CS 4400 Fall 2016
Midterm Exam 1 – Practice

Name: _____

Instructions You will have eighty minutes to complete the actual open-book, open-note exam. Electronic devices will be allowed only to consult notes or books from local storage; network use will be prohibited. The actual exam will be a little shorter than this practice exam.

For the next four questions, assume the following register and memory state:

CPU

register	value
`rax`	`0x0200`
`rbx`	`0x0100`
`rcx`	`0x0080`
`rdx`	`0x0002`

Memory

address	value (8 bytes)
`0x0300`	`0x001`
`0x0308`	`0x002`
`0x0310`	`0x030`
`0x0318`	`0x400`

1. What is the value of `(%rax,%rbx)` as a source argument to `subq`?

2. What is the value of `0x208(%rbx)` as a source argument to `movq`?

3. What is the value of `0x10(%rax,%rcx,2)` as a source argument to `movq`?

4. What is the value of `0x8(%rbx,%rdx,4)` as a source argument to `leaq`?

The next three questions refer to `compare` defined as

```
int compare(TYPE a, TYPE b) {
  return (VAR1 >= VAR2);
}
```

where the macros `VAR1` and `VAR2` can be defined as `a` or `b` and the macro `TYPE` can be defined as `int`, `long`, or `unsigned`.

5. What definitions of `TYPE`, `VAR1`, and `VAR2` are consistent with the following compiled form?

```
xorl    %eax, %eax
cmpl    %esi, %edi
setge   %al
ret
```

6. What definitions of `TYPE`, `VAR1`, and `VAR2` are consistent with the following compiled form?

```
xorl    %eax, %eax
cmpq    %rdi, %rsi
setge   %al
ret
```

7. What definitions of `TYPE`, `VAR1`, and `VAR2` are consistent with the following compiled form?

```
xorl    %eax, %eax
cmpl    %edi, %esi
setnb   %al
ret
```

8. After running the assembly sequence

```
        orl  $0x8, %eax
        movl $0x10, %ebx
        cmpl %ebx, %eax
        jb  .L1
        movl $0x8, %eax
    .L1:
        movb $3, %cl
        shrl %cl, %eax
```

what is the value of register `%eax`?

9. Given that the function go

```
int go(int n, ARGS) {
  int i;
  DECLS
  for (i = 0; i < n; i++)
    a += ((i & 1) ? a : b);
  return a;
}
```

compiles as

```
   testl   %edi, %edi
   movl    %esi, %eax
   jle     L2
   movl    %edx, %esi
   xorl    %ecx, %ecx
   jmp     L3
L5:
   testb   $1, %cl
   movl    %eax, %esi
   cmove   %edx, %esi
L3:
   addl    $1, %ecx
   addl    %esi, %eax
   cmpl    %edi, %ecx
   jne     L5
L2:
   rep ret
```

pick a combination of `ARGS` and `DECLS` (**not necessarily in the same row**) that fits:

- `ARGS` is `int a`
- `ARGS` is `int b`
- `ARGS` is `int a, int b`
- `DECLS` is *empty*
- `DECLS` is `int a = 0`
- `DECLS` is `int b = a`

The next two questions both use `a` as defined by

```
int a[16][32];
```

10. What is the array-access form (i.e., `a[`*i*`][`*j*`]` for specific *i* and *j*) that is equivalent to `((int *)a)[47]`?

11. What is the pointer-access form (i.e., `((int *)a)[`*n*`]` for a specific *n*) equivalent to `a[2][16]`?

12. Given that

```
int sum_element(int i, int mat1[][M],
                int j, int mat2[][N]) {
  return mat1[i][j] + mat2[j][i];
}
```

compiles as

```
movslq  %edi, %rdi
movslq  %edx, %rdx
leaq    (%rdi,%rdi,2), %rax
leaq    (%rsi,%rax,4), %rax
movl    (%rax,%rdx,4), %eax
leaq    (%rdx,%rdx,4), %rsi
leaq    (%rcx,%rsi,4), %rcx
addl    (%rcx,%rdi,4), %eax
ret
```

then what are the values of the constants `M` and `N` among the following possibilities?

- `M` = 10 and `N` = 6
- `M` = 12 and `N` = 2
- `M` = 3 and `N` = 5
- `M` = 4 and `N` = 5
- `M` = 5 and `N` = 12
- `M` = 8 and `N` = 17

The next two questions use `fish` defined as

```
typedef struct fish {
  char color[6];
  int variety;
} fish;
```

13. What is `offsetof(fish, variety)`?

14. Given the declaration

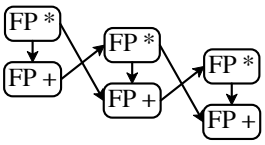
```
fish fa[100];
```

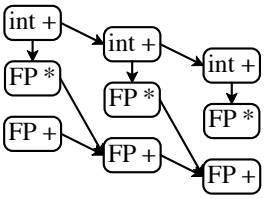
and if the array `fa` starts at address `0x10000`, then what is the address of `fa[32].variety`?

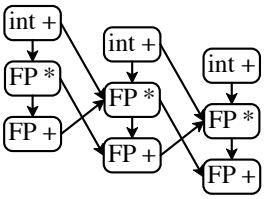
The next two questions refer to the `iterate` function defined as

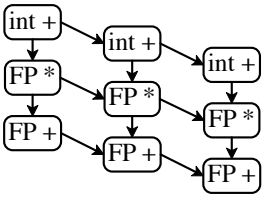
```
double iterate(double v, double u, int steps) {
  while (steps--) {
    u = u + v;
    v = 2 * steps;
  }
  return v+u;
}
```

15. Which of the following correctly represents the dependency graph of `iterate` over three iterations, where each column corresponds to a single iteration?

- 

- 

- 

- 

16. Based on the dependency graph, how many cycles will `iterate` take (expressed as a multiple of `steps`)?

Answers

1. `0x1`

2. `0x2`

3. `0x30`

4. `0x110`

5. `TYPE = int, VAR1 = a, VAR2 = b`

6. `TYPE = long, VAR1 = b, VAR2 = a`

7. `TYPE = unsigned, VAR1 = b, VAR2 = a`

8. `1`

9. `ARGS` is `int a, int b` and `DECLS` is *empty*

10. `a[1][15]`

11. `((int*)a)[80]`

12. `M = 3, N = 5`

13. `8`

14. `0x10188`

15. The second one

16. `3*steps`