

## INFORMATION AND COMMUNICATION TECHNOLOGY PAPER 2

11:15 am – 12:45 pm (1 hour and 30 minutes)

This paper must be answered in English

### INSTRUCTIONS

- (1) This paper consists of **THREE** sections, Section A, Section B and Section C. Attempt **ALL** questions in any **TWO** sections.
- (2) Write your answers in the **DSE(B)** Answer Book provided. Start each question (not part of a question) on a new page.
- (3) The last page of this Question Paper contains SQL commands and symbols used in entity-relationship diagrams which you may find useful.

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end of the examination session

**Section A Databases**

1. A university department is setting up a database to manage its courses offerings. The requirements of the database are described below:

*Each course must be taught by one professor, but a professor teaches at least one course. Some courses do not require a lab session, while some courses have multiple lab sessions. Each Lab Session is associated with exactly one course.*

The partial ER diagram for the database is given below. Draw the ER diagram for the database. It is not necessary to draw attributes. (4 marks)



2. An entertainment company organizes music concerts in Hong Kong. They use a database to manage ticket sales. Currently, all data are stored in a table called `TICKET_SALES`.

`TICKET_SALES`

Field name	Description	Example
<code>TicketID</code>	Ticket number	T2001
<code>ConcertID</code>	Concert number	C001
<code>ConcertName</code>	The name of the concert	20 <sup>th</sup> Year Live Tour in Hong Kong
<code>Date</code>	The date on which the concert is held	2025/10/07
<code>VenueID</code>	Venue number	V001
<code>VenueAddress</code>	The location of the venue	Convention and Exhibition Centre
<code>SeatNum</code>	The specific seat number assigned to the ticket	A110
<code>Performer</code>	The name of the artist performing in the concert	48 Group

A new database schema in Third Normal Form is drafted below. The database table `Ticket` stores information on tickets, while the database table `Concert` stores the information of each concert.

Complete the missing parts of the following schema. Write down “N/A” if the table does not have any foreign key. (5 marks)

`Ticket` (  )

Foreign key:

`Concert` (  )

Foreign key:

`Venue` (`VenueID`, `VenueAddress`)

Foreign key:

3. A school library uses a database to manage its books and loan records. The database includes the following tables:

LOAN

Field name	Data type	Description	Example
LoanID	Character	Loan record number	L1005
BookID	Character	Book number	B0777
StudentID	Character	Student number	S202501
LoanDate	Date	The date the book was borrowed	2025/12/01
DueDate	Date	The date the book is due for return	2025/12/15

Write SQL statements for the following tasks.

- (a) Write an SQL statement to find all loan records for the student with student number 'S202501' who has borrowed the book with book number 'B0777'. (2 marks)
- (b) To improve the performance of the search in (a), a librarian creates an index. Given that a librarian needs to frequently check the borrowing records of a specific student, create an index using the fields `BookID` and `StudentID` of the `LOAN` table. (2 marks)

4. A school manages the membership of two extra-curricular clubs: the Chess Club and the Bridge Club. The database contains two tables, CHESS and BRIDGE.

CHESS

StudentID	Name
S101	Amy
S102	Ben
S103	Cat
S106	Fay

BRIDGE

StudentID	Name
S102	Ben
S104	Dan
S105	Eva
S106	Fay

- (a) Consider the following two SQL commands:

Statement 1:

```
DELETE FROM CHESS
```

Statement 2:

```
DROP TABLE CHESS
```

What is the difference between the above two SQL statements?

(1 mark)

- (b) The school wants to generate a list of all students participating in board games.

Statement 3:

```
SELECT * FROM CHESS  
UNION  
SELECT * FROM BRIDGE
```

Statement 4:

```
SELECT * FROM CHESS  
UNION ALL  
SELECT * FROM BRIDGE
```

What is the difference between the above two SQL statements?

(1 mark)

- (c) Write down the output after executing the following SQL statement.

(2 marks)

```
SELECT StudentID FROM CHESS  
MINUS  
SELECT StudentID FROM BRIDGE
```

5. An online bookstore, BookWorld, uses a database to manage its sales. The database includes the following tables:

CUSTOMER

Field name	Type	Description	Example
CustID	Character	Customer number	C9001
CustName	Character	Customer	Tai Man
RegDate	Date	The date the customer registered	2025/10/31

Primary Key: CustID

Foreign Key: N/A

PRODUCT

Field name	Type	Description	Example
ProdID	Character	Product number	P001
ProdName	Character	Book title	Introduction to python
Category	Character	Book genre	Non-Fiction
Price	Numeric	Book price	120

Primary Key: ProdID

Foreign Key: N/A

SALES

Field name	Type	Description	Example
SaleID	Character	Sales number	S1001
CustID	Character	Customer number	C9001
ProdID	Character	Product number	P001
Quantity	Integer	Number of items sold in this transaction	2

Primary Key: SalesID

Foreign Key: CustID, ProdID

Write SQL statements to complete tasks (a) to (d) below.

- (a) List the names of all customers who registered with BookWorld in the year 2023. (2 marks)
- (b) List the product names of all books purchased by the customer with customer number 'C1024'. (2 marks)
- (c) List the names of products that have never been sold. (2 marks)
- (d) The sales team wants to understand the popularity of each book category. For each book category, list the category name and the total number of books sold. Only include categories where the total number of books sold is greater than 500. (3 marks)
- (e) Briefly describe the purpose of the following SQL statement. (2 marks)

```
SELECT ProdName, Price
FROM PRODUCT P1
WHERE Price > (
    SELECT AVG(Price)
    FROM PRODUCT P2
    WHERE P2.Category = P1.Category)
```

- (f) A new customer with CustID 'C9002' has just registered. The system attempts to add the customer record (Statement 1) and their purchase record (Statement 2).

Statement 1:

```
INSERT INTO CUSTOMER
VALUES ('C9002', 'Chris Wong', '2025-12-08')
```

Statement 2:

```
INSERT INTO SALES
VALUES ('S1211', 'C9002', 'P1023', 10)
```

Which of the following execution sequences will lead to a data integrity issue? Explain briefly.

Sequence A:

Statement 1 → Statement 2

Sequence B:

Statement 2 → Statement 1

(2 marks)

**END OF SECTION A**

## Section B Web Application Development

6. ABC Company sells five types of electrical appliances to customers, including air conditioners, fans, smartphones, tablet computers, and smart home gadgets. The company uses a web page to allow customers to search for products they want.

Draft the web page which allows customers to search for product other than entering the name of the product. Show the result of the search. The search result should include two types of multimedia elements. Annotate your design if appropriate. (3 marks)

7. John uses a DHCP server to assign IP addresses to devices in an office.

(a) Give an advantage and a limitation of this approach. (2 marks)

(b) Apart from the IP address, give **two** pieces of information that the DHCP server will provide to the devices. (2 marks)

8. A conferences hall is equipped with some access points (APs), each supporting up to 50 simultaneous connections.

(a) Although 3 APs are sufficient for more than 170 simultaneous connections, the network designer installs a total of 6 APs. Give an advantage of this approach. (1 mark)

(b) The connection to AP involves WPA2. Give a function of WPA2. (1 mark)

(c) To provide instantaneous video streaming, both TCP and UDP can be used. Give an advantage of using TCP and UDP respectively. (2 marks)

9. Pauline creates a web site for children to learn different occupation.

(a) She uses an image map on an image with people wearing different uniforms.

(i) Give a limitation of using an image map. (1 mark)

(ii) Can JavaScript for the same purpose? Explain briefly. (1 mark)

(b) Pauline can purchase a server to host the web site or subscribe to a hosting service. Give an advantage of each approach respectively. (2 marks)

10. A cinema is creating a web site to allow customers buy tickets online. The following is the first 20 lines of the file `index.php`.

Line	Code
1	<code>&lt;!DOCTYPE html&gt;</code>
2	<code>&lt;html&gt;</code>
3	<code>  &lt;head&gt;</code>
4	<code>    &lt;style&gt;</code>
5	<code>      body {</code>
6	<code>        margin: 0;</code>
7	<code>        width: 65ch;</code>
8	<code>        font-family: "Arial", sans-serif;</code>
9	<code>        padding: 1rem;</code>
10	<code>      }</code>
11	<code>      h1 {</code>
12	<code>        font-size: 16px;</code>
13	<code>      }</code>
14	<code>    &lt;/style&gt;</code>
15	<code>    &lt;title&gt;Movie Ticketing System&lt;/title&gt;</code>
16	<code></code>
17	<code>    &lt;link href="/style.css" rel="stylesheet" /&gt;</code>
18	<code>  &lt;/head&gt;</code>
19	<code>  &lt;body&gt;</code>
20	<code>    &lt;h1&gt;Movie Ticketing System&lt;/h1&gt;</code>
.	
.	

- (a) Briefly describe the purpose of line 1 of `index.php`. (1 mark)
- (b) Apart from the title of the web page, give **two** more pieces of metadata the company can include on this web page. (2 marks)
- (c) Although line 12 of `index.php` sets the font-size to 16px, all web browsers do not render h1 in 16px. Give a possible reason of this phenomenon. (1 mark)

Lines 21-58 of index.php are as follows-

Line	Code	
21	<code>&lt;hr /&gt;</code>	
22	<code>&lt;form action="/process.php" method="POST"&gt;</code>	
23	<code>&lt;label for="customer-name"&gt;Customer Name:&lt;/label&gt;</code>	
24	<code>&lt;input name="customer_name" id="customerName" type="text" /&gt;</code>	
25		
26	<code>&lt;label for="number-adult"&gt;Number of Adult:&lt;/label&gt;</code>	
27	<code>&lt;input name="number-adult" id="numberOfAdult" type="text" min="0" max="10" /&gt;</code>	
28		
29	<code>&lt;label for="number-concession"&gt;Number of Child/Elderly:&lt;/label&gt;</code>	
30	<code>&lt;input name="number-concession" id="numberOfConcession" type="text" min="0" max="10" /&gt;</code>	
31		
32	<code>&lt;hr /&gt;</code>	
33		
34	<code>&lt;label for="movie-selection"&gt;Movie Name:&lt;/label&gt;</code>	
35	<code>&lt;select name="movie" id="movieSelection"&gt;</code>	
36	<b>Part (e)</b>	
37		
38		
39		
40		
41		
42		
43	<code>&lt;/select&gt;</code>	
44	<code>&lt;div&gt;</code>	
45	<code>&lt;p&gt;Total Number of Tickets: &lt;span id="totalTickets"&gt;0&lt;/span&gt;</code>	
46	<code>&lt;/p&gt; &lt;p&gt;Total Price: HK\$ &lt;span id="totalPrice"&gt;0&lt;/span&gt;</code>	
47	<code>&lt;/p&gt;</code>	
48	<code>&lt;/div&gt;</code>	
49	<code>&lt;hr /&gt;</code>	
50		
51	<code>&lt;div&gt;</code>	
52	<code>&lt;input type="submit" value="Buy Tickets" /&gt;</code>	
53	<code>&lt;/div&gt;</code>	
54	<code>&lt;/form&gt;</code>	
55		
56	<code>&lt;script src="/main.js"&gt;&lt;/script&gt;</code>	
57	<code>&lt;/body&gt;</code>	
58	<code>&lt;/html&gt;</code>	

(d) Modify line 27 and line 30 so that only numbers can be input in the field.

(1 mark)

(e) On line 36-43, the following php scripts are used to populate the drop-down list.

Line	Code
:	
:	
36	<?php
37	include_once 'MOVIES.php';
38	
39	for (\$i = 0; \$i < count(\$MOVIES); \$i++) {
40	echo '<option value="' . (e)(ii)(1) . '">' . (e)(ii)(2) . '</option>';
41	}
42	?>
:	
:	

The file MOVIES.php contains the following 2 lines of code-

Line	Code
1	<?php
2	\$MOVIES = ["History Of Coffee", "Business in the City", "Mix of Colour"];

- (i) Give an advantage of using the file MOVIES.php to store the names of the movie. (1 mark)
- (ii) Complete line 40 of index.php such that the first movie has a value of 1 instead of 0. (2 marks)

(f) The file `main.js` contains the following lines of code-

Line	Code
1	<code>function updateTotalTickets() {</code>
2	<code>    const totalAdultTickets = Number(</code>
3	<code>        document.getElementById("numberOfAdult").value</code>
4	<code>    );</code>
5	<code>    const totalConcessionTickets = Number(</code>
6	<code>        document.getElementById("numberOfConcession").value</code>
7	<code>    );</code>
8	<code>    const totalTickets =</code>
9	<code>        totalAdultTickets + totalConcessionTickets;</code>
10	
11	<code>    document.getElementById("totalTickets").innerHTML =</code>
	<code>        totalTickets;</code>
12	<code>    document.getElementById("totalPrice").innerHTML = calPrice(</code>
13	<code>        totalAdultTickets,</code>
14	<code>        totalConcessionTickets</code>
15	<code>    );</code>
16	<code>    return;</code>
17	<code>}</code>
18	
19	<code>function calPrice(numberOfAdult, numberOfConcession) {</code>
20	
21	
22	
23	
24	<b>Part (f)(i)</b>
25	
26	<code>    return totalPrice;</code>
27	<code>}</code>
28	
29	<code>document.addEventListener("DOMContentLoaded", function () {</code>
30	<code>    document</code>
31	<code>        .getElementById("numberOfAdult")</code>
32	<code>            .addEventListener(" (f)(ii) ", updateTotalTickets);</code>
33	<code>    document</code>
34	<code>        .getElementById("numberOfConcession")</code>
35	<code>            .addEventListener(" (f)(ii) " , updateTotalTickets);</code>
36	<code>});</code>

- (i) The function `calPrice()` is used to calculate the total price of tickets to be paid. Each adult ticket costs HK\$ 100 and each concessionary ticket costs \$50. The argument `numberOfAdult` and `numberOfConcession` represents the number of adult tickets and the number of concessionary tickets respectively. Complete `calPrice()`. (2 marks)
- (ii) The function `updateTotalTickets()` should be called whenever the input fields for ticket number change. Write down a keyword for line 32 and line 35 of `main.js`. (1 mark)
- (iii) Give a reason why client-scripting should be used instead of server-side scripting for the purpose in (ii). (1 mark)

The file `process.php` is used to process the data received from `index.php`. The file `process.php` contains the following lines of codes-

Line	Code
1	<?php
.	.
.	.
.	.
7	<code>\$conn = mysqli_connect(\$host, \$username, \$password, \$db);</code>
8	
9	<code>if (!\$conn) {</code>
10	<code>    die("Connection Error" . mysqli_error());</code>
11	<code>}</code>
12	
13	<code>\$customerName = \$_POST["customer-name"];</code>
14	<code>\$numAdu = \$_POST["number-adult"];</code>
15	<code>\$numCon = \$_POST["number-concession"];</code>
16	<code>\$movie = \$_POST["movie"];</code>
17	
18	<code>\$fields = [\$customerName, \$movie, \$numAdu, \$numCon];</code>
19	
20	<code>\$values = "CURRENT_TIMESTAMP, ";</code>
21	
22	<code>foreach ( <input type="text" value="(g)(i)(1)"/> ) {</code>
23	<code>    if (\$field == \$fields[0]) {</code>
24	<code>        \$values = \$values . "'" . \$field . "'" . ", ";</code>
25	<code>    } else {</code>
26	<code>        \$values = <input type="text" value="(g)(i)(2)"/> ;</code>
27	<code>    }</code>
28	<code>}</code>
29	
30	<code>\$values = substr(\$values, 0, -2);</code>
31	
32	<code>\$sql = "INSERT INTO PURCHASES (purchaseDT, name, movie, numAdult, numConcession) VALUES (" . \$values . ")";</code>
33	
34	<code>mysqli_query(\$conn, \$sql);</code>
35	
36	<code>mysqli_close(\$conn);</code>
37	
38	<code>header("Location: /success.php?name=" . \$customerName);</code>
39	<code>?&gt;</code>

(g) Consider the content of `process.php`.

(i) The foreach loop in lines 22-28 appends each value of `$fields` into the string `$values` for insertion. Complete line 22 and line 26 respectively. (2 marks)

(ii) What is the function of line 38 of `process.php`? (1 mark)

**END OF SECTION B**

**Section C Algorithm and Programming**

11. S1 is a stack of size 8. The following subprogrammes are used to manipulate the stack-

Subprogrammes	Description
len(S)	Returns the number of elements in stack S
push(S, e1)	Push the element e1 to stack stack S
pop(S)	Returns and removes the topmost element in stack S
rev(S)	Reverse the elements in stack S

(a) In pseudocode, write the subprogramme `isFull(S)`, which returns `True` if the stack is currently full and `False` otherwise. (1 mark)

(b) Consider the following design of `rev(S)`, where A is a 0-based array of size 8.

```

rev(S)
  FOR i FROM 0 to 7 DO
    A[i] ← pop(S)
  FOR i FROM 0 to 7 DO
    push(S, A[i])

```

There is an error in the design. Briefly describe the error and a corresponding solution. (2 marks)

12. The following pseudocode representation of an algorithm performs an insertion sort over a 0-based integer array A. There are N elements in A.

```

i ← 0
REPEAT
  (a)(1)
  WHILE j > 0 AND (a)(2) DO
    T ← A[j]
    A[j] ← A[j - 1]
    A[j - 1] ← T
    j ← j - 1
  i ← i + 1
UNTIL (a)(3)

```

(a) Complete the algorithm above to sort A in ascending order. (3 marks)

(b) Write down the name of a sorting algorithm which has a higher execution efficiency over insertion sort when N is large. (1 mark)

13. 7 people join a speed dating programme. After the programme, each person needs to rate the other participants on a scale of 1 to 7.

The two-dimensional array  $SC$  stores the scores after the programme. In the example below,  $SC[i, j]$  refers to the score given to the  $j$ -th person by the  $i$ -th person.

$i \backslash j$	0	1	2	3	4	5	6
0	-1	2	1	1	3	6	7
1	3	-1	7	6	4	2	4
2	5	3	-1	3	7	7	6
3	6	7	1	-1	2	3	4
4	1	2	6	5	-1	3	1
5	1	4	2	6	5	-1	6
6	6	3	7	3	1	2	-1

- (a) What is the score given by the 5-th person to the 0-th person? (1 mark)
- (b) The subprogramme `star(per)` displays both the average score of the person of index `per` and whether he/she is a star performer, i.e. he/she received 3 or more scores of at least 5 points. The average score is shown in 2 decimal places.

For example,

	Display	Description
<code>star(0)</code>	<code>0*: 3.67</code>	The asterisk (*) next to 0 indicates there are at least 3 or more people gives him/her a score of at least 5 points
<code>star(1)</code>	<code>1: 3.50</code>	

Write `star(per)` in Python, C++ or Pascal. State the programming language used in your answer. (2 marks)

(c) The pseudocode representation of the subprogramme `pair(i, j)` is as follows-

```
pair(i, j)
  IF i = j THEN RETURN -1
  RETURN SC[i, j] + SC[j, i]
```

The manager of the speed dating programme writes the following programme to find the pair of participants with the highest score-

```
10   bi ← 0
20   bj ← 0
30   FOR i FROM 0 TO 6 DO
40     FOR j FROM 0 TO 6 DO
50       IF pair(bi, bj) < pair(i, j) THEN
60         bi ← i
70         bj ← j
80   OUTPUT bi, bj
```

- (i) After executing the programme above, `bi` must be smaller than `bj`. Why? (1 mark)
- (ii) Modify line 40 to reduce the number of iterations in the programme. (1 mark)

14. To control a robot, a user-defined data type `INS` is used to provide the direction and the number of units to be travelled. There are two fields in `INS`-

Field	Description
<code>dir</code>	A character representing the direction of the travel. Can either be either 'E' (East) or 'N' (North).
<code>dis</code>	An integer representing the number of units to be travelled.

The array `InsArr` stores a number of instructions of type `INS`. Suppose the robot always starts at (0, 0). The following shows an example of `InsArr` and the corresponding result after executing these instructions.

<code>i</code>	0	1	2	3
<code>InsArr[i]</code>	{dir: 'E', dis: 2}	{dir: 'N', dis: 1}	{dir: 'E', dis: -1}	{dir: 'N', dis: 2}

5						
4						
3		★				
2						
1		☆	☆			
0	★		☆			
y/x	0	1	2	3	4	5

☆ represents intermediate steps  
★ represents start and final positions

In the example above, the distance between the starting position and the ending position is  $\sqrt{1^2 + 3^2} = \sqrt{10}$ .

- (a) Suppose there are `C` instructions in `InsArr`. Complete the following pseudocode representation of the algorithm which finds the distance between the starting position and the ending position. (2 marks)

```

CalcDist ()
    dx ← 0
    dy ← 0
    FOR i FROM 0 TO C - 1 DO
        IF (a)(1) THEN
            dx ← dx + InsArr[i].dis
        ELSE
            dy ← (a)(2)
    RETURN the square root of (dx ** 2 + dy ** 2)

```

- (b) Describe a sensor which can be installed on the robot to detect potential obstacles on the path. (1 mark)

15. ABC Town is creating a vote to decide the best restaurant of a district. Each vote consists of the name of the restaurant and a score between 0.0 and 5.0 inclusive. Arrays  $N$  and  $S$  are used to store the name and the score in parallel. The first 7 elements of  $N$  and  $S$  are shown as follows-

$i$	0	1	2	3	4	5	6
$N[i]$	WCD	WCD	KFD	SAD	SAD	KFD	WCD
$S[i]$	3.2	4.0	4.5	1.2	3.7	4.1	3.7

- (a) According to the first 7 elements of  $N$  and  $S$ , what is the average score of the restaurant “KFD”? (1 mark)

Suppose there are a total of  $C$  votes.

- (b) Write a programme in Python/C++/Pascal to output the number of votes which shares the highest rating. Indicate your choice of programming language on the answer paper. (3 marks)
- (c) The following function `getUnique()` returns a new array  $NX$  which stores the names in  $N$  exactly once.

```

getUnique ()
10   size ← 1
20   NX[0] ← N[0]
30   FOR i FROM 0 TO C - 1 DO
40       IF NOT exists(NX, N[i], size) THEN
50           size ← size + 1
60           Resize NX to size
70           NX[i] ← N[i]
80   RETURN NX

```

- (i) The function `exists(arr, el, size)` returns True if `el` exists in `arr`. Otherwise, it returns False. Write `exists(arr, el, size)` in pseudocode. (3 marks)
- (ii) There is one error after line 40 of `getUnique()`. Briefly explain the error and give the corresponding correction. (2 marks)
- (iii) Suppose  $N$  is sorted in ascending order. Briefly describe changes on `getUnique()` to improve the efficiency. (2 marks)
- (d) The function `getAverage(T)` returns the average rating of restaurant with name  $T$ . Write `getAverage(T)` using Python/C++/Pascal. Indicate your choice of programming language on the answer paper. (2 marks)
- (e) After finding the average rating of each restaurant, the result is stored using a linked list. Give an advantage and a disadvantage of using a linked list. (2 marks)

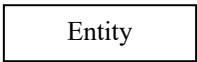
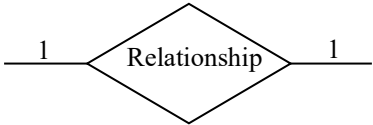


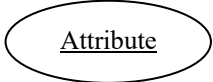
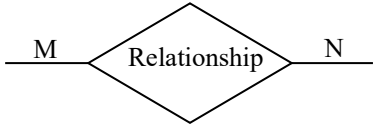
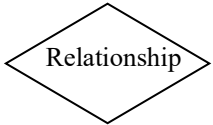
**END OF SECTION C**

**END OF PAPER**

### Database (SQL commands - based on SQL-92 Standard)

Constants	FALSE, TRUE
Operators	+, -, *, /, >, <, =, >=, <=, <>, %, _, ', AND, NOT, OR
SQL	ABSOLUTE (ABS), AVG, INT, MAX, MIN, SUM, COUNT ASC, AT, CHAR (CHR), CHAR_LENGTH (LEN), LOWER, TRIM, SPACE, SUBSTRING (SUBSTR/MID), UPPER, VALUE (VAL) DATE, DAY, MONTH, YEAR ADD, ALL, ALTER, ANY, AS, ASC, BETWEEN, BY, CREATE, DELETE, DESC, DISTINCT, DROP, EXISTS, FROM, GROUP, HAVING, IN, INDEX, INNER JOIN, INSERT, INTEGER, INTERSECT, INTO, LEFT [OUTER] JOIN, LIKE, MINUS, NULL, RIGHT [OUTER] JOIN, FULL [OUTER] JOIN, ON, ORDER, SELECT, SET, TABLE, TO, UNION, UNIQUE, UPDATE, VALUES, VIEW, WHERE

### Symbols Used in Entity-Relationship Diagrams

Meaning	Symbol	Meaning	Symbol
Entity		One-to-One Relationship	
Attribute		One-to-Many Relationship	
Key Attribute		Many-to-Many Relationship	
Relationship		Participation constraints: Use   on Mandatory side Use ○ on Optional side	