THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

This exam paper must not be removed from the venue

Venue _____

Seat Number _____

Student Number |__|__|__|__|__|__|__|__|

Family Name _____

First Name _____

School of Information Technology and Electrical Engineering

EXAMINATION

Semester Two Final Examinations, 2018

INFS7903 Relational Database Systems

This paper is for St Lucia Campus students.

Examination Duration: 120 minutes

Reading Time: 10 minutes

Exam Conditions:

This is a Central Examination

This is a Closed Book Examination - no materials permitted

During reading time - write only on the rough paper provided

This examination paper will be released to the Library

Materials Permitted In The Exam Venue:

(No electronic aids are permitted e.g. laptops, phones)

Calculators - Casio FX82 series or UQ approved (labelled)

Materials To Be Supplied To Students:

None

Instructions To Students:

Please answer all questions on the examination paper.

Total Marks: 100 (to be scaled down to 60)

Additional exam materials (eg. answer booklets, rough paper) will be provided upon request.

For Examiner Use Only

Question	Mark

Total _____

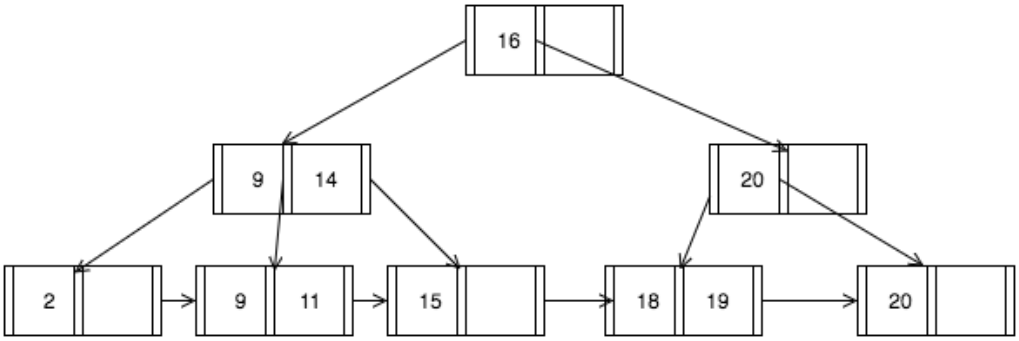
Questions 1-2 Consider the following relation:

Make	Model	Color	Price
Honda	Accord	Blue	Medium
Honda	Civic	Red	Low
Toyota	Corolla	Black	Low
Toyota	Camry	Red	Medium
BMW	X3	Black	High

Question 1 [4 marks] Assume the relation shown above and a bitmap index is created on attribute '*Price'*. What is the total size of that index in bits?

Question 2 [4 marks] Again, assume the relation shown above, provide a sketch of the binary bitmap index corresponding to the value *'Toyota"*?

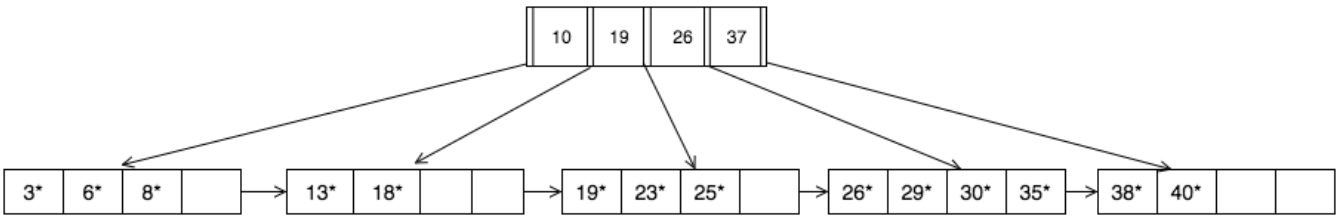
Questions 3-4 Consider the B+ tree in the following figure:



Question 3 [3 marks] What is the minimum number of tree nodes that are accessed to satisfy the query: Get all records with key greater than 11 and less than 21?

Question 4 [3 marks] What would be the total number of leaf nodes after inserting the value “17”?

Questions 5-6 Consider the B+ tree in the following figure, and assume the following rule applies for redistributing keys after a leaf node split: **Two keys** stay in the old leaf node and the remaining keys move to a new leaf node.



Question 5 [3 marks] Start from the original B+ tree; show the updated tree after inserting “10”.

Question 6 [8 marks] Start from the original B+ tree; show the updated tree after inserting “31”.

Questions 7-8 Given two relations R1 and R2, where R1 contains N1 tuples, R2 contains N2 tuples, and N2 > N1 > 0, answer the following questions.

Question 7 [2 marks] What is the minimum and maximum number of tuples produced from R1 X R2?

Question 8 [2 marks] Assume relation R2 contains an attribute named x, what is the minimum and maximum number of tuples produced from $\sigma_{x=5}$ (R2)?

A	B	C	D
101	10	5	alex
102	20	6	alex
103	20	9	bob
104	10	7	$\mathbf{x}_1$
105	10	4	$\mathbf{x}_2$
106	20	3	carrie
107	20	8	dawn

C	D	E
4	bob	30
5	$\mathbf{x}_3$	40
6	$\mathbf{x}_4$	50
7	carrie	40

Questions 9-12 Assume the two relations shown above and assume that their natural right outer join is given as:

A	B	C	D	E
105	10	4	bob	30
102	20	6	alex	50
104	10	7	carrie	40
null	null	5	elle	40

Given these three tables, in the following questions, determine the missing values in the first two relations:

Question 9 [1 marks] What is the correct value for x1?

Question 10 [1 marks] What is the correct value for x2?

Question 11 [1 marks] What is the correct value for x3?

Question 12 [1 marks] What is the correct value for x4?

Question 13 [10 marks]:

You are given the following tables, where the primary keys are underlined:

branch (branch_name, branch_city, assets)

account (account_number, branch_name, balance)

Now, consider the following SQL query:

```
Select T.branch_name
From branch T, branch S
Where T.assets > S.assets and S.branch_city = "Brisbane"
```

Write the most optimized relational-algebra expression that is equivalent to that query. Justify your choice.

Questions 14-15 Let relations $r_1(A, B, C)$ and $r_2(C, D, E)$ have the following properties: r_1 has 20,000 tuples, r_2 has 45,000 tuples, 25 tuples of r_1 fit in one block, and 30 tuples of r_2 fit in one block. Further, assume that the size of available memory is 900 blocks. Estimate the number of block transfers, using each of the following join strategies for $r_1 \bowtie r_2$:

Question 14 [5 marks] Tuple-based nested-loop join.

Question 15 [5 marks] Block-based nested-loop join.

Questions 16-17 Consider the following relational schema:

```
Students (sid,name,age,gpa,year)

Courses (cid, name, professor)

Enrollment (sid, cid, credits)
```

Further, assume that the number of distinct values for the attribute professor is 100 and the number of distinct values for the attribute name is 200. What is the selectivity of the following queries (<> is the SQL syntax for “not equals”):

Question 16 [4 marks]

```
SELECT *

FROM Courses

WHERE name <> "INFS2200";
```

Question 17 [4 marks]

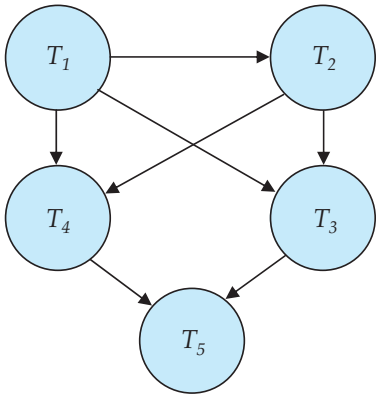
```
SELECT *

FROM Courses

professor = "Smith";
```

Question 18 [2 marks] In the **timeout mechanism** for handling deadlocks, compare the pros and cons of long timeout vs. short timeout.

Question 19 [2 marks] Briefly explain the **write-ahead logging (WAL)** protocol

Question 20 [2 marks] If a **steal/no-force** buffer management policy is in place, which recovery operations are needed for system recovery? Justify your answer.

Question 21 [5 marks] Consider the precedence graph in the following figure. Is the corresponding schedule conflict serializable? Explain your answer.



Question 22 [2 marks] If a database system supports ACID properties for transaction execution, what are the possible results for A and B, after executing the following transactions, with an initial value of A=50 and B=100?

T1:

```
read(B)
B=B+50
write(B)
read(A)
A=A-50
write(A)
```

T2:

```
read(B)
tmp=B*0.1
B=B-tmp
write(B)
read(A)
A=A+tmp
write(A)
```

Questions 23-24 Consider the following two transactions:

T1: read(A); read(B); if A = 0 then B:=B+1; write(B).

T2: read(B); read(A); if B = 0 then A:=A+1; write(A).

Question 23 [6 marks] Add all the lock and unlock instructions to transactions T1 and T2, so that they obey the two-phase locking protocol.

Question 24 [4 marks] Can the execution of these transactions result in a deadlock? Justify your answer using an example.

Questions 25-27 Consider the schedule given below, in which R(·) and W(·) stand for 'Read' and 'Write', respectively.

time	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9	t_{10}
T_1	R(A)	W(A)	W(E)	R(B)		W(B)	R(C)	W(C)	R(D)	W(D)
T_2			R(A)		W(A)	R(D)	W(D)	W(E)		W(A)
T_3				R(C)	W(C)			R(F)	W(F)	

Question 25 [6 marks] Construct the precedency graph for that schedule.

Question 26 [5 marks] Is the above schedule conflict serializable? If you answer "yes", provide the equivalent serial schedule. If you answer "no", briefly explain why.

Question 27 [5 marks] Is this schedule possible under the two-phase locking protocol? Justify your answer.

END OF EXAMINATION