Matric No: _____

EDINBURGH NAPIER UNIVERSITY

SCHOOL OF COMPUTING

ALGORITHMS AND DATA STRUCTURES

SET09117

Academic session:	**JULY/AUGUST 2018**	Diet:	**SECOND**
Exam duration: (excluding reading time)	**2:00**	Reading time:	**0**
		Total exam time:	**2:00**

Please read full instructions before commencing writing

Exam paper information

- Total number of pages: **Five (5)**
- Number of questions: **Four (4)**
- **Attempt all four (4) questions.**

Special instructions

- None

Special items

- Calculator

Examiner(s): Simon Wells, Simon Powers, Emma Hart

1)

a. Describe the main features of the von Neumann architecture and explain how this architectural approach is useful in the analysis of data structures and algorithms.

(7 marks)

b. Using "Big O" notation describe the complexity of the following code:

```
def all_combos(input_list):
  results = []
  for outer_item in the_list:
    for inner_item in the_list:
      results.append((outer_item, inner_item))
  return results
```

In your answer you should explain any assumptions that you've made in your calcuations.

(10 marks)

c. Whilst solving a programming problem you must choose between two algorithms, one that runs in linear time O(n) and another that runs in quadratic time $O(n^2)$. Which would you choose? In your answer you should justify your choice, explain the meaning of the terms linear and quadratic in this context, and identify an example algorithm for each.

(8 marks)

[Total 25 marks]

2)

a. Describe how Stack data structures can be used to implement undo and redo features. In your answer you should identify the operations associated with Stacks, the effect that these operations have on the data stored therein, and how these considerations help you to solve the undo/redo problem.

(9 marks)

b. Compare and contrast the binary search algorithm to another search algorithm (such as linear search). In your answer you should identify the advantages and disadvantages of each algorithm and the circumstances under which you might choose one over the other.

(8 marks)

c. Sort the following array of numbers into ascending order using the Insertion sort algorithm: [8, 2, 7, 3, 4] For each iteration of the algorithm write out the state of the partially sorted array and identify the element under consideration.

(8 marks)

[Total 25 marks]

3) Consider an open-addressed hash table of size 11. The hash table uses the following hash function:

$$h(x) = x \text{ modulo } 11$$

a. Insert the following elements in order using linear probing, showing the array after adding each element, and indicating when each collision occurs:

11, 3, 22, 33, 6, 9, 1, 2, 12, 36

(14 marks)

b. Define the load factor of a hash table, and explain how the load factor of the hash table affects the number of probes that must be performed to insert or retrieve an element.

(4 marks)

c. Give one advantage of quadratic probing compared to linear probing.

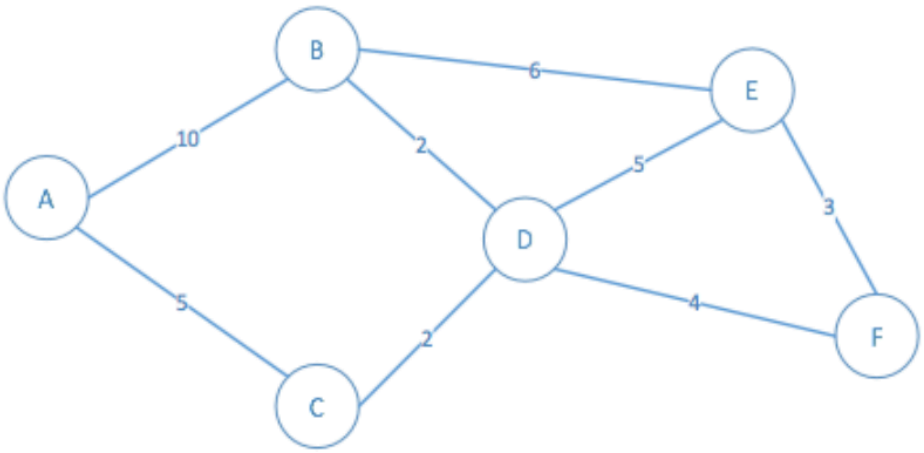
(2 marks)

d. Explain how hashing can be used to verify that a file has not been tampered with or corrupted during transmission.

(5 marks)

[Total 25 marks]

4) Answer the following with respect to the graph below:



a. Kruskal's algorithm may be used to calculate the minimum spanning tree of a graph. Show how Kruskal's algorithm would construct a minimum spanning tree for the above graph commencing from node A. Describe the algorithm, and describe each step taken.

(10 Marks)

b. Show how Dijkstra's algorithm can be used to calculate path costs from Node A to every other node. Describe the algorithm, and describe each step taken.

(12 Marks)

c. Explains the properties of a *Hamiltonian Circuit* and provide an example based on the above graph.

(3 marks)

[Total 25 Marks]

END OF PAPER