**UNIVERSITY OF BRISTOL**

**January 2018**

**FACULTY OF ENGINEERING**

**Examination for the Degrees of**
**Bachelor of Engineering**
**Master of Engineering**

**COMS10001**
**PROGRAMMING AND ALGORITHMS II**

**TIME ALLOWED:**
**2 Hours.**

**THIS IS A SAMPLE PAPER**
**This paper contains *four* questions.**
**Each question is worth *30 marks*.**
***Three* answers will be used for assessment.**
**The maximum for this paper is 90 marks.**

**<u>Other instructions</u>**

1. **Calculators must have the Engineering Faculty seal of approval.**

**TURN OVER ONLY WHEN TOLD TO START WRITING**

**Q1:** This question is about algorithmic complexity and recursion.

(a) Define big-O.

*(5 marks)*

(b) Define big-Theta.

*(5 marks)*

(c) Finding the maximum of a list by checking every item has big-Theta of $n$, why is it we can specify big-Theta rather than big-O?

*(5 marks)*

(d) What is big-Theta of $(n^2+1)/(n^2+2)$.

*(5 marks)*

(e) Find big-Theta for the recursion relation

$$T(n) = 8T(n-1) - 7$$

with $T(0) = 0$.

*(10 marks)*

**Q2:** This question is about sorting.

(a) Describe the radix sort algorithm and apply it to $(41, 29, 13, 23, 49)$.

*(10 marks)*

(b) Discuss the algorithmic complex of radix sort.

*(20 marks)*

**Q3:** This question is about balanced trees.

(a) Define a balanced binary tree. Why might a heap be useful?

*(10 marks)*

(b) Describe when a LR rotation is needed and explain how the reotation is done.

*(10 marks)*

(c) Describe when a RR rotation is needed and explain how the reotation is done.

*(10 marks)*

**Q4:** This question is about adverserial search and Euler's theorem.

(a) Draw the tree for the $(3, 1, 1)$ game of nim and use minimax to decide which move the first player should play.

*(10 marks)*

(b) Consider the four-node undirected graph

$$A = \begin{pmatrix} 0 & 1 & 2 & 3 \\ 1 & 0 & 3 & 1 \\ 2 & 3 & 0 & 1 \\ 3 & 1 & 1 & 0 \end{pmatrix}$$

For which starting and ending nodes does it have an Eulerian path?

*(10 marks)*

(c) Draw the graph and the path.

*(10 marks)*

**END OF EXAM PAPER**