

Matric No: _____

EDINBURGH NAPIER UNIVERSITY

SCHOOL OF COMPUTING

ALGORITHMS AND DATA STRUCTURES

SET09117

Academic session: **2014/5** Diet: **Second**

Exam duration: **1:30** Reading time: **0**

(excluding reading time) Total exam time: **1:30**

Please read full instructions before commencing writing

Exam paper information

- Total number of pages:
- Number of questions: 5
- Attempt three question.

Special instructions

- None

Special items

- Calculator

Examiner(s): Andrew Cumming, Neil Urquhart

1

a) 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.

(10)

b) Describe the process of sorting the following array of numbers into ascending order using Quicksort

[4, 1, 5, 2, 3]

You may use diagrams to support your answer and should, for each step show the state of the array, and identify the pivot, the elements that are compared, any elements that are moved, and any partition operations

(15)

2

a) What is a hash function? In your answer you should give an example of a hash function, identify why such functions are useful, and describe the desirable properties of a good hash function.

(5)

b) Given a hash table of size 7 and the following hash function:

$$h(x) = x \text{ modulo } 7$$

Use quadratic probing to insert the following elements in order,

1,15,14,3,9,5,2

For each element identify:

(i) Each slot that the elements tries to occupy.

(ii) Whether a collision occurs.

(iii) Give the final order of the array.

(20)

3)

a) Given the following grammar, G:

- (R1) $S \rightarrow \text{if (B) } V$
- (R2) $S \rightarrow \text{while (B) } V$
- (R3) $V \rightarrow \text{else } S$
- (R4) $V \rightarrow \text{pass}$
- (R5) $V \rightarrow \text{exit}$
- (R6) $B \rightarrow \text{true}$
- (R7) $B \rightarrow \text{false}$

Identify which of the following are members of the language defined by G. Where possible show the derivation.

- (i) if (true) pass
- (ii) if (false) else if (true) pass
- (iii) while (true) else while (false) else if (true) exit
- (iv) while (true) else if (pass) exit
- (v) if (true) else if (true) else if (true) pass

(12)

b) Define a grammar that will produce the following language

$\{ab, aabb, aaabbb, aaaabbbb, \dots, a^n b^n\}$

(3)

c) Define a grammar that will produce the following language

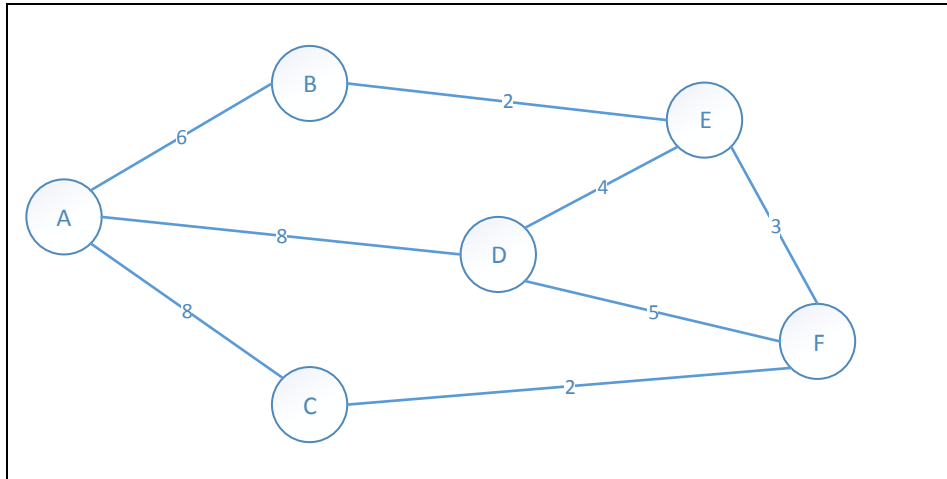
$\{s, ssw, sssww, ssssswww, ssssssswww, \dots, s^{n+1} w^n\}$

(3)

d) What is a Parser? In your answer you should describe the role that Parsers play within a language-processing pipeline and the relation of parsers to formal grammars.

(7)

4 Answer the following questions with reference to this graph:



- 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)
- 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. (10)
- c) Explains the properties of a Hamiltonian Circuit and provide an example based on the above graph. (5)

5 a)

Use Dijkstra's shunting algorithm to convert following expressions in infix notation to Reverse Polish notation. Please show your working.
(You may assume a precedence order of $*$ / $+$ - .)

i) $3 - 2 + 1$

(3 Marks)

ii) $1 * 2 / 3$

(3 Marks)

iii) $1 + 2 * 3 - 4 / 5$

(3 Marks)

b) A Reverse Polish Notation expression may be evaluated using a stack. Draw diagrams to represent the stack and show each stage in evaluating the following expressions. For each stage give a written description of the operation being carried out on the stack.

i) $1 \ 5 \ 4 \ - \ +$

(4 Marks)

ii) $4 \ 2 \ 3 \ * \ +$

(4 Marks)

c) Explain the basic operation of a Turing Machine. Your answer should cover, at least, the role of the tape, symbols, machine table, states and operations.

(6 Marks)

d) A programming language may be described as Turing Complete, what is meant by this?

(2 Marks)