

Name:

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

Initials:

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`:

```
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`:

```
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`:

```
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

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 = 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 `len(a)`?

- (A) 9
- (B) 7
- (C) 6
- (D) 8
- (E) 5

Problem 6. What does the following code fragment write?

```
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?

```
import stdio

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

- | | |
|-----|----|
| (A) | 9 |
| (B) | 1 |
| (C) | 49 |
| (D) | 25 |
| (E) | 81 |

Problem 8. Consider the assignments `a = set("newton")` and `b = set("einstein")`.

a. What is the value of the expression $a - b$?

- (A) {"o", "w"}
- (B) {"i", "o", "s", "w"}
- (C) {"e", "n", "t"}
- (D) {"e", "i", "n", "o", "s", "t", "w"}
- (E) {"i", "s"}

b. What is the value of the expression `a & b`?

- (A) {"i", "s"}
 (B) {"o", "w"}
 (C) {"e", "i", "n", "o", "s", "t", "w"}
 (D) {"e", "n", "t"}
 (E) {"i", "o", "s", "w"}

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 `Ⓕ` and `Ⓕ` separated by a space. What does the following command output?

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

- (A) FLF FRF
- (B) FLFLFRFLFRFRFLFLFRFRFLFLFRF FRFRFLFRFLFLFRFRFLFLFRFLFRFRFLF
- (C) FLFLFRF FRFRFLF
- (D) F F

(E) FLFLFRFLFRFRFLF FRFRFLFRFLFLFRF

Problem 10. Consider the following functions:

```
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 = 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 `sum(filter(lambda x: x % 4 == 0, a))`?

- (A) 36
- (B) 30
- (C) 12
- (D) 24
- (E) 18

c. What is the value of the expression `sum(map(lambda x: x // 6, a))`?

- (A) 12
- (B) 10
- (C) 24
- (D) 30
- (E) 18

Problem 12. Consider the following recursive function:

```
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 `mystery(2, 3)`?

- (A) 1
- (B) 5
- (C) 8
- (D) 6
- (E) 2

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

- (A) 15
- (B) 8
- (C) 3
- (D) 243
- (E) 2

c. What does the function `mystery()` compute in general about a and b ?

- (A) ab
- (B) $a \bmod b$
- (C) $a + b$
- (D) $|a - b|$
- (E) a^b

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