VIT
Vellore Institute of Technology

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

Fall Semester 2023-2024

CONTINUOUS ASSESSMENT TEST – II

(Common Question Paper & Key)

Programme Name & Branch : B.Tech – All Specialization
Course Name & code : BCSE302L – Database Systems
SLOT : A1+TA1 & A2+TA2
Exam Duration : 90 Min. **Maximum Marks: 50**

ANSWER ALL THE QUESTIONS(5X10=50 Marks)

Q.No	Question	Module	Max Mark	CO	BL
1	**a.** Consider the following relation and functional dependencies. R(A,B,C,D,E,F), F= { A→BC, AC→DEF, F→AB} **i.** List all of the candidate keys **(1 mark)** **Answer:** $A^+ = A$ = ABC A→BC = ABCDEF AC→DEF $F^+ = F$ = FAB F→AB = FABC A→BC = FABCDE AC→DEF Candidate Keys are A and F. **ii.** Give the minimal cover for F. **(5 mark)** **Answer:** A→BC: Case 1: B can be extraneous?	3	6+4	CO2	BL3

F'={A→C, AC→DEF, F→AB}

A+ on F'= ACDEFB contains attribute B, **So B is extraneous.**

F = {A→C, AC→DEF, F→AB}

AC→DEF:

Case 1.1: A is extraneous?

C+=C does not contains attribute DEF, **So A is not Extraneous**

Case 1.2: C is extraneous?

A+=ADEFCB does contains attribute DEF, **So C is Extraneous**

F = {A→C, A→DEF, F→AB}

A→DEF:

Case 1.3: D is extranoeus?

F'= {A→C, A→EF, F→AB}

A+ on F'=CEFAB not contain D, Hence D is not extra.

Case 1.4: E is extraneous?

F'= {A→C, A→DF, F→AB}

A+ on F'=CDFAB not contain E, E is not extra.

Case 1.5: F is extraneous?

F'= {A→C, A→DE, F→AB}

A+ on F' = CDEAB does not contain F, F is not extra.

F→AB:

Case 1.6: A is extraneous?

F' = {A→C, A→DEF, F→B}

F+ on F'=FB does not contain A, A is not extra.

Case 1.7: B is extraneous?

F' = {A→C, A→DEF, F→A}

F+ on F'=FACDEF not contain B, B is not extra.

Fc = { A→C, A→DEF, F→AB}→{ A→CDEF, F→AB}

All left hand side are unique and no extraneous attribute in FD.

A→BC

Case 2: C can be extraneous

F'={A→B, AC→DEF, F→AB}

A+ on F'= AB not contain attribute C, C is not extra.

So Final minimal cover Fc = {A→CDEF, F→AB}

b. Given a relational schema R(A, B, C, D, E) and a set of functional dependencies P and Q such that:
P = {A→B, AB→C, D→AC, D→E}, Q = {A→BC, D→AE}
Check whether P and Q are equivalent? **(4 mark)**

Answer:

To check $P \subseteq Q$

Let's find closure of the left side of each FD of P using FD Q.

1. A+ = ABC (using A → BC)
2. AB+ = ABC (using A → BC)
3. D+ = DAEBC (using D → AE and A → BC)
4. D+ = DAEBC (using D → AE and A → BC)

Now compare closure of each A, AB, D and D calculated using FD Q with the right-hand side of FD P. Closure of each A, AB, D and D has all the attributes which are on the right-hand side of each FD of P. Hence, we can say **P is a subset of Q**

To check $Q \subseteq P$

Using definition of equivalence of FD set, let us determine the right-hand side of the FD set of Q using FD set P.

Given P = { A → B, AB → C, D → AC, D → E} and Q = { A → BC, D → AE }

Let us find closure of the left side of each FD of Q using FD P.

1. A+ = ABC (using A → B and AB → C)
2. D+ = DACEB (using D → AC, D → E, and A → B)

Now compare closure of each A, D calculated using FD P with the right-hand side of FD Q. Closure of each A and D has all the attributes which are on the right-hand side of each FD of Q. **Q is a subset of P**

Hence P is equivalent to Q

2 Consider a Student table which has information about the subjects and the activity the students have enrolled in. Subject and Activity are the two attributes that are independent of each other.

a. Check whether the given table is in 4NF? If not, partition the table and convert to 4NF. **(5 mark)**

Student	Subject	Activity
Jones	Data Structures	P01
Bella	Algorithms	P03
Bella	Computation	P06
Bella	Algorithms	P07
Bella	Computation	P08
Margot	Database	P09
Margot	Compiler	P09
Pricy	Network	P06

3 | 5+5 | CO2 | BL6

Answer:

The table consists of multivalue dependency since all the column of the table has duplicate values.

And the Subject ad Activity are independent.

Hence

Student→→Subject and Student→→Activity exists in the table.

All the attribute of the table act as key.

So the Given table is not in 4NF.

We decompose the table into R1, R2, and R3 such as

Table R1:

Student	Subject
Jones	Data Structures
Bella	Algorithms
Bella	Computation
Margot	Database
Margot	Compiler
Pricy	Network

Key: {Student, Subject}

Table R2:

Student	Activity
Jones	P01
Bella	P03
Bella	P06
Bella	P07
Bella	P08
Margot	P09
Pricy	P06

Key: {Student, Activity}

Hence the table are in 4NF.

b. If the partition tables are in 4NF, check whether it is in 5NF? **(5 mark)**

Answer:

If above partition is considered then it is not in 5NF.

We decompose the table into R1, R2, and R3 such as

Table R1:

Student	Subject
Jones	Data Structures
Bella	Algorithms
Bella	Computation
Margot	Database
Margot	Compiler
Pricy	Network

Key: {Student, Subject}

Table R2:

Student	Activity
Jones	P01
Bella	P03
Bella	P06
Bella	P07
Bella	P08
Margot	P09
Pricy	P06

Key: {Student, Activity}

Table R3:

Key: {Subject, Activity}

Subject	Activity
Data Structures	P01
Algorithms	P03

Computation	P06
Algorithms	P07
Computation	P08
Database	P09
Compiler	P09
Network	P06

Hence the table are in 4NF.

To check R1, R2 and R3 are in 5NF should satisfy

$$R1 \bowtie R3 \bowtie R2 \equiv R$$

We perform $R1 \bowtie_{Subject} R3$

Student	Subject	Activity
Jones	Data Structures	P01
Bella	Algorithms	P03
Bella	Algorithms	P07
Bella	Computation	P06
Bella	Computation	P08
Margot	Database	P09
Margot	Compiler	P09
Pricy	Network	P06

We perform $(R1 \bowtie_{Subject} R3) \bowtie_{activitiy} R2$

Student	Subject	Activity
Jones	Data Structures	P01
Bella	Algorithms	P03
Bella	Algorithms	P07
Bella	Computation	P06
Bella	Computation	P08

Margot	Database	P09
Margot	Compiler	P09
Pricy	Network	P06

$$R1 \bowtie R3 \bowtie R2 \equiv R$$

Hence R1, R2 and R3 are in 5NF.

3 Consider the below relational database, where the primary keys are underlined.

employee (**emp-name**, street, city),

works (**emp-name**, company-name, salary),

company (**company-name**, city),

manages (emp-name, manager-name)

Give an expression in the relational algebra to express each of the following queries: **(5X2=10 marks)**

a. Find the employee's name whose salary is greater than 5000.

Answer:

$$\Pi_{emp-name}\left(\sigma_{salary>5000}(works)\right)$$

b. Find the names, street address, and cities of residence of all employees who work for Honda Company and earn more than 10,000.

Answer:

$$\Pi_{e.emp-name,\ e.street,\ e.city}$$

$$(\sigma_{company-name='honda' \wedge salary>10000 \wedge e.emp-name=emp-name}(\rho_e(employee) \times works))$$

c. Find the names of all employees in this database who live in the same city as the company for which they work.

Answer:

$$\Pi_{emp-name}($$

4	10	CO3	BL6

	$\sigma_{emp-name=w.emp-name \wedge city=c.city \wedge w.company-name=c.company-name}$ $(emp \bowtie \rho_w(works) \bowtie \rho_c(company))$ **d.** Find the names of all employees in this database who do not work for Honda Company. **Answer:** $\Pi_{emp-name}(works) - \Pi_{emp-name}\left(\sigma_{company='honda'}(works)\right)$ **e.** Find the total salary, minimum salary and maximum salary for each company. **Answer:** $company - name\ \mathcal{G}_{sum(salary),min(salary),max(salary)}(works)$				
4	Consider an ordered file with 50,000 records stored on a disk with block size B = 512 bytes. File records are of fixed size and are un-spanned, with record length R = 50 bytes. **a.** How many blocks are needed for the file? **(1)** **Answer:** Blocking Factor $bfr = \lfloor(B/R)\rfloor = \lfloor(512/50)\rfloor$=10 record/block **Block needed for file** $b = \lceil(r/bfr)\rceil$=$\lceil(50000/10)\rceil$=5000 blocks **b.** How many blocks access is needed if a binary search is performed? **(1)** **Answer:** **Binary search takes** = $\lceil log_2 b\rceil$=$\lceil log_2 5000\rceil$= 13 block access. **c.** Consider the ordering key field of the file is 8 bytes long, a block pointer, P = 5 bytes long, and a primary index is constructed for the file. **i.** What is the size of the index file? **(1)** **Answer:** **Size of index** R= V+P = 8+5 = 13 bytes.	4	10	C03	BL3

ii. What is the blocking factor for the primary index file? **(1)**

Answer:

Blocking factor

$bfr_i = \lfloor (B/R_i) \rfloor = \lfloor (512/13) \rfloor$ = 39 record/block

iii. How many numbers of index entries will be there for the primary index file? **(1)**

Answer:

No.of index entries = No.of blocks of file b = 5000 entries

iv. How many numbers of index block are needed? And how many block access will be performed to search for a record using the index? **(2)**

Answer:

No. of index block $b_i = \lceil (r_i/bfr_i) \rceil$=$\lceil (5000/39) \rceil$=129 blocks

For Linear search = 129 block access in worst case.

For Binary search = $\lceil log_2 b \rceil$=$\lceil log_2 129 \rceil$= 7+1=8 block access

d. Consider non-ordering key field of the file is 10 bytes long and the block pointer, P = 5 bytes long, and a secondary index is constructed on the non-ordering key field of the file.

i. What is the size of secondary index? **(1)**

Answer:

Size of Secondary index R_i= V+P = 10+5 = 15 bytes.

ii. What is blocking factor for secondary index? **(1)**

Answer:

Blocking factor

$bfr_i = \lfloor (B/R_i) \rfloor = \lfloor (512/15) \rfloor$ = 34 record/block

	iii. How many numbers of index blocks are needed? and how many block access will be performed to search for a record using the secondary index? **(1)** **Answer:** No.of index entries r_i= No.of records in file = 50000 entries **No. of index block** $b_i = \lceil(r_i/bfr_i)\rceil = \lceil(50000/34)\rceil$=1471 blocks **For Linear search =** 1471 block access in worst case. **For Binary search** =$\lceil log_2 b \rceil = \lceil log_2 1471 \rceil$=11+1=12 block access				
5	Find which of these terms refers to Atomicity, Consistency, Isolation, Durability; and explain with example. **a.** The changes of a successful transaction occurs even if the system fail occurs. **b.** The transaction takes place at once or doesn't happen at all. **c.** Multiple transactions occur independently without interference. **d.** The database must be consistent before and after the transaction. **Answer:** a. Durability b. Atomicity c. Isolation d. Consistency	5	10	CO4	BL2