NYU, Tandon School of Engineering
Extended Bridge to CS — Spring 2024

Exam 1

Part 1: Short Response

Question 1

Convert the decimal number $(165)_{10}$ to its **base-5** representation. You don't need to show your work.

Question 2

What is the largest integer and smallest integer you can represent using a **6-bit two's complement number system**? You don't need to show your work.

Part 2: Multiple Choice (no need to explain your choice)

Question 3

The domain of the variables x and y consists of all the students in our class. Define the predicates:

- $I(x)$: x has an Internet connection.

- $C(x, y)$: x and y have chatted over the Internet.

Select the logical expression that is equivalent to:
"There are two students in your class who have not chatted with each other over the Internet."

(a) $\exists x \exists y (x \neq y \wedge \neg C(x, y))$

(b) $\exists x \exists y (x \neq y \rightarrow \neg C(x, y))$

(c) $\forall x \exists y (x \neq y \wedge \neg C(x, y))$

(d) $\exists x \exists y (x = y \wedge \neg C(x, y))$

Question 4

Select the set that is equivalent to:
$$\overline{A} \cup (A \cap B)$$

(a) $\emptyset$

(b) A

(c) $\overline{A} \cup B$

(d) U

(e) None of the above

Question 5

Select the proposition that is logically equivalent to:

$$(p \rightarrow \neg q)$$

(a) $\neg p \vee q$

(b) $\neg p \vee \neg q$

(c) $p \vee \neg q$

(d) None of the above

Question 6

If I work all night on this homework, then I can answer all the exercises. If I answer all the exercises, I will understand the material. Therefore, if I work all night on this homework, then I will understand the material.

What is the rule of inference being used in the above statement?

(a) Resolution

(b) Disjunctive Syllogism

(c) Hypothetical Syllogism

(d) None of the above

Question 7

Select the logical expression that is equivalent to:

$$\neg \forall y \exists x \exists z (P(x, y, z) \vee Q(x, y))$$

(a) $\exists y \exists x \neg \exists z (P(x, y, z) \vee Q(x, y))$

(b) $\exists y \forall x \forall z (\neg P(x, y, z) \wedge \neg Q(x, y))$

(c) $\exists y \forall x \forall z (\neg P(x, y, z) \vee \neg Q(x, y))$

(d) $\exists y \forall x \forall z (P(x, y, z) \wedge \neg Q(x, y))$

(e) None of the above

Question 8

The domain and target set of functions f and g are $\mathbb{Z}$. The functions are defined as:

$$f(x) = 2x^2 + 3$$
$$g(x) = 5x + 7$$

An explicit formula for the function $g \circ f(x)$ will be:

(a) $50x^2 + 140x + 101$

(b) $50x^2 + 140x + 5$

(c) $10x^2 + 10$

(d) $10x^2 + 22$

Question 9

Let A be defined to be the set:
$$\{1, 2, 3\}$$

Let f be defined as:
$$f : P(A) \to P(A)$$

defined as follows for:
$$x \subseteq A, \quad f(x) = A - x$$

Select the correct description of the function f:

(a) One-to-one and onto

(b) One-to-one but not onto

(c) Not one-to-one but onto

(d) Neither one-to-one nor onto

Question 10

The domain for x and y is the set of real numbers. Select the statements that are **true**.

(a) $\forall x \exists y (xy = 0)$

(b) $\exists x \forall y (x + y = 0)$

(c) $\exists x \forall y (xy = 0)$

(d) $\forall x \exists y (x + y = 0)$

Question 11

Theorem: If the sum of two positive real numbers is larger than 400, then at least one of the two numbers is larger than 200.

A proof by contradiction of the theorem starts by assuming which fact?

(a) Suppose that there exist two real numbers, x and y, such that $x + y > 400$ and both x and y are less than or equal to 200.

(b) Suppose that there exist two real numbers, x and y, such that $x + y > 400$ and either x or y is less than or equal to 200.

(c) Suppose that there exist two real numbers, x and y, such that $x + y > 400$ and both x and y are larger than or equal to 200.

(d) Suppose that there exist two real numbers, x and y, such that $x + y > 400$ and both x and y are larger than 200.

Part 3: True/False (no need to explain your choice)

Question 12

$$A = \{a, b, c, d, \{b\}, \{d\}, \{a, b, c\}\}$$

For the following statement, state if it is true or false (no need to explain your choice).

$$\emptyset \subseteq P(A)$$

- True

- False

Question 13

$$A = \{a, b, c, d, \{b\}, \{d\}, \{a, b, c\}\}$$

For the following statement, state if it is true or false (no need to explain your choice).

$$\{a, b, d\} \subseteq A$$

- True

- False

Question 14

Let A be defined as the set:
$$A = \{a, b, c, d, \{b\}, \{d\}, \{a, b, c\}\}$$

For the following statement, state if it is true or false (no need to explain your choice).

$$\{a, b, c\} \in A$$

- True

- False

Question 15

$$A = \{a, b, c, d, \{b\}, \{d\}, \{a, b, c\}\}$$

For the following statement, state if it is true or false (no need to explain your choice).

$$\{a, b, c, \{b\}\} \in A$$

- True

- False

Question 16

$$A = \{a, b, c, d, \{b\}, \{d\}, \{a, b, c\}\}$$

For the following statement, state if it is true or false (no need to explain your choice).

$$|A| = 7$$

- True

- False

Question 17

$$A = \{a, b, c, d, \{b\}, \{d\}, \{a, b, c\}\}$$

For the following statement, state if it is true or false (no need to explain your choice).

$$\emptyset \in A$$

- True

- False

Question 18

For the following statement, state if it is true or false (no need to explain your choice).

$$|\emptyset| = 1$$

- True

- False

Part 4: Written Response

- Pay special attention to the style of your code. Choose meaningful names for your variables, define constants where needed, and choose the most suitable control statements, etc.

- In all questions, you may assume that the user enters inputs as they are asked. For example, if the program expects a positive integer, you may assume that the user will enter positive integers.

- Don't worry too much about indentation. "tab" is not available in the text box, and hence you may use space.

- No need to document your code. However, you may add comments if you think they are needed for clarity.

Question 19

Write a program that reads a positive odd integer, n, and prints a shape of n lines consisting of asterisks $(*)$ as follows:

1st line: print 1 asterisk

2nd line: print 3 asterisks

3rd line: print 5 asterisks

...

...

...

$(n-1)$th line: print $2n-3$ asterisks

nth line: print $2n-1$ asterisks

Your program should interact with the user **exactly** as demonstrated in the following three execution examples:

Execution example 1:

```
Please enter a positive odd integer:
3
*
***
*****
```

Execution example 2:

```
Please enter a positive odd integer:
7
*
***
*****
*******
*********
***********
*************
```

Execution example 3:

```
Please enter a positive odd integer:
5
*
***
*****
*******
*********
```

Question 20

Consider the following definition:

Definition: A traditional die/dice is a cube with each of its six faces marked with a different number of dots (pips) from one to six. When thrown or rolled, the die/dice comes to rest showing a random integer from one to six on its upper surface, with each value being equally likely.

For this program, the user will enter a number between 1 and 6 to simulate the rolling event. If the user types 1, we will consider that the user has rolled the dice and the face with one dot (pip) appeared. If the user types 2, we will consider that the user has rolled the dice and the face with two dots (pips) has appeared, and so on.

Write a program that reads from the user a sequence of numbers between 1 and 6 and prints the **following statistics**:

```
Total number of times of Faces with even numbered dots appeared:
Number of times Face with one dot appeared:
```

```
Number of times Face with three dots appeared:
Number of times Face with six dots appeared:
```

Implementation requirement:

1. The user should enter their numbers, each one in a separate line, and type -1 to indicate the end of the input.

2. You are not allowed to use C++ syntactic features that were not covered in the Bridge program so far.

3. Faces with even numbered dots are Face with two dots, Face with four dots, and Face with six dots.

Your program should interact with the user **exactly** the same way, as demonstrated below:

Execution example:

```
Please enter a sequence of numbers in between 1 and 6, each one in a separate line.
End your sequence by typing -1:
1
5
5
1
3
5
6
1
2
3
1
2
4
5
6
2
-1

Total number of times Faces with even numbered dots appeared: 6
Number of times Face with one dot appeared: 4
Number of times Face with three dots appeared: 2
Number of times Face with six dots appeared: 2
```