c) Carry (y/n):
- (d) Overflow (y/n):

7. $C0\text{ -- } + C0\text{ -- }$

- (a) Sum, saturated:
- (b) Sum, modular:
- (c) Carry (y/n):
- (d) Overflow (y/n):

4 Units of Information

Outcome 1a, 6 answers: Many storage manufacturers sell the same product at different capacities (e.g., Western Digital My Book; Drobo storage array; SanDisk SDXC Memory Card). Go window shopping and find product listings for the smallest- and largest-capacity versions of such a product.

1. (not graded; mainly for reference) Provide the brand, model, min/max capacities, and prices of the product line you've chosen:

2. Interpret the device capacities as decimal units (i.e., megabytes, gigabytes, terabytes, etc.). Show your calculations to answer the following:
 - (a) How much does a kilobyte cost on the smallest-capacity version of the device?
 - (b) How much does a kilobyte cost on the largest-capacity version of the device?
 - (c) What is the price difference, on a per-kilobyte basis, between the smallest- and largest-capacity versions of the device?

3. Interpret the device capacities as binary units (i.e., mebibytes, gibibytes, tebibytes, etc.). Show your calculations to answer the following:
 - (a) How much does a kibibyte cost on the smallest-capacity version of the device?
 - (b) How much does a kibibyte cost on the largest-capacity version of the device?
 - (c) What is the price difference, on a per-kibibyte basis, between the smallest- and largest-capacity versions of the device?

5 IEEE 754 Encoding

Outcome 1a, 8 answers: Read each question carefully and provide the requested answers using the proper encoding:

1. Choose a number between 0 and 1 that has at least 4 non-zero digits in the decimal and is *not* a power of 2 (e.g., 0.0625 is 2^{-4} and thus would not count):

Your chosen number in decimal form: _____

4. Choose 16-digit hexadecimal number where no more than 2 adjacent digits are the same (e.g., 0102 EFF3 E157 C411 is not allowed because of FF and 11):

(a) Provide the IEEE 754 floating-point value that these bits represent in base 2 (use scientific notation):

(b) Provide its closest approximate value in base 10 (use scientific notation if necessary):

6 Character Encoding

Outcome 1b, 44 answers: Read each question carefully and provide the requested answers using the proper encoding. *Remember to show your work to prove that you encoded these manually:*

1. The city of Los Angeles is unhappy with the Unicode SNOWMAN character, as they are unable to use it on their official documents to represent a fun day in the snow. They requested a new “sandman” symbol in its place.

Pick a codepoint for this new character, and show how it would be encoded in UTF-8, UTF-16, and UTF-32. The codepoint must be have 6 unique digits and start with a 10 (i.e., it belongs under Supplemental Private Use Area-B).

10_____

- (a) UTF-8:
- (b) UTF-16:
- (c) UTF-32:

2. Encode the first eight letters of your first and last name combined (including the space in between) as requested, *replacing four of them* with corresponding characters from the Enclosed Alphanumerics Unicode block (uppercase or lowercase, your choice):

(a) UTF-8:

(b) UTF-16:

(c) UTF-32:

(since we're dealing with Unicode anyway, if your name, when properly written, has an accent or other diacritical, then use that too)

3. Choose four emoji without variants (the monster master list can be found in <http://unicode.org/emoji/charts/full-emoji-list.html>) to describe your dream vacation. Encode them:

(a) UTF-8:

(b) UTF-16:

(c) UTF-32:

Fun tip: Remember that there are *flag* emoji to represent specific locations.

4. This one is given 5 times the weight: explain why <https://xkcd.com/380/> is funny. (yes, it's funny) Remember, XKCD comics include a mouseover caption that is an integral part of the strip.