Name: ____________________________

Directions: Work only on this sheet (on both sides, if needed); do not turn in any supplementary sheets of paper. There is actually plenty of room for your answers, as long as you organize yourself BEFORE starting writing. In order to get full credit, SHOW YOUR WORK.

1. (15) On typical machines, including Intel, stacks grow toward __________ and thus the stack pointer __________ as the stack grows. (The second blank should contain either “gets smaller” or “gets larger.”)

2. (10) In the output of as -a on p.3 of the machine-language unit in the printed lecture notes, suppose we had forgotten the decl instruction in line 31. Then what would the value 75F8 in line 32 change to?

3. (10) Look at the call instruction on p.3, and consider the two bulleted actions at the top of that page. Which one of the following is true?

   (i) The two actions will be done during Step A of the call.

   (ii) The two actions will be done during Step B of the call.

   (iii) The two actions will be done during Step C of the call.

   (iv) The two actions will be done during different steps of the call.

4. (5) In class, it was mentioned that some machines allow an immediate operand to be specified in a ret instruction, e.g

   ret $8

   The goal of this is to eliminate the need to

   ________________________________

5. Here is (most of) the output of as -a on a certain .s file:

   2 .data
   3 0000 00000000 x: .long 12
   4 0004 00500000 y: .long 5

   6 .text
   7 .global _start
   8 _start:
   9 0000 68000000 pushl $x
   9 0005 68040000 pushl $y
   10 0022 C3 ret

   The subroutine trade does what it says, i.e. swaps two words. After the call, x will contain 5 and y will contain 12.

   Suppose the .data and .text segments being at 0x1000 and 0x2000, respectively.

   (a) (15) Lines 18 and 19 have been censored here. Line 18 deals with the EAX register; state what the assembly-language portion of line 18 is.

   (b) (5) Based on the above information and our discussion in class, it would appear that the Intel engineers anticipated that among all the instructions used in this program, __________ would be used most frequently in general usage.

   (c) (10) Suppose we have a direct-mapped cache, with line size 256 bytes (not counting the “extra word”), with 64 lines. Then if y is in the cache, which line will it be in?

   (d) (5) Infer from the above listing what the general format of a pushl instruction is (analogous to our notation that an immediate-to-register move instruction has the format 10111DDDIMM4).

   (e) (10) State what values, if any, will be in the MAR and MDR during Step C of the ret instruction.

6. Suppose the addone() function in the example in our notes were to return an int value, consisting of the old (i.e. pre-incremented) value in the memory location being incremented.

   (a) (5) Give a single assembly language instruction to add to addone.s to accomplish this change.

   (b) (10) Suppose in TryAddOne.c the call to addone() was done as

   printf(\"%d\n\", addone(&x));

   Show the additional line(s) which would be generated by gcc in TryAddOne.s.
Solutions:

1. 0 gets smaller
2. 75F9
3. (iii)
4. Clean up the stack after the call.
5.a

\texttt{movl (%eax), %ecx}

5.b ret (shortest instruction)
5.c \( (0x1000 + 0x0004) / 0x100 = 0x10 = 16 \); 16 mod 64 = 16
5.d 01101000IMM4
5.e MDR: 0x2000+0xf = 0x200f; MAR unknown with data given
6.a

\texttt{movl (%ebx), %eax}

6.b

\texttt{pushl %eax}
\texttt{pushl $.LC0}