M17/4/COMSC/HP1/ENG/TZ0/XX

Diploma Programme
Programme du diplôme
Programa del Diploma

Computer science
Higher level
Paper 1

Friday 5 May 2017 (afternoon)

2 hours 10 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer all questions.
- The maximum mark for this examination paper is **[100 marks]**.

~~InOrder~~ :

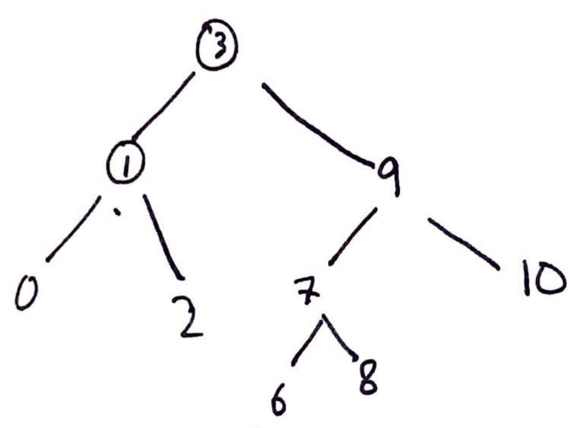
Preorder : VLR 3 x

Postorder: LRV

0, 2, 1 x

Inorder : LVR :

0, 1, 2, 3, 6, 7, 8, 9, 10



6 pages

2217–7011

ANSWER BOOKLET
LIVRET DE RÉPONSES
CUADERNILLO DE RESPUESTAS

1

$\frac{84}{100} = 84\%$.

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4 PAGES / PÁGINAS

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17 M 20 P 1 - C S H L

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Example Ejemplo 27 | 27

Example Ejemplo 3 | 3

1

Beta testing exists to confirm that a product will work in the environment it was designed for. This means that usually, a small sample of end-users will volunteer, or be selected to test a program, both for functionality and bugs. 2

2

- Human error (e.g. accidental deletion)
- Physical error (e.g. hard drive failure) 2

3

~~S~~

- New features added to the programs
- Security / bug fix. 2

6

04AX01

4 Cache memory works as an intermediary between RAM and the CPU, either external and/or internal.. As it uses SRAM, it is much faster than RAM, meaning it ~~f~~ can hold frequently used data/instructions or data/instructions that will be needed by the CPU in the ~~futer~~ future, ~~acting~~ enabling faster retrieval and reducing bottlenecks in waiting for RAM. 2

5 • The OS allocates "blocks" of memory to each of the running processes, enabling multitasking.
• These blocks are seperate, and the physical, complicated implementation are abstracted through a process called "mapping" → hence, all running processes will never exceed their own blocked memory, ~~hence causing other op~~ ~~tt~~ failure to do so would see processes crash often
• If a process requires more memory than it has available VRAM may be used by the memory management unit to prevent further crashes.

2

6 ~~Network layer~~

• Security layer: protocols for security ~~teg~~ and communication
• Physical layer: actual transmission of 0s and 1s.

1

7 · Compression: reducing file size by removing useless, or statistically redundant data ✓

·

Negative consequences:

- slow down data transmission, especially lossless data compression as data must first be compressed then decompressed ✓
- accidental deletion / removal of important data may lead to unintended consequences. 2

8 MAC: a physical identifier of a network interface card → seen by the network when a device connects to it. ✓

→ whitelisting may be used to only allow verified devices onto the network ✓

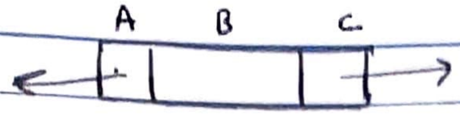
→ blacklisting may be used to prevent certain devices from joining the network.

3

↳ check up on blacklisting.

5

9



Each node on a doubly linked list has:

C· forward pointer ✓ (pointing to next element, or null

B· ~~a~~ body, (containing the contents of the element).

A· backwards pointer (pointing to ~~ay~~ the previous element, or the header).

3

body = data BOD

10

Each function call must be held on a recursive stack which is held in memory. This stack keeps getting appended to until the base case is reached. This becomes particularly memory intensive if there are many recursive function ~~call~~ calls ✓.

2

11

• act responsively and intelligently to changes in the larger environment ✓

2

• act on behalf of an owner. ✓

independently

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2

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Example / Ejemplo 27 | 27
Example / Ejemplo 3 | 3

12

(a)(i) The process of moving data from one system to another (e.g. when two businesses merge). This will often require formatting changes such as currency, dates etc.

1

(ii) • The company which is being taken over may, especially if it is international, ~~have~~ use different ~~practices~~ formatting practices to store data. This includes factors like date format and character set (e.g needing to migrate various asian character sets onto an ASCII system is problematic).

• The companies may also use different currencies in which case either these need to be converted to that of the larger company (which already has it's own problems), or new data format accomodations must be made in the existing system to accont for different currencies.

3

=> make the expansion relate directly to a concern,
e.g. => diff. character sets will lead to data incompatibility
=> data loss during transmission due to...
=> different file structure...
=> different validation rules.

4

(b) • Training employees on ~~the~~ a system which they are not already accustomed to. The employees whose system will likely be changed will ~~not~~ need re-training, particularly if their job roles, with respect to the system change.

• Type of integration of a new system. Whether the larger company decides to replace the taken-over business' system with their own, or implement an entire new system, the type of implementation will need to be considered as part of change management (e.g. direct, parallel, pilot, & phased). This ~~can~~ have drastic impacts on employee acceptance to change, and exposure to risk during integration. 4

=> costs, testing, data entry, time frame.

(c) (i) X = (A OR B) C = X AND Y
Y = (A NAND B)

A	B	X	Y	C
0	0	0	1	0
0	1	1	1	1
1	0	1	1	1
1	1	1	0	0

3

(ii) C = X AND Y
∴ C = (A OR B) AND (A NAND B)
= A XOR B.

7

~~(d) Compare the input columns (in this case the columns for A and B) to the output column(s) (in this case column C).~~

~~If each the inputs on two respe truth diagrams (for two logic tables (for two logic diagrams) match the overall output - usually the RHS column, then both logic diagrams are equivalent, despite the~~

(d) Compare the output column (in this case, column C) on two or more truth tables ~~diagrams~~ for two or more logic diagrams. If they are equivalent (presuming the input to the respective truth tables are equivalent), then the logic diagrams must be equivalent.

⇒ NOTE: the number of input variables MUST be the same for this test to be valid. If they are not, then there is absolute certainty that the logic diagrams are different.

2

1 3

(a)

DATA.hasNext()	A	A>=0	A Mod 2 = 0	B	C
TRUE ✓	2	TRUE	TRUE	{2}	{}
TRUE	4	TRUE	TRUE	{2,4}	{}
TRUE	-1	FALSE	-	{2,4}	{}
TRUE	3	TRUE	FALSE	{2,4} ✓	{3} ✓
FALSE					

3

(b) ~~ARRAY~~

```
Initialise ARRAY, LOW, HI, INDEX = -1, SEARCH
FOUND = False
loop while FOUND == False :
    MID = (HI+LOW) div 2 ×
    if ARRAY[MID] .equals(SEARCH): *
        FOUND = TRUE
        INDEX = MID
    end if
    if ~~VALUE~~ SEARCH < ~~MID~~ ARRAY[MID] then:
        HI = MID - 1
    end if
    if SEARCH > ARRAY[MID] then
        LOW = MID + 1
    end if
end loop
output INDEX
```

3

* if ARRAY[MID] == SEARCH, then:

6

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3

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Example Ejemplo 27 | 27 — Example Ejemplo 3 | 3

13

(c)
```
S = input( "enter a number)
NUMBERS.resetNext() ; COUNTER = 0
loop while NUMBERS.hasNext()
    D[COUNTER] = NUMBERS.getNext()
    COUNTER = COUNTER + 1
end loop

// linear search.
FOUND = FALSE
COUNTER1 = 0
loop while COUNTER1 < COUNTER
    if D[COUNTER1] == S then
        FOUND = TRUE
    end if
    COUNTER1 = COUNTER1 + 1
end loop
// output
if FOUND == TRUE :
    output "found"
else : output "not found"
end if .
```

exit when FOUND == ~~FALSE~~ TRUE

4

4

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04AX01

(d) Check whether the element being appended to D is GREATER than the element previously appended to D. This can be done by :

- Using a TEMP that is always the last element of the array ✓
- Comparing ~~ARRAY~~ D[COUNTER] with ~~ARRAY[~~ ~~COUNTER-1]~~ D[COUNTER-1]

Note: this check must be bypassed for the first item being added to D ✓

=> flag ×

2

1 4

(a) • Paging involves breaking memory down into smaller chunks of memory ("pages") ✓ → similarly sized.

- These pages may be "swapped" into secondary storage if the need for VRAM arises. ✓

1 → research.

(b) • latest operating systems will likely be ~~ozeo~~ optimised for newer systems → likely it's performance will be reduced as it may not have enough RAM to run it's self, let alone other processes.

- Multimedia gaming will involve many peripherals, each requiring interrupts for CPU time. With limited RAM and processing capacity, severe bottlenecks may appear if too much input occurs.

3

- Multimedia games are often very memory-intensive, and require vast amounts of RAM to function. The gaming experience may be reduced if VRAM needs to be used to extend the limited 1GB, or might even crash.

2

(c) • The player could use the stack to "undo" their player's actions, if this was a necessary feature of the game.
- This way, using LIFO, the most recent action may be accessed first to undo. 2

(d) loop while S.isEmpty() == FALSE
    TEMP = S.pop()
    Q.enqueue(TEMP)
end loop

4

~~=> NOTE: this algorithm is~~

(e) The number of elements pertaining to that queue need not be known. This may be particularly important if elements are continually added to the queue during gameplay, and it is impossible to know how many elements will eventually be added.

=> specifics : allocating / deallocating memory..

15

(a) $24 \times 7 = 168$

∴ 168 readings were taken. 1

(b)

	00:00	01:00	... →
MON			
TUE			
WED			
⋮ ↓			

Row = day
Column = time

```
Initialise A[7][24]
WEATHER.resetNext()
DAY = 0
 HOUR = 0
 loop while WEATHER.hasNext()
     TEMP = WEATHER.getNext()
     A[DAY][HOUR] = TEMP
     HOUR = HOUR + 1
     if HOUR mod 24 == 0 then
         DAY = DAY + 1
         HOUR = 0
     end if
 end loop
```

4

5

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Example / Ejemplo 27 [27] Example / Ejemplo 3 [3]

15

(c)
```
// search for highest temp
DAY = 0
TIME = 0
HIGHEST = -9999 ; INDEX1 = -1 ; INDEX2 = -1
loop while DAY < 7
    if A[DAY][TIME] > HIGHEST then
        HIGHEST = A[DAY][TIME]
        INDEX1 = DAY
        INDEX2 = TIME
    end if
    TIME = TIME + 1
    if TIME mod 24 == 0 :
        DAY = DAY + 1
        TIME = 0
    end if
end loop
output convert(INDEX1)
```

=> note: subprocess convert() on following page.

6

6

04AX01

```
begin convert(INDEX)
    if INDEX == 0:
        return "Monday"
    end if
    if INDEX == 1:
        return "Tuesday"
    end if
    if INDEX == 2:
        return "Wednesday"
    end if
    if INDEX == 3:
        return "Thursday"
    end if
    if INDEX == 4:
        return "Friday"
    end if
    if INDEX == 5:
        return "Saturday"
    end if
    if INDEX == 6:
        return "Sunday"
    end if
end convert.
```

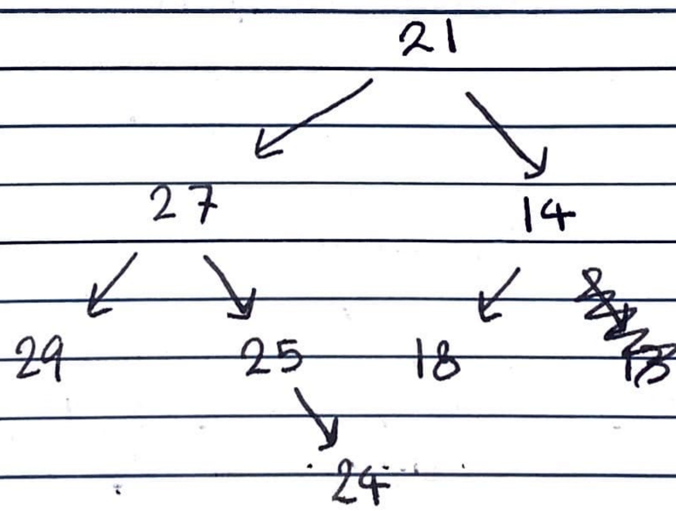
=> well, this was pointless.

(d) ⇒ A binary ~~tree~~ search tree can be used, where each subtree ~~is~~ contains values more ~~than~~ than the root node, and vice versa with the right subtree.

⇒ When reading in the values, duplicates may be ignored (so that the binary search tree contains all unique values).

⇒ Once data is read in, an "inorder" search will reveal all temperatures in descending order. Note: the left and right subtrees were REVERSED in step #1 → hence inorder returns descending, not ascending. 3

EA. EXAMPLE



Inorder : 29, 27, 25, 24, 21, 18, 14, ~~[illegible]~~

1 6 (a) An embedded system refers to a control system that exists within the system being controlled. In the example of the electric motor, the motor it's self will contain the ~~sensors, a~~ sensor(s), microprocessor and actuator to control the speed.

=> dedicated/specific function 1

(b) A feedback system will always aim to reach a desired value. ~~The~~ This value will usually be user-defined, and with the use of feedback each time the sensor reachs a new value, ~~the previous~~ it should be nearer to the desired value. 2

emphasise output -> input.

(c) 1) The user will set a desired value (probably in rotations-per-minute RPM) in the microprocessor.

2) A sensor will sense how many RPMs ~~at~~ the electric motor is currently spinning at. This ~~RPM~~ RPM sensor may use technology like light gates or torque sensors, creating an analogue output. As the system is embedded, this sensor will intuitively be a part of the motor's internal structure.

3) The analogue reading will need to be converted to a digital electronic signal, using an ADC, which is then sent to the microprocessor.

4) The ~~p~~ microprocessor will complete calculations to convert the value into RPM -> a light gate reading, for example, must be converted using ~~parameters like circumference~~ complex calculations.

3

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(5)

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Example / Ejemplo 27 [27] Example / Ejemplo 3 [3]

16 (C - contd.)

5) The calculated RPMs are compared with the desired RPM set by the user in step 1. A signal to speed up or slow down the motor are then sent to ~~a~~ a DAC (NOTE: a max RPM should be accounted for as well)

6) The DAC converts the electronic speed/slow down signal to an analogue signal which is then sent to ~~and~~ the actuator (the electric motor it's ~~a~~ self). The actuator will either speed up or slow down (or remain the same) according to the analogue signal.

6

→ be more concise

(d) The described control system is ~~decen~~ centralised as the monitor device/panel will contain it's dedicated operating system specifically designed ~~for~~ for the power station. All it's components (sensors and output transducers) will be situated where required to ensure the dedicated OS can see and control all the required hardware within

6

04AX01

the power plant.

- When the sensors require ~~..~~ processing time, they will send an interrupt to the central processor.
- The interrupt will be passed to an ~~interrupt~~ interrupt handler, which will save the state of the ~~..~~ current processes, and prioritise the device that sent the interrupt.
- As the processor has a dedicated OS, it will be able to prioritise inputs (e.g. an emergency device will ~~alway~~ always the priority).

- The sensors participating in a feedback loop will likely to use the central OS to control actuators, such as coolant pumps having a desired temperature - it is likely that these important devices will also have embedded decentralised back-ups.

3