TUNKU ABDUL RAHMAN UNIVERSITY OF MANAGEMENT AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATION TECHNOLOGY

ACADEMIC YEAR 2023/2024

JANUARY EXAMINATION

COMPUTER SCIENCE BACS3183
ADVANCED DATABASE MANAGEMENT

WEDNESDAY, 10 JANUARY 2024 TIME: 9.00 AM – 11.00 AM (2 HOURS)

BACHELOR OF COMPUTER SCIENCE (HONOURS) IN DATA SCIENCE

BACHELOR OF INFORMATION SYSTEMS (HONOURS) IN ENTERPRISE INFORMATION SYSTEMS

BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN INTERNET TECHNOLOGY
BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN SOFTWARE SYSTEMS DEVELOPMENT

Instructions to Candidates:

Answer **ALL** questions. All questions carry equal marks.

BACS3183 ADVANCED DATABASE MANAGEMENT

Question 1

a) There are two types of information under the *nature* category. Explain and provide an example of each type within TAR UMT environment. (10 marks)

b) Explain any **FIVE (5)** disadvantages of Traditional File-based Processing System. (10 marks)

c) With reference to the TAR UMT Library environment, illustrate and explain (using ERD, Crow's Foot notation) how a "many-to-many" relationship is modelled (exclude all attributes). Many-to-many relationship need to be resolved and you must indicate the strong or weak relationship lines. (5 marks)

[Total: 25 marks]

Question 2

The *Pigeon Satellite Company's* database is shown as follows:

Customer (CustIC, CustName, CustGender, CustAddress, CustContact)
Channel (ChannelID, ChannelTitle, ChannelDescription)
Package (PackageID, PackageName, PackagePrice, NoOfChannel)
Registration (CustIC*, PackageID*, RegisterDate)
PackageChannel (PackageID*, ChannelID*, StartDate)

Note: customer gender is either 'M' for male or 'F' for female.

a) Write a ***relational algebra*** statement for each of the following questions:

(i) List out all female customers (IC, name, address and contact) whose IC number starts with '*001111*'. (3 marks)

(ii) List out all male customers (IC, name, address and contact) who are staying at '*Platinum Louis*'. (3 marks)

(iii) List out all customers (IC, name, gender and contact) who are subscribed to the '*Hokkien Festival'* (package name). (6 marks)

(iv) List out the total number of packages subscribed by each customer (IC and name). (4 marks)

Question 1 a)

Qualitative information
- It is a type of information that describes the properties or characteristics used to identify things.
- For example, the block H is TARUMT campus has color of red.

Quantitative information
- It is a type of information where the values have been measured or counted.
- For example, TARUMT campus has 4 canteens.

Question 1 b)

Program-data dependence
- Each program has to maintain the metadata for each file they use.

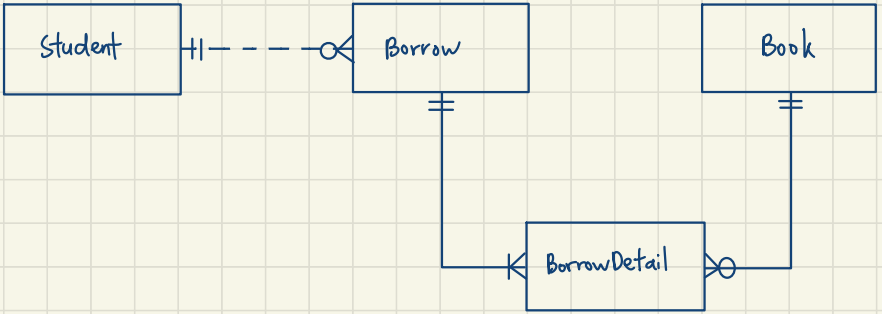
Data redundancy
- Different systems or programs have their separate copies of the same data.

Limited data sharing
- There is no centralized control of data.

Lengthy development time
- Programmers must design their own file formats.

Excessive program maintenance
- The program maintenance cost may take 80% of information system budget.

Question 1 c)



- Each student may have zero-to-many borrow records while each borrow record belongs to one and only one student.
- Each borrow record may consists of one-to-many books while each book may be listed in zero-to-many borrow records.

Question 2 a)

(i) π CustIC, CustName, CustAddress, CustContact (σ CustGender = 'F' $\wedge$ CustIC LIKE '001111%' (Customer))

(ii) π CustIC, CustName, CustAddress, CustContact (σ CustGender = 'M' $\wedge$ CustAddress LIKE '%Platinum Louis%' (Customer))

(iii) π CustIC, CustName, CustGender, CustContact (Customer) $\bowtie$ (Customer.CustIC = Registration.CustIC (Registration)) $\bowtie$ (Registration.PackageID = Package.PackageID (σ PackageName = 'Hokkien Festival' (Package)))

(iv) π CustIC, CustName (Customer) $\bowtie$ Customer.CustID = Registration.CustID $\Im$ COUNT PackageID (Registration)

Question 2 (Continued)

b) Write the ***SQL commands*** to fulfil the requirements specified for the following scenarios:

(i) All users of the database can view the customer information, but only Peggy (registration supervisor) can update the customer name, address and contact. (4 marks)

(ii) Jonathan (registration manager) can do whatever he wishes to the customer information. At the same time, Jonathan should be able to grant the privilege to others. (3 marks)

(iii) Recently, Peggy has resigned from the *Pigeon Satellite Company*, and she is no longer permitted to do anything on customer information. (2 marks)

[Total: 25 marks]

Question 3

Given the **VenueBooking** table as follows:

MemberID	MemberName	TypeID	TypeDesc	VenueID	VenueName	VenueSize	FeePerHour	Purpose	BookingDate	BookingTime
M5010	Alice	MT001	VVIP	V0001	Planet Hall	Small	100	Meeting	08/01/2022	10:00 – 12:00
M5010	Alice	MT001	VVIP	V0003	Galaxy Hall	Large	300	Press Conference	08/01/2022	14:00 – 16:00
M5010	Alice	MT001	VVIP	V0001	Planet Hall	Small	100	Meeting	11/11/2022	09:00 – 11:00
M7888	Thomas	MT003	Normal	V0003	Galaxy Hall	Large	300	Staff Meeting	11/11/2022	09:00 – 13:00
M7888	Thomas	MT003	Normal	V0003	Galaxy Hall	Large	300	Annual Dinner	12/11/2022	16:00 – 23:00
M3002	Penny	MT003	Normal	V0003	Galaxy Hall	Large	300	Married Dinner	15/03/2022	16:00 – 23:00
M3002	Penny	MT003	Normal	V0003	Galaxy Hall	Large	300	Full Moon Party	12/12/2022	11:00 – 18:00
M3355	Julie	MT002	VIP	V0002	Sunrise Hall	Medium	200	Birthday Party	12/12/2022	16:00 – 23:00

(Hint: The hourly usage fee is charged based on size of the venue.)

Table 1: Details of VenueBooking Table

a) Normalise Table 1 to a set of Third Normal Form (3NF) relations. Your answer should show all the three stages of normalisation (1NF, 2NF and 3NF) by using the Database Design Language format (underline all primary keys, composite keys and use an * to indicate the foreign keys). State the functional dependency/dependencies that is/are removed from second and third Normal Form. Besides that, 1NF must be divided into repeating and non-repeating group relations from its original 1NF table. (16 marks)

b) Based on the sample data shown in the **VenueBooking** table above, provide a specific example for insertion, modification and deletion anomalies. (9 marks)

[Total: 25 marks]

Question 2 b)

(i) GRANT SELECT(CustIC, CustName, CustGender, CustAddress, CustContact) ON Customer TO PUBLIC;
GRANT UPDATE(CustName, CustAddress, CustContact) ON Customer TO Peggy;

(ii) GRANT ALL PRIVILEGES ON Customer TO Jonathan WITH GRANT OPTION;

(iii) REVOKE ALL PRIVILEGES ON Customer FROM Peggy;

Question 3 a)

1NF;

VenueBooking (MemberID , MemberName , TypeID , TypeDesc , VenueID , VenueName , VenueSize , FeePerHour , Purpose , BookingDate , BookingTime)

Member (MemberID , MemberName, TypeID , TypeDesc)
VenueBooking (MemberID*, VenueID , VenueName, VenueSize, FeePerHour, Purpose , BookingDate , BookingTime)

2NF :

VenueID → VenueName , VenueSize , FeeperHour (Partial dependency)

Member (MemberID , MemberName , TypeID , TypeDesc)
Venue (VenueID , VenueName , VenueSize , FeePerHour)
VenueBooking (MemberID* , VenueID* , Purpose , BookingDate , BookingTime)

3NF :

TypeID → TypeDesc (Transitive dependency)
VenueSize → FeeperHour (Transitive dependency)

Member (MemberID , MemberName , TypeID*)
Type (TypeID , TypeDesc)
Venue (VenueID , VenueName , VenueSize*)
VenueSizeFee (VenueSize , FeePerHour)
VenueBooking (MemberID* , VenueID* , Purpose , BookingDate , BookingTime)

Question 3 b)

Insertion anomaly:
It is not possible to insert a new record of Member in the VenueBooking table unless the member has booked a venue.

Modification anomaly:
When we update the MemberName of the record `Alice' (M5010), we will have to update the MemberName value of the other associated rows to ensure the data consistency.

Deletion anomaly:
When we delete the member record `Julie' (M3355), the venue record `Sunrise Hall' (V0002) will also be deleted.

Question 4

a) Based on the following set of MemberID for the Member table as shown in *Table 2*:

MemberID	MemberName	MemberGender	MemberContact
111	Michelle Ong	F	012-3366998
122	Steven Tang	M	017-5896789
133	Eve Yap	F	011-33889758
144	Eric Wong	M	016-7895689
155	Amy Ng	F	016-5223030
166	Alice Tan	F	019-4455668

Table 2: Member Table

(i) Construct a *B+-tree* final structure of order 3 (6 marks)

(ii) Construct a *B+-tree* final structure of order 4 (3 marks)

b) In a multi-user environment, simultaneous access to the same data can result in interference and data loss. Assume that Dylan and Sarah are both accessing the same account as shown in the *Diagram 1* below:

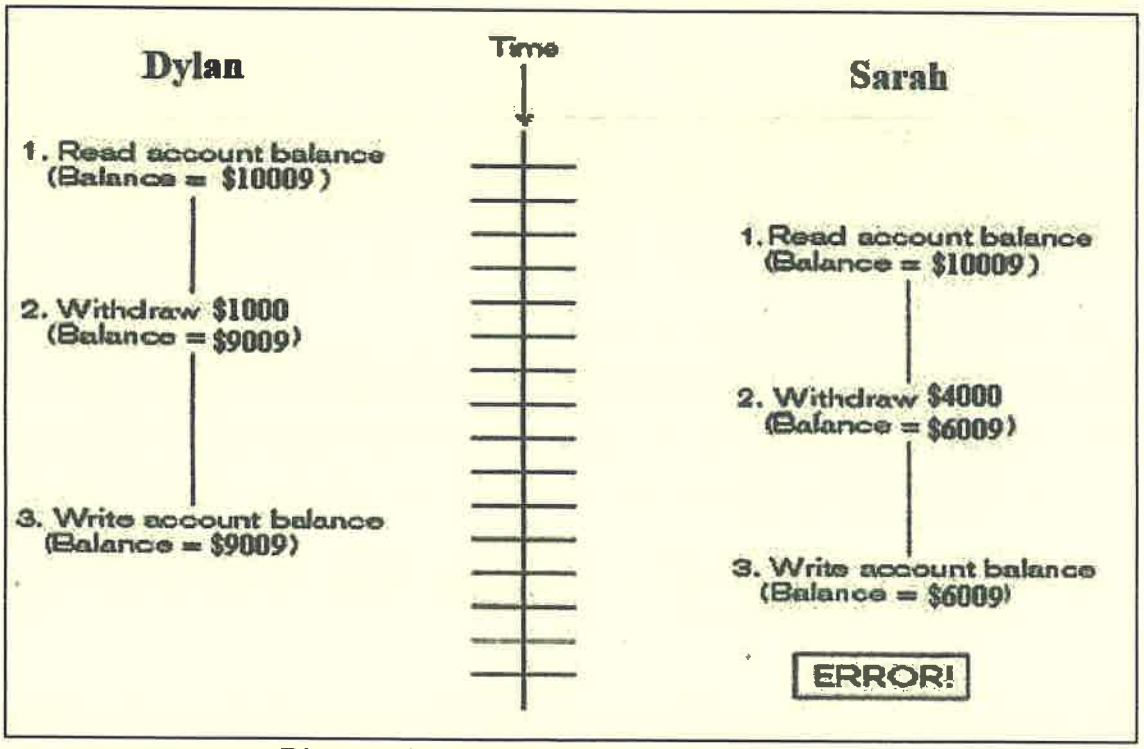


Diagram 1: Transaction with Timeline

Discuss with the help of a diagram, how the above problem can be solved through:

(i) Locking mechanism (5 + 3 marks)

(ii) Versioning approach (5 + 3 marks)

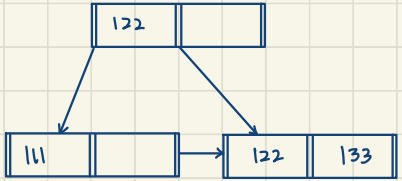
[Total: 25 marks]

Question 4 a) (i)

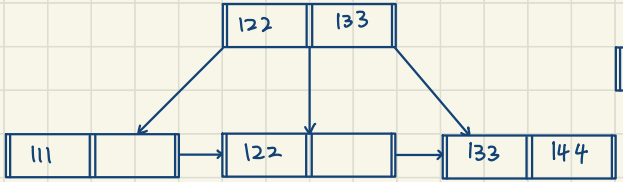
Step 1

Step 2

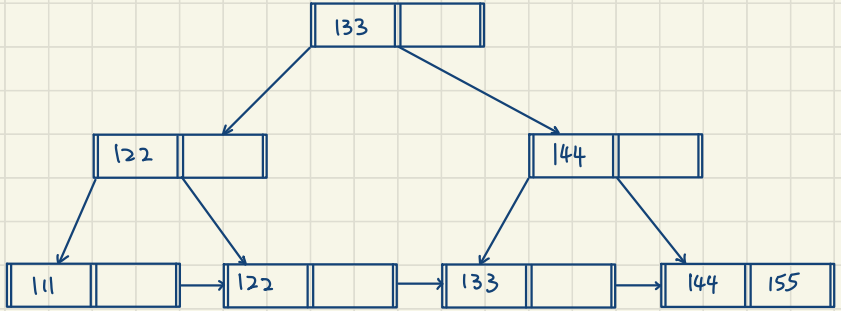
Step 3



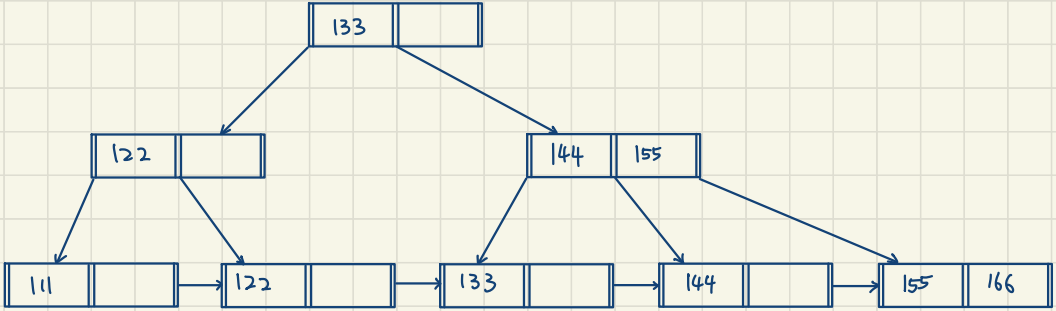
Step 4



Step 5



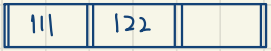
Step 6



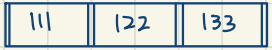
Question 4 a) (ii)

Step 1

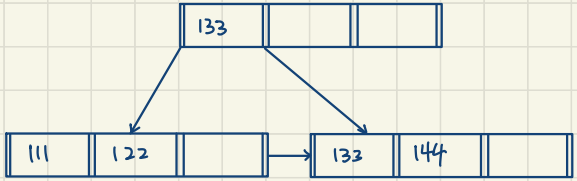
Step 2



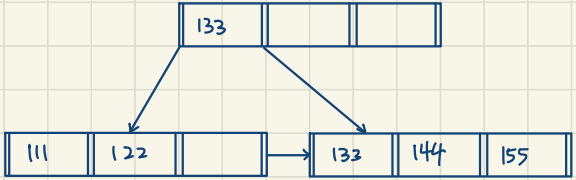
Step 3



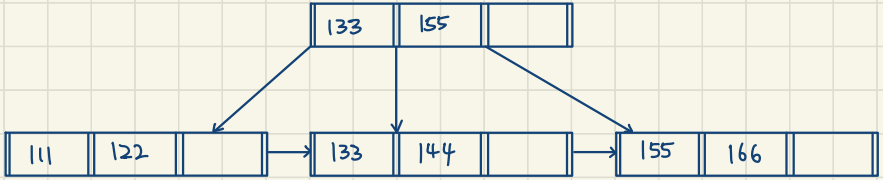
Step 4



Step 5

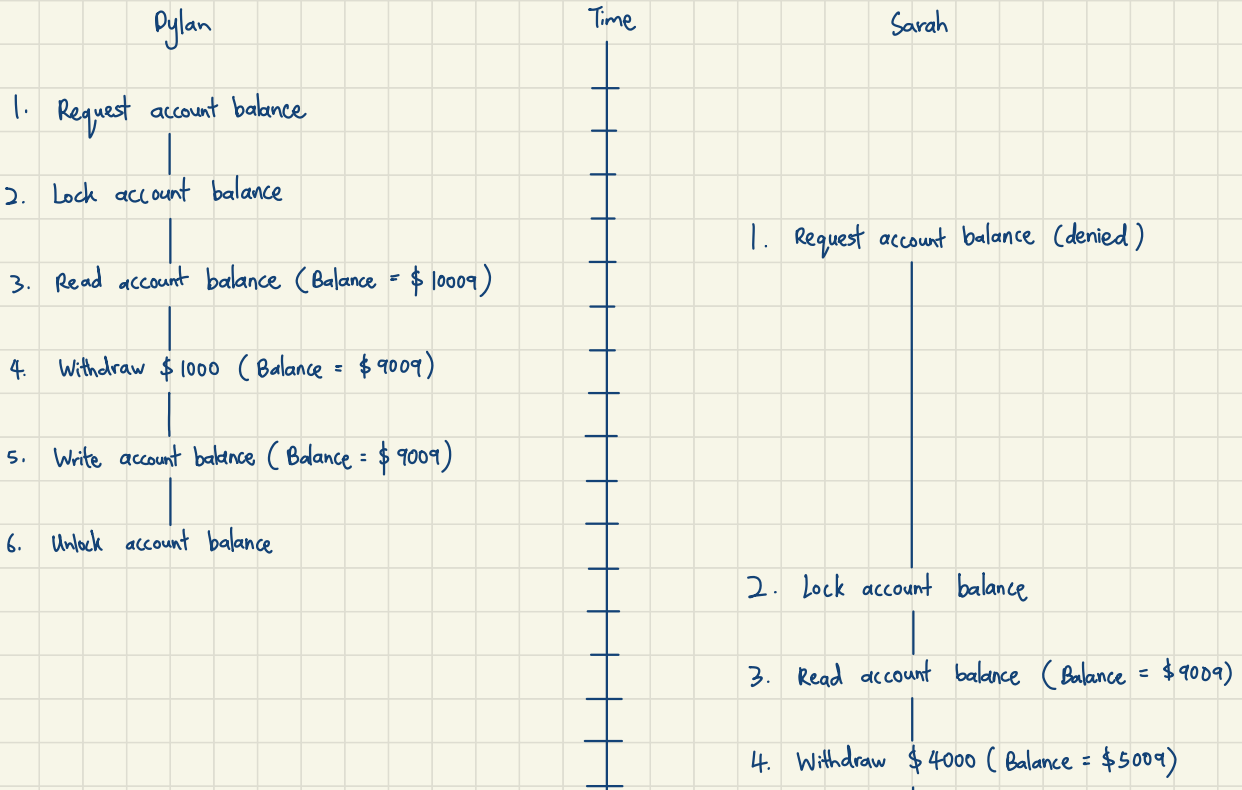


Step 6



Question 4 b) (i)

- When the first user is accessing the account balance, it will write lock on the account balance first.
- So, the second user will not be allowed to access the account balance when requesting access to account balance which is currently accessed by first user until the first user has finished transaction and unlock account balance.
- Thus, data consistency can be ensured.



5. Write account balance (Balance = 500)

6. Unlock account balance

Question 4 b) (ii)

- Versioning approach allows two users to read or update the same account balance data item concurrently
- At commit, it will check whether there is a conflict occurred on the account balance data item. If yes, the transaction will be rolled back and restarted.