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1 (a) (i) \[a + b + 7 \]
(ii) \[2 + 3 \times 5 + 1 \]

2nd mark for completely correct

(b) evidence for 12 and 4

(c) (i) In-order traversal // (Traverse each subtree in the order) left-root-right

(ii) \[E \times M \times c \times 2 \times^*\] =

(iii) Post-order traversal // (Traverse each subtree in the order) left-right-root

[Total: 8]

2 (a) Security is improved/better managed
Different users can have different ‘views’ of/access to data
Program-data independence // Changing a field does not require an applications program re-write
Queries and reports quickly produced
Reduced data duplication/redundancy
Reduced data inconsistencies
Better managed data integrity/data validation // Validation code does not need to be present in all applications programs
If implemented with a DBMS it will allow concurrent access to the database

(b) (i) many runners compete in many races // many-to-many // M:m

(ii) one club organises many races // one-to-many // 1:M

(c) (i) Intermediate table (not labelled RUNNER, RACE, CLUB, etc.)
2 X one-to-many relationship

(ii) Primary key of RACE/Primary key RaceDate
// Primary key of RUNNER/Primary key MemberID
Is used as a foreign key in the link table

(d) (i) (Yes) since there is a not a repeated group of attributes

(ii) (Yes) Since there is only a single attribute primary key // there are no partial dependencies // all non-key attr. are dependent on the primary key
(iii) There are dependent non-key attributes // ClubAddress is dependant on ClubName [1]

(iv)  \text{RUNNER(MemberID, RunnerName, RunnerDOB, ClubName)}

\text{CLUB(ClubName, ClubAddress)}

If primary key not indicated penalise once only

(e) Avoids data duplication/repeated data
Avoids data inconsistencies
Ensures data integrity

(f)  \text{SELECT RaceDate, OrganisingClubName}
\text{FROM RACE}
\text{WHERE RaceDate > #01/01/2013# AND Distance < 10}

Do not penalise imprecise syntax in the WHERE line

[Total: 19]

3 (a) a single processor
program consists of a sequence of stored instructions
Instructions + data
are stored (in a continuous block) of primary/main memory
instructions are executed in sequence

(b) (i) 122
(ii) 5C
(iii) Fewer digits used to represent any number // long string difficult to interpret
Les less likely to make a mistake when copying/converting a digit string
Easy to convert from binary to hex (vice versa) than binary to denary

MAX 2

MAX 1
(c) (i) 16 bits

(ii)

<table>
<thead>
<tr>
<th>Fetch stages</th>
<th>Special purpose registers</th>
<th>Busses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PC</td>
<td>MAR</td>
</tr>
<tr>
<td>MAR ← [PC]</td>
<td>7A</td>
<td></td>
</tr>
<tr>
<td>PC ← [PC] + 1</td>
<td>7B</td>
<td></td>
</tr>
<tr>
<td>MDR ← [MAR]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIR ← [MDR]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the buses column penalise once for any additional incorrect ticks MAX 5

(d)

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Register</th>
<th>Accumulator (ACC)</th>
<th>Index Register (IX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIX 200</td>
<td>Accumulator (ACC)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>LDD 201</td>
<td>216</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDI 201</td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDX 201</td>
<td>63</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 per contents [4]

[Total: 15]

4 A class is the design/blueprint/template (from which objects are later created) [1]
A class consists of properties/attributes and methods/procedures/functions [1]

An object is an instance of a class [1]
An object must be based on a class definition [1]
Many objects can exist for the same class [1]

MAX 3
(b) The class diagram includes:

- **BOOK + RECORDING** subclasses
- **FILM + MUSIC** subclasses of **RECORDING**
- Recognised notation for inheritance

**RESOURCE** class
- **Title** : STRING
- **OnLoan** : BOOLEAN

**BOOK** class
- **Author** : STRING

**FILM** class
- **RunningTime** : INTEGER

**MUSIC** class
- **NoOfTracks** : INTEGER

**RECORDING** class
- **ReleaseDate** : DATE

MAX 8

(c) *Encapsulation*
- Combining together of an object’s properties and the methods
- Restricts the programmer’s access to the object’s data // Hiding of data
- Data values can only be read/written using the methods of the class

[Total: 13]

5 (a) Last item added is the first item to leave // or equivalent wording
- R. LIFO

(b) (i) **HARRIS**
- 17843

(ii) PROCEDURE PushJob
- IF **TopOfStack** = 1000
- THEN
- OUTPUT “Stack is already FULL”
- ELSE
- INPUT NewUserID
- INPUT NewReferenceNo
- **TopOfStack** ← **TopOfStack** + 1
- SpoolJob[**TopOfStack**].JobReference ← NewReferenceNo
- SpoolJob[**TopOfStack**].UserID ← NewUserID
- ENDIF
- ENDPROCEDURE
(c) PROCEDURE PopJob
   IF TopOfStack = -1
   THEN
      OUTPUT “There are no print jobs waiting”
   ELSE
      PROCESS SpoolJob[TopOfStack]
      TopOfStack ← TopOfStack – 1
   ENDIF
ENDPROCEDURE

(d) May not be a fair way to order the outputs
Some print jobs may wait a long time before printing
Better choice is a queue
Since first print job sent will be the first to be output // First in – First out

MAX 3

[Total: 13]

6 (a) (i) File allocation table
    Storage space is organised into allocation units/clusters
    There is a record for each allocation unit/cluster
    Records are marked as either used // available // unusable
    Allocation units/clusters for each file are maintained as a linked list
    There is a separate FAT for each logical volume/partition

MAX 2

(ii) Allocation units allocated to the file …
    Have their record status changed to ‘available’

(b) (i) 1. Save the contents of the program counter on the stack
        2. Also save contents of all other registers
        3. Load and run the appropriate Interrupt Service routine (ISR)
        4. Restore all other registers
        5. Restore the Program Counter
        6. Continue execution of the interrupted process

(ii) Disable interrupts of a lower priority (before step 1)
    Check for receipt of interrupt (during Step 3)
    If interrupt received before completion of step 3, go to step 1
      // Save the registers for the current process – the ISR
    Compare priority with level below which interrupts already disabled
    Enable interrupts of a lower priority (after Step 5)

MAX 3

[Total: 12]
7 (a) Possible answers include:
- Encryption of email traffic
- Email data if intercepted cannot be read
- Encryption of passwords
- Designed to prevent unauthorised access

(b) *Encryption algorithm* ...
The calculation/process/sequence of steps for converting the message text/data

*Encryption key*
A number/parameter used by the encryption algorithm // e.g. the displacement shift for transposing characters

(c) *Asymmetric encryption* ...
Private key is known only to the owner//Public key is known by both parties
Public and private keys are obtained from the purchase of a digital certificate //
Keys are generated at the start of a secure (e.g. web or email) session

EITHER ...
- Sender will use their own private key
- Receiver decrypts using the sender’s public key

OR ....
- Sender uses the recipient’s public key
- Receiver decrypts using their own private key

(d) *Authorisation* ...
Different permissions granted to different users
Restricted access to certain data files/directories/physical devices
User IDs

*Authentication*
Passwords
(Digital) signature // (Digital) certificate
Use of biometric data and methods

[Total: 11]
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1 (a) (i) \( x \cdot y - 5 \) / \[1\]
(ii) \( \frac{2}{4} a \cdot 1 + \) \[1\]
\[2^\text{nd} \text{mark for completely correct} \]  

(b) Evidence for 12 or 6  
Answer 2  
[1]

(c) (i) In-order traversal // (traverse each subtree in) the order left-root-right  
[1]
(ii) \( 1 2 / b * h * \)  
[1]
(iii) Post(-order) traversal // (Traverse/visit each subtree in) the order left-right-root  
[1]

[Total: 8]

2 (a) Security is improved/better managed  
Different users can have different ‘views’ of/access to data  
Program-data independence  
// Changing a field does not require an applications program re-write  
Queries and reports quickly produced  
Reduced data duplication/repetition/redundancy  
Reduced data inconsistencies  
Better managed/or similar data integrity/data validation  
// Validation code does not need to be present in all applications programs  
If implemented with a DBMS it will allow concurrent access to the database  
MAX 3

(b) (i) Many product can be supplied by one supplier // many-to-one // M:1  
[1]
(ii) Many products appear on many orders // many-to-many // M:M  
[1]

(c) (i) Intermediate table (not labelled PRODUCT, ORDER, etc.)  
2 X one-to-many relationship  
[1]
(ii) Primary key of PRODUCT/Primary key ProductID // Primary key of ORDER  
Is used as a foreign key in the link table  
[1]
(d) (i) (Yes) since there is a not a repeated group of attributes [1]

(ii) (Yes) since there is only a single attribute primary key
// there are no partial dependencies
// all non-key attr. are dependent on the primary key [1]

(iii) There are dependent non-key attributes //
SupplierName and/or SupplierTelNo are dependent on SupplierID [1]

(iv) PRODUCT(ProductID, ProductDescription, RetailPrice, SupplierID)
SUPPLIER(SupplierID, SupplierName, SupplierTelNumber) [1]

If primary key not-indicated penalise once only

(e) Avoids data duplication/avoids repeated data // reduces data redundancy [1]
Avoids data inconsistencies [1]
Ensures data integrity [1]

MAX 2

(f) SELECT CustomerID, OrderNo
FROM ORDER
WHERE OrderDate = #15/01/2014# AND PaymentMethod = ’D’
(AND ISPaid = TRUE) [1]

Do not penalise imprecise syntax in the WHERE line

[Total: 19]

3 (a) Temporary storage location
   general purpose/special (purpose)
   Inside the (micro)processor [1]

   MAX 2

(b) (i) 3C [1]

(ii) 271 [1]

(iii) Fewer digits used to represent any number // long string difficult to interpret [1]
Less likely to make a mistake when copying/converting a digit string [1]
Easy to convert from binary to hex (vice versa) than binary to denary [1]

R. Hex is easier to understand/write MAX 1
(c) (i) 2 bytes

(ii) The Program Counter contains 30

\[ \text{MAR} \leftarrow [\text{PC}] \]  // MAR given the contents of the PC
\[ \text{PC} \leftarrow [\text{PC}] + 1 \]  // PC is incremented
\[ \text{MDR} \leftarrow [\text{MAR}] \]  // The contents of the address in MAR is copied to MDR
\[ \text{CIR} \leftarrow [\text{MDR}] \]  // The contents of MDR are copied to CIR

OR ... If the candidate’s answer uses the suggested instruction:

The Program Counter contains 30
PC contents are copied to MAR
PC contents are incremented to 31
The contents of address 30 / 2150 is copied to MDR
MDR contents / 2150 is copied to CIR

MAX 5

(d)

\[
\begin{array}{c|c|c|c}
\text{ACC} & \text{IX} & \text{Memory} & \text{Address} \\
\hline
13 & 1 & 13 & 0 \\
\hline
(13) & 2 & 13 / \text{ft} & 27 \\
\hline
14 & 3 & & \\
\hline
27 & 22 & & \\
\hline
49 & 4 & & \\
\end{array}
\]

[Total: 15]
4 (a) A class is the design/blueprint/template (from which objects are later created) [1]
A class consists of properties/attributes and methods/procedures/functions [1]
An object is an instance of a class [1]
An object must be based on a class definition [1]
Many objects can exist for the same class [1]

MAX 3

(b) The class diagram includes:

ADMIN + PROJECTSTAFF subclasses of EMPLOYEE [1]
PROGRAMMER + TECHAUTHOR subclasses of PROJECTSTAFF [1]

Recognised notation for inheritance [1]

EMPLOYEE class FullTimeIndicator : BOOLEAN // CHAR [1]
Salary(Grade) : any except DATE/BOOLEAN [1]

ADMIN class Department : STRING [1]

PROJECTSTAFF class ProjectTeam : STRING [1]

PROGRAMMER class ProgrammingLanguage : STRING [1]

TECHAUTHOR class SoftwareSpecialism : STRING [1]

NB: check for any attribute repeated in a child class. If present score 0.

MAX 8

(c) Encapsulation
Combining together of an object’s properties/data and the methods [1]
Restricts the programmer’s access to the object’s data // provides for ‘data hiding’ [1]
Data values can only be read/written using the methods of the class [1]

MAX 2

[Total: 13]
5 (a) Boolean
Flags when the input name is found

//Serial search algorithm
INPUT SearchName
IsFound ← FALSE
Index ← 1

REPEAT
  IF Customer[Index] = SearchName
     THEN
     IsFound ← TRUE
     OUTPUT “FOUND” at position Index
  ELSE
     Index ← Index + 1
  ENDIF
UNTIL (IsFound = TRUE) OR Index=101 / >100

IF IsFound = FALSE // Index = 101/>100
     THEN
     OUTPUT “Customer name was NOT FOUND”
ENDIF

(b) 50 // half the number of customers

(c) (i) Items in order
(ii) The function makes a call to itself (in two places)
(iii) BinarySearch (Surname, “Hwang”, 1, 11)

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
<th>Middle</th>
<th>RETURNS...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>(5)</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

[Total: 14]
6  (a)  

Mark as follows ...

-126 binary  
-5 binary  
Correct final pattern (f/t from their -126 and -5)  
Answer is incorrect since outside range possible represented with single byte // answer overflows// final bit pattern is NOT -131  

(b)  (i)  Mantissa: +13/16  
      Exponent: +3  
      Number: +13/16 \times 2^3 // evidence of shifting the mantissa three places  
       6.5  
       MAX 3  

(ii) The mantissa starts with the digits 01  
     // the first two bits in the mantissa are different  

(iii) More bits used for the mantissa will result in greater accuracy/precision  
     More bits used for the exponent will result in larger range of numbers  

[Total: 10]
7 Possible answers include:

(a) Encryption of email traffic
   Email data if intercepted cannot be read

   Encryption of passwords // logging-in to “something”
   Designed to prevent unauthorised access

   Hospital patient records
   Will safeguard the privacy/confidentially of data

(b) Plain text
   The (message) text/data/ before encryption // unaltered text/original text
   Cipher text
   The (message) text after encryption

(c) Symmetric encryption
   The plain text/data is encrypted using ...
   An encryption key
   Decryption is done using the same/ or by implication key ……
   and a matching decryption algorithm/process

(d) Authorisation
   Different permissions granted to different users
   Restricted access to certain data files/directories/physical devices
   User IDs

Authentication
   Passwords
   (Digital) signature // (Digital) certificate
   Use of biometric data and methods

[Total: 11]
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1 (a) (i) \( p \ q + 2 \)

(ii) \( 6 \ 3 \ 5 \ p \ * + / \)

2nd mark for completely correct

(b) Evidence for 6 and 2
Final answer 3

(c) (i) In-order traversal // (Traverse all subtrees in the order) left-root-right

(ii) \( A \ 3.14 \ r \ 2 \ ^* = \)

(iii) Post-order traversal // (Traverse all subtrees in the order) left-right-root

[Total: 8]

2 (a) Security is better managed
Program-data independence // Changing a field does not require an applications program re-write
Better managed data integrity/data validation // Validation code does not need to be present in all applications programs
Queries and reports quickly produced
If implemented with a DBMS it will allow concurrent access to the database
Reduced data duplication // data inconsistencies

MAX 3

(b) (i) many cars are hired to many customers // many-to-many // M:m

(ii) one depot has based there many cars // one-to-many // 1:M

(c) Link table shown...
2 X one-to-many relationships

(d) (i) (Yes) since there is a not a repeated group of attributes

(ii) (Yes) Since there is only a single attribute primary key // There are no partial dependencies // All no-key attributes are dependant on the primary key

(iii) Two of the non-key attributes are dependant // DepotManager and DepotAddress are dependant on DepotID
(iv) \[ \text{CAR}(CarRegistrationNo, CarMake, CarModel, HirePriceCode, DepotID) } \]
\[ \text{DEPOT}(DepotID, DepotAddress, DepotManager) \]

If the primary key is not indicated, penalise once only

(e) avoids data duplication
   avoids data inconsistencies

(f) \[ \text{SELECT HireID, CustomerID} \]
\[ \text{FROM HIRE} \]
\[ \text{WHERE CustomerID = 'C674' AND CarRegistration = '456431'} \]

[Total: 19]

3  (a) Temporary storage location
   Inside the (micro)processor

(b) (i) 127
(ii) 123
(iii) less digits used to represent any number
      Less likely to make a mistake when copying/converting a digit string
      Easy conversion between binary and hex (vice versa) than binary and denary

MAX 1

(c) (i) 2 bytes
(ii) \[ \text{MAR} \leftarrow [PC] \quad \text{// MAR given the contents of the PC} \]
\[ \text{PC} \leftarrow [PC] + 1 \quad \text{// PC is incremented} \]
\[ \text{MDR} \leftarrow [[MAR]] \quad \text{// The contents of the address in MAR is copied to MDR} \]
\[ \text{CIR} \leftarrow [MDR] \quad \text{// The contents of MDR are copied to CIR} \]

OR, if the candidate uses the suggested instruction ....
\[ \text{MAR} \leftarrow 40 \quad \text{// PC contents of 40 are copied to MAR} \]
\[ 7324/\text{The contents of address 40 is copied to the MDR} \]
\[ \text{PC} \quad \text{is incremented from 40 to 41} \]
\[ 7324/\text{contents of location 40 is copied to CIR} \]

MAX 5
(d)

<table>
<thead>
<tr>
<th>Memory address</th>
</tr>
</thead>
<tbody>
<tr>
<td>153</td>
</tr>
<tr>
<td>160</td>
</tr>
<tr>
<td>151</td>
</tr>
<tr>
<td>152</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>150</td>
</tr>
<tr>
<td>151</td>
</tr>
<tr>
<td>23</td>
</tr>
<tr>
<td>36</td>
</tr>
<tr>
<td>36</td>
</tr>
<tr>
<td>151</td>
</tr>
</tbody>
</table>

[Total: 15]
4 (a) Rules are: 15 and 25

(b) (i) Who = zhen
Who = kong

(ii) false

(iii) false

(c) (i) has_licence(X) AND passed_theory_Test(X) AND
passed_driving_test(X, motorbike)

each clause scores 1
use of two AND operators

(ii)

9 ?- passed_theory_test(Who), not(passed_driving_test(Who, car)),
not(passed_driving_test(Who, motorbike)).

Who = yin ;

OR (using the anonymous variable) ...

10 ?- passed_theory_test(Who), not(passed_driving_test(Who, _)).

Who = yin ;

(d) has_licence(ho) returns TRUE  // clause 11
age(ho, A) returns 15  // A=15
minimum_age(motorbike, L) returns L=15  // clause 2
A >= L returns FALSE
able_to_drive(ho, motorbike) returns false

MAX 3

[Total: 12]
5 (a) BOOLEAN
Flags when the book title is found
STRING (for SearchBook)

OPENFILE Book.txt for Output
INPUT SearchBook
IsFound ← FALSE

REPEAT
READ next book data value and assign to NextBook
IF NextBook = SearchBook
    IsFound ← TRUE
    OUTPUT “FOUND”
ENDIF
UNTIL (IsFound = TRUE) OR EOF

IF IsFound = FALSE // NOT IsFound
    THEN
        OUTPUT “Book title was NOT FOUND”
    ENDIF
CLOSEFILE

(b) The search will read on average 125 records

(c) (i) The data items must be in order
      (ii) The function makes a call to itself (in two places)
      (iii) BinarySearch(BookTitle, “Tortoise Care”, 1, 11)
            High < Low is FALSE
            Middle = 6
            BookTitle[6] > “Tortoise Care” is FALSE
            BookTitle[6] < “Tortoise Care” is TRUE
            BinarySearch(BookTitle, “Tortoise Care” 7, 11)

            High < Low is FALSE
            Middle = 9
            BookTitle[9] > “Tortoise Care” is FALSE
            BookTitle[9] < “Tortoise Care” is TRUE
            BinarySearch(BookTitle, “Tortoise Care” 10, 11)

            High < Low is FALSE
            Middle = 10
            BookTitle[10] > “Tortoise Care” is FALSE
            BookTitle[10] < “Tortoise Care” is FALSE
            RETURN 10

ENDFUNCTION
ENDFUNCTION

[Total: 16]
6 (a)  *Boot file* ...

- Stored in the BIOS/ROM  
  The initial sequence of instructions run when the computer is powered on  
  Information on which drive to look for the operating system  
  Triggers the loading of the operating system  

MAX 3

(b)  (i)  *An interrupt*  
- A signal from some device  
- To indicate that some event has occurred  
- The device is seeking the attention of the processor  

MAX 1

(ii)  *Hardware generated* ...
- Reset  
- Multiprogramming ‘end of time slice’  
- Other valid answers ...

*Software generated* ...
- Division by zero error  
- Other valid answers ...

MAX 2

(c)  *Running*  
- The process currently has use of the processor  

*Ready*  
- The process would like to use the processor when the current process releases the processor  

*Suspended*  
- The process cannot currently use the processor// or by example, the job is currently using an I/O device  

[Total: 9]
7 (a) (i) 

Firewall
Hardware or software to control unauthorised access to a private network

Modem
Hardware used to convert analogue signals to digital signals (and vice versa)

Switch
Hardware used to connect nodes in a circuit switching network

Network Interface card
Circuit board which connects the computer to a network

Router
Device to direct packets across a packet switched network

Bridge
Device used to connect two bus network segments to allow communication between all nodes

(ii) Network (Interface) card [1]

(b) (i) Copper wire/coaxial/twisted pair
Wire conducts electricity // changing current denotes different signals
Optic fibre cabling
Separate fibres used for separate signal
Data travels very fast
Signal transmitted as light pulses/travels at the speed of light
Radio/Microwave signals
Wireless communication // allows for mobile communication
Mark as 2 × 2 MAX 4

(ii) Maximum possible distance
Speed of communication // data transfer rate [1]

[Total: 11]