I. Choose the correct answer(s) for multiple choice questions 1 to 11. Each question has at least one correct answer. For questions 12 and 13, write only the final result(s). **Enter all answers in file Answers.docx. Only the answers in this file will be considered for the grade.**

1. Consider schedule S below:

T1	T2	T3
	read(B)	
	B = B - 200	
	write(B)	
		read(A)
		A = A + 20
		write(A)
read(A)		
A = A – 50		
write(A)		
		read(B)
		B = B – 10
		write(B)
	read(A)	
	A = A + 50	
	write(A)	
read(B)		
B = B + 200		
write(B)		

time

Before the execution above, A = 600 and B = 700.

a. S is serializable. A serial schedule that's equivalent to S (in its effect on the database) is: T1 followed by T3 followed by T2.
b. S is serializable. A serial schedule that's equivalent to S (in its effect on the database) is: T2 followed by T3 followed by T1.
c. S is not serializable.
d. S is serializable. A serial schedule that's equivalent to S (in its effect on the database) is: T3 followed by T2 followed by T1.
e. None of the above answers is correct.

2. T1 and T2 are 2 concurrent transactions (there are no other concurrent transactions). The final result of their execution must be identical to the result obtained when executing:
a. either transaction T1 or transaction T2, but not both
b. half of the operations in T1 followed by half of the operations in T2
c. only transaction T1
d. only transaction T2
e. None of the above answers is correct.

3. I is an index with search key <a, b>.
a. If I is a hash index, I matches condition *a=8 AND b=7*.
b. If I is a hash index, I matches condition *b = 5 AND a > 3*.
c. If I is a hash index, I matches condition a=9 AND b<10 AND c<2 AND d<7.
d. If I is a B+ tree index, I matches condition a=9 AND b>10.
e. None of the above answers is correct.

4. Under the READ COMMITTED isolation level:
a. *nonrepeatable reads* can occur
b. *nonrepeatable reads* can't occur
c. *dirty reads* can't occur
d. *dirty reads* can occur
e. None of the above answers is correct.

5. In the context of transaction processing, the acronym ACID stands for:
a. atomicity, consistency, integrity, derivability
b. atomicity, credibility, integrity, durability
c. atomicity, consistency, isolation, durability
d. atomicity, consistency, ideality, derivability
e. None of the above answers is correct.

6. Choose the correct answer(s):
a. *Unrepeatable reads* cannot occur under SERIALIZABLE.
b. *Dirty reads* cannot occur under READ UNCOMMITTED.
c. *Dirty reads* cannot occur under REPEATABLE READ.
d. *Unrepeatable reads* can occur under READ COMMITTED.
e. None of the above answers is correct.

7. The reduction factor for condition *Salary > 3000*, assuming data is uniformly distributed and there is an index *I* on *Salary*, can be estimated by:
a. 1 / NKeys(I)
b. 10 / NKeys(I)
c. (IHigh(I) – ILow(I)) / (IHigh(I) – 3000)
d. (IHigh(I) – 3000) / (IHigh(I) – ILow(I))
e. None of the above answers is correct.

8. To prevent an SQL injection attack:
a. Users are asked nicely not to commit an attack.
b. Statements are parameterized.
c. String separators are preceded with ":-)".
d. Data validation is performed using regular expressions.
e. None of the above answers is correct.

9. Phantom deadlocks:
a. Are detected using the Wound-Wait policy.
b. Are detected using the Wait-Die policy.
c. Can lead to unnecessary aborts.
d. Are detected using ARIES.
e. None of the above answers is correct.

10. Consider schedule S below (all transactions commit):

T1	T2	T3
R(A)		
	W(F)	
R(D)		
		W(B)
	R(A)	
	W(A)	
W(E)		
	R(D)	
		W(A)
		R(C)
		R(B)
		R(D)

time

a. the following serial schedule is conflict equivalent with S: T1 followed by T2 followed by T3.
b. (W(T3, B), R(T3, B)) belongs to the conflict relation of S.
c. S is not conflict serializable.
d. S is conflict serializable.
e. None of the above answers is correct.

11. In distributed databases:
a. A vertical fragment is a subset of rows.
b. Two vertical fragments of a relation R can be stored at different sites.
c. Vertical fragments of a relation R can't be replicated.
d. A vertical fragment is a subset of columns.
e. None of the above answers is correct.

12. Encode the data *grata superveniet, quae non sperabitur, hora!* using the secret encryption key *marinpreda* and the table of codes below. Let M be the obtained string. Write the substring of M that consists of characters on positions <13, 14, 15> (the first character in M is on position 1).

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z	,	!
00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28

13. Let P and S be 2 relations. P has 90.000 records; a page can hold 300 P records. S has 150.000 records; a page can hold 375 S records.
a. Compute the cost of $S \otimes_{S.PID=P.PID} P$ using *index nested loops join*. S is the outer relation. Each tuple in S has exactly 1 matching tuple in P (with the same PID value). There is a hash index on PID in P that uses alternative a2 for data entries. Assumptions: you need 1.2 I/Os (on average) to retrieve the appropriate page in the hash index and 1 I/O to retrieve the page in P that contains the matching tuple.
b. Compute the cost of sorting P with *simple two-way merge sort*.
c. S is stored at Timişoara, P is stored at Cluj-Napoca. Compute the cost of $P \otimes_{P.PID=S.PID} S$ using *page-oriented nested loops join* in Cluj-Napoca, without caching. P is the outer relation.

II. Think of an application that's powered by a relational database. In this context:

a. Draw the database diagram (at least 4 interrelated tables, with primary keys and foreign keys).

b. Describe one real-world scenario in which different users are trying to access and manipulate the data concurrently, along with the problems that can occur.

c. Write a query with one SELECT clause, one FROM clause, one WHERE clause and one JOIN clause. The SELECT clause must contain two columns. The WHERE clause must have two terms of the form *AttributeName Operator Value*, where $Operator \in \{<, \leq, =, >, \geq, <>\}$; the terms must be connected by AND. Draw an evaluation plan for the query and describe the query's evaluation (with concrete algorithms and costs).