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**ASIA PACIFIC UNIVERSITY**  
**OF TECHNOLOGY & INNOVATION**

## **Database Management Group Assignment Part 1**

### **E-Library Management System**

Module Code:

**AICT015-4-1-DBM**

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## **1.0 Introduction**

In today's fast-paced world, a modern library in Kuala Lumpur entails an up-to-date database management system in order to cater to the pursuits of its patrons. The system can fulfil the evolving demands of the library and foster a seamless experience for the patrons. The obligation of the librarians extends beyond the management of books; they ensure that the books are readily available for borrowing by accessing the system. This assignment focuses on designing a Database Management System (DBMS) for an E-library management system.

## **2.0 Database and Database Management System**

### **2.1 Disadvantages of File-Based System**

Database design plays a vital role in defining the database's expected use. Different types of databases may be needed by different approaches. Due to the evolution of technology, people have found out that managing data with a file system is obsolete. Thus, a conversion from a manual to a computer system has occurred. Therefore, a numerous "home-grown" system is resulted. To demonstrate a database system for the E-library management system, we discussed it within a group and we chose to use the Data Management System (DBMS) instead of the file-based system.

File-based system is a collection of file folders stored in a file cabinet. In addition, the organizations involved within folders are usually based on the data's expected use. Nevertheless, it is a system that is adequate for small amounts of data with few reporting requirements. Therefore, finding and using data will consume lots of time and become cumbersome as the file folders will be growing. Due to the problems that show the file-based system is time-consuming, it only allows one user to access at one time while DBMS allows multiple users to access at the same time. If Librarian A is altering the book table, Librarian B couldn't alter the librarian table. Librarian B would need to wait for Librarian A as long as they are managing the library system using the file-based system.

As the number of files expands, system administration in file-based systems becomes increasingly difficult, where the library contains multiple tables such as books, members, and librarians. Besides, these tables consist of different data like "BookID", "LibrarianID", "Name" and many more. If each department in the library maintains its data by creating its files, data redundancy will occur. Hence, the linkage between the tables will make the system administration even more complicated.

Thus, file-based systems can only make changes in existing file structure which causes a higher probability of making mistakes compared to DBMS. For example, the librarian will have to find each file that recorded the wrong author and change it individually. This kind of modification would consume lots of time while DBMS would expedite the process. Update anomalies, deletion anomalies and insertion anomalies are the data anomalies that frequently occur when changes in redundant data are not executed successfully.

## **2.2 Advantages of Database and DBMS**

DBMS is a software program that allows users to create, maintain and alter a database that can efficiently manage and analyse their data. As a result, DBMS is more suitable for managing data in a library as it allows users to manage a large amount of data and ensure data integrity and performance (Kapilsparshi, 2023).

DBMS performs functions that guarantee the integrity and consistency of data. It enforces rules and constraints on the data, ensuring that all data is accurate and consistent. In this case, librarians may use it for data validation, such as checking constraints and triggers as it provides various tools that will help in enhancing the integrity of data (Aggarwal, 2023).

Thus, DBMS has a security management function that may enforce user security and data privacy within the database. This function may safeguard all the data from unauthorized users, online theft and many more (Aggarwal, 2023). Unfortunately, file-based systems are easy to access as their security features are hard to program and therefore often omitted.

Additionally, DBMS has a lower probability of making mistakes in managing the data. Data redundancy is more likely to occur when complex entries are made in several different files or frequently in one or more files. For example, if the librarian wishes to alter the author of the book, with the help of DBMS, they will just need to change it in the book table and the remaining tables that were linked with it will be updated to the latest. Since we will use DBMS for the E-library management system, data anomalies will be avoided.

### **3.0 Business Rules**

1. Librarians are responsible for knowing the number of copies of each book in the library and the number currently out on loan.
2. Each book is identified by its ISBN.
3. Two books with the same title can have different ISBNs if they are written by different authors or published by different publishers.
4. Editions of the same book have different ISBNs.
5. A book can have several book copies.
6. Each book copy is distinguished from one another by its BookCopy\_ID despite having the same ISBN.
7. Each book title must have a corresponding description, ranging from at least one sentence to several paragraphs, which is not more than 800 characters.
8. Members are allowed to borrow a maximum of ten books at any one time.
9. Members can reserve books out on loan, they will be informed by the librarian when the books become available for loan.
10. Members are allowed to reserve a maximum of five books at any one time.
11. Reference books, journals, student projects, and theses are not allowed to be loaned, which is labelled black colour tag.
12. Different loan durations exist based on book categories, where yellow-tagged books can be borrowed for three days, red-tagged books can be borrowed for one day only, and green-tagged books can be borrowed for 15 days.
13. Members are required to pay fines for overdue books. The fines for books with yellow tags are RM1.00 each day, books with red tags are RM 4.00 each day, and books with green tags are RM0.50 each day.
14. Members who borrow at least ten times yearly are defined as active.
15. Members who seldom or never borrow any books are considered inactive.
16. Members are not allowed to borrow other books if they fail to return the book they have previously borrowed.
17. If a member fails to return a book borrowed from the library three times before it is overdue, they will no longer be permitted to borrow the book again.

## 4.0 Normalisation

Normalisation is an indispensable process in developing a database for consistently organising e-library data. In the relational database, normalisation has come to be a standard for reviewing and improving table structure as well as evaluating database quality (Amin et al., 2019). Normalisation works through a series of stages called normal forms, which are first normal form (1NF), second normal form (2NF), and third normal form (3NF), even though high-level normal forms exist. Data is decomposed into multiple tables that form linkages with each other which have relationships in the process of normalisation. The purpose of normalisation is to enhance data integrity by diminishing data redundancy as well as eliminating data anomalies such as update, insertion, and deletion anomalies (Kopp et al., 2021).

### 4.1 Unnormalised Form (UNF)

Table name: BORROW\_BOOKCOPY

Borrow_ID	Member_ID	MEM_Name	MEM_Contact	MEM_Status	BookCopy_ID	ISBN	Author_ID	AU_Name	Category_ID	Tag	BorrowDuration	OverDueFine
B001	M001	Andy Lau	60123456789	Active	BC_0001	ISBN_0001	A001	J. K. Rowling	C03	Green	15	0.5
					BC_0004	ISBN_0002						
					BC_0018	ISBN_0006						
B002	M002	Angelina Jolie	60112345678	Active	BC_0019	ISBN_0007	A001	J. K. Rowling	C03	Green	15	0.5
B003	M005	Lalisa	60145678901	Active	BC_0029	ISBN_0011	A002	Stephenie Meyer	C03	Green	15	0.5
					BC_0035	ISBN_0014						
B004	M012	Tom Cruise	60112345678	Active	BC_0087	ISBN_0043	A022	Marie Curie	C02	Red	1	3
B005	M005	Lalisa	60145678901	Active	BC_0004	ISBN_0002	A001	J. K. Rowling	C03	Green	15	0.5
B006	M001	Andy Lau	60123456789	Active	BC_0070	ISBN_0031	A010	Charles Addams	C01	Yellow	3	1
B007	M042	Rapunzel	60112345678	Active	BC_0021	ISBN_0007	A001	J. K. Rowling	C03	Green	15	0.5

Title	Genre	Publisher_ID	PU_Name	PubicationDate	BorrowDate	ReturnDate	DueDate	OverDue
Harry Potter and the Cursed Child	Fantasy	P001	Company Bloomsbury	26-Jun-97	20-Oct-23	04-Nov-23	4-Nov-23	0
Harry Potter and the Philosopher's Stone				7-Feb-98				
Harry Potter and the Order of the Phoenix				16-Jul-05				
Harry Potter and the Half-Blood Prince	Fantasy	P001	Company Bloomsbury	21-Jul-07	20-Oct-23	04-Nov-23	4-Nov-23	0
New moon	Fantasy	P002	Company Woodslan	21-Aug-06	20-Oct-23	05-Nov-23	4-Nov-23	1
Breaking Dawn				8-Feb-08				
The Discovery of Radium. Research on Radioactive Substances	Science	P002	Company Woodslan	4-Sep-20	6-Nov-23	08-Nov-23	7-Nov-23	1
Harry Potter and the Philosopher's Stone	Fantasy	P001	Company Bloomsbury	7-Feb-98	20-Nov-23	06-Dec-23	5-Dec-23	1
Addams Family: An Eviltion	Children	P004	Company Willington	1-Jan-10	23-Nov-23	26-Nov-23	26-Nov-23	0
Harry Potter and the Half-Blood Prince	Fantasy	P001	Company Bloomsbury	21-Jul-07	08-Dec-23	23-Dec-23	23-Dec-23	0

**Figure 1: E-Library Member Borrow Record**

(Please take into consideration that the UNF table in Figure 1 should be together, however this could make Figure 1 blurry. In order to make Figure 1 easy to see, the UNF table has been divided.)

Figure 1 demonstrates an unorganised data structure with repeating groups, which is member information. UNF contains empty cells, which leads to difficulties in querying when retrieving specific information. Conversion of 0NF to 1NF involves eliminating repeating groups and redundant data.

## 4.2 First Normal Form (1NF)

Table name: BORROW\_BOOKCOPY

Borrow_ID	Member_ID	MEM_Name	MEM_Contact	MEM_Status	BookCopy_ID	ISBN	Author_ID	AU_Name	Category_ID	Tag	BorrowDuration
B001	M001	Andy Lau	60123456789	Active	BC_0001	ISBN_0001	A001	J. K. Rowling	C03	Green	15
B001	M001	Andy Lau	60123456789	Active	BC_0004	ISBN_0002	A001	J. K. Rowling	C03	Green	15
B001	M001	Andy Lau	60123456789	Active	BC_0018	ISBN_0006	A001	J. K. Rowling	C03	Green	15
B002	M002	Angelina Jolie	60112345678	Active	BC_0019	ISBN_0007	A001	J. K. Rowling	C03	Green	15
B003	M005	Lalisa	60145678901	Active	BC_0029	ISBN_0011	A002	Stephenie Meyer	C03	Green	15
B003	M005	Lalisa	60145678901	Active	BC_0035	ISBN_0014	A002	Stephenie Meyer	C03	Green	15
B004	M012	Tom Cruise	60112345678	Active	BC_0087	ISBN_0043	A022	Marie Curie	C02	Red	1
B005	M005	Lalisa	60145678901	Active	BC_0006	ISBN_0002	A001	J. K. Rowling	C03	Green	15
B006	M001	Andy Lau	60123456789	Active	BC_0070	ISBN_0031	A010	Charles Addams	C01	Yellow	3
B007	M042	Rapunzel	60112345678	Active	BC_0021	ISBN_0007	A001	J. K. Rowling	C03	Green	15
OverDueFine	Title			Genre	Publisher_ID	PU_Name	PubicationDate	BorrowDate	ReturnDate	DueDate	OverDue
0.5	Harry Potter and the Cursed Child			Fantasy	P001	Company Bloomsbury	26-Jun-97	20-Oct-23	04-Nov-23	4-Nov-23	0
	Harry Potter and the Philosopher's Stone			Fantasy	P001	Company Bloomsbury	7-Feb-98	20-Oct-23	04-Nov-23	4-Nov-23	0
	Harry Potter and the Order of the Phoenix			Fantasy	P001	Company Bloomsbury	16-Jul-05	20-Oct-23	04-Nov-23	4-Nov-23	0
0.5	Harry Potter and the Half-Blood Prince			Fantasy	P001	Company Bloomsbury	21-Jul-07	20-Oct-23	04-Nov-23	4-Nov-23	0
0.5	New moon			Fantasy	P002	Company Woodslan	21-Aug-06	20-Oct-23	05-Nov-23	4-Nov-23	1
	Breaking Dawn			Fantasy	P002	Company Woodslan	8-Feb-08	20-Oct-23	05-Nov-23	4-Nov-23	1
3	The Discovery of Radium. Research on Radioactive Substances			Science	P002	Company Woodslan	4-Sep-20	6-Nov-23	08-Nov-23	7-Nov-23	1
0.5	Harry Potter and the Philosopher's Stone			Fantasy	P001	Company Bloomsbury	7-Feb-98	20-Nov-23	06-Dec-23	5-Dec-23	1
1	The Addams Family: An Eviltion			Children	P004	Company Willington	1-Jan-10	23-Nov-23	26-Nov-23	26-Nov-23	0
0.5	Harry Potter and the Half-Blood Prince			Fantasy	P001	Company Bloomsbury	21-Jul-07	08-Dec-23	23-Dec-23	23-Dec-23	0

**Figure 2: First Normal Form (1NF) of E-Library Member Borrow Record**

(Please take note that the 1NF table in Figure 2 should be put together, yet doing so could cause Figure 2 to become hazy and the yellow-highlighted column represents the primary key of the table. The 1NF table has been separated to make Figure 2 easier to view.)

As shown in Figure 2, Borrow\_ID and BookCopy\_ID are identified as a composite primary key that uniquely identifies attribute values such as ReturnDate, DueDate, and OverDue. In 1NF, each cell contains a single atomic value, meaning it holds a single value and indivisible piece of information. Also, all dependencies are identified in 1NF.

### Full Dependency:

Borrow\_ID + BookCopy\_ID → ReturnDate, DueDate, OverDue

### Partial Dependency:

Borrow\_ID → Member\_ID, MEM\_Name, MEM\_Contact, MEM\_Status, BorrowDate

BookCopy\_ID → ISBN, Author\_ID, AU\_Name, Category\_ID, Tag, BorrowDuration, OverDueFine, Title, Genre, Publisher\_ID, PU\_Name, PublicationDate

### Transitive Dependency:

Member\_ID → MEM\_Name, MEM\_Contact, MEM\_Status



ISBN → Title, Genre, PublicationDate

Author\_ID → AU\_Name

Category\_ID → Tag, BorrowDuration, OverDueFine

Publisher → PU\_Name

### 4.3 Second Normal Form (2NF)

Table name: BORROW_BOOKCOPY														
Borrow_ID	BookCopy_ID	ReturnDate	DueDate	OverDue										
B001	BC_0001	04-Nov-23	04-Nov-23	0										
B001	BC_0004	04-Nov-23	04-Nov-23	0										
B001	BC_0018	04-Nov-23	04-Nov-23	0										
B002	BC_0019	04-Nov-23	04-Nov-23	0										
B003	BC_0029	05-Nov-23	04-Nov-23	1										
B003	BC_0035	05-Nov-23	04-Nov-23	1										
B004	BC_0087	08-Nov-23	7-Nov-23	1										
B005	BC_0004	06-Dec-23	5-Dec-23	1										
B006	BC_0070	26-Nov-23	26-Nov-23	0										
B007	BC_0021	23-Dec-23	23-Dec-23	0										

Table name: BOOK_COPY														
BookCopy_ID	ISBN	Author_ID	AU_Name	Category	Tag	BorrowDuration	OverDueFine	Title	Genre	Publisher_ID	PU_Name	PubicationDate		
BC_0001	ISBN_0001	A001	J. K. Rowling	C03	Green	15	0.5	Harry Potter and the Cursed Child	Fantasy	P001	Company Bloomsbury	26-Jun-97		
BC_0004	ISBN_0002	A001	J. K. Rowling	C03	Green	15		Harry Potter and the Philosopher's Stone	Fantasy	P001	Company Bloomsbury	7-Feb-98		
BC_0018	ISBN_0006	A001	J. K. Rowling	C03	Green	15		Harry Potter and the Order of the Phoenix	Fantasy	P001	Company Bloomsbury	16-Jul-05		
BC_0019	ISBN_0007	A001	J. K. Rowling	C03	Green	15	0.5	Harry Potter and the Half-Blood Prince	Fantasy	P001	Company Bloomsbury	21-Jul-07		
BC_0021	ISBN_0007	A001	J. K. Rowling	C03	Green	15	0.5	Harry Potter and the Half-Blood Prince	Fantasy	P001	Company Bloomsbury	21-Jul-07		
BC_0029	ISBN_0011	A002	Stephenie Meyer	C03	Green	15	0.5	New moon	Fantasy	P002	Company Woodslan	21-Aug-06		
BC_0035	ISBN_0014	A002	Stephenie Meyer	C03	Green	15		Breaking Dawn	Fantasy	P002	Company Woodslan	8-Feb-08		
BC_0070	ISBN_0031	A010	Charles Addams	C01	Yellow	3	1	The Addams Family: An Eviltion	Children	P004	Company Willington	1-Jan-10		
BC_0087	ISBN_0043	A022	Marie Curie	C02	Red	1	3	The Discovery of Radium. Research on Radioactive Substances	Science	P002	Company Woodslan	4-Sep-20		

Table name: BORROW					
Borrow_ID	Member_ID	MEM_Name	MEM_Contact	MEM_Status	BorrowDate
B001	M001	Andy Lau	60123456789	Active	20-Oct-23
B002	M002	Angelina Jolie	60112345678	Active	20-Oct-23
B003	M005	Lalisa	60145678901	Active	20-Oct-23
B004	M012	Tom Cruise	60112345678	Active	6-Nov-23
B005	M005	Lalisa	60145678901	Active	20-Nov-23
B006	M001	Andy Lau	60123456789	Active	23-Nov-23
B007	M042	Rapunzel	60112345678	Active	08-Dec-23

**Figure 3: Second Normal Form (2NF) of E-Library Member Borrow Record**

(Please take note that the yellow-highlighted column represents the primary key of the table as well as the blue-highlighted columns represent the primary key of its table and refer to the primary key of another table as a foreign key.)

Figure 3 illustrates a well-structured table adhering to 2NF. In 2NF, partial dependencies are resolved as no attribute is dependent solely on a portion of the primary key. This has greatly reduced redundancy and duplicate rows. When non-key attributes rely on the entire primary key, data integrity is enhanced due to the updates to related data are streamlined. As we can see, BookCopy\_ID and Borrow\_ID serve as primary keys within their respective tables. However, within the BORROW\_BOOKCOPY table, they are both primary keys and foreign keys. The reason that BookCopy\_ID and Borrow\_ID are both primary keys and foreign keys in the BORROW\_BOOKCOPY table is to establish the connections between the BORROW table and the BOOKCOPY table. Therefore, this relationship facilitates the retrieval of ReturnDate, DueDate and OverDue.

#### 4.4 Third Normal Form (3NF)

Table name: BORROW_BOOKCOPY					Table name: BOOK_COPY		Table name: AUTHOR	
<u>Borrow_ID</u>	<u>BookCopy_ID</u>	ReturnDate	DueDate	OverDue	<u>BookCopy_ID</u>	ISBN	<u>Author_ID</u>	AU_Name
B001	BC_0001	04-Nov-23	04-Nov-23	0	BC_0001	ISBN_0001	A001	J. K. Rowling
B001	BC_0004	04-Nov-23	04-Nov-23	0	BC_0004	ISBN_0002	A002	Stephenie Meyer
B001	BC_0018	04-Nov-23	04-Nov-23	0	BC_0018	ISBN_0006	A010	Charles Addams
B002	BC_0019	04-Nov-23	04-Nov-23	0	BC_0019	ISBN_0007	A022	Marie Curie
B003	BC_0029	05-Nov-23	04-Nov-23	1	BC_0021	ISBN_0007		
B003	BC_0035	05-Nov-23	04-Nov-23	1	BC_0029	ISBN_0011		
B004	BC_0087	08-Nov-23	7-Nov-23	1	BC_0035	ISBN_0014		
B005	BC_0004	06-Dec-23	5-Dec-23	1	BC_0070	ISBN_0031		
B006	BC_0070	26-Nov-23	26-Nov-23	0	BC_0087	ISBN_0043		
B007	BC_0021	23-Dec-23	23-Dec-23	0				

Table name: BOOK						
<u>ISBN</u>	Title	Genre	PubicationDate	Author_ID	Category_ID	Publisher_ID
ISBN_0001	Harry Potter and the Cursed Child	Fantasy	26-Jun-97	A001	C03	P001
ISBN_0002	Harry Potter and the Philosopher's Stone	Fantasy	7-Feb-98	A001	C03	P001
ISBN_0006	Harry Potter and the Order of the Phoenix	Fantasy	16-Jul-05	A001	C03	P001
ISBN_0007	Harry Potter and the Half-Blood Prince	Fantasy	21-Jul-07	A001	C03	P001
ISBN_0011	New moon	Fantasy	21-Aug-06	A002	C03	P002
ISBN_0014	Breaking Dawn	Fantasy	8-Feb-08	A002	C03	P002
ISBN_0031	The Addams Family: An Evilution	Children	1-Jan-10	A010	C01	P004
ISBN_0043	The Discovery of Radium. Research on Radioactive Substances	Science	4-Sep-20	A022	C02	P002

Table name: MEMBER				Table name: PUBLISHER	
<u>Member_ID</u>	MEM_Name	MEM_Contact	MEM_Status	<u>Publisher_ID</u>	PU_Name
M001	Andy Lau	60123456789	Active	P001	Company Bloomsbury
M002	Angelina Jolie	60112345678	Active	P002	Company Woodsland
M005	Lalisa	60145678901	Active	P004	Company Willington
M012	Tom Cruise	60112345678	Active		
M042	Rapunzel	60112345678	Active		

Table name: BORROW			Table name: CATEGORY			
<u>Borrow_ID</u>	<u>Member_ID</u>	BorrowDate	<u>Category_ID</u>	Tag	BorrowDuration	OverDueFine
B001	M001	20-Oct-23	C01	Yellow	3	1
B002	M002	20-Oct-23	C02	Red	1	3
B003	M005	20-Oct-23	C03	Green	15	0.5
B004	M012	6-Nov-23				
B005	M005	20-Nov-23				
B006	M001	23-Nov-23				
B007	M042	08-Dec-23				

**Figure 4: Third Normal Form of E-Library Member Borrow Record**

(Please take note that the yellow-highlighted column represents the primary key of the table, the green-highlighted column represents the foreign key of the table while blue-highlighted

columns represent the primary key of its table and refer to the primary key of another table as a foreign key.)

Figure 4 exhibits that there are no duplicate rows and repeating groups in 3NF. The introduction of 3NF eliminates transitive dependencies as all non-key attributes depend directly on the primary key, which in turn depends on the entire primary key. This helps to strengthen data integrity and improve data flexibility because the update of the database is reflected consistently across related data. Therefore, the tables in 3NF have determinant but there will be no tables that contain inappropriate dependencies.

## 5.0 Entity Relationship Diagram

Entity Relationship Diagram, also known as ERD, is a type of data model that is utilised to visualise the interactions of components and relationships within a system (Idrissov et al., 2020). ERD is an adapted graphical tool for the representation of sophisticated relationships. It helps to analyse data requirements to create a well-designed database. In this scenario, it is an essential process to create ERD towards the development of the e-library database (Cohen & Gil, 2021).

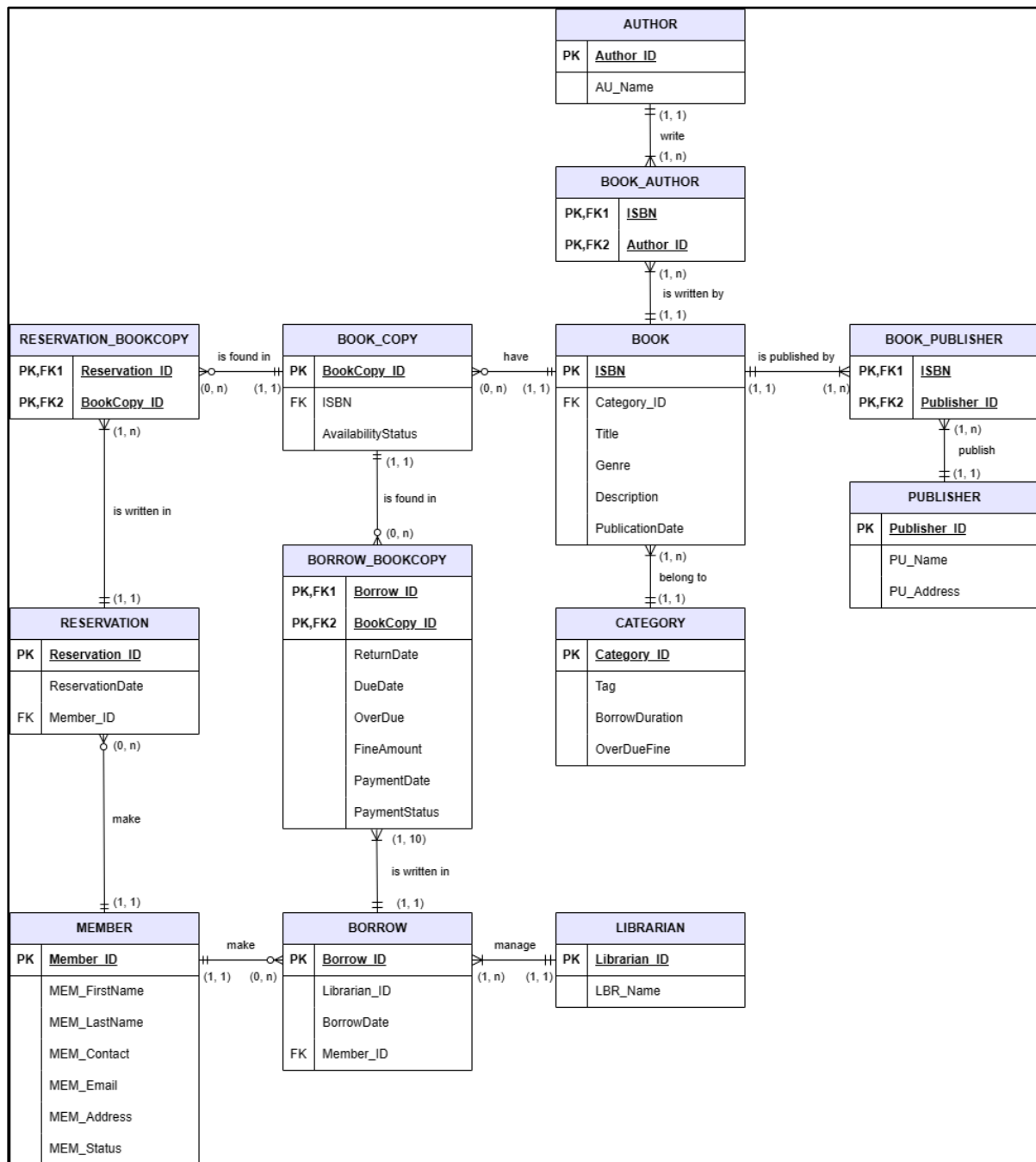


Figure 5: Entity Relationship Diagram (ERD) of the E-Library Management System

## **6.0 Conclusion**

A successful library may have an effective database management system. An efficient database management system can ensure the accuracy of the data and decrease the time-consuming on finding the data.

In this project, we determine the entities in our Entity-relationship diagram (ER diagram). We added attributes to each entity and defined the relationships between the entities. We also added cardinality and connectivity to every relationship in our ER diagram (Gliffy, 2020).

We did the normalisation which is the process of organizing data in the database. (Microsoft 365, 2023) We convert Unnormalized Form (UNF) to First Normal Form (1NF), Second Normal Form (2NF), and Third Normal Form (3NF) to ensure that there are no repeating attributes in the database. We convert UNF to 1NF by eliminating duplicate groups and redundant data. In 1NF, every cell is structured to accommodate a sole atomic value. We resolved the partial dependencies to ensure that no attribute depends uniquely on the segment of the primary key in 2NF. Lastly in 3NF, there are no repeating rows and duplicate data.

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