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Instructions. There are 3 problems on this check-in. Each problem is worth 10 points. You will have 90 minutes to work on the problems.
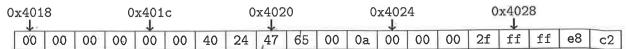
This is a closed-book check-in. You may use one 8.5x11" two-sided sheet of notes. Calculators are allowed. But you may not use books, computers, other printed materials, laptops, etc.

Write all of your answers on the checkin itself. **Answers written on scratch paper not be scanned hence will not be graded.** There is some blank space on the next page of the exam that you may use to continue any answers that you can't fit on any later page. **If you use that space, you must clearly say so in the space allocated for answering the question!**

Data Sizes		Register usage		Callee-saved registers
char	1 bytes	%rdi	first argument	%rsp
short	2	%rsi	second argument	%rbp
int	4	%rdx	third argument	%rbx
double	8	%rcx	fourth argument	%r12
pointer	8	%rax	function result	%r13
		%rsp	stack pointer	%r14
				%r15

1. Pointers and Memory [10 pts]

Consider the following state of memory in a **big endian** machine. The contents of each byte in memory are depicted **in hex** in the boxes, with the hex values on top depicting the addresses of some of the bytes.

0x4018   0x401c   0x4020   0x4024   0x4028

| 00 | 00 | 00 | 00 | 00 | 00 | 40 | 24 | 47 | 65 | 00 | 0a | 00 | 00 | 00 | 2f | ff | ff | e8 | c2 |

Assume we have declared the following variables:

```
int* p = 0x4020;
int* q = 0x4018;
```

For each of the following expressions, determine the binary value **expressed in hex** that the expression evaluates to as well as the type of that value.

Expression	Value (in hex)	Type
*p	0X47650009	integer
p+2	0X4028	integer pointer
*(p+2)	0XFFFFe8C2	integer
(char*) p	0X4020	Character Pointer
((char) p)	0X47	character
(((char) p) + 1)	0X65	Character
*q	0X00000000	integer
*((int**) q)	0X00000000	integer
((int) q)	undefined?	There is no value at 0x00 000000
((int**) q) + 1	0X401C	integer pointer

2

2. Bits and Binary Numbers [10 pts]

   Assume that we have declared two variables as follows:

```
unsigned char x = 56;
unsigned char y;
```

   Fill in the empty boxes in the table below.

Expression	Base-10 Representation	Binary Representation
x	56	0011 1000
y	137	1000 1001
x & y	8	0000 1000
x^y	78	0100 1110
x && (!y)	1	0000 0001
~y	118	0110 1110
(x >> 4) << 1	6	0000 0110
x + y	193	1100 0001
y / 8	—	undefined behaviour because 8 = wordsize
UMax_8	255	1111 1111

Hint: UMax_8 denotes the maximum possible value that can be represented as a 8-bit unsigned char.

3. Signed Ints and Floats [10 pts]

Assume that we have declared the following four variables on a **big-endian** machine:

```
int x1 = -93;
int x2 = x1/2;
float y1 = ((float) x1)/2;
float y2 = y1/4;
```

(a) What is the (four byte) binary representation (written in hexadecimal) of x1?

OX. F F F F F F 9 3

(b) What is the (four byte) binary representation (written in hexadecimal) of x2?

0X F F F F F F E 8

4

(c) What is the (four byte) binary representation (written in hexadecimal) of y1?

In binary: $(-1)^1 \cdot 2^{126} \cdot 1 \cdot 1111\ 1111\ 1111\ 1111\ 1010\ 0011$

In hex: 0xFFFE8C00

(d) What is the (four byte) binary representation (written in hexadecimal) of y2?

In binary $= (-1)^1 \cdot 2^{125} \cdot 1 \cdot 1111\ 1111\ 1111\ 1111\ 1010\ 0011$

0x3FFE8C00

Use the space below to complete any answers that did not fit on any following page.