

TUNKU ABDUL RAHMAN UNIVERSITY OF MANAGEMENT AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATION TECHNOLOGY

ACADEMIC YEAR 2024/2025

JANUARY EXAMINATION

BACS3183 ADVANCED DATABASE MANAGEMENT

THURSDAY, 9 JANUARY 2025

TIME: 6.30 PM – 8.30 PM (2 HOURS)

BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN INTERNET
TECHNOLOGY

BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN SOFTWARE SYSTEMS
DEVELOPMENT

BACHELOR IN DATA SCIENCE (HONOURS)

BACHELOR OF SOFTWARE ENGINEERING (HONOURS)

Instructions to Candidates:

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

Question 1

- a) For each TAR UMT item in the following table, provide an example to differentiate between *quantitative* and *qualitative* information.

	Item	Quantitative Information	Qualitative Information
(i)	Bus		
(ii)	Building		
(iii)	Tree		
(iv)	Table		
(v)	Projector		

(10 marks)

- b) With reference to the TAR UMT environment, illustrate and explain (using ERD, Crow's Foot notation) how the relationships between *Lecturer*, *Student* and *Course* entities are modelled (exclude all attributes). Many-to-many relationship needs to be resolved and you must indicate the strong or weak relationship lines. (15 marks)

[Total: 25 marks]

Question 2

The *Animal Adoption System*'s database is shown as follows:

Zoo (ZooID, ZooName, SizeInAcres, OperationDate, CountryID*)
Country (CountryID, CountryName)
Animal (AnimalID, AnimalName, AnimalGender, Quantity, CategoryID*)
Category (CategoryID, CategoryName)
AnimalAdoption (ZooID*, AnimalID*, AdoptionDate, CostPerUnit, AdoptionQuantity)

Note: animal gender is either 'M' for male, 'F' for female or 'H' for Hermaphrodite. Different animal ID will be assigned to animals based on its gender.

- a) Write a *relational algebra* statement for each of the following questions:
- List out all animals (ID, name, gender and quantity) which are under the 'Cat' category. (3 marks)
 - List out all zoos (ID, name, size and operation date) within Malaysia. (3 marks)
 - List out all hermaphroditic animals (ID, name and quantity) which are adopted by 'Safari Zoo' in the month of May 2024. (6 marks)
 - List out the total quantity of animals for each animal category (ID and name). (4 marks)

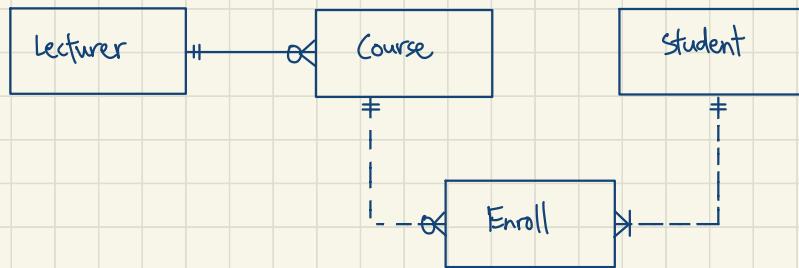
Question 1

- a) For each TAR UMT item in the following table, provide an example to differentiate between *quantitative* and *qualitative* information.

	Item	Quantitative Information	Qualitative Information
(i)	Bus	Maximum passenger capacity is 30 people.	The color of the bus is yellow.
(ii)	Building	The height of the building is 50 meters.	The color of the building is red.
(iii)	Tree	The number of fruits on the tree is 30.	The leaves of the tree has green color.
(iv)	Table	The table's surface area is 150 cm^2 .	The texture of the table is smooth.
(v)	Projector	The projector has a weight of 6 kg.	The brightness of the projector display is bright.

(10 marks)

- b) With reference to the TAR UMT environment, illustrate and explain (using ERD, Crow's Foot notation) how the relationships between *Lecturer*, *Student* and *Course* entities are modelled (exclude all attributes). Many-to-many relationship needs to be resolved and you must indicate the strong or weak relationship lines. (15 marks)



- Each lecturer can teach zero-to-many courses and each course can only be assigned to one and only one lecturer.
- Each student can enroll for zero-to-many courses and each course can be taken by zero-to-many students.

Question 2

- a) (i) $\pi \text{ AnimalID, AnimalName, AnimalGender, Quantity } (\text{Animal}) \bowtie (\text{Animal. CategoryID} = \text{Category. CategoryID} \wedge \text{CategoryName} = \text{'Cat'} (\text{Category}))$
- (ii) $\pi \text{ ZooID, ZooName, SizeInAcres, OperationDate } (\text{Zoo}) \bowtie (\text{Zoo. CountryID} = \text{Country. CountryID} \wedge \text{CountryName} = \text{'Malaysia'} (\text{Country}))$
- (iii) $\pi \text{ AnimalID, AnimalName, Quantity } (\text{AnimalGender} = \text{'H'} (\text{Animal})) \bowtie (\text{Animal. AnimalID} = \text{AnimalAdoption. AnimalID} \wedge \text{AdoptionDate} \geq \text{'01/05/2024'} \wedge \text{AdoptionDate} \leq \text{'31/05/2024'} (\text{AnimalAdoption})) \bowtie (\text{AnimalAdoption. ZooID} = \text{Zoo. ZooID} \wedge \text{ZooName} = \text{'Safari Zoo'} (\text{Zoo}))$
- (iv) $\pi (\text{CategoryID}, \text{CategoryName}) (\text{Category}) \bowtie \text{Category. CategoryID} = \text{Animal. CategoryID} \text{ } \exists \text{ } \text{sum } \text{Quantity } (\text{Animal})$

BACS3183 ADVANCED DATABASE MANAGEMENT**Question 2 (Continued)**

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

	Object (Table)	Access (Yes / No)	Authorisation	User	Allow other users to access (Yes / No)	
(i)	Animal	Yes	Read on AnimalID, AnimalName and Quantity.	All Users	No	(2 marks)
(ii)	Animal	Yes	Update on Quantity.	Wendy	No	(2 marks)
(iii)	Animal	Yes	Can do everything.	Selina	Yes	(3 marks)
(iv)	Animal	No	No authorisation.	Vincent	No	(2 marks)

[Total: 25 marks]

Question 3

Given the **PackageRegistration** table as follows:

CustID	CustName	NationalityID	NationalityDesc	PackageID	PackageName	PackageCost	ProviderID	ProviderName	RegistrationDate	PhoneNo
C1001	Eric	N060	Malaysian	P108	Prepaid 5G 25	25.00	P0003	Digi	01/01/2023	016-3966112
C1001	Eric	N060	Malaysian	P203	Hotlink 100GB 5G	35.00	P0001	Maxis	01/01/2023	012-3366887
C1001	Eric	N060	Malaysian	P108	Prepaid 5G 25	25.00	P0003	Digi	02/03/2024	012-3366887
C1008	Selina	N065	Singaporean	P108	Prepaid 5G 25	25.00	P0003	Digi	08/03/2023	016-4587125
C1008	Selina	N065	Singaporean	P203	Hotlink 100GB 5G	35.00	P0001	Maxis	15/06/2024	012-4877457
C1100	Wendy	N065	Singaporean	P301	U Prepaid 40	40.00	P0002	U Mobile	12/08/2023	018-3881818
C1322	Siti	N062	Indonesian	P203	Hotlink 100GB 5G	35.00	P0001	Maxis	11/11/2023	012-3552525
C1322	Siti	N062	Indonesian	P108	Prepaid 5G 25	25.00	P0003	Digi	03/01/2025	012-3552525

NOTE: Customer can change package using the same phone number.

Table 1: Details of PackageRegistration 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 **PackageRegistration** table above, provide a specific example for insertion, modification and deletion anomalies. (9 marks)

[Total: 25 marks]

Question 2 b)

- (i) GRANT SELECT (AnimalID, AnimalName, Quantity) ON Animal TO PUBLIC;
- (ii) GRANT UPDATE (Quantity) ON Animal TO Wendy;
- (iii) GRANT ALL PRIVILEGES ON Animal TO Selina WITH GRANT OPTION;
- (iv) REVOKE ALL PRIVILEGES ON Animal FROM Vincent;

Question 3 a)

INF:

Package Registration (CustID, CustName, NationalityID, NationalityDesc, PackageID, PackageName, PackageCost, ProviderID, ProviderName, RegistrationDate, PhoneNo)



Customer (CustID, CustName, NationalityID, NationalityDesc)

Package Registration (CustID*, PackageID, PackageName, PackageCost, ProviderID, ProviderName, RegistrationDate, PhoneNo)

2NF:

$\text{Package ID} \rightarrow \text{PackageName, PackageCost, ProviderID, ProviderName}$ (Partial dependency)

$\text{Customer} (\underline{\text{CustID}}, \text{CustName}, \text{NationalityID}, \text{NationalityDesc})$

$\text{Package} (\underline{\text{PackageID}}, \text{PackageName}, \text{PackageCost}, \text{ProviderID}, \text{ProviderName})$

$\text{PackageRegistration} (\underline{\text{CustID}}^*, \underline{\text{PackageID}}^*, \underline{\text{RegistrationDate}}, \text{PhoneNo})$

3NF:

$\text{NationalityID} \rightarrow \text{NationalityDesc}$ (Transitive dependency)

$\text{ProviderID} \rightarrow \text{ProviderName}$ (Transitive dependency)

$\text{Customer} (\underline{\text{CustID}}, \text{CustName}, \text{NationalityID}^*)$

$\text{Package} (\underline{\text{PackageID}}, \text{PackageName}, \text{PackageCost}, \text{ProviderID}^*)$

$\text{Nationality} (\underline{\text{Nationality}}, \text{NationalityDesc})$

$\text{Provider} (\underline{\text{ProviderID}}, \text{ProviderName})$

$\text{PackageRegistration} (\underline{\text{CustID}}^*, \underline{\text{PackageID}}^*, \underline{\text{RegistrationDate}}, \text{PhoneNo})$

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

Insertion anomaly :

It is not possible to add a new customer record in the table unless the customer has registered for a package.

Modification anomaly :

When we update the **ProviderName** of record 'P0001' from 'Maxis' to 'Maxis Plus', we also have update the similar **ProviderName** in other rows to prevent data inconsistency.

Deletion anomaly :

When we delete the **PackageRegistration** record named 'Wendy' (C100), we will also delete the package record of 'U Prepaid 40' (P301).

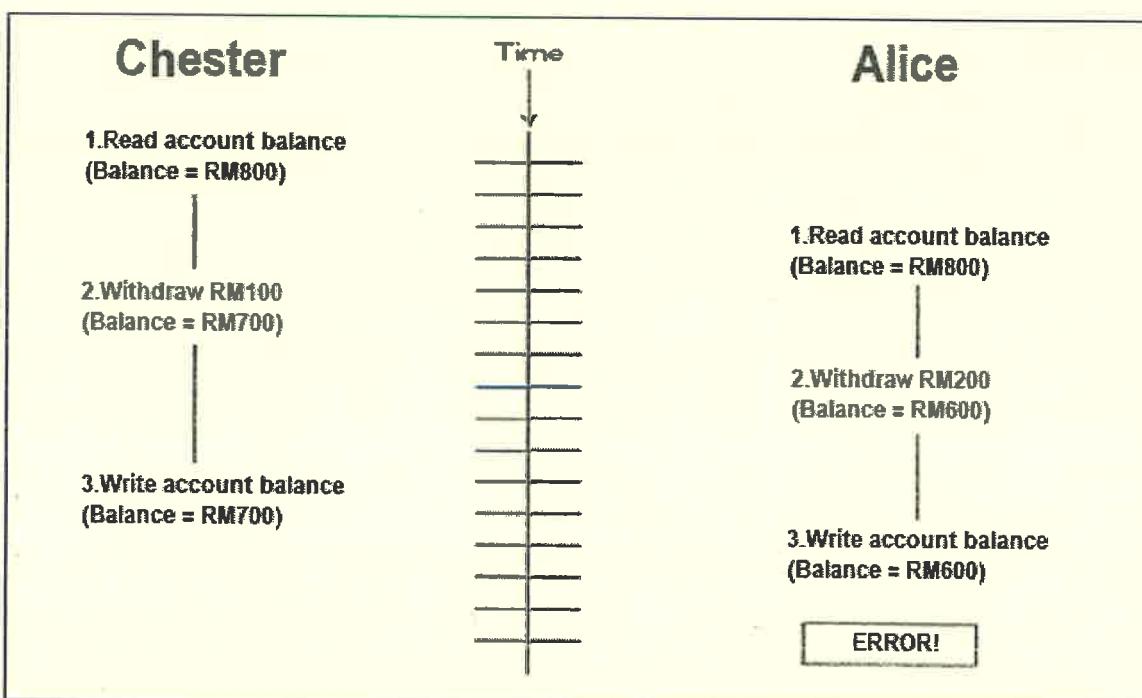
Question 4

- a) Based on the following set of AnimalID for the **Animal** table as shown in *Table 2*:

AnimalID	AnimalName	CostPerUnit	Qty
201	Kalimantan Tiger	50800.00	2
202	Indonesia Elephant	35800.00	3
203	Snow Penguin	25400.00	2
204	White Peacock	18500.00	1
205	Africa Snail	500.00	5
206	Orang-utan	32500.00	2

Table 2: Animal Table

- (i) Construct a *B+-tree* final structure with degree of 3 (6 marks)
- (ii) Construct a *B+-tree* final structure with degree of 4 (4 marks)
- (iii) Construct a *B+-tree* final structure with degree of 5 (3 marks)
- b) In a multi-user environment, simultaneous access to the same data can result in interference and data loss. Assume that Chester and Alice are both accessing the same account as shown in *Figure 1* below:

**Figure 1: Transaction with Timeline**

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

- (i) Versioning approach (4 + 2 marks)
- (ii) Locking mechanism (4 + 2 marks)

[Total: 25 marks]

Question 4 a)

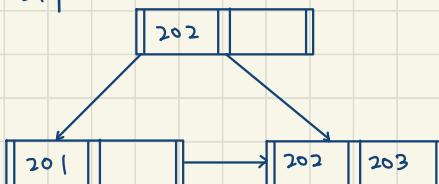
(i) Step 1



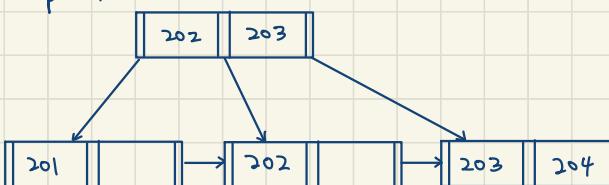
Step 2



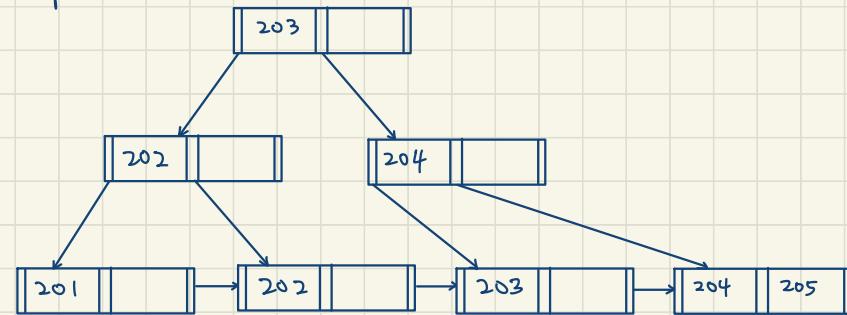
Step 3



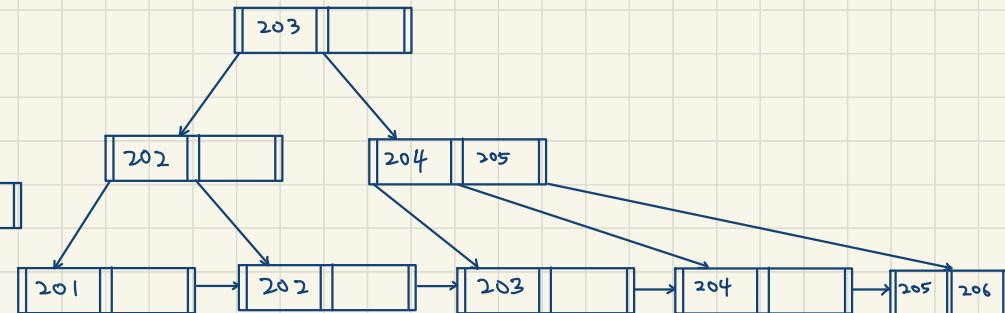
Step 4



Step 5



Step 6



(ii)

Step 1



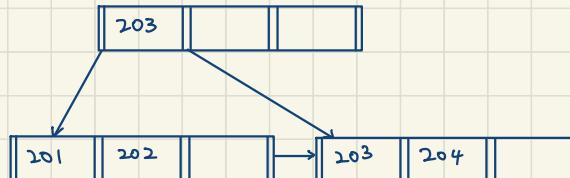
Step 2



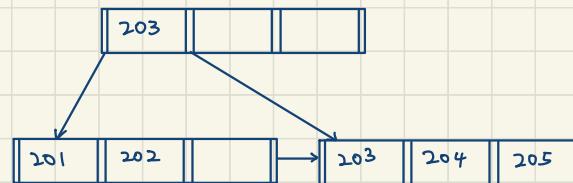
Step 3



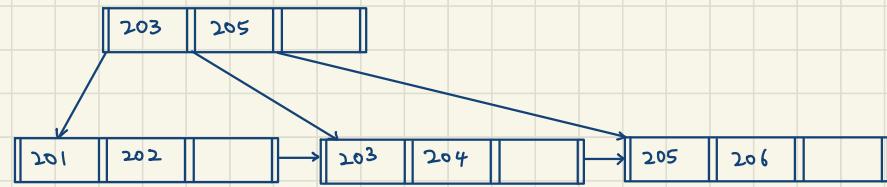
Step 4



Step 5



Step 6



(iii)

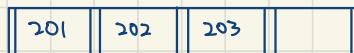
Step 1



Step 2



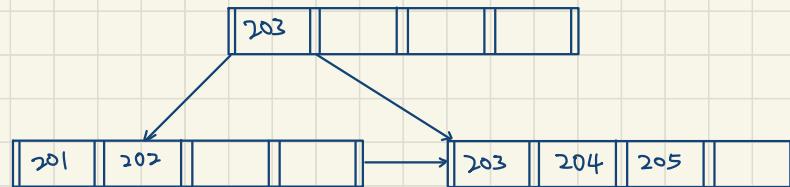
Step 3



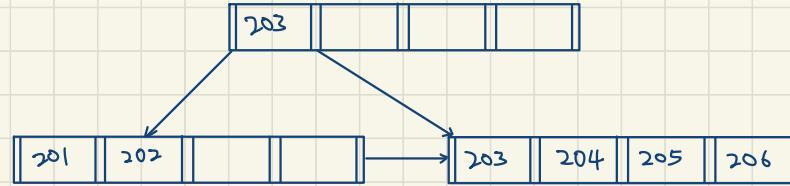
Step 4



Step 5



Step 6



Question 2 b)

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

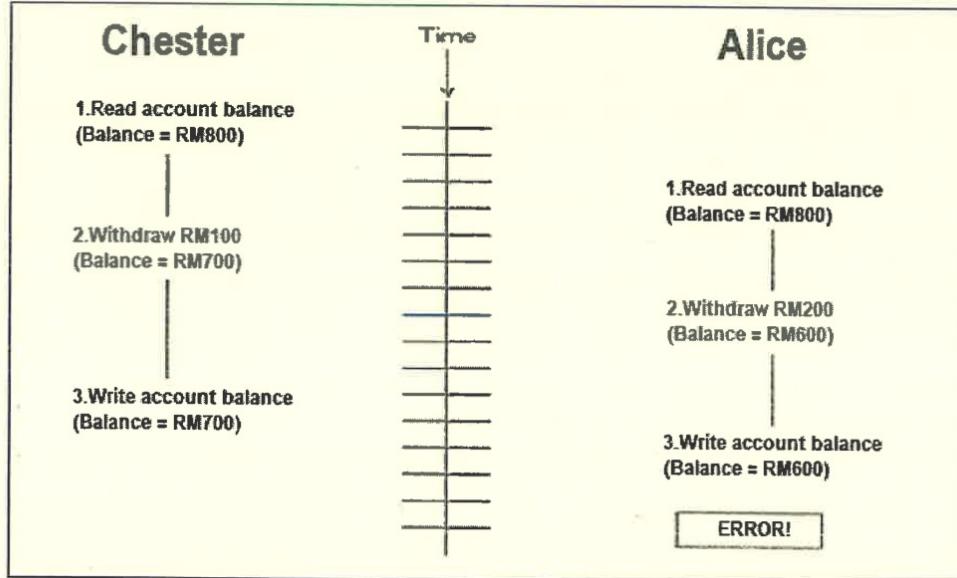


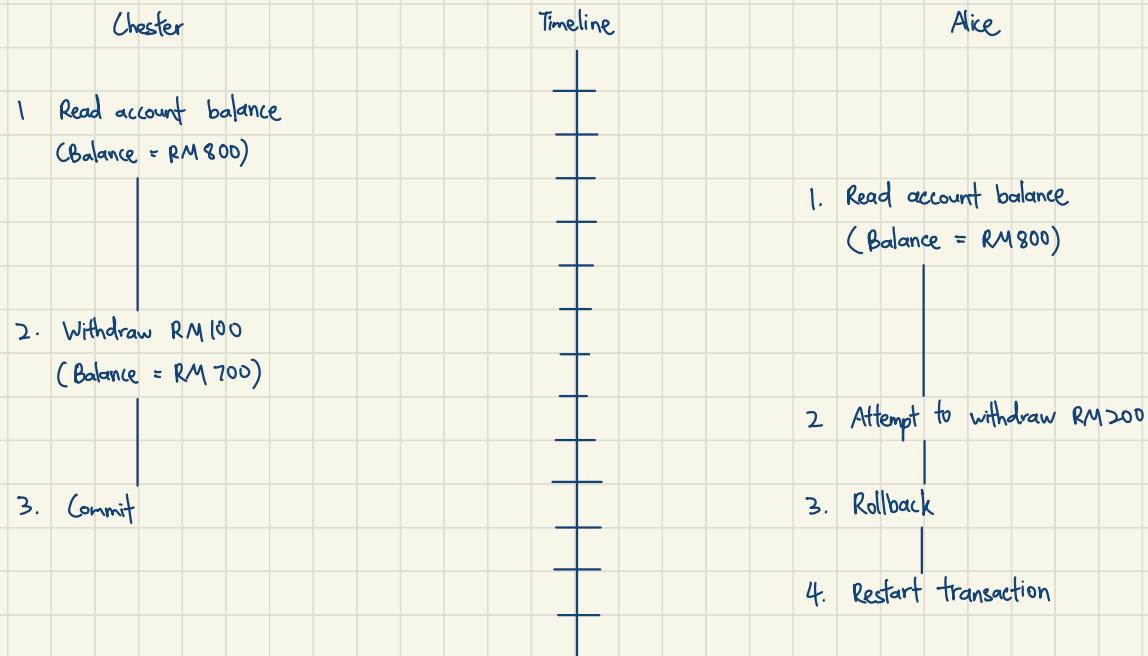
Figure 1: Transaction with Timeline

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

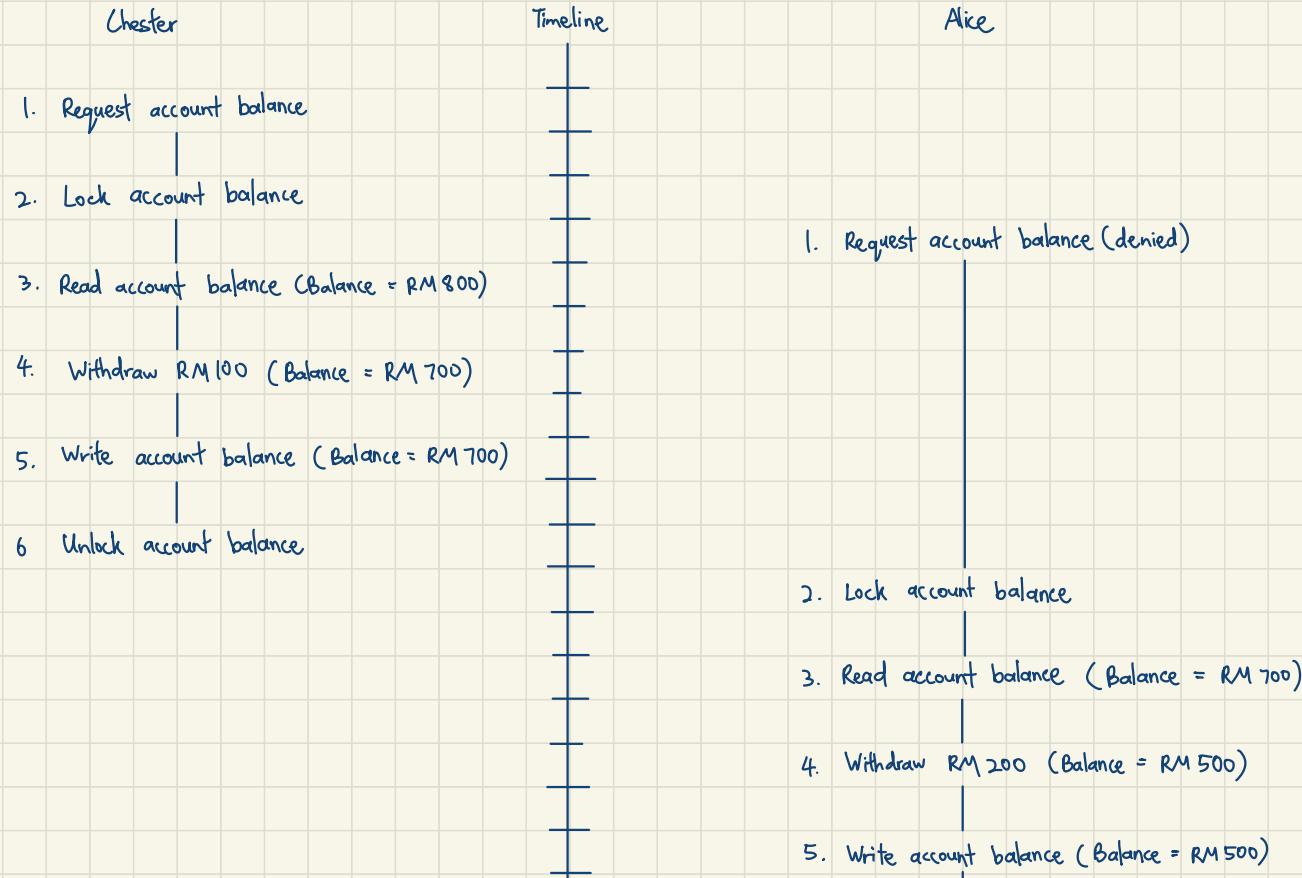
- (i) Versioning approach (4 + 2 marks)
- (ii) Locking mechanism (4 + 2 marks)

[Total: 25 marks]

- (i) - Versioning approach will allow concurrent users to read and update the same item data with version number labeling, but it will check whether there is conflict before committing.
- If the version is unchanged, it will commit the changes and increment the version.
 - Else, it will rollback the transaction and restart transaction with the latest version.



- (ii) - When one user want to read or write the data, the transaction will locks the data.
- So, other transaction must wait or are blocked until the lock is released.
- It can prevent transaction and data conflicting but consuming more computational resources.



6. Unlock account balance

Lecturer answer explanation :

Versioning approach :

Optimistic approach to concurrency control. Assumption is that simultaneous updates will be infrequent. Each transaction can attempt an update as it wishes. The system will reject an update when it senses a conflict. Use of rollback and commit for this.

Locking mechanism :

The most common way of achieving serialization. Finish one transaction before starting another. Data that is retrieved for the purpose of updating is locked for the updaters. No other user can perform update until unlocked.