UNIVERSITY OF LONDON

CM1025

BSc EXAMINATION

COMPUTER SCIENCE

Fundamentals of Computer Science

Release date: Tuesday 6 September 2022 at 12:00 midday British Summer Time

Submission date: Wednesday 7 September 2022 by 12:00 midday British Summer Time

Time allowed: 24 hours to submit

INSTRUCTIONS TO CANDIDATES:

Section A of this assessment consists of a set of **TEN** Multiple Choice Questions (MCQs) which you will take separately from this paper. You should attempt to answer **ALL** the questions in Section A. The maximum mark for Section A is **20** and is worth 20% of your final mark.

Section A will be completed online on the VLE. You may choose to access the MCQs at any time following the release of the paper, but once you have accessed the MCQs you must submit your answers before the deadline or within **4 hours** of starting whichever occurs first.

Section B of this assessment is an online assessment to be completed within the same 24-hour window as Section A. We anticipate that approximately **1 hour** is sufficient for you to answer Section B. Candidates must answer **TWO** out of the THREE questions in Section B. The maximum mark for Section B is **50** and is worth 80% of your final mark.

You may use any calculator for any appropriate calculations, but you may not use computer software to obtain solutions. Credit will only be given if all workings are shown.

You should complete Section B of this paper and submit your answers as **one document**, if possible, in Microsoft Word or a PDF to the appropriate area on the VLE. Each file uploaded must be accompanied by a coversheet containing your **candidate number**. In addition, your answers must have your candidate number written clearly at the top of the page before you upload your work. Do not write your name anywhere in your answers.

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SECTION A

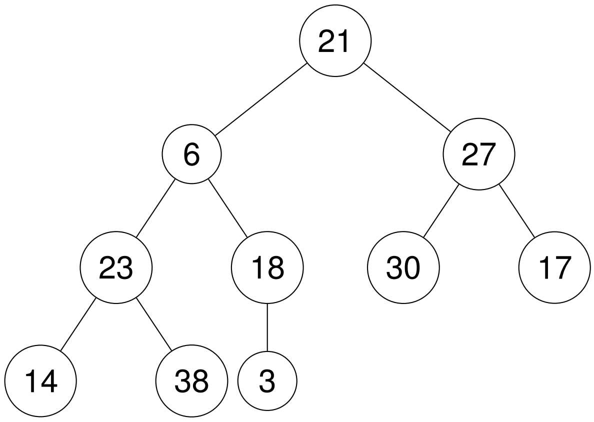
Candidates should answer the **TEN** Multiple Choice Questions (MCQs) quiz, **Question 1** in Section A on the VLE.

SECTION B

Candidates should answer any **TWO** questions in Section B

Question 2

(a) Heapify the following tree, make every step clear. (Min heap) [6]



(b) Design a regular expression that accepts the language of all binary strings with exactly one occurrences of 000. [4]

(c) Answer the following for the context-free grammar:

$$G:$$

$$S \to VXUV$$
$$X \to 0U11VX|\epsilon$$
$$U \to 0U|\epsilon$$
$$V \to 1V|\epsilon$$

- Give two non-empty strings that can be generated from G, show the derivations. [4]
- Give two strings that cannot be generated from the context-free grammar G. [2]
- Can string 0010 be generated by G? Justify your reasoning. [2]
- What is the language of G? [3]

(d) Using the Master theorem write the time complexity of the following, make every step clear.

- $T(n) = 4T(n/2) + O(n^2)$ [4]

Question 3

(a) Using the Master theorem write the time complexity of the following, make every step clear.

- $T(n) = 9T(n/3) + O(1)$

[4]

(b) Design a context-free grammar that accepts the language of all binary strings with at most one occurrence of 000. [8]

(c) Design a Turing Machine that accepts all binary strings in the form of a palindrome. [7]

(d) Use the merge sort to sort the following list in ascending order. Show your work step by step. [6]

4 19 6 15 10 3 8 11 1

Question 4

(a) Assume $S = \{$ NKem(N), Elena(E), Fatima(F)$\}$and $H = \{$Whittington(W), Royal Free(R), Highgate(H)$\}$. The list of the preference is as follows. Find the stable match using the Gale-Shapley algorithm. Show the steps of the algorithms clearly. [6]

Whittington (W)	N	E	F
Royal Free(R)	F	E	N
Highgate(H)	F	N	E

NKem	H	W	R
Elena	W	H	R
Fatima	W	R	H

(b) Design a Context-free Grammar that accepts the language of all binary words with exactly two occurrences of 'a' and at least one 'b'. [5]

(c) Write the asymptotic functions of the following. Prove your claim: if you claim $f(n) = O(g(n))$ you need to show there exist c, k such that $f(x) \leq c \cdot g(x)$ for all $x > k$.

- $h(n) = 5n + n \log n + 3$ [4]
- $l(n) = 8n + 2n^2$ [4]

(d) Design a Turing Machine that accepts all binary words in the form of $a^i b^{2i}$ for $i \geq 0$. [6]

END OF PAPER

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