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Instructions

1. Write your name at the top of the first page and your initials at the bottom of every page.
2. Do *not* staple the exam.
3. Return the exam with *all* the pages, arranged in *ascending* order.
4. This is a closed-book exam. No form of communication is permitted (eg, talking, texting, etc.) during the exam, except with the course staff.
5. No electronic devices are permitted.
6. There are 25 multiple-choice questions in this exam, each worth 3 points.
7. Each question has *exactly one* correct answer, which must be *clearly* marked in the circle provided. Your answer will be considered incorrect otherwise.
8. You may use the blank spaces for any scratch work.
9. 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 189.

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

- (A) 10110101
☒ (B) 10111101
 (C) 01000010
 (D) 01000011
 (E) 01001010

$$\begin{array}{r} 128 \\ + 32 \\ \hline 160 \\ + 16 \\ \hline 176 \end{array}$$

$$\begin{array}{r} 10111 \\ 1286432168921 \end{array}$$

b. What is the 8-bit binary (base 2) representation of the negative of the number (ie, -189)?

- ☒ (A) 01000011
 (B) 01001010
 (C) 10110101
 (D) 10111101
 (E) 01000010

$$\begin{array}{r} 10111101 \\ 01000010 \\ \hline 01 \end{array}$$

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

- ☒ (A) 572
 (B) 725

$$\begin{array}{r} 189 / 8 = 23R5 \\ 23 / 8 = 2R7 \end{array}$$

Initials: VD

1 / 7

- (C) 527
 (D) 257
☒ (E) 275

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

```
import stdio
import sys

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

If the program is run as follows:

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

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

- (A) 9
 (B) 7
☒ (C) 5
 (D) 8
 (E) 6

b. What does the program write?

- (A) Alice Bob Carol Dan Eve Fred mystery.py
 (B) mystery.py Fred Carol Bob Alice Dan Eve
 (C) Fred Eve Dan Carol Bob Alice
 (D) mystery.py Fred Eve Dan Carol Bob Alice
☒ (E) Alice Bob Carol Dan Eve Fred

Problem 3. Consider the following program `mystery.py`:

```
import stdio
import sys

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

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

- (A) 169
☒ (B) 25
 (C) -65
 (D) 65

$$\begin{array}{l} a = 81 \\ b = 2 \cdot 9 + 4 = 22 \\ c = 4^2 = 16 \\ a - b + c = 81 - 22 + 16 = 75 \end{array}$$

Initials: VD

2 / 7

(E) 97

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`:

```
import stdio
import sys

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

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

- (A) 385
 (B) 25
 (C) 55
 (D) 165
 (E) 220

b. What does the program write in general?

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

Problem 5. Consider the assignment `a = range(1, 16, 3)`.a. What is the value of the expression `a`?

- (A) [4, 7, 10, 13]
 (B) [1, 4, 7, 10, 13]
 (C) [4, 7, 10, 13, 16]
 (D) [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]

Initials:

3 / 7

(E) [1, 4, 7, 10, 13, 16]

b. What is the value of the expression `sum(a)`?

- (A) 34
 (B) 51
 (C) 35
 (D) 50
 (E) 120

Problem 6. What does the following code fragment write?

```
import stdio

a = []
for x, y, z in zip([1, 2, 3], [4, 5, 6], [7, 8, 9]):
    a += [x + y + z]
stdio.writeln(max(a))
```

- (A) 18
 (B) 6
 (C) 9
 (D) 12
 (E) 3

Problem 7. What does the following code fragment write?

```
import stdio

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

- (A) 49
 (B) 7
 (C) 21
 (D) 14
 (E) 343

Problem 8. Consider the assignments `a = set('einstein')` and `b = set('turing')`.a. What is the value of the expression `b - a`?

- (A) {'e', 's'}
 (B) {'i', 'r', 't', 'n', 'g', 'a', 's', 'u'}

Initials:

4 / 7

- (C) {'r', 'u', 'e', 'g', 's'}
 (D) {'u', 'g', 'r'}
 (E) {'n', 'i', 't'}

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

- (A) 'n', 'i', 't'
 (B) 'i', 'x', 't', 'n', 'g', 'o', 's', 'u'
 (C) 'x', 'u', 'o', 'g', 's'
 (D) 'o', 's'
 (E) 'u', 'g', 'x'

Problem 9. Consider the following program `mystery.py`:

```
import stdio

x = stdio.readString()
y = stdio.readString()
stdio.write(x + 'L' + y)
stdio.write(' ')
stdio.write(y + 'R' + x)
stdio.writeln()
```

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

```
$ python3 mystery.py < input.txt | python3 mystery.py | python3 mystery.py | python3 mystery.py
```

- [illegible]

Problem 10. Consider the following functions:

```
def f(x, k = 3):  
    return k * x + 1  
  
def g(x, k):  
    return x % k
```

a. What is the value of the expression $f(6, 5)$?

- | | |
|------------------------------------|----|
| <input type="radio"/> A | 19 |
| <input type="radio"/> B | 18 |
| <input checked="" type="radio"/> C | 31 |
| <input type="radio"/> D | 11 |

Initials: vp

- (E) 30

b. What is the value of the expression $g(f(6), 5)$?

- (A) 2
 (B) 0
 (C) 1
 (D) 3
 (E) 4

c. What is the value of the expression $f(g(19, 7))$?

- ☐ A 7
☒ B 16
☐ C 13
☐ D 10
☐ E 1

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

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

- ☐ A 3
☐ B 4
☐ C 6
☐ D 7
☒ E 5

b. What is the value of the expression `sum(filter(lambda x: x % 4 != 0, a))`?

- | | |
|------------------------------------|----|
| <input type="radio"/> A | 12 |
| <input type="radio"/> B | 30 |
| <input checked="" type="radio"/> C | 36 |
| <input type="radio"/> D | 24 |
| <input type="radio"/> E | 18 |

c. What is the value of the expression `sum(map(lambda x: x // 4, a))`?

- (A) 12
 (B) 14
 (C) 24
 (D) 18

Initials: Vh

(E) 30

Problem 12. Consider the following recursive function:

```
def mystery(a, b):  
    if b == 0:  
        return 1  
    return a * mystery(a, b - 1)
```

a. What is the value of the expression `mystery(3, 1)`?

(A) 0

(B) 2

(C) 4

☒ (D) 3

(E) 9

b. What is the value of the expression `mystery(3, 5)`?

(A) 15

(B) 3

(C) 243

(D) 8

☒ (E) 2c. What does the function `mystery()` compute in general about a and b ?(A) $a + b$ (B) ab (C) $|a - b|$ (D) a^b ☒ (E) $a \bmod b$