✖

Capstone Exam

Continue Course

Back to Week 1

✓ **21/25** points earned (84%)

Quiz passed!

✓ 1 / 1 points

1.

Instructions: The following exam contains 25 questions from IIPP, PoC, and AlgTh. We suggest that you browse all of the questions first before you start working seriously on the exam. Also, please review the Honor Code for this exam before you begin. You may use any materials available on the web. But, you may not solicit help from another human to complete this exam.

You have an unlimited numbers of attempts at this exam. However, this is a three day delay between attempts. Each time you submit the exam for grading Coursera will select new variants of the exam questions. Note that the differences between these variants can be small. **Work through each exam question carefully on each attempt.**

Finally, if you are convinced that an exam question is in error, you may send email to *fundamentalscomputing@online.rice.edu*. However emails of the form "I'm confused about a problem" may be ignored. Good luck on the exam. You can do this!

Question 1: Consider a function in Python whose execution terminates with the statement

```
return
```

Enter the value returned by the function in the text box below.

None

Correct Response

Correct. In Python, functions without an explicit return value return `None` by default.

✗ 0 / 1 points

2.

Consider the following snippet of Python code:

```
var1 = 7

def var3(var1, var2):
    var0 = var1 + var2
    global var4
    var4 = 17
    return var0 + var4

print var3(var1, var1)
```

What global names are created during execution of this code snippet? What local names are created during execution of this code snippet?

○ **Global** - `var1`, `var3`, `var4`

Local - `var0`, `var1`, `var2`

○ **Global** - `var1`, `var2`, `var4`

Local - `var0`, `var2`

● **Global** - `var1`, `var4`

Local - `var0`, `var1`, `var2`

Incorrect Response

Incorrect.

○ **Global** - `var3`, `var4`

Local - `var0`, `var1`, `var2`

✓ 1 / 1 points

3.

Which of the following Python expressions can be used as a key to a dictionary in Python?

□

□ `0`

Correct Response

□ `False`

Correct Response

□ `[0]`

Correct Response

□ `set([0])`

Correct Response

□ `"0"`

Correct Response

□ `(0)`

Correct Response

✓ 1 / 1 points

4.

In `SimpleGUI` (and most other GUIs), a point on the canvas is indexed by two coordinates. Which statement below correctly characterizes the change in the position of a point on the canvas as these coordinates are varied?

○ Increasing the first coordinate moves the point upward. Increasing the second coordinate moves the point right.

○ Increasing the first coordinate moves the point right. Increasing the second coordinate moves the point upward.

○

Increasing the first coordinate moves the point downward

Increasing the first coordinate moves the point downward. Increasing the second coordinate moves the point right.

○ Increasing the first coordinate moves the point right. Increasing the second coordinate moves the point downward.

Correct Response

Correct.

✓ 1 / 1 points

5.

We will revisit the **`BankAccount`** class from Quiz 6a in IIPP. Here is a slightly modified template for the **`BankAccount`** class.

```
class BankAccount:
    def __init__(self, initial_balance):
        """
        Creates an account with the given balance.
        """
        …

    def deposit(self, amount):
        """
        Deposits the amount into the account.
        """
        …

    def withdraw(self, amount):
        """
        Withdraws the amount from the account.
        Each withdrawal resulting in a balance of
        less than 10 dollars (before any fees) also
        deducts a penalty fee of 5 dollars from the balance.
        """
        …

    def get_balance(self):
        """
        Returns the current balance in the account.
        """
        …

    def get_fees(self):
        """
        Returns the total fees ever deducted from the account.
        """
        …
```

The **`deposit`** and **`withdraw`** methods each change the account balance. The **`withdraw`** method also deducts a fee of 5 dollars from the balance if the

The **withdraw** method also deducts a fee of 5 dollars from the balance if the withdrawal (before any fees) results in a balance of less than 10 dollars. Since we also have the method **get_fees**, you will need to have a variable to keep track of the fees paid.

Implement that **BankAccount** class as described above. Here's one possible test with multiple accounts. This test should print the values 10, 5, 0, and 5.

```
account1 = BankAccount(10)
account1.withdraw(15)
account2 = BankAccount(15)
account2.deposit(10)
account1.deposit(20)
account2.withdraw(20)
print account1.get_balance(), account1.get_fees(), account2.get_bala
nce(), account2.get_fees()
```

Copy-and-paste the following much longer test. What four numbers are printed at the end? Enter the four numbers, separated only by spaces.

```
account1 = BankAccount(20)
account1.deposit(10)
account2 = BankAccount(10)
account2.deposit(10)
account2.withdraw(50)
account1.withdraw(15)
account1.withdraw(10)
account2.deposit(30)
account2.withdraw(15)
account1.deposit(5)
account1.withdraw(20)
account2.withdraw(15)
account2.deposit(25)
account2.withdraw(15)
account1.deposit(10)
account1.withdraw(50)
account2.deposit(25)
account2.deposit(25)
account1.deposit(30)
account2.deposit(10)
account1.withdraw(15)
account2.withdraw(10)
account1.withdraw(10)
account2.deposit(15)
account2.deposit(10)
account2.withdraw(15)
account1.deposit(15)
account1.withdraw(20)
account2.withdraw(10)
account2.deposit(5)
account2.withdraw(10)
account1.deposit(10)
account1.deposit(20)
account2.withdraw(10)
account2.deposit(5)
account1.withdraw(15)
```

```
account1.withdraw(20)
account1.deposit(5)
account2.deposit(10)
account2.deposit(15)
account2.deposit(20)
account1.withdraw(15)
account2.deposit(10)
account1.deposit(25)
account1.deposit(15)
account1.deposit(10)
account1.withdraw(10)
account1.deposit(10)
account2.deposit(20)
account2.withdraw(15)
account1.withdraw(20)
account1.deposit(5)
account1.deposit(10)
account2.withdraw(20)
print account1.get_balance(), account1.get_fees(), account2.get_bala
nce(), account2.get_fees()
```

-75 55 30 30

Correct Response

✓ 1 / 1 points

6.

In IIPP, we used reference diagrams to visualize the behavior of Python programs that involved mutable objects such as lists. These reference diagrams can be viewed as instances of directed graphs (ala Algorithmic Thinking) in which nodes contain the data stored in the list and the directed edges correspond to references in the diagram.

If we view reference diagrams as directed graphs in this manner, which of the following snippets of Python code has a reference diagram whose corresponding directed graph contains a cycle?

○

```
crazy = [1, 1]
crazy[1] = crazy[1]
```

●

```
crazy = [1, 1]
crazy[1] = crazy
```

Correct Response

Correct.

○

```
crazy = [1, 1]
crazy = crazy[1]
```

○

```
crazy = [1, 1]
crazy[1] = crazy[0]
```

✓ 1 / 1 points

7.

Consider this submitted solution to the Rock-paper-scissors-lizard-Spock mini-project from IIPP. This solution is either correct or has one line of code that is in error.

If the program is correct, enter the number 0 in the box below. If the submitted program has an error, enter the number of the erroneous line as a positive integer in the box below.

Note that the lines are numbered starting at one as done in IDLE and CodeSkulptor. (Hint: IDLE displays the line number of the currently selected line in the lower right corner of the window.)

66

Correct Response

Correct. The expression `comp_number - player_number` needs to be enclosed in parentheses to ensure that the difference computed before the result is taken modulo 5.

✓ 1 / 1 points

8.

Consider this submitted solution to the Pong mini-project from IIPP. Note that the paddles do not move in response to key presses.

Modifying four consecutive lines of code fixes this problem and yields a working program. Enter the line number of the first line of code that needs to be modified. Again, the lines are numbered starting at one as done in IDLE or CodeSkulptor.

63

Correct Response

Correct. The paddles' vertical position should depend on `paddle1_pos` and `paddle2_pos`.

✓ 1 / 1 points

9.

Consider this submitted solution to the Blackjack mini-project from IIPP. Note that the program throws an `AttributeError`.

Modifying exactly one line of the program corrects this error and yields a program that works correctly. Enter the number of the line of code that needs to be modified. Again, the lines are numbered starting at one as done in IDLE or CodeSkulptor.

86

Correct Response

Correct. A `Deck` object should be initialized to consist of a list of `Card` objects, not tuples.

✓ 1 / 1 points

10.

Consider the following sequence of operations on a stack. In this sequence

Add(5) means to push 5 onto a stack. *Rem*() means to pop an element off of a stack.

Add(4), *Add*(8), *Rem*(), *Add*(7), *Add*(6), *Add*(5), *Rem*(), *Rem*(), *Add*(2), *Rem*(), *Add*(3), *Add*(7)

Perform these operations on an initially empty stack. What are the contents of the stack after all of these operations are complete?

Indicate your answer with a single number in which each digit is an element on the stack. The right-most element (the least significant digit) should be the next element to be popped. For example, 321 would indicate a stack with three elements (3, 2, and 1) and 1 would be the next element to be popped.

4737

Correct Response

✓ 1 / 1 points

11.

What is the probability of rolling a Yahtzee (five of a kind) on a single roll of 5 six-sided dice?

Enter a single numerical answer with at least four significant digits of precision below

0.000771605

Correct Response

Remember that your answer should include four significant digits of precision, not just four digits.

✓ 1 / 1 points

12.

Assume you have an unfair die. The die has a 0.1 probability of landing on 1, a 0.2 probability of landing on 2, a 0.3 probability of landing on 3, a 0.15 probability of landing on 4, a 0.05 probability of landing on 5, and a 0.2 probability of landing on 6.

Write a function, `probability(outcomes)`, that takes a list of numbers as input (where each number must be between 1 and 6 inclusive) and computes the probability of getting the given sequence of outcomes from rolling the unfair die. Assume the die is rolled exactly the number of times as the length of the `outcomes` input.

For example, the result of `probability([1])` should be `.1`.

What is the result of the following call to the function?

```
probability([4, 2, 6, 4, 2, 4, 5, 5, 5, 5, 1, 2, 6, 2, 6, 6, 4, 6,
 2, 3, 5, 5, 2, 1, 5, 5, 3, 2, 1, 4, 4, 1, 6, 6, 4, 6, 2, 4, 3, 2,
 5, 1, 3, 5, 4, 1, 2, 3, 6, 1])
```

Enter a single numerical answer with at least four significant digits of precision in the box below. Note that Coursera will accept floating point numbers formatted using Python's scientific notation.

4.782969E-44

Correct Response

✓ 1 / 1 points

13.
Consider a process that grows binary trees. At time step 0, the process starts with a tree, T, that consists of a single node. Thereafter, the following happens in each step of the process:

1. The existing tree, T, is copied, creating an identical tree, S.
2. A new root node, R, is created.
3. The left child of R is set to T.
4. The right child of R is set to S.
5. The tree rooted at R becomes the new T for the next step of the process.

Which arithmetic sum models the number of nodes in T after time step n?

○ $1 + 2 + 4 + \cdots + 2^n$

Correct Response

○ $1+1+2+\cdots+2^{n-1}$

○ $0+1+2+\cdots+n-1$

○ $1+3+7+\cdots+2^{n+1}-1$

✓ 1 / 1
points

14.
Which math expression is equivalent to the sum that is the answer to the previous question?

○ 2^n-1

○ 2^n

[✓ ○ $2^{n+1}-1$]

Correct Response

○ $\frac{n(n+1)}{2}$

○ $2^{n-1}+1$

✗ 0 / 1
points

15.
Consider rooted trees in which the number of children for each node is equal to the height of the subtree rooted by the node. If the height of the root of the tree is n, enter a math expression for the maximum number of leaves in a tree that satisfies this property.

Preview

$$(n-1)!$$

(n-1)!

Incorrect Response

Consider formulating a recurrence that describes the solution to this problem and then solve the recurrence.

Reveal correct answer

✓ 1 / 1 points

16.

Consider the following grid:

0	1	2	■	4	5
■	7	■	9	10	■
12	13	14	15	16	17
■	19	20	21	■	23

The neighbors of a particular grid square are the squares that are up, down, left, and right from that square. Black squares are blocked and cannot be searched. If you start a Breadth-first Search from square 15, which of the following are possible orders in which the squares could be searched?

For this problem, you may assume that the neighbors of a cell are represented using a set as done in "Algorithmic Thinking".

□ 15, 9, 14, 16, 21, 10, 13, 20, 19, 7, 4, 12, 17, 23, 5, 1, 2, 0

Correct Response

□ 15, 16, 17, 9, 10, 21, 20, 14, 13, 23, 4, 19, 12, 5, 19, 7, 1, 0, 2

Correct Response

□ 15, 9, 14, 16, 21, 10, 13, 20, 17, 4, 7, 12, 19, 23, 5, 1, 0, 2

Correct Response

□ 15, 14, 21, 9, 16, 20, 13, 10, 17, 19, 7, 12, 4, 23, 1, 5, 2, 0

Correct Response

✓ 1 / 1 points

17.

"Pick-A-Number" is a game in which the board consists of a list of numbers. On a player's turn, that player may pick a number on either end of the list. Turns alternate. When the list is exhausted, the winner is the player with the highest sum of the numbers they picked.

For example, consider the following game board:

3, 5, 2, 1

Players P1 and P2 play optimally as follows:

- P1 picks 1, leaving 3, 5, 2
- P2 picks 3, leaving 5, 2
- P1 picks 5, leaving 2
- P2 picks 2

P1 then wins 6 to 5.

Write a recursive function, `pick_a_number(board)` that takes a list representing the game board and returns a tuple that is the score of the game if both players play optimally. Here, optimal play means that the player maximizes his/her final score. The returned tuple should be ordered with the current player's score first and the other player's score second.

Compute the value of the expression below:

```
pick_a_number([12, 9, 7, 3, 4, 7, 4, 7, 3, 16, 4, 8, 12, 1, 2, 7, 1
1, 6, 3, 9, 7, 1])
```

Enter just the two numbers with a space between them. For example, if your function returns `(6, 5)` (as it should on the above example game), you should just enter **6 5** in the answer box.

81 62

Correct Response

✗ 0 / 1 points

18.
Consider the following five functions:

1. $1^n + 2^n + \cdots + 1000^n$
2. n^{1000}
3. $(n^3 + 2n)/(2n + 1)$
4. $(n^2 + 1)/(n + 1)$
5. $(n!)^n$

Your task is to reorder the functions in the list above so that each function is big-O of the functions below it. As these functions are reordered, the initial numbers assigned to each function should be preserved.

Once you have successfully reordered the functions, enter the numbers associated with the reordered functions (ordered from top to bottom) in the box below. For example, if function 5 is big-O of function 4, function 4 is big-O of function 3,..., and function 2 is big-O of function 1, enter your answer as **5 4 3 2 1** in the box below.

5 1 2 3 4

Incorrect Response
Make sure that your order is not reversed. As a hint, the first number should be 4.

✓ 1 / 1 points

19.
Let $G = (V, E)$ be an undirected graph with n nodes and m edges, and let $deg(v)$, for $v \in V$, denote the degree of node v. Give an expression in terms of m, n, or both, for the term $\sum_{v \in V} deg(v)$.

Preview

$2m$

2*m

Correct Response

Correct.

Your answer, 2*m, is equivalent to the instructor's answer 2*m.

✓ 1 / 1 points

20.

The *transitive closure* of a directed graph $g = (V, E)$ is a directed graph $g' = (V, E')$ such that $(u, v) \in E'$ if and only if there is a path from u to v in g. The following is a dynamic programming algorithm (incomplete) for computing the adjacency matrix, denoted by $R^{(n)}$, of the transitive closure of directed graph g that is given by its adjacency matrix A. In this question, we assume the nodes in V are numbered $1, 2, \ldots, n$.

```
$R^{(0)} \leftarrow A;$
for $k \leftarrow 1$ to $n$ do
   for $i \leftarrow 1$ to $n$ do
      for $j \leftarrow 1$ to $n$ do
         $R^{(k)}[i, j] \leftarrow \ldots;$
Return $R^{(n)}$
```

The fifth line is missing the term to be assigned to $R^{(k)}$. Which of the following gives the correct term?

○ $R^{(k-1)}[i, k]$ **and** $R^{(k-1)}[k, j]$

○ $R^{(k-1)}[i, j]$ **or** $R^{(k-1)}[i, k]$ **or** $R^{(k-1)}[k, j]$

○ $R^{(k-1)}[i, j]$ **and** $(R^{(k-1)}[i, k]$ **or** $R^{(k-1)}[k, j])$

○ $R^{(k-1)}[i, j]$ **and** $R^{(k-1)}[i, k]$ **and** $R^{(k-1)}[k, j]$

○ $R^{(k-1)}[i, j]$

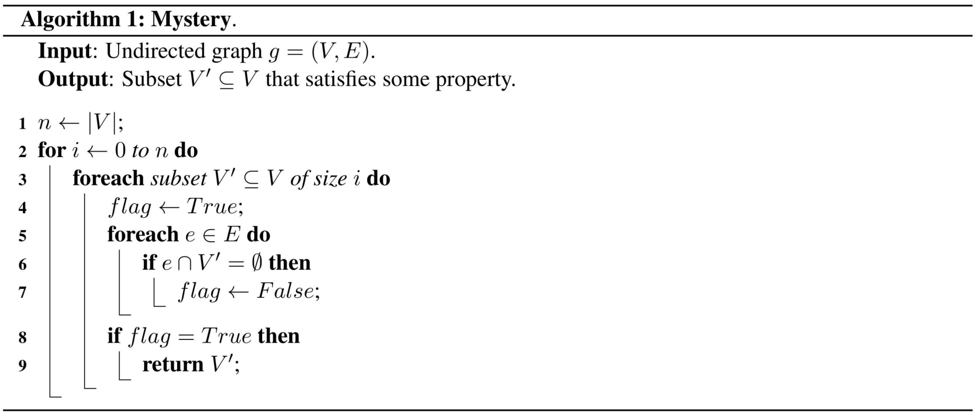
● $R^{(k-1)}[i, j]$ **or** $(R^{(k-1)}[i, k]$ **and** $R^{(k-1)}[k, j])$

Correct Response

✓ 1 / 1 points

21.

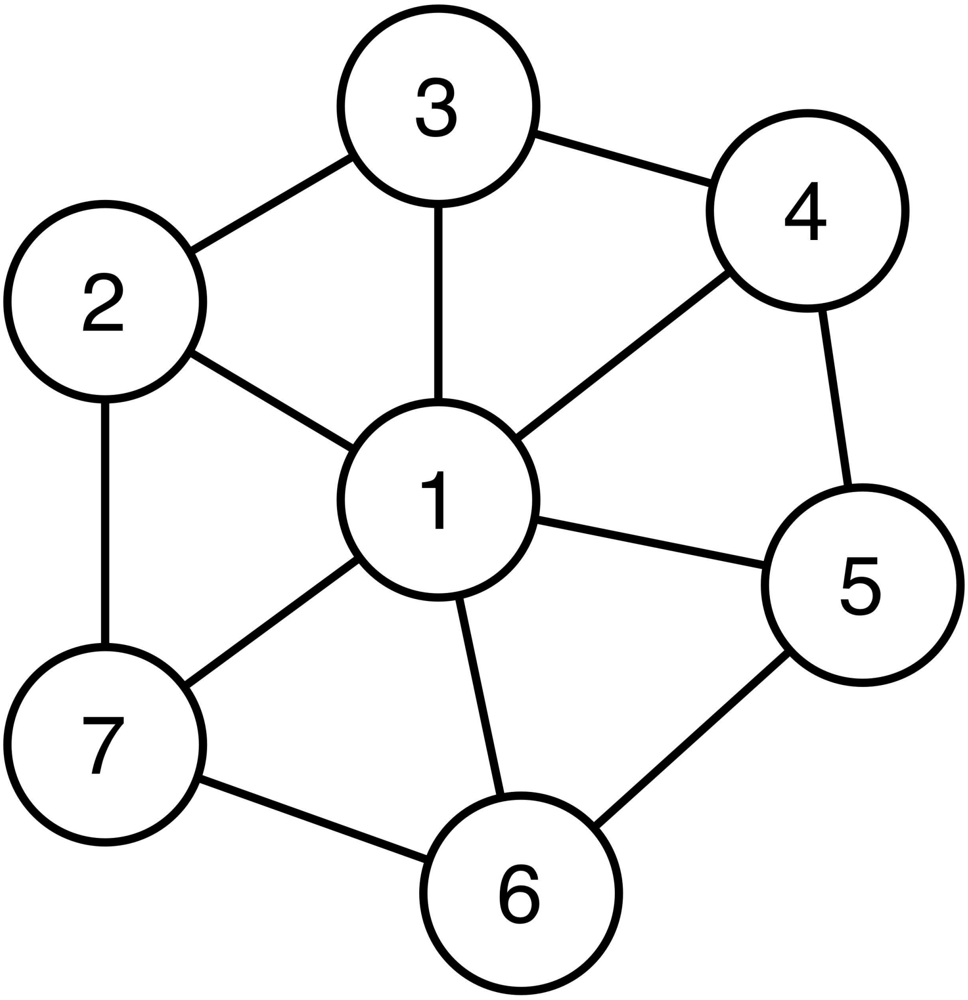
Questions 21 - 25 refer to the following pseudo-code of Algorithm **Mystery**:



```
Algorithm 1: Mystery.
  Input: Undirected graph $g = (V, E)$.
  Output: Subset $V' \subseteq V$ that satisfies some property.

n ← |V|;
for $i \leftarrow 0$ to $n$ do
    foreach subset $V' \subseteq V$ of size $i$ do
        $flag \leftarrow True$;
        foreach $e \in E$ do
            if $e \cap V' = \emptyset$ then
                $flag \leftarrow False$;
        if $flag = True$ then
            return $V'$;
```

For some input graphs, the output of the algorithm might not be unique. If we use the following graph $g1$ as input to Algorithm **Mystery**, which of the following sets could Algorithm **Mystery** return as output?



g1

□ $\{1, 2, 4, 6\}$

Correct Response

□ $\{1\}$

Correct Response

□ $\{2, 3, 4, 5, 6\}$

Correct Response

□ $\{1, 2, 3, 4, 5, 6, 7\}$

Correct Response

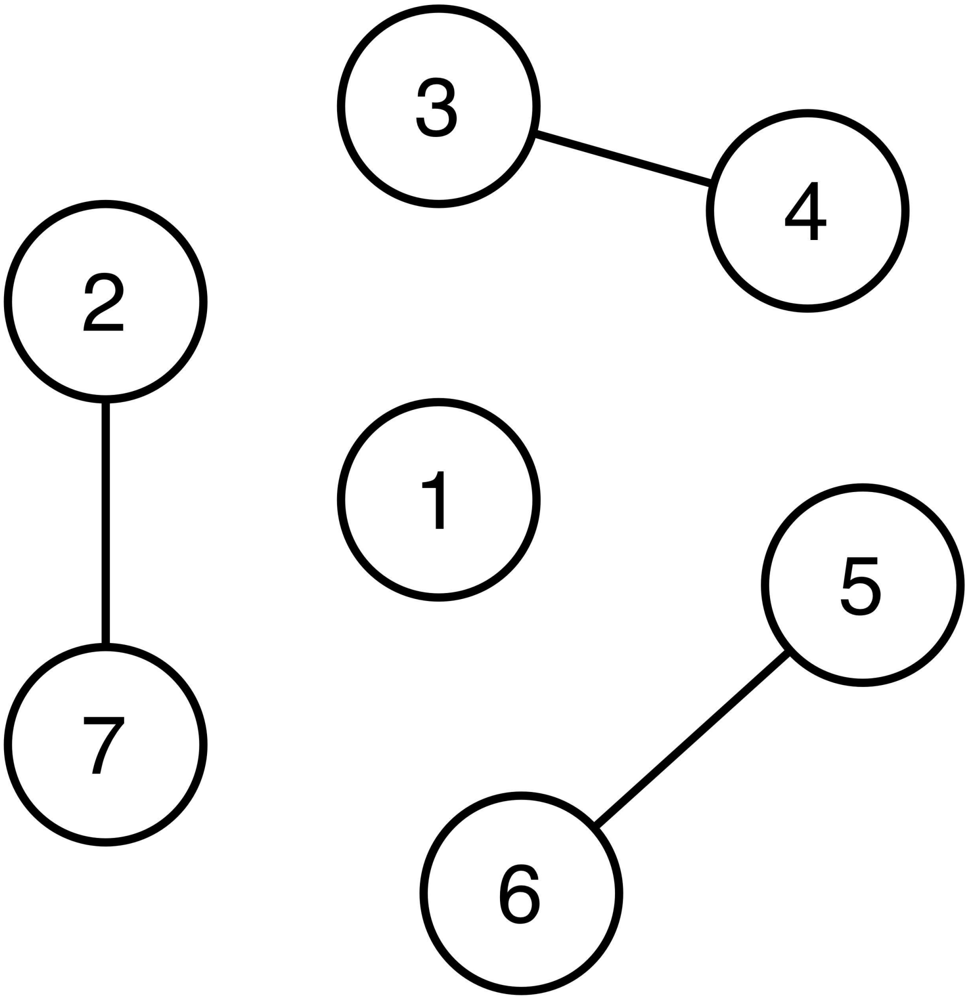
□ $\{1, 3, 5, 7\}$

Correct Response

✓ 1 / 1 points

22.

If we use the following graph $g2$ as input to Algorithm **Mystery**, which of the following sets could Algorithm **Mystery** return as output?



g2

□ $\{1, 2, 3, 4, 5, 6, 7\}$

Correct Response

□ $\{1\}$

Correct Response

□ $\{2, 4, 5\}$

Correct Response

□ $\{2, 3, 4, 5, 6, 7\}$

Correct Response

□ $\{2, 3, 7\}$

Correct Response

✓ 1 / 1 points

23.
Which of the following statements correctly specifies the output of Algorithm **Mystery**?

○ A subset $V' \subseteq V$ such that every edge in E has at least one of its endpoints in V'.

○ A subset $V' \subseteq V$ of minimum size such that every node in V' is connected to every other node in the graph.

○ A subset $V' \subseteq V$ of minimum size such that every edge in E has both of its endpoints in V'.

● A subset $V' \subseteq V$ of minimum size such that every edge in E has at least one of its endpoints in V'.

Correct Response

○ A subset $V' \subseteq V$ such that every node in V' is connected to every other node in the graph.

✗ 0 / 1 points

24.
For an input graph g with n nodes and m edges, that is represented by its adjacency list, which of the following terms gives the tightest bound on the worst-case running time of Lines 5–7 in Algorithm **Mystery**? Assume that testing membership of an element in a set takes $O(1)$ operations.

○ $O(mn)$

● $O(n^2)$

Incorrect Response

○ $O(m + n)$

○ $O(n)$

✓ 1 / 1 points

25.

As your final task, implement Algorithm **Mystery** from Question 21 in Python 2 and run your implementation on the undirected graphs defined in this provided code. These graphs are represented in the standard dictionary form used in "Algorithmic Thinking".

To aid you in testing your code, Algorithm **Mystery** should return sets of size 6 and 9, respectively, on the graphs `GRAPH3` and `GRAPH4` from the provided code. Once you are confident that your implementation is correct, run your code on `GRAPH6` and enter the size of the computed set as an integer in the box below.

Warning: If you plan to use CodeSkulptor for this problem, be warned that your code may take a long time to run. In desktop Python, our solution takes 10-15 seconds to process the last graph. Expect running times on the order of 10+ minutes if you use CodeSkulptor.

11

Correct Response