CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2013 series

9691 COMPUTING

9691/31 Paper 3 (Written Paper), maximum raw mark 90

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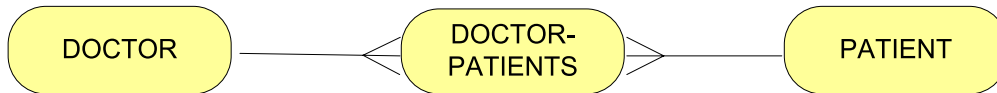
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1 (a) (i) Many-to-many [1]

(ii) E-R diagram

DOCTOR —< Treats >— PATIENT

[1]

(iii)

DOCTOR ———< DOCTOR-PATIENTS >——— PATIENT

Link table drawn [1]

2 × one-to-many relationships [1]

primary key in DOCTOR links to foreign key in link table [1]

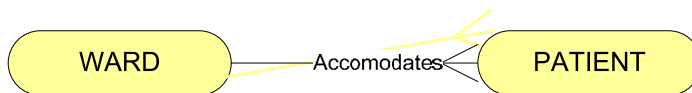primary key in PATIENT links to foreign key in link table [1]

No mention of foreign key scores max 1 for final two points …

(b) (i) One to many [1]

(ii) E-R diagram

WARD —< Accomodates >— PATIENT

[1]

(c) The primary key of table WARD - WardName [1]

Matches to WardName in the PATIENT table [1]

(d) Displays a 'list' of the ward**s** (names) [1]
R. <u>Number of</u> wards
Which has unoccupied beds available [1]
R. the condition explained using the attribute identifiers

[Total: 12]

2 **(a)** Meta language

Rules // Grammar (which describe a high level programming language / protocol specification)

The <u>syntax</u> or <u>structure</u> of all program statements [2]

(b) (i) A <u>rule </u>which is defined in terms of itself

NB Not 'procedure' ... [1]

(ii) Rule 3 [1]

(iii)

Expression	Valid / Invalid	Rules used	
0	Invalid	1 , 4	4, 2
"1"	Valid	4 then combination of 1,2 and 3	combination of 1,2 and 3, end with 4
"001"	Valid	4 then combination of 1,2 and 3 AND rule 3 used more than once	combination of 1,2 and 3 with rule 3 used more than once, ends with 4

[1 + 1]

[1 + 1]

[1 + 1 + 1]

(c) `<Dollar> ::= $`

`<BinaryString> ::= <Paren theses><Binary><Parentheses>`

`|<Parentheses><Dollar><Binary><Parentheses>`

Note: credit alternative answers which use an intermediate expression [2]

[Total: 13]

3 (a) Direct addressing / LDD [1]

(b) Indexed addressing / LDX [1]

(c) Annotation to show 203 used as a forwarding address [1]

Accumulator contains 38 [1]

(d)

ACC	Memory location		Output
	109	110	
19 (must be the first column entry)		0	
20	20		
37			
38			
58		**58 /ft**	**58 /ft**

1 mark for each of the emboldened numbers in the correct column and sequence [MAX 5]

(e) Labels added to a (symbol) table // creates a list of addresses [1]

Labels are later looked up to determine the actual address / Assembler must allocate
addresses to labels [1]

Mnemonic looked up to give binary code/machine code [1]

Macro instructions are expanded into a group of instructions [1]

The software makes two passes through the source program [1]
[MAX 3]

[Total: 12]

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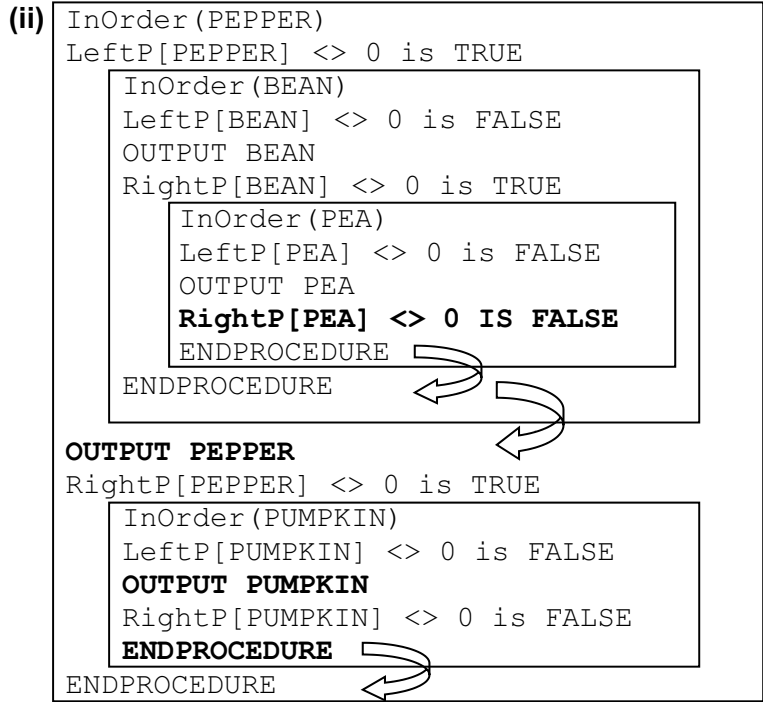4 (a) (i) Dynamic data structure changes <u>size</u> ...   [1]

At execution time   [1]

// A static data structure has a fixed <u>size</u>   [1]
                                                                                               [MAX 2]

(ii) Dynamic data structure matches size to data requirements   [1]

Takes <u>memory</u> from heap as required //
returns <u>memory</u> as required (following node deletion)   [1]

There is no wasted <u>memory</u> space / makes efficient use of <u>memory</u>   [1]
                                                                                               [MAX 1]

(b)
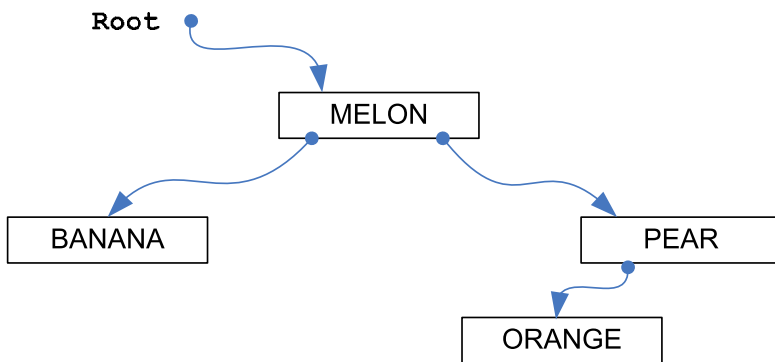
Root is MELON1   [1]
Correct left subtree   [1]
Correct right subtree   [1]

(c) **(i)** InOrder(LeftP[Root]) // InOrder(RightP[Root])   [1]

(ii)
```
InOrder(PEPPER)
LeftP[PEPPER] <> 0 is TRUE
      InOrder(BEAN)
      LeftP[BEAN] <> 0 is FALSE
      OUTPUT BEAN
      RightP[BEAN] <> 0 is TRUE
            InOrder(PEA)
            LeftP[PEA] <> 0 is FALSE
            OUTPUT PEA
            RightP[PEA] <> 0 IS FALSE
            ENDPROCEDURE
      ENDPROCEDURE

OUTPUT PEPPER
RightP[PEPPER] <> 0 is TRUE
      InOrder(PUMPKIN)
      LeftP[PUMPKIN] <> 0 is FALSE
      OUTPUT PUMPKIN
      RightP[PUMPKIN] <> 0 is FALSE
      ENDPROCEDURE
ENDPROCEDURE
```
[4]

(iii) The procedure has to backtrack/unwind from the current call   [1]

To return to the calling procedure // return to the addresses from which called   [1]
                                                                          [MAX 1]

[Total: 12]

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5 **(a)** **(i)** *The keyword table contains:*

all the language keywords/reserved words + <u>with a matching token</u>　　　[1]

The symbol table stores:

each identifier/variable found (and its data type)　　　[1]

the values of all constants　　　[1]

the upper and lower bounds of arrays　　　[1]
[Mark as: 1 + 1]
[MAX 2]

(ii) Keywords are looked up in the keyword table　　　[1]

Keywords are converted to tokens　　　[1]

Identifiers/Variables are looked up in the symbol table　　　[1]

Identifiers/variables are converted to actual addresses　　　[1]
[MAX 2]

(iii) The white space // redundant characters are removed　　　[1]

Illegal identifier names are identified　　　[1]
[MAX 1]

(b) **(i)** *Optimising*
Code will <u>execute/run/process</u> faster　　　[1]
Code requires less memory
Reduce the amount of code　　　[1]

R. 'more efficient' <u>// removes redundant code</u>

(ii) Any example where the code could be changed　　　[1]
E.g. input of a list of number to compute the total (There would be no need to store the numbers first)

[Total: 8]

6 (a) (i) *Batch processing*

All input/processing/output is performed as a batch [1]

There may be a time delay before processing [1]

All the (data) is processed together/at the same time [1]

There is no user involvement [1]

Processing will not start until all the data is available/collected [1]
[MAX 3]

(ii) *Interactive processing*
The user is constantly interacting directly with the processor [1]

(b) (i) PROG23 [1]

(ii) Any two from PROG17, PROG44 and 45 [1]

(iii) Jobs do not have to occupy a continuous block of memory [1]

Move all jobs still loaded in the partition so that when a job completes there is only ever one 'hole' remaining [1]

Make the partitions of variable size [1]

Allow only part of a program to be initially loaded // paging //segmentation [1]
[MAX 2]

(c) Operating system // specific modules e.g. interrupt handler/scheduler, etc [1]

device drivers [1]

<u>examples</u> of system software or utilities [1]

R. "System software" and "Utilities" [MAX 2]

(d) Runnable // Ready [1]

the program is capable of being run and is awaiting its turn for the use of the processor [1]
R. explanation of (only) 'ready to use the processor'

Suspended // Blocked [1]

the program is unable use the processor/ or by example, the job is currently using an I/O device [1]
Note: the explanation marks are not dependant on the correct name

[Total: 14]

7 (a) (i) 2 [1]

(ii) COMPILE ERROR // reporting an error [1]

(iii) 0 [1]

(iv) COMPILE ERROR // reporting an error [1]

(b) (i) `FUNCTION StringFound(ThisArray : STRING , UBound : INTEGER,`
`ThisValue : STRING)  RETURNS BOOLEAN`

Mark as follows:
`FUNCTION StringFound` [1]

`'Array variable' : STRING data type` [1]

`ThisValue : STRING // 'UBound' : INTEGER` [1]

(ii) Numbered 1 – Parameter identifiers labelled [1]

Numbered 2 – `(RETURNS)  BOOLEAN` [1]

(iii) `CityWasFound = StringFound(CapitalCities, 300, "LISBON")`

Mark as follows:
`CityWasFound = StringFound( ...` [1]

"LISBON" is the correct position (f/t from 'their' <u>function header</u>) [1]

[Total: 11]

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Question 8

(a) (i) Example [1]

   (ii) *two of the points explained ...*

     moveable …
     mechanical device ...
     sense its surroundings ... ... clear example // temperature, etc.
     controlled by a program ... [MAX 2]

(b) Robotic arm [1]

  Explained in the context of 'their' robot [1]

  Sensor [1]

  Capture data [1]

  Actuator // Motor [1]

  To drive various motors to perform the robot's movement [1]

  Microprocessor [1]

  To process the various inputs and execute the control program [1]

  Camera [1]

  To capture images [1]

  Memory [1]

  To temporarily store input data [1]

  Speaker [1]

  To provide audio output [1]
                     [MAX 4]

(c) real-time [1]

[Total: 8]