Cairo University	CMP401 Advanced Database Systems
Faculty of Engineering	External Final Exam - Fall 2013
Computer Engineering Department	Sunday 5/1/2014 - 120 Minutes

Question 1:

Choose ALL suitable answers.

1. Databases are usually stored in secondary storage because
   - (a) databases are usually too big to fit in main memory
   - (b) secondary storage is more reliable
   - (c) secondary storage is faster
   - (d) the cost of secondary storage devices is cheaper than main memory
   - (e) none of the above
2. When a disk is initialized, the interblock gaps are used for
   - (a) marking the end of a block
   - (b) avoiding interblock interference
   - (c) identifying the next block
   - (d) give the read/write head room to move across cylinders
   - (e) none of the above
3. A disk is rated at 5000 rpm and 8 ms seek time. The average rotational delay is
   - (a) 8 ms
   - (b) 12 ms
   - (c) 20 ms
   - (d) 28 ms
   - (e) none of the above

4. For double buffering to improve performance all of the following must be true

   (a) read and write operations must be allowed to be performed simultaneously

   (b) separate processor must be available to handle disk I/O

   (c) the block processing time must be greater than the block reading time

   (d) the block processing time must be smaller than the block reading time

   (e) none of the above

5. Record format should encode fields in the format <field-type, field-value> when

   (a) the record has a variable length format

   (b) the record has a few optional fields

   (c) the record has many optional fields but few actually appear in each record

   (d) when records have attributes that consist of large unstructured objects

   (e) none of the above

6. An ordered file has $r = 10000$ records with the following record structure (4-byte ID, 28-byte Name), where ID is the primary key. If the block pointer is 4 bytes and the block size $B = 512$ bytes, a search for a record with a specific ID takes

   (a) 2 block accesses

   (b) 10 block accesses

   (c) 11 block accesses

   (d) 63 block accesses

   (e) none of the above

7. Except for the last block in a file of records with unspanned organization the wasted space per block is at most

   (a) 0 bytes

   (b) size of block pointer

   (c) B/R

   (d) $B - bfr * R$

   (e) none of the above

8. Record insertion operation is most efficient in

   (a) spanned files
   (b) unspanned files
   (c) ordered files
   (d) unordered files
   (e) none of the above

9. A technique for collision resolution in hashed files by storing the record at the first unused position subsequent to the occupied position specified by the has function

   (a) open addressing
   (b) chaining
   (c) dynamic hashing
   (d) multiple hashing
   (e) none of the above

10. A file is stored using linear hashing. Accessing a record using its ID takes at most

    (a) 1 block accesses
    (b) 2 block accesses
    (c) d block accesses (where d is the global depth)
    (d) $d + 1$ block accesses
    (e) none of the above

11. A file of records (NAME, CITY) where NAME is the only key attribute is usually searched by CITY. The following indexing structure can improve search performance

    (a) primary index
    (b) non-dense secondary index
    (c) dense secondary index
    (d) clustering index
    (e) none of the above

12. Making indexes multilevel improve search efficiency because

(a) they support conjunctive queries more efficiently
(b) they allow searching by multiple keys
(c) they reduce the required storage space
(d) they reduce the number of blocks accessed
(e) none of the above

13. B^+-trees may be preferred to B-trees because

(a) B^+-trees have smaller fan out
(b) B^+-trees have smaller depth
(c) B^+-trees store key values only at leaf nodes
(d) B^+-trees internal nodes, except the root, are at least half-full
(e) none of the above

14. Partitioned hashing is better than regular hashing because

(a) they support conjunctive queries more efficiently
(b) they allow searching by multiple keys
(c) they reduce the required storage space
(d) they reduce the number of blocks accessed
(e) none of the above

15. A method for efficiently sorting large files that won't fit in RAM

(a) external sorting
(b) extensible hashing
(c) partitioned hashing
(d) merge sort

16. Network Attached Storage technology are better than SAN technology with respect to

(a) Off-loading file system management to the storage device
(b) higher throughput
(c) improved reliability
(d) higher utilization of storage space
(e) none of the above

17. Incremental logging with deferred updates implies that the recovery subsystem must necessarily

(a) store the old value of the updated item in the log

(b) store the new value of the updated item in the log

(c) store both the old and the new value of the updated item in the log

(d) store only the Begin Transaction and Commit Transaction records in the log

(e) none of the above

18. In case of transaction failure under a deferred update incremental logging scheme, which of the following will be needed?

(a) an undo operation

(b) a redo operation

(c) an undo and redo operation

(d) none of the above

19. When using a log based recovery scheme, it might improve performance as well as provide a recovery mechanism by

(a) writing the log record to disk when each transaction commits

(b) writing the appropriate log records to disk during the transaction execution

(c) waiting to write the log records until multiple transactions commit and writing them as a batch

(d) never writing the log records to the disk

(e) none of the above

20. The owner account of a relation in a database

(a) is always the database administrator

(b) is always the creator of the database

(c) is typically the creator of the relation

(d) has full privileges on the relation

(e) none of the above

Question 2

1. **Under what situations whould denormalization of a database schema be preferable? Give an example of useful denormalization.**

Denormalization is preferable under heavy read-load and when the application is read intensive. Because:

1- The data is present in the same table so there is no need for any joins, hence the selects are very fast.

2- A single table will all the required data allows much more efficient index usage. If the columns are indexed properly, then results can be filtered and sorted by utilizing the same index.

for example

a large database with complex schemas, and it's require to retrieve data from twelve or more tables in a single query, and the application need to perform this query hundreds of times per minute & the speed of data retrieval is important factor.

So in this case a denormalization is preferable to be performed.

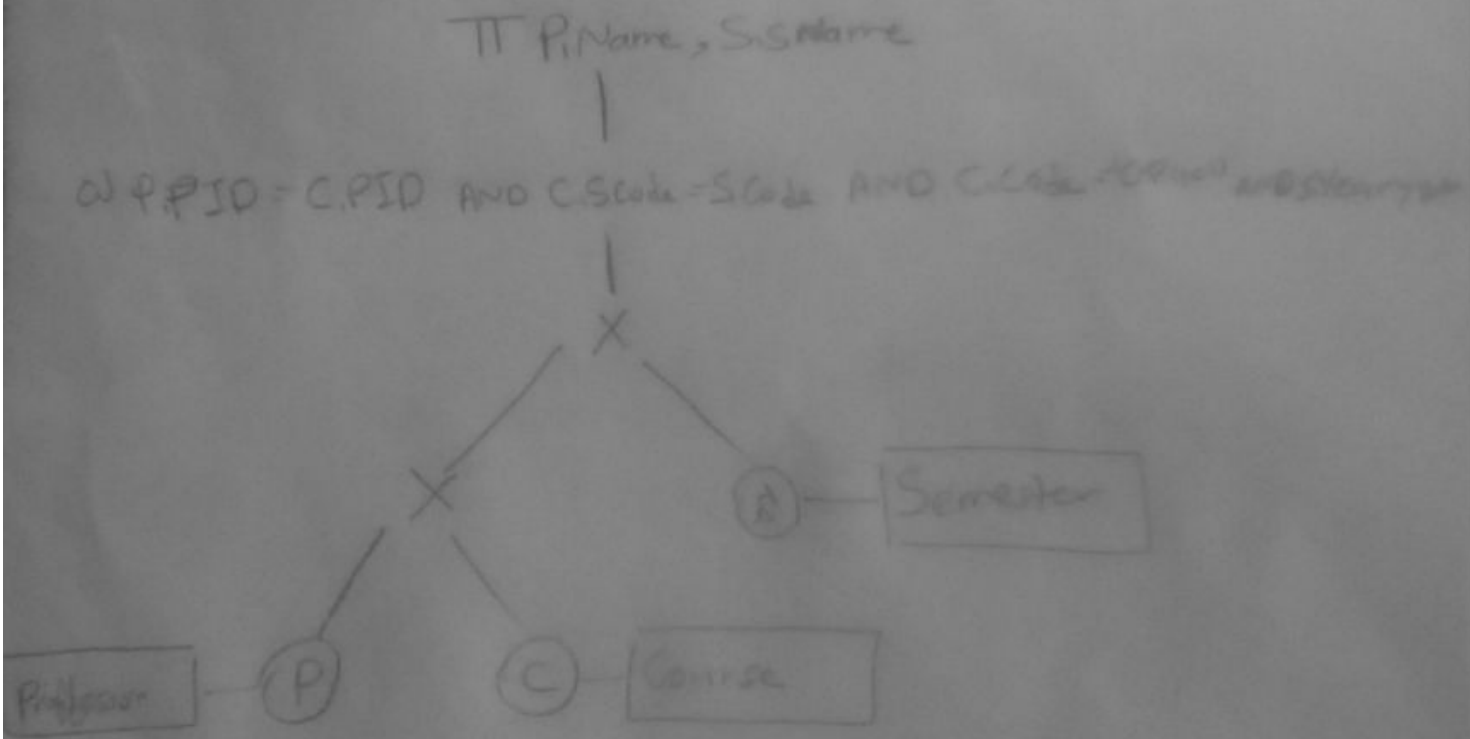
2. Given the following relations for the entities Professor, Course and Semester:

Professor (PID, Name, DeptID)
Course(Code, CName, DeptID, PID,SCode)
Semester(Code, Year, SName)

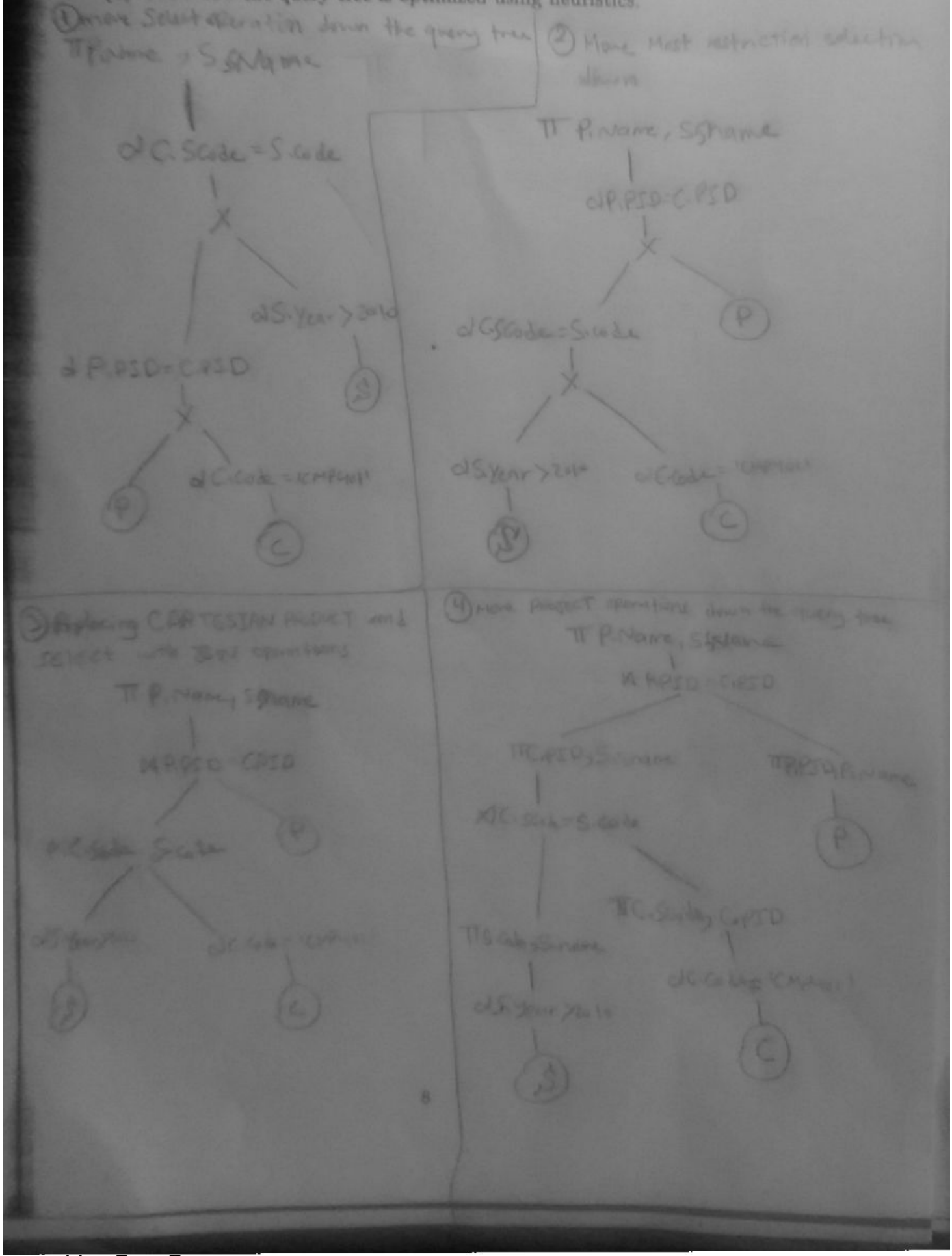
And the following Query
SELECT P.Name, S.SName FROM Professor P, Course C, Semester S
WHERE P.PID = C.PID AND C.SCode = S.Code AND C.Code = "CMP401"
AND S.Year>2010

Assume all ID attributes are 4 bytes, all Code attributes are 10 bytes and all Name attributes are 50 bytes. A block is 512 bytes.

(a) Draw the initial query tree .



(b) Show how the query tree is optimized using heuristics.



Question 3

1. **Describe the ACID properties of transactions**

*Atomicity: A transaction is an atomic unit of processing. It should be performed in its entirety or not performed at all.

*Consistency preservation: It should take the database from one consistent state to another, if it's completely executed without interference from other transactions.

*Isolation: a transaction should appear as though it's executed in isolation from other transactions (The execution of a transaction should not be interfered with by any other transaction executing concurrently).

*Durability: The changes applied to the database by a committed transaction must persist in the database.

2. **Use an example to show how shared locks improve concurrency**

When an insertion is being applied to a database then a specific leaf node must be locked in exclusive mode. If that node is not full the insertion will not cause changes to higher-level index nodes which implies that they need not be locked exclusively.

A conservative approach for insertions would be to lock the root node in exclusive mode and then to access the appropriate child node of the root.

More optimistic approach would be to request and hold shared locks on the nodes leading to the leaf nodes, with an exclusive lock on the leaf. If the insertion causes the leaf to split, the insertion will propagate to one or more higher-level nodes. Then the locks on the higher-level nodes can be upgraded to exclusive mode.

3. Give an example for two of the three problems that may occur when concurrent execution is uncontrolled.

* The Lost Update Problem:

- This occurs when two transactions that access the same database items have their operations interleaved in a way that makes the value of some database item incorrect.

* The Temporary Update:

- This occurs when one transaction updates a database item and then the transaction fails for some reason.
- The update item is accessed by another transaction before it is changed back to its original value.

* The Incorrect Summary problem:

- If one transaction is calculating an aggregate summary function on a number of records while other transactions are updating some of these records, the aggregate function may calculate some values before they are updated and others after they are updated.

4. Consider the three transactions T_1, T_2, and T_3, and the schedules S_1 and S_2 given below.

$T_1 : r_1(X); r_1(Z); w_1(X)$

$T_2 : r_2(Z); r_2(Y); w_2(Z); w_2(Y)$

$T_3 : r_3(X); r_3(Y); w_3(Y)$

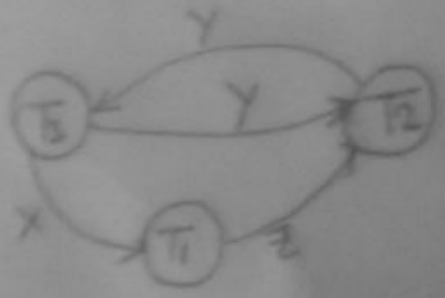
$S_1 : r_1(X); r_2(Z); r_3(X); r_1(Z); r_2(Y); r_3(Y); w_1(X); w_2(Z); w_3(Y); w_2(Y); c_1; c_2; c_3$

$S_2 : r_1(X); r_2(Z); r_1(Z); r_3(X); r_3(Y); w_1(X); w_3(Y); r_2(Y); w_2(Z); w_2(Y); c_1; c_2; c_3$

(a) Draw the serializibility (precedence) graphs for S_1 and S_2 and state whether each schedule is serializable or not. If a schedule is serializable, write down the equivalent serial schedule(s).

S1: Not Serializable

* Cycle $X(T_3 \to T_1), Z(T_1 \to T_2); Y(T_2 \to T_3)$
* Cycle $Y(T_2 \to T_3), Y(T_3 \to T_2)$

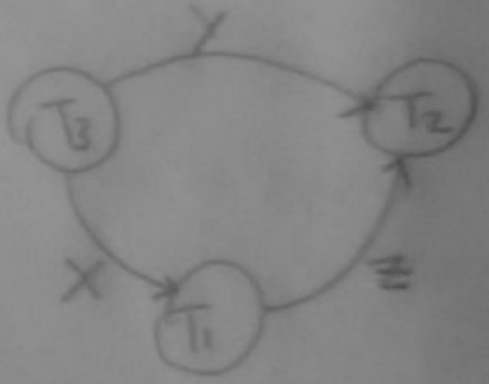


S2:

Serializable

Serial schedule is

T_3 T_1 T_2



(b) Determine whether S_2 is strict, cascadeless, recoverable or nonrecoverable and justify your answer.

Nonrecoverable, because T_2 read Y after T_3 write Y and T_2 is commited first.

Question 4

1. Consider the Wait-Wound and the Wait-Die schemes

   (a) What are they used for?

   They used for deadlock avoidance

   (b) What are the common aspects and the different aspects between them?

Common aspects:

- Both shares abort younger transaction that may be involved in deadlock
- Both deadlock free but may cause endless aborts

Different aspects:

Wait-Wound	Wait-Die
- Younger transaction is allowed to wait on older transaction - older transaction requesting item held by younger transaction aborts it.	- older transaction is allowed to wait on younger transaction - younger transaction requesting an item held by older transaction is aborted and restarted

   (c) How do they avoid starvation of transactions?

Wait-Die:
by allowing wait only if waiting process is older.
Since timestamps increase in any chain of waiting processes cycles are impossible

Wound-wait:
allow wait only if waiting process is younger and the timestamps decrease in any chain of waiting process.

To avoid starvation a process should not be assigned a new timestamp each time it restarts.

2. For recovery in ARIES, study the shown log at time of crash.

(a) Show the transaction table and the dirty page table at time of check point and after the analysis phase of the recovery process.

(b) Explain what will happen in the other two phases of the recovery process

LSN	Last_LSN	Trans_Id	Type	Page_Id
1	0	T1	Update	A
2	0	T2	Update	B
3	2	T2	Commit	
4	Begin checkpoint			
5	End checkpoint			
6	1	T1	Commit	C
7	0	T3	Update	
8	7	T3	Commit	A

Question 5

1. How can the view mechanism be used as an authorization mechanism?

If the owner A of a relation R wants another account B to be able to retrieve only some fields of R, then A can creat a view V of R that include only those attributes and then grant Select on V to B.

So now B can only retrive certain part of R and blocked from the other part.

2. Discuss the system of propagation of privileges and the revokation thereof

Propagation:
Giving Grant of Privilege to other accounts without knowledge of owner account
i.e. GRANT OPTION

Revokation:
Is desirable to Grant a Privilege to a user temporary
i.e. owner Grant Privilege to user for specific task and wants to revoke it after the task end.
He use Revoke command.

top secret

secret

unclassified

$TS \geq S \geq C \geq U$

confidential

3. Consider the relation shown below using mandatory access control.

   (a) Fill in the proper values for TC (tuple classification)

   (b) How would it appear to a user with classification U?

   (c) Suppose a classification U user tries to update the salary of "Ahmed" to 50,000; what would be the result of this action? And why is this necessary?

National ID	Name	Salary	Job Performance	TC
123456789	Ahmed	40,000 C	Fair S	S
234567891	Hassan	60,000 C	Good S	S

S > C

b)

123456789	Ahmed	Null (U)	Null (U)	U
234567891	Hassan	Null (U)	Null (U)	U

c)

123456789	Ahmed	40,000 (C)	Fair (S)	S
123456789	Ahmed	50,000 (U)	Null (U)	U
234567891	Hassan	Null (U)	Null (U)	U

→ invisible to U

→ Visible to U

This is called Polyinstantiation which allows different versions of the same information to exist of different classification levels.

It's necessary because it will hide the security level of the column and the user will see the record's information depending on his/her security level.