CSSE2010 / CSSE7201 – Introduction to Computer Systems
Exercises – Week Seven
Instruction Set Architecture

Exercises

Some of the questions below are taken from or based on questions in Tanenbaum, Structured Computer Organisation, 5th edition.

1. How many memory reads are required to read a word of the given width in each of the following circumstances. (If more than one answer is possible depending on the alignment, then give the best-case and the worst-case.)
   (a) 4 byte word, 8-bit data bus, natural alignment required
   (b) 4 byte word, 16-bit data bus, natural alignment required
   (c) 8 byte word, 32-bit data bus, natural alignment required
   (d) 2 byte word, 8-bit data bus, no alignment restrictions
   (e) 8 byte word, 16-bit data bus, no alignment restrictions
   (f) 8 byte word, 32-bit data bus, no alignment restrictions
   Why is it advantageous for a processor to require natural alignment?

2. For each of the following scenarios, how wide (in bits) does the address bus need to be?
   (a) A CPU that uses byte addressing (i.e. has an addressable cell size of one byte) and supports 2^{36} bytes of memory with a 4 byte wide data bus
   (b) A CPU that uses byte addressing and supports 2^{32} bytes of memory with an 8 byte wide data bus
   (c) A CPU that uses byte addressing and supports 2^{16} bytes of memory with an 8 *bit* wide data bus
   (d) A CPU that has an addressable cell size of 2 bytes and supports 2^{32} bytes of memory with a 4 byte wide data bus

3. Assume that a memory contains the following byte values at the given addresses:

Address (decimal)	Data (hex)
1028	88
1029	01
1030	AA
1031	10
1032	F0
1033	C0
1034	00
1035	00
1036	80
1037	00
1038	00
1039	2B

   If you assume that this machine uses little-endian representation, what are the values (in decimal) of
   (a) the two byte unsigned integer stored at address 1028?
   (b) the two byte two's complement integer stored at address 1030?
   (c) the four byte two's complement integer stored at address 1028?
   (d) the ASCII[1] character stored at address 1039?

[1] You will need to search for information on ASCII encoding of characters – this hasn't been covered in classes.

If you assume that this machine uses big-endian representation, what are the values (in decimal) of

(e) the two byte unsigned integer stored at address 1028?
(f) the two byte two's complement integer stored at address 1030?
(g) the four byte two's complement integer stored at address 1028?
(h) the ASCII character stored at address 1039?

4. Identify the type of addressing used for all of the following Atmel AVR instructions. (You may need to refer to the Instruction Set Manual or the Instruction Set reference.)

```
(a)     add r5,r3
(b)     adiw ZH:ZL, 63
(c)     andi r19,$AA
(d)     mov r3,r5
(e)     in r25,$16
(f)     ld r2,Y
(g)     ldi r30,$F0
(h)     lds r10,$FF00
```