THE UNIVERSITY OF BRITISH COLUMBIA

COSC 222, 2022 Term 1 Practice Midterm

1) [2 marks] Rank by increasing asymptotic worst-case time complexity the following functions:
   A. $n^3 - 2\,n^2$
   B. $20 \log n + 4$
   C. $n \log n^2$
   D. $n - n^{1/3}$
   E. $\sqrt{n}$
   F. e^n

- Consider the following code:

MyClass.java

```
public class MyClass {
	public boolean isEven(int n) {
		return ((n & 1) == 0);
	}
	int recur(int n) {
		if (n==0) return 2;
		if (n==1) return 3;
		if (isEven(n)) return n*n;
		return 2*n+1;
	}
}
```

MyClassTest.java

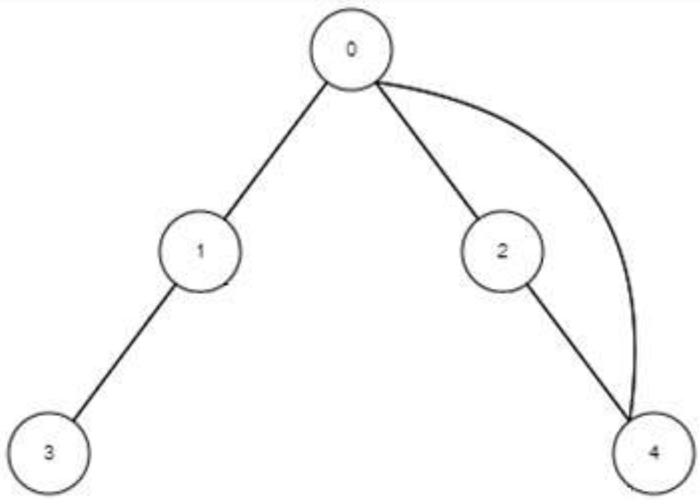
```
Import …
class MyClassTest {
	private MyClass m;

	@BeforeEach
	void setUpBeforeClass() throws Exception {
		this.m = new MyClass();
	}
	@Test
	void testIsEven() {
		assertTrue(m.isEven(0) & !m.isEven(1) & !m.isEven(3));
	}
	@Test
	void testRecur_base() {
		assertTrue(m.recur(0)==2);
		assertTrue(m.recur(1)==3);
	}
	@Test
	void testRecur_general() {
		assertTrue(m.recur(7)==15);
	}
}
```

Use the following terminology to evaluate the quality of unit tests.
Insufficient; more tests are needed to ensure code quality (as defined in labs for the course)
Inappropriate; some tests violate fundamental unit testing rules

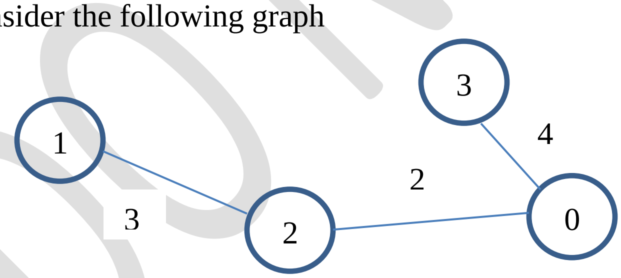
2) [2 marks] You analyze the unit testing for this code as
   A. Insufficient and inappropriate
   B. Sufficient, but inappropriate
   C. Appropriate, but insufficient
   D. Good; satisfies all code quality rules

- Consider the following graph



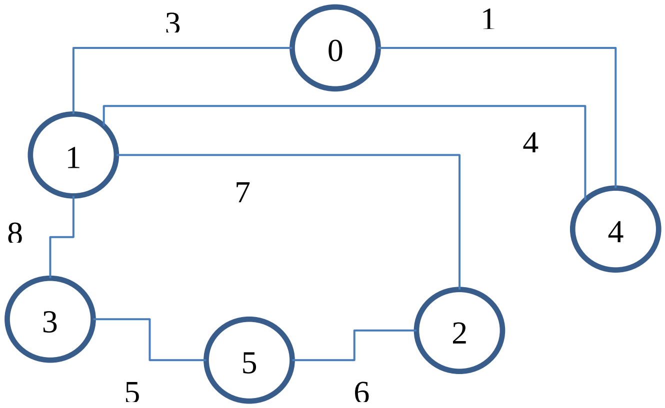
3) [1 mark] Select the correct graph representation
   A. 0->1->2->4
      1->0->3
      2->0->4
      3->1
      4->0->2
   B. 0->1->3
      1->0->3->4
      2->0->4
      3->1
      4->0->2
   C. 0->1->2->4
      1->3
      2->0->4
      3->1
      4->0->2
   D. 0->1->2->4
      1->0->3
      2->0->4
      3->2
      4->0->2
   E. 0->1->2->4
      1->0->3
      2->0->4
      3->1->2
      4->0->2

- Consider the following graph



4) [3 marks] Applying Dijkstra's shortest path algorithm starting from node 0, select the order in which the nodes are added to the explored set.
   A. 0, 3, 2, 1
   B. 0, 2, 3, 1
   C. 0, 2, 1, 3
   D. 2, 0, 3, 1
   E. 2, 0, 1, 3

- Consider the following graph



Applying Kruskal's algorithm

5) [3 marks] [Open answer] the list of edge weights added in order is:

6) [2 marks] the array representing the union-find/disjoint-set data structure has final values

A.

0	1	2	3	4	5
-1	-1	-1	-1	-1	-1

B.

0	1	2	3	4	5
4	-1	-1	5	1	-1

C.

0	1	2	3	4	5
4	-1	5	5	1	-1

D.

0	1	2	3	4	5
1	2	3	4	5	-1

E.

0	1	2	3	4	5
4	5	3	5	1	-1

F.

0	1	2	3	4	5
4	2	-1	5	1	2

- A company wishes to perform the following operations on its data (assume there are m transactions and n customers and n is less than m). Each transaction includes customer name, address, purchase amount, and date
    a. Input a new transaction including customer name, address, purchase amount, and date
    b. List the top 5 customers by total purchases made till now
    c. List all purchases made by a customer (assume there are h purchases)
    d. Update customer information

7) Select the closest asymptotic worst-case **time** complexity for the above operations when the data structure used is an unsorted list
   A. Quadratic $O(n^2 + m^2 + nm)$
   B. Linear $O(n + m)$
   C. Log linear $O((n + m)\log(n + m))$
   D. Logarithmic $O(\log(n + m))$
   E. Exponential $O(2^n + 2^m)$

8) Select the closest asymptotic worst-case **space** complexity for the above operations when the data structure used is an unsorted list
   A. Quadratic $O(n^2 + m^2 + nm)$
   B. Linear $O(n + m)$
   C. Log linear $O((n + m)\log(n + m)\ )$
   D. Logarithmic $O(\log(n + m)\ )$
   E. Exponential $O(2^n + 2^m)$

[Open answer] Propose a combination of data structures that improves the time complexity; indicate the time complexity of your data structure, e.g., 9) a. Array indexed on age, O(1)

9) Data structure(s):
10) a. time complexity
11) b. time complexity
12) c. time complexity
13) d. time complexity

- [Open answer] You are given 2 arrays A and B of sizes n and m respectively. Array A contains pairs of objects storing a key and a value. Array B contains similar information i.e., objects with a key and an associated value. Explain an algorithm to list all the objects as key in array A, value in array A, and value in array B for which the key in array B is equal to the key in array A. For example,

Array A

Key	Value
1	Mary
42	Linda
84	Jennifer

Array B

Key	Value
1	London
64	Paris
84	New York

The output should be

Key	Value A	Value B
1	Mary	London
84	Jennifer	New York

Indicate the complexity of your algorithm (space and time) including of any pre-processing step performed to speed the listing operation (if any).
You can assume that the keys are integer valued, and all the data is known beforehand (offline algorithm).

14) [Open answer]