COMP518 Assignment 3 (of 3): 25% of the final grade

Due: 17:00 on Thursday, January 7th

Please submit your solutions **electronically**, based on the following instructions, at the electronic submission system of the Computer Science Department which you can find at the following url. **Do not use red colour in your solutions, include your name and student number and leave some space between your answers for feedback**.

`https://sam.csc.liv.ac.uk/COMP/Submissions.pl?strModule=COMP518`.

The submission of your solutions should be in a **single PDF** file containing **all** your answers and additionally, the **MySQL** commands in question 1 **should be submitted separately** in a plain text format **(.TXT)** file. It should be stressed that **only** the code that appears in the txt file will be assessed (tested) but you will receive your feedback in the PDF file only. Make sure that you test that your **MySQL** code works in the version installed in the lab, because this is the version which is going to be used for the assessment.
Learning outcomes:

1. Design and implement database systems.
2. Develop the ability to use SQL as a data definition and data manipulation language, and to develop a critical understanding of querying a relational database withSQL.
3. Develop a systematic understanding of transaction management and concurrency control in database systems

Assessment's purpose:

1. Create a relational database and express queries to a relational database by using SQL.
2. Simultaneous transactions and concurrency control.

Failure in the assessment may be compensated for by higher marks in other components of the module. Marking of subquestions will be based on the marking descriptors of the University's Code of Practice on Assessment. Standard UoL penalty applies for late submission.

The last possible date of submission is **1 week** after the original deadline, because a feedback will be given afterwards. Please be aware of the University guidelines on **plagiarism and collusion**.

Total: 100 marks

Question One (60 marks)

Consider the following relational database schema, where the underline attributes are the primary keys:

- Employee(eid, ename, age)
- Department(did, dname, dtype, address)
- WorksIn(eid, did, since)
- Product(pid, pname, ptype, pcolor)
- Sells(did, pid, quantity);

1. **(14 marks)** Create the above schemas in **MySQL**, using the **CREATE TABLE** statement. Make sure that you define all possible **keys**, and that **entity integrity** and **referential integrity** are guaranteed. Explain in detail any assumptions you may make.
2. Provide **MySQL** queries for the following:
   (a) **(3 marks)** Find the names of departments which sell blue products.
   (b) **(6 marks)** Find the names of departments which sell products of type tool and products of type toy.
   (c) **(8 marks)** Find the names of departments which sell blue products and do not have any employee older than 40.
   (d) **(9 marks)** For each department report the department-id and the age of the oldest employee working in it.
   (e) **(9 marks)** Find the names of employees who are older than at least one employee working in department 'Central'.
   (f) **(11 marks)** Find the names of employees working in departments which have sold at least 5 types of products.

Hint: A good idea would be to populate sample data into your database using MySQL. This will help you to verify that your MySQL queries are correct.

Question Two (30 marks)

Assume that there are three transactions T_1, T_2, T_3 that operate (read and write) on the data items A, B, and C. We are using the following notation: RJ(X) means that the transaction T_J reads the data item X, while WJ(X) means that the transaction T_J writes on the data item X. For example R1(A) means that the transaction T_1 reads the data item A, i.e., $read(T_1, A)$, while W3(B) would mean that the transaction T_3 writes on the data item B, i.e., $write(T_3, B)$.

You are given the following schedules S1, S2

1. S1: R1(A),R1(B),W1(A),R2(A),R1(C),W1(C),R3(C),W2(A),R3(B),W3(A)
2. S2: R1(A),W1(A),R2(C),R2(B),R3(C),W3(C),R3(A),R1(B),W1(B),R1(C)
3. S3: R1(A),R1(B),W1(A),R2(A),W3(C),W1(C),W2(A)

   For each of the above schedules

   (i) **(3 marks)** create the precedence graph of the conflicts.

   (ii) **(2 marks)** show whether the schedule is conflict-serializable or not. In case it is conflict-serializable, show a corresponding serial schedule. In case it is **not** conflict-serializable, explain shortly why this is the case.

   (iii) **(5 marks)** can this schedule occur by use of (two-phase locking) 2PL? Explain your answer.

Question Three (10 marks)

Consider the following transactions T_1 and T_2

Time	T_1	T_2
1	read item(A)	
2	A=A-2	
3		product = 1
4		read item(A)
5	write item(A)	
6		product = product*A
7		A=A-1
8	read item(B)	
9	B=B+1	
10	write item(B)	
11	commit	
12		write item(A)
13		read item(B)
14		B=B+1
15		product = product*B
16		commit

At time step 0 the value of A is 3 and B is 5.

1. **(8 marks)** What are the values of the data items A and B after time step 16? What value does the "product" have[1]? You should give a table, having the values of the data items

[1]Note that "product" is a local variable of the transaction, that does not necessarily exist in the database.

in the database at each time step, as well as the value of the local variable "product". We assume that the local variable "product" **doesn't have a value** before the time step 3. Your solution should start like in the following table.

Time	A	B	product
0	3	5	n/a
1	3	5	n/a
⋮	⋮	⋮	⋮

2. **(1 marks)** What are the **final** values of the data items A and B if we first execute T_1, and then T_2? What **final** value does the "product" have?

3. **(1 marks)** What are the **final** values of the data items A and B if we first execute T_2, and then T_1? What **final** value does the "product" have?