HWA CHONG INSTITUTION C2 PRELIMINARY EXAMINATION 2023

COMPUTING Higher 2

13 Sept 2023	Paper 1 (9569 / 01)	1400 1700 hrs
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READ THESE INSTRUCTIONS FIRST

An answer booklet will be provided with this question paper. You should follow the instructions on the front cover of the answer booklet. If you need additional answer paper ask the invigilator for a continuation booklet.

Answer ALL questions.

Approved calculators are allowed.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is **100**.

This document consists of 8 printed pages.

1. The examinations department of a school needs to store data on the examinations taken by its students. Examination subjects are classified as one of the two types, namely academic subjects and practical subjects.

For all subjects, the data that will be stored include:

- Subject code
- Subject name
- Subject type

The assessment process for an academic subject comprises two written papers. The duration of each of these two papers will be stored.

For the practical subject's assessment process there are no written papers but there is a single practical examination. A practical examination has a duration and a final date.

- (a) Draw a diagram that shows suitable classes and their relationships for a solution to this problem that uses OOP techniques. Include appropriate attributes and methods in each class.
- (b) The school also offers vocational subjects to their students. A vocational subject has no formal examinations, but the assessment is based on the work that the students complete throughout the course. However, this coursework has to be completed by a certain date.

Suggest any changes that need to be made to the classes used in **part** (**a**). [3]

- (c) Explain the difference between a class and an object. [2]
- (d) Give **two** benefits of Object-Oriented programming. [2]

2. (a) Describe **one** advantage and **one** disadvantage of client-server network. [2]

- (b) Describe **one** disadvantage of packet switching and how the problem can be handled. [2]
- (c) Describe **two** differences between switch and router in the TCP/IP model. [2]
- (d) Explain the term Domain Name Server (DNS) and how it works. [5]

- 3. (a) Give **one** example of multi-factor authentication. [1]
 - (b) Explain how a Denial of Service (DOS) attack can compromise an internal server and suggest one protection scheme to detect a DOS attack. [3]
 - (c) Give **two** purposes of using digital signature and describe how it works. [8]
- 4. (a) The following are the inorder and postorder traversal of a binary tree whose nodes are labelled 1, 2, ..., 9.

Inorder: 4, 7, 2, 1, 5, 3, 8, 6, 9

Postorder: 7, 4, 2, 5, 8, 9, 6, 3, 1

- (i) Draw the binary tree with the nodes labelled. [3]
- (ii) Give the preorder traversal of this binary tree. [2]
- (b) The following names are to be inserted in a binary search tree in the order given:

Lorna, Peter, Romeo, Betty, Anthony, Linda, Matthew

Assuming an empty tree to start with, show how these names will be stored by drawing a tree diagram. [2]

- (c) By using suitable example and diagram, describe a situation where a binary search tree becomes inefficient. [2]
- (d) Give an advantage of using a binary search tree for storing data over a linked list. [1]

5. In a country club, every member is issued a Membership Identification Number (MIN). MIN is a unique number comprises of 10 digits separated by two dashes. The last digit of MIN is a check digit using a modulus-10 system.

Consider the MIN 456-789-5468. The check digit is calculated based on the left-most 9 digits. The first step is to double every alternate digits, starting with the second-last digit and moving left. Then sum all the digits, including both the unchanged digits as well as those doubled (e.g. 18 contributes 1 + 8). The following illustrates the process:

Digit	Double	Sum of digits
6		6
4	8	(0+8)
5		5
9	18	(1+8)
8		8
7	14	(1+4)
6		6
5	10	(1+0)
4		4
,	Total Sum	52

The total sum 52 is then divided by 10. If the remainder is 0, then the check digit is 0, otherwise, use 10 to subtract by the remainder to obtain the check digit.

- (a) Using **pseudocode**, write an algorithm to validate a MIN number. [6]
- (b) Using the algorithm in part (a), determine whether the following MIN numbers are valid.(i) 456-789-0126
 - (ii) 986-745-0124 [2]
- (c) The algorithm for verifying MIN number contains a few weaknesses. Identify a weakness and explain how it can be solved. [2]

- 6. The school wants to deploy an efficient method to store and search students' names. Student A suggests entering the names into an array and using binary search.
 - (a) Explain why the array must be sorted before performing binary search. [1]

[2]

(b) State **two** features of a successful recursive function.

Names are stored in Array in ascending order. Student A writes the recursive function below to search for Target in Array. It returns True if Target is found and False otherwise.

01	FUNCTION B(Array, Target, Low, High) RETURNS BOOLEAN
02	IF Low > High THEN
03	RETURN False
04	ELSE
05	Mid 🗲 (Low + High) div 2
06	IF Target < Array[Mid] THEN
07	B(Array, Target, Low, Mid - 1)
80	ELSE IF Target > Array[Mid]
09	B(Array, Target, Mid + 1, High)
10	ELSE
11	RETURN True
12	ENDIF
13	ENDIF
14	ENDFUNCTION

Note: the div operation returns an integer value after division, e.g. 7 div 2 = 3.

- (c) State the significance of line 02. [1]
- (d) Name the type of error for lines 07 and 09. Modify these two lines to make the function work. [2]
- (e) Write down the statement to call the function to perform the binary search. [1]

Student B suggests storing the names in a hash table and using hash table search.

- (f) State **two** features of a good hashing algorithm. [2]
- (g) Explain how two different records hashing to the same location can be managed. [2]
- (h) Use time complexity to explain the advantage of a hash table search might have over a binary search.

- 7. In a football league, there are several teams. A database is created to store data about the clubs and the players that play for them.
 - Each player belongs to a single club.
 - A club can have multiple players, but only one coach.
 - Each player can play multiple positions.

This table shows the data about the clubs and their players:

ClubID	Club	Club	Coach	DisvorID	Player	Player	Position
ClubID	Name	City	Name	PlayerID	Name	Age	Code
			Mickey	9663	Dale	25	GK
ClubID 14 6 12				4336	Aliba	22	DF
				2603	Blanc	25	DF MF
14	Cannons	Islington		8257	Bukasa	22	DF MF FW
				1160	Marty	22	MF FW
				3984	Fan	24	DF MF
				2115	Øguard	24	MF
ClubID 14 6 12	Pies	Tyne	Hao	4988	Роро	31	GK
				1846	Mares	25	DF MF
				6277	Toni	23	DF MF
0				5956	Ishak	23	FW
				7555	Batman	23	DF
				9616	Wilcock	24	MF FW
				1849	Anono	27	GK
12	Zombies	Salford	Rick	7951	Ford	25	FW
				8293	McGuy	30	DF

(a) Explain whether the above table is normalised.

[1]

The following table is created to keep track of the physical attributes required to play these positions, allowing the coach to better monitor the players' development.

Table: POSITION

PosCode	PosName	MainSkill	SecondarySkill
GK	Goalkeeper	Agility	Strength
DF	Defender	Strength	Technique
MF	Midfielder	Speed	Technique
FW	Forward	Speed	Agility

A relational database is to be used. Using the information above, design the database that consists of a number of tables.

(b) Draw the Entity-Relationship (E-R) diagram to show the tables in third normal form (3NF) and their relationships between them.

A table description can be expressed as:

TableName (<u>Attribute1</u>, <u>Attribute2</u>, Attribute3, ...)

The primary key is indicated by underlining one or more attributes. Foreign keys are indicated by using a dashed underline.

The POSITION table has been identified with the table descriptions:

POSITION (<u>PosCode</u>, PosName, MainSkill, SecondarySkill)

(c) Using the information given, write table descriptions for the other tables you identified in part (b).

The player McGuy changed his club from Zombies to the Pies.

(d) Write an SQL query to reflect this in the database. [2]

A new player joined the club Zombies. The following are his personal information:

PlayerID	Player	Player	Position
	Name	Age	Code
7777	Redondo	38	MF FW

- (e) Write SQL query statement(s) to add the player into the database. [4]
- (f) Write an SQL query to output the name, club name and age of all the players with 'Speed' as their main skill, ordered by their age from youngest to oldest. [6]
- (g) The Zombies collected their players' health data to monitor their development and match fitness. This data was later used in advertisements for an energy drink. State **one** Data Protection Obligation breached under PDPA, and explain what the club should have done before using the data in advertisements. [2]

- 8. The base-6 system, also known as the senary or hexary system, is a numeral system that uses six symbols to represent numbers: 0, 1, 2, 3, 4, and 5. This is a popular system due to its divisibility.
 - (a) Using pseudocode, write a function dec2sen(n) that takes in a decimal number n and returns its equivalent senary (base-6) representation as a string.

(b) Give the senary-string for the decimal value of 100.	[1]
(c) Convert '1234' from senary to decimal.	[1]

The base-36 system, which uses the Arabic numerals 0-9 and the latin letters A-Z, is commonly used by URL redirection systems like TinyURL. The base-36 system is closely related to the base-6 system.

(d) Explain why the base-36 system is closely related to the base-6 system. [1]