UNIVERSITY OF WESTMINSTER

COLLEGE OF DESIGN, CREATIVE AND DIGITAL INDUSTRIES
School of Computer Science and Engineering
SEMESTER 2 2021/22

Module Code:	**5SENG003C.2.2021**
Module Title:	**Algorithms: Theory, Design and Implementation**
Module Leader:	**Klaus Draeger**
Release Time:	**Thursday, 05th May 2022, 13:30**
Submission Deadline:	**Thursday, 05th May 2022, 15:50**

Instructions to Candidates:

Please read the instructions below before starting the paper

- Module specific information is provided below by the Module Leader
- The Module Leader will be available during the exam release time to respond to any queries.
- As you will have access to resources to complete your assessment any content you use from external source materials will need to be referenced correctly. Whenever you directly quote, paraphrase, summarise, or utilise someone else's ideas or work, you have a responsibility to give due credit to that person. Support can be found at:
  https://www.westminster.ac.uk/current-students/studies/study-skills-and-training/research-skills/referencing-your-work
- This is an individual piece of work so do not collude with others on your answers as this is an academic offence
- Plagiarism detection software will be in use
- Where the University believes that academic misconduct has taken place the University will investigate the case and apply academic penalties as published in Section 10 Academic Misconduct regulations.
- ***Once completed please submit your paper via the Assignment submission. In case of problems with submission, you will have two opportunities to upload your answers and the last uploaded attempt will be marked. Note that instructions on how to compile and submit your handwritten and/or typed solutions will have been sent to you separately.***
- ***Work submitted after the deadline will not be marked and will automatically be given a mark of zero***

Module Specific Information

PLEASE WRITE YOUR STUDENT ID CLEARLY AT THE TOP OF EACH PAGE

You are advised (but not required) to spend the first ten minutes of the examination reading the questions and planning how you will answer those you have selected.

Answer ALL 10 questions. Each question is worth 10 marks.

5SENG003C.2.2021 Algorithms: In-class test

Only one correct answer per question. No negative marking. Each question is worth **10** marks.

Question 1

Suppose you have the following runtime data for an algorithm. What complexity class do they indicate?

Input size	Seconds
1000	5
2000	19
4000	78
8000	313
16000	1251

Question 2

Consider the following code fragment. Based on its structure, what is its complexity class?

```
int m = 0;
for ( int i = 0; i < n ; i ++)
  for ( int j = 0; j < n ; j ++)
    for ( int k = 0; k < i ;   k ++)
      m += i ;
```

Question 3

Suppose we use Binary Search to find the value 11 on the following array. Which array elements get checked, in which order, and why?

index	0	1	2	3	4	5	6
value	2	3	5	7	11	13	17

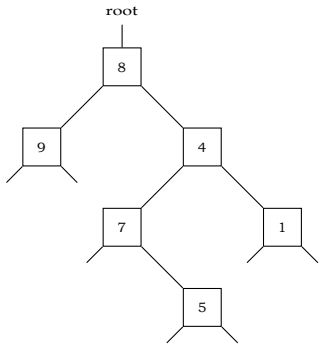
Question 4

Suppose we run Selection Sort to sort the following array in increasing order. What does the array look like after the first 3 iterations, and why?

index	0	1	2	3	4	5	6
value	13	3	17	5	2	7	11

Question 5

Suppose we remove the value 7 from the following binary search tree. What does the resulting tree look like?

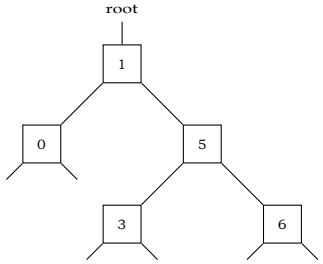


To enter your answer, write the contents of the tree one level at a time, using "–" to indicate missing nodes.
For example, the above tree would be written

8
9 4
– – 7 1
– – – – – 5 – –

Question 6

Suppose we insert the value 4 in the following AVL tree, and re-balance it. What does the resulting tree look like?



To enter your answer, write the contents of the tree one level at a time, using "–" to indicate missing nodes.
For example, the above tree would be written

1
0 5
– – 3 6

Question 7

Consider the following array representation of a Min-Heap. How does this change after extracting the minimum element?

index	0	1	2	3	4	5	6
value	0	1	4	2	3	6	5

Question 8

Consider the undirected graph given by

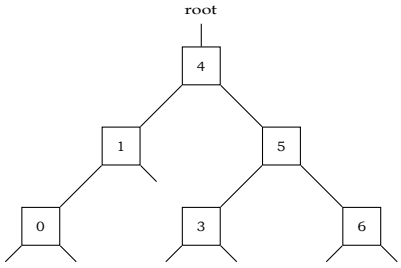
V = {a ,b ,c, d, e, f}

E = { {a,b}, {a,c}, {a,e}, {a,f}, {b,c}, {b,d}, {b,f}, {c,d}, {d,e}, {d,f}, {e,f} }

What is an Euler walk? Does this graph have one? If yes, give an example. If not, why not?

Question 9

Suppose we use a pre-order traversal to output the following tree. What does this traversal do? What is the resulting output?



Question 10

For this question, consider the Booean satisfiability problem:

Input: A Boolean formula using n variables Output: true, if there is some combination of variable values that makes the formula true; otherwise false.

What would a brute force algorithm for this problem do? What is its complexity in terms of n?