codebash

OCR A Level Computer Science H446

H446/01 Computer systems

Mock examination | Set A

Time allowed: 2 hours 30 minutes
You must have: a black pen, an HB pencil and a ruler
You must not use: a calculator

Candidate name _____

Class _____ **Candidate number** _____

Instructions

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space, use the additional answer page at the end of this paper and write the question number(s) clearly.
- Answer **all** the questions.
- Where a question asks for code, you may answer in OCR pseudocode or a high-level programming language unless the question says otherwise.

Information

- The total mark for this paper is **140**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **26** pages.

For teacher use

Question	Max	Mark
1	20	
2	15	
3	16	
4	11	
5	18	
6	25	
7	18	
8	17	
Total	**140**	

Student self-assessment (complete after the mock)
What went well?
Where can I improve, and how?
Percentage: **Grade:**

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1 GrowWell makes controllers for commercial greenhouses. Each controller reads temperature and humidity sensors and switches vents and irrigation pumps on and off.

(a) Describe how the program counter (PC), memory address register (MAR), memory data register (MDR) and current instruction register (CIR) are used during the **fetch** stage of the fetch-decode-execute cycle.

[4]

(b) The controller's processor uses a Harvard architecture.

Explain why a Harvard architecture is suitable for the controller.

[2]

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(c) When the humidity rises above a set level, the humidity sensor sends an interrupt to the processor.

Describe how the processor handles this interrupt.

[5]

(d) The processor uses pipelining. The controller's program contains many conditional branch instructions.

Explain how a conditional branch instruction can reduce the benefit of pipelining.

[3]

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(e) The controller uses a RISC processor.

Explain **two** reasons why a RISC processor is suitable for this controller.

1

2

[4]

(f) The controller stores its program and its sensor logs on flash storage rather than on a magnetic hard disk drive.

Give **two** reasons why flash storage is more suitable for the controller.

1

2

[2]

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2 A museum uses a simple processor in its visitor-counting machines. Programs are written in Little Man Computer (LMC). The LMC instruction set is shown below.

Mnemonic	Instruction	Mnemonic	Instruction
ADD	Add	BRA	Branch always
SUB	Subtract	BRZ	Branch if zero
STA	Store	BRP	Branch if positive (zero or more)
LDA	Load	INP	Input
OUT	Output	HLT	End program
DAT	Data location		

(a) The following LMC program has been written.

```
 1          INP
 2          STA num
 3  loop    LDA num
 4          OUT
 5          SUB step
 6          STA num
 7          BRP loop
 8          HLT
 9  step    DAT 3
10  num     DAT 0
```

Complete the trace table for the program when the input is **7**. You may not need all the rows.

Accumulator	num	Output

[4]

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(b) Write an LMC program that:

- inputs positive whole numbers one at a time until 0 is input
- then outputs how many of the numbers input were **greater than 50**.

You may assume every number input is between 0 and 999.

[6]

(c) The museum's newer machines use a processor that supports indexed addressing.

Describe indexed addressing and state why it is useful when processing every item in an array.

[2]

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(d) The museum's newer programs are written in a high-level language and compiled.

Describe what happens during the **lexical analysis** stage of compilation.

[3]

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3 A remote weather station stores and processes its readings in binary.

(a) **(i)** Show how the denary number **-75** is represented as an 8-bit two's complement integer. Show your working.

[2]

(ii) The station calculates a change in temperature using 8-bit two's complement arithmetic:

```
01011010 - 00110111
```

Show how the subtraction is carried out by adding the two's complement of the second number. Show your working.

[3]

(b) Some readings are stored as floating point numbers using an 8-bit two's complement mantissa followed by a 4-bit two's complement exponent.

(i) Convert the following floating point number to denary. Show your working.

Mantissa	Exponent
0 1 1 0 1 1 0 0	0 0 1 1

[2]

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(ii) The following floating point number is **not** normalised.

Mantissa	Exponent
1 1 1 1 0 1 1 0	0 0 1 1

Normalise the number, using the same format. Show your working.

Mantissa	Exponent

[3]

(iii) Two readings are stored as normalised floating point numbers in the same format.

	Mantissa	Exponent
A	0 1 1 0 0 0 0 0	0 0 1 0
B	0 1 0 1 0 0 0 0	0 0 0 1

Calculate **A + B**. Give your answer as a normalised floating point number in the same format. Show your working.

Mantissa	Exponent

[3]

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(c) The station stores the state of eight sensors in a status byte. The current status byte is `10010001`.

Bit 2 (counting from 0 at the right) must be set to 1 without changing any other bit.

Complete the table to show the bitwise operation, the mask and the result, and the result of a logical shift right by 2 places applied to the **original** status byte.

Bitwise operation	
Mask	
Result of the operation	
Original byte after logical shift right by 2	

[3]

4 **(a)** Simplify the following Boolean expression. Show each stage of your working and name the law or rule used at each stage.

(A ∨ B) ∧ (A ∨ ¬B) ∧ ¬(¬A ∧ C)

[4]

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(b) A logic circuit has four inputs, A, B, C and D. Its output F is 1 for these input combinations only:

A	B	C	D	F
0	0	0	0	1
0	0	1	0	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	1	0	1

F is 0 for all other combinations.

Complete the Karnaugh map and use it to write a simplified expression for F.

AB \ CD	00	01	11	10
00				
01				
11				
10				

F =

[4]

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(c) A full adder has inputs A, B and Cin (carry in) and outputs Sum and Cout (carry out).

(i) Complete the truth table for the full adder.

A	B	Cin	Sum	Cout
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[2]

(ii) Describe how full adders are connected to add two 4-bit binary numbers.

[1]

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5 Riverside Racquets Club stores its court bookings in a single table, BOOKING. Part of the table is shown. The primary key is the combination of CourtNo, BookingDate and StartTime. Each court has one surface.

CourtNo	BookingDate	StartTime	Surface	MemberID	MemberName	MemberPhone
2	2027-03-14	10:00	Clay	M017	Ana Price	07700 900123
1	2027-03-14	09:00	Hard	M052	Tom Okafor	07700 900456
3	2027-03-14	11:00	Grass	M017	Ana Price	07700 900123
2	2027-03-15	09:00	Clay	M088	Lily Shaw	07700 900789

(a) The table is in first normal form.

Explain why the table is not in third normal form (you may refer to second normal form), and show the tables needed to store the data in third normal form. Identify the primary key and any foreign keys in each table.

[5]

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(b) Draw an entity relationship diagram for the tables in your answer to part (a).

[3]

(c) The club uses the tables in third normal form. In SQL, `ORDER BY field` sorts the results into ascending order of that field.

Write an SQL statement to list the name and phone number of each member with a booking on 2027-03-14, together with the court number and start time of the booking. The results must be in order of start time.

[4]

(d) Explain what is meant by **referential integrity**, using an example from the club's database.

[2]

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(e) Two receptionists try to book court 3 for 10:00 on the same day at the same moment.

Explain how record locking and the isolation property of ACID prevent the court from being booked twice.

[4]

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6 TicketTide sells concert tickets through its website.

(a) Describe how the layers of the TCP/IP stack are used when a customer's browser sends a request to the TicketTide web server.

[4]

(b) The request is sent across the internet using packet switching.

Describe **two** advantages of packet switching over circuit switching for this purpose.

1

2

[2]

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(c) When a customer pays, the browser and the server use asymmetric encryption to begin a secure session. They then switch to symmetric encryption.

Explain how asymmetric encryption is used here, and why symmetric encryption is then used.

[4]

(d) TicketTide stores a hash of each customer's password rather than the password itself.

Explain why.

[2]

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(e) The ticket page contains this HTML:

```
<input type="text" id="qty">
<button onclick="checkQty()">Buy</button>
<p id="msg"></p>
```

When the button is clicked, the JavaScript function `checkQty()` runs. The value entered will always be a whole number. The value in the text box can be read using `document.getElementById("qty").value`.

Write the JavaScript function `checkQty()`. It must:

- read the quantity entered in the text box
- display **Quantity accepted** in the paragraph with id msg if the quantity is from 1 to 6 inclusive
- otherwise display **Choose 1 to 6 tickets** in the same paragraph.

[4]

(f)* TicketTide wants its website to appear higher in search engine results.

Discuss how a search engine indexes web pages and uses the PageRank algorithm to order its results. In your answer, evaluate what TicketTide could do to improve its position in the results.

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[9]

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7 A hospital uses networked bedside monitors that send readings to a central server.

(a) The server's operating system uses paging, segmentation and virtual memory.

Describe the difference between paging and segmentation, and what is meant by virtual memory.

[3]

(b) The server receives four processing jobs. The table shows when each job arrives and how long it needs.

Job	Arrival time	Time needed
P	0	6
Q	1	3
R	2	1
S	4	2

The operating system uses the **shortest remaining time** scheduling algorithm. A job can be pre-empted when a new job arrives.

(i) Complete the table to show which job is running in each time unit. Each column is one time unit, starting at the time shown.

Start	0	1	2	3	4	5	6	7	8	9	10	11
Job												

[2]

(ii) State **one** disadvantage of shortest remaining time scheduling.

[1]

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(c) Patient records are stored in a hash table with 11 slots, numbered 0 to 10. The hash function is `PatientID MOD 11`. Collisions are resolved by placing the record in the next free slot, wrapping round from slot 10 to slot 0.

Show the contents of the table after these patient IDs are inserted in this order:

4521, 2913, 7372, 1418, 6059

Slot	0	1	2	3	4	5	6	7	8	9	10
PatientID											

[3]

(d)* The hospital plans to introduce software that uses artificial intelligence to decide automatically which patients a doctor should see first, based on monitor readings and patient records.

Discuss the legal, moral and ethical issues the hospital should consider before introducing this software.

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[9]

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8 StrideOn, a small start-up, is developing a fitness app. Part of the app uses the class Activity shown below.

```
 1  class Activity
 2      private name
 3      private minutes
 4      public procedure new(givenName, givenMinutes)
 5          name = givenName
 6          minutes = givenMinutes
 7      endprocedure
 8      public function getMinutes()
 9          return minutes
10      endfunction
11      public function calories()
12          return minutes * 5
13      endfunction
14  endclass
```

(a) A class Run is needed. Run inherits from Activity. It has an extra private attribute, distance, which stores the distance run in kilometres. Its constructor takes a name, a number of minutes and a distance.

Run overrides the method calories(), so that it returns the distance multiplied by 62.

Write the class Run in pseudocode or program code.

[5]

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(b)* StrideOn has four developers. The founders want users to try early versions of the app and give feedback. They expect the requirements to change as they learn what users want.

Evaluate the suitability of the waterfall, spiral and agile (including extreme programming) methodologies for developing the app. Recommend the methodology StrideOn should use.

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[12]

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END OF QUESTION PAPER

Additional answer space. If you use this page, write the question number clearly in the margin.

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