UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

Department of Computing

B. Sc. Examination 2018

IS51009C
Fundamentals of Computer Science

Duration: 3 hours

Date and time:

This paper is in two parts: part A and part B. You should answer ALL questions from part A and THREE questions from part B. Part A carries 40 marks, and each question from part B carries 20 marks. The marks for each part of a question are indicated at the end of the part in [.] brackets.

There are 100 marks available on this paper.

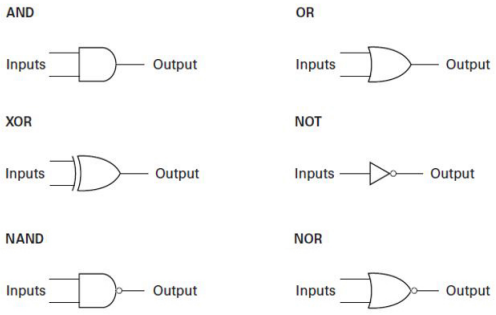
THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM

Part A

Answer all parts of this question. There is only one correct answer for each question.

Question 1

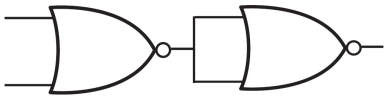
This figure should remind you of the descriptive shapes of the four basic logic gates along with the NAND and NOR gates.



(a) When does a NOT gate with one input, output 0? [4]

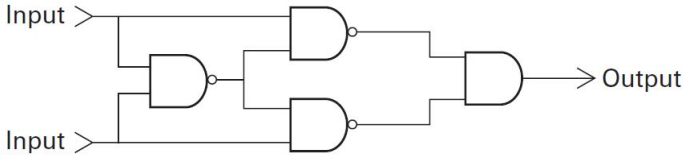
i. When the input is 1
ii. When the input is 0
iii. Always
iv. Never

(b) Which logic gate does the following circuit behave like? [4]



i. an AND gate
ii. a NAND gate
iii. a OR gate
iv. a NOR gate

(c) What is the output of the following circuit when (a) the upper input is 1 and the lower input is 0, and (b) when both inputs are 0.



i. (a) 0 (b) 0
ii. (a) 1 (b) 0
iii. (a) 0 (b) 1
iv. (a) 1 (b) 1

[4]

(d) In which network topology is a collision detection protocol required? [4]

i. BUS topology
ii. STAR topology
iii. Both STAR and BUS topologies
iv. Neither

(e) Which of the following is **not** a type of machine instruction? [4]

i. Complex Instruction Set Computing (CISC)
ii. Data Transfer
iii. Arithmetic / Logic
iv. Control

(f) Assume we have a logic gate with 6 inputs. How many rows would the truth table for the particular logic gate have? [4]

i. $2^{6-1} = 32$
ii. $2^{6+1} = 128$
iii. $6^2 = 36$
iv. $2^6 = 64$

(g) What is the primary difference between 32-bit CPUs and 64-bit CPUs? [4]

i. The size of the registers and machine instructions
ii. The size of the physical and virtual memory
iii. The size of the bus and the number of connected devices
iv. The number of machine instructions

(h) In decimal form, what is the Hamming distance between the bit-strings 0111 0011 and 1111 0110? [4]

i. 1
ii. 2
iii. 3
iv. Undefined

(i) Which of the problems is undecidable?

i. Whether or not a given programme will terminate
ii. The Traveling Salesman Problem
iii. Sorting an array of numbers by the index of another array
iv. Computing the Hamming distance between two strings of unequal length

[4]

(j) What is the difference between NP and NP-Complete problems? [4]

i. NP-Complete problems are more computationally complex than NP problems
ii. It is known that P = NP is true, but P =? NP-Complete remains unknown
iii. NP-Complete problems require more memory / space than NP problems, but are otherwise of the same complexity
iv. None of the above

Part B

Question 2 Operating Systems & Computer Architecture

(a) Describe why using interrupts instead of pre-allotted time-slices, tends to make operating systems more responsive. [4]

(b) What would happen if main memory / physical memory were to fill up and the computer had no configured swap memory? (That is, virtual memory is entirely RAM.) [4]

(c) Describe the differences between batch- and multi-processing systems. [3]

(d) Describe the Stored Program Concept and its importance. [4]

(e) Explain the difference between RISC- and CISC-based CPUs. [5]

Question 3 Compression

(a) Give the run-length encoded compression of the the string AAEEEEXAXEEEAAE. [5]

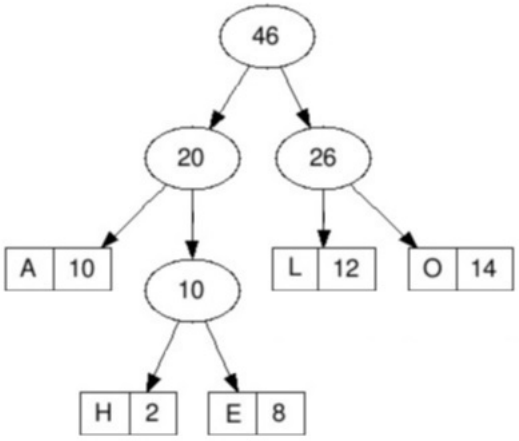
(b) Give three examples of situations where lossy compression would be preferred to lossless compression. [5]

(c) Assume you have a message `aab bba aab bba`. Show how the message would be encoded with Lempel–Ziv–Welch (LZW), starting with a dictionary containing a, b and space (' ') along with the final dictionary. Show your work. [5]

(d) This question is about Huffman trees.

i. Give an example string, that would yield the partially completed Huffman tree below. [2]

ii. Complete the codebook of the tree. [3]



Question 4 Data Storage

(a) Write down the truth table for (i) the XOR gate, and (ii) the NAND gate [4]

(b) You are given the **fractions** 100.0101 and 111.011 in binary. What is the decimal value represented? [5]

(c) What is the advantage of representing binary values in two's complement? [2]

(d) Perform the following additions by assuming values are encoded in two's complement notation. Identify whether results are truncated or when results are incorrect due to overflow. Give your results in binary.

(i) 00101+01000 [3]

(ii) 11111+00001 [3]

(iii) 01111+00001 [3]

Question 5 Theory

(a) What does it mean for an algorithm to belong to the complexity class ...

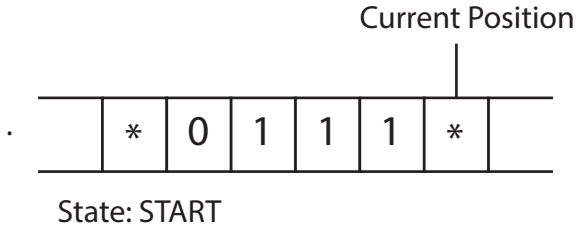
i. $\Omega(n)$? [2]

ii. $O(n)$? [2]

iii. $\Theta(f(n))$? [2]

(b) You are given the following Turing machine and tape, that uses symbols $*$, 1 and 0 (with $*$ indicating the beginning and end position of the symbols written on the tape, as seen below).

Apply the machine to the tape, showing your work, and the final tape and position. What is the functionality of this machine? [6]



Current State	Read	Write	Move	Next State
START	$*$	$*$	Left	STATE 1
STATE 1	1	1	Left	STATE 2
STATE 1	0	0	Left	STATE 1
STATE 2	1	1	Left	STATE 3
STATE 2	0	0	Left	STATE 1
STATE 3	1	0	Left	STATE 1
STATE 3	0	0	Left	STATE 1
STATE 1	$*$	$*$	No Move	HALT
STATE 2	$*$	$*$	No Move	HALT
STATE 3	$*$	$*$	No Move	HALT

(c) This question is about searching an array of sorted values.

i. Explain the binary search algorithm. [2]

ii. Given data containing x elements, how many steps would you expect binary search to take? [2]

(d) In two to four sentences each, describe ...

i. The defining feature that separates Machine Learning algorithms from other Artificial Intelligence algorithms. [2]

ii. The Turing test and its importance. [2]

 END OF EXAMINATION