Question One (60 marks)

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

- Employee(<u>eid</u>, ename, age)
- Department(<u>did</u>, dname, dtype, address)
- WorksIn(<u>eid, did</u>, since)
- Product(<u>pid</u>, pname, ptype, pcolor)
- Sells(<u>did, pid</u>, 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?