Instructions

1. Write your name at the top of the first page and your initials at the bottom of every page.

2. When you are done, return the exam with all the pages, arranged in ascending order. Do not staple the exam.

3. This is a closed-book exam. No form of communication is permitted (eg, talking, texting, etc.), except with the course staff.

4. No electronic devices are permitted.

5. There are 25 multiple-choice questions in this exam, each worth 3 points.

6. The answer to each question must be marked with a pencil as shown in the following example. It will be considered incorrect otherwise.

   Example. What is Albert Einstein’s miracle year?

   A 1879
   B 1900
   C 1905
   D 1917
   E 1955

7. You may use the blank spaces for any scratch work.

8. Discussing the exam contents with anyone who has not taken the exam is a violation of the academic honesty code.

Problem 1. Consider the decimal (base 10) number 117.

a. What is the 8-bit binary (base 2) representation of the number?

A 01110101
B 01010101
C 01110111
D 10110101
E 01110001
b. What is the 8-bit binary (base 2) representation of the negative of the number (ie, -117)?

A 10110101
B 01110001
C 01110111
D 10001011
E 10001010

c. What is the 3-bit octal (base 8) representation of the number?

A 156
B 165
C 265
D 256
E 171

**Problem 2.** Consider the following program `mystery.py`:

```python
import stdio
import sys

for x in reversed(sys.argv[1:]):
    stdio.write(x + ' ')
stdio.writeln()
```

If the program is run as follows:

```
$ python3 mystery.py Alice Bob Carol Dan Eve
```

a. What is the value of the expression `len(sys.argv)`?

A 7
B 5
C 4
D 3
E 6

b. What does the program write?

A Eve Dan Carol Bob Alice mystery.py
B mystery.py Alice Bob Carol Dan Eve
C Eve Dan Carol Bob Alice
D Eve Dan Carol Bob Alice mystery.py python3
E Alice Bob Carol Dan Eve
Problem 3. Consider the following program mystery.py:

```python
import stdio
import sys
x = int(sys.argv[1])
y = int(sys.argv[2])
a = x + y
b = x - y
stdio.writeln(a * b)
```

a. What does mystery.py write when its inputs are 9 and 4?

A 9  
B 97  
C -65  
D 65  
E 169  

b. What does mystery.py compute and write in general?

A \( y^2 - x^2 \)  
B \( x^2 - y^2 \)  
C \( x^2 + y^2 \)  
D \( (x - y)^2 \)  
E \( (x + y)^2 \)  

Problem 4. Consider the following program mystery.py:

```python
import stdio
import sys
n = int(sys.argv[1])
x = 0
i = 1
while i <= n:
    if i % 2 == 0:
        x += i ** 2
    i += 1
stdio.writeln(x)
```

a. What does the program write when its input is 10?

A 165  
B 25  
C 55  
D 385  
E 220  

Initials: 3 / 8
b. What does the program write in general?

A. Sum of the squares of integers less than or equal to \( n \)
B. Sum of the squares of odd integers less than or equal to \( n \)
C. Sum of the integers less than or equal to \( n \)
D. Sum of the squares of even integers less than or equal to \( n \)
E. The value \( n^2 \)

**Problem 5.** Consider the assignment \( a = \text{range}(16, -2, -3) \).

a. What is the value of the expression \( a \)?

A. \([16, 13, 10, 7, 4, 1]\)
B. \([13, 10, 7, 4, 1]\)
C. \([16, 14, 12, 10, 8, 6, 4, 2, 0, -2]\)
D. \([16, 13, 10, 7, 4, 1, -2]\)
E. \([13, 10, 7, 4, 1, -2]\)

b. What is the value of the expression \( \text{len}(a) \)?

A. 9
B. 7
C. 6
D. 8
E. 5

**Problem 6.** What does the following code fragment write?

```python
import stdio
a = []
for x, y in zip([3, 4], [4, 3]):
a += [x * y]
stdio.writeln(sum(a))
```

A. 24
B. 7
C. 12
D. 4
E. 3

**Problem 7.** What does the following code fragment write?

```python
import stdio
a = {}
for v in range(1, 10, 2):
a[v] = v ** 2
stdio.writeln(a[7])
```

Initials: 4 / 8
Problem 8. Consider the assignments \( a = \text{set}(\text{\textquote{newton}}) \) and \( b = \text{set}(\text{\textquote{einstein}}) \).

a. What is the value of the expression \( a - b \)?

\[
\begin{align*}
A & \quad \{\text{o}, \text{w}\} \\
B & \quad \{\text{i}, \text{o}, \text{s}, \text{w}\} \\
C & \quad \{\text{e}, \text{n}, \text{t}\} \\
D & \quad \{\text{e}, \text{i}, \text{n}, \text{o}, \text{s}, \text{t}, \text{w}\} \\
E & \quad \{\text{i}, \text{s}\}
\end{align*}
\]

b. What is the value of the expression \( a \& b \)?

\[
\begin{align*}
A & \quad \{\text{i}, \text{s}\} \\
B & \quad \{\text{o}, \text{w}\} \\
C & \quad \{\text{e}, \text{i}, \text{n}, \text{o}, \text{s}, \text{t}, \text{w}\} \\
D & \quad \{\text{e}, \text{n}, \text{t}\} \\
E & \quad \{\text{i}, \text{o}, \text{s}, \text{w}\}
\end{align*}
\]

Problem 9. Consider the following program \text{mystery.py}:

\begin{verbatim}
import stdio

x = stdio.readString() \\
y = stdio.readString() \\
stdio.write(x + \text{"L"} + y) \\
stdio.write(' ') \\
stdio.write(y + \text{"R"} + x) \\
stdio.writeln()
\end{verbatim}

Next, suppose that the file \text{input.txt} contains the two strings \text{F} and \text{F} separated by a space. What does the following command output?

\[
\begin{align*}
A & \quad \text{FLF FRF} \\
B & \quad \text{FLFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFR} \\
C & \quad \text{FLFLFRFRFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFR} \\
D & \quad \text{F F} \\
E & \quad \text{FLFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFRFLFR}
\end{align*}
\]
Problem 10. Consider the following functions:

```python
def f(x):
    return x ** 2 + 7

def g(x):
    return x % 19

def h(x):
    return f(g(x))
```

a. What is the value of the expression \( f(6) \)?

- A  32
- B  10
- C  43
- D  17
- E  7

b. What is the value of the expression \( g(f(6) - 11) \)?

- A  10
- B  13
- C  17
- D  6
- E  7

c. What is the value of the expression \( h(g(f(6))) \)?

- A  43
- B  296
- C  107
- D  56
- E  32

Problem 11. Consider the assignment \( a = \text{range}(0, 30, 6) \).

a. What is the value of the expression \( \max(a) \)?

- A  36
- B  30
- C  24
- D  29
- E  31
b. What is the value of the expression \( \text{sum(} \text{filter(} \lambda x: x \mod 4 == 0, a)\text{)} \)?

A. 36  
B. 30  
C. 12  
D. 24  
E. 18  

c. What is the value of the expression \( \text{sum(} \text{map(} \lambda x: x \div 6, a)\text{)} \)?

A. 12  
B. 10  
C. 24  
D. 30  
E. 18  

**Problem 12.** Consider the following recursive function:

```python
def mystery(a, b):
    if b == 0:
        return 1
    if b % 2 == 0:
        return mystery(a * a, b // 2)
    return a * mystery(a * a, b // 2)
```

a. What is the value of the expression \( \text{mystery}(2, 3) \)?

A. 1  
B. 5  
C. 8  
D. 6  
E. 2  

b. What is the value of the expression \( \text{mystery}(3, 5) \)?

A. 15  
B. 8  
C. 3  
D. 243  
E. 2  

c. What does the function \( \text{mystery()} \) compute in general about \( a \) and \( b \)?

A. \( ab \)  
B. \( a \mod b \)  
C. \( a + b \)  
D. \( |a - b| \)  
E. \( a^b \)  

Initials: 7 / 8
Answers

Problem 1. A, D, B
Problem 2. E, C
Problem 3. D, B
Problem 4. E, D
Problem 5. A, C
Problem 6. A
Problem 7. C
Problem 8. A, D
Problem 9. E
Problem 10. C, B, E
Problem 11. C, A, B
Problem 12. C, D, E