THE UNIVERSITY OF AUCKLAND

Semester One, 2020
Campus: City

TEST

SOFTWARE ENGINEERING

Fundamentals of Database Systems

(Time Allowed: 24 Hours)

NOTE:

- You must answer **all** questions in this test
- Calculators are **NOT** permitted.
- This is a 24-hour open book test. Please complete the assessment **only by yourself**.
- You are **NOT** allowed to discuss the questions/answers with others during the test.
- Answer all questions in a separate document and submit the answers in a single PDF file via Canvas test submissions by 5pm on 22 May 2020.

Academic Integrity

The University of Auckland will not tolerate cheating, or assisting others to cheat, and views cheating in coursework as a serious academic offence. The work that a student submits for grading must be the student's own work, reflecting his or her learning. Where work from other sources is used, it must be properly acknowledged and referenced. This requirement also applies to sources on the world-wide web. A student's assessed work may be reviewed against electronic source material using computerised detection mechanisms. The University of Auckland's full guidelines on procedures and penalties for academic dishonesty are available here.

Question	Mark	Out Of
1		14
2		24
3		40
4		8
5		14
Total		100

Question 1 (14 marks)

a) What are the main advantages of using a database solution?

[4 marks]

b) What are the different types of database users (give examples of each types)?

[4 marks]

c) Describe the three-tier client/server architecture for a database solution? And explain why this kind of architecture can enhance security?

[6 marks]

Question 2 (24 marks)

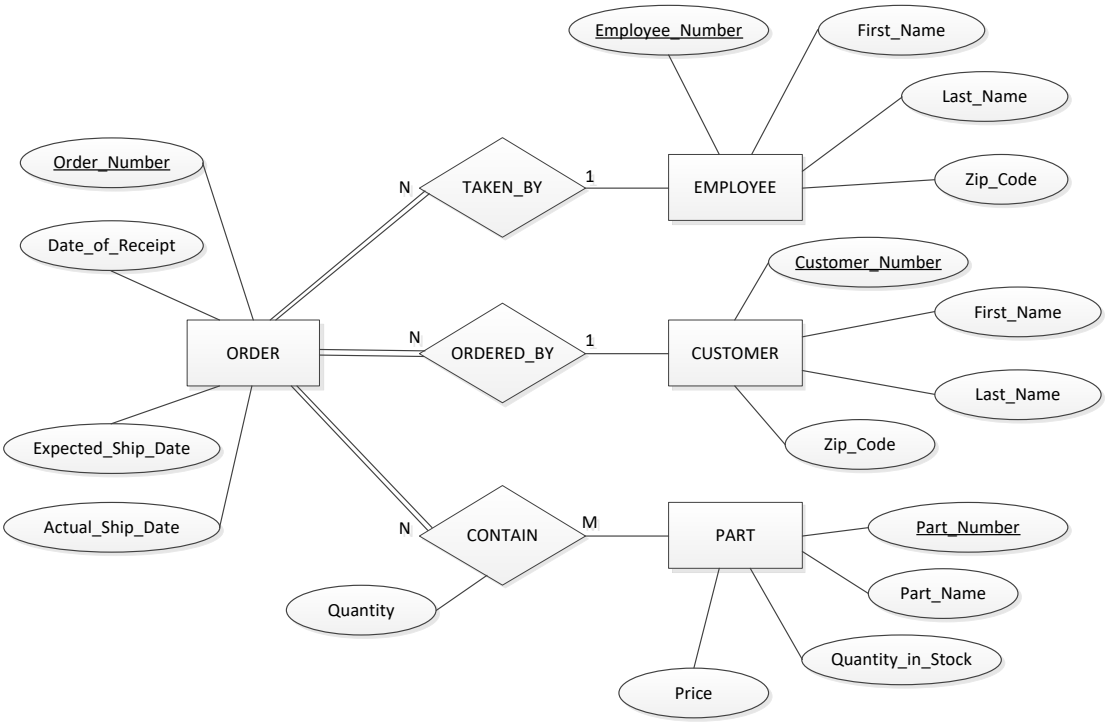
a) Consider a simplified online auction database system in which members participate in selling and buying of items. The data requirements for this system are summarized as follows:

- The online system has members who are identified by a unique member id and are described by an email address, name, password, home address, and a phone number.
- Items can be placed by members for sale, which are identified by a unique item number. Items are also described by an item title, an item description, a starting bid price, a bidding increment, the start date and the end date of the auction.
- Members make bids for items they are interested in. A bidding price and the time of bid placement are recorded. The member at the end of the auction with the highest bid price is declared as the winner, and a transaction between the two members (i.e., the buyer and the seller) is proceeded after. The transaction records the price of the sold item, the bank account number of the seller and the shipping address of the buyer.

Use the Entity–Relationship diagram to design a data model for the online auction system. State any unspecified requirements, and make appropriate assumptions to complete the specification.

[12 marks]

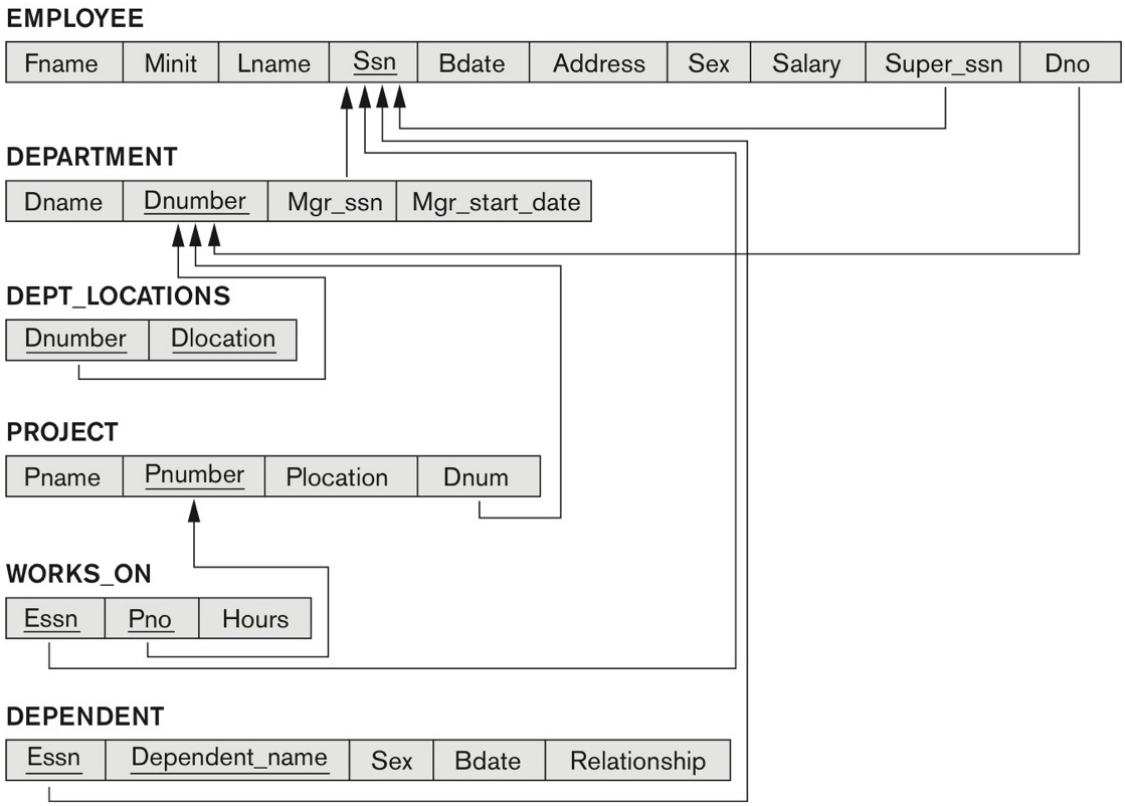
b) Using the algorithm taught in the lectures, map the following `Customer-Order` ER diagram into a relational database schema. Specify all primary keys and foreign keys.



[12 marks]

Question 3 (40 marks)

The following questions use the COMPANY database schema and the sample database state shown below.



EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

WORKS_ON

Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

a) Define the following Queries as SQL statements:

i. Retrieve the social security numbers and names of all employees (show Ssn, Fname and Lname) who either work in department 1 or directly supervise an employee who works in department 1.

[5 marks]

ii. For each department, retrieve the department number, department name, and the average salary of employees who work in that department, (show Dnumber, Dname, Avg_Sal).

[5 marks]

iii. List the employees (show all attributes) who have no dependents.

[5 marks]

b) Define the following Views as SQL statements:

i. A view that has the department name, manager name, and manager salary for every department, (show Dname, Fname, Lname, Salary).

[5 marks]

ii. A view that has the employee name, supervisor name, and employee salary for each employee who works in the 'Administration' department, (show Fname, Lname, Sup_Fname, Sup_Lname, Salary).

[5 marks]

c) Define the following Queries as Relational Algebra expressions:

i. Retrieve the names of employees (show Fname and Lname) who do not work on any project.

[5 marks]

ii. Retrieve the names of employees (show Fname and Lname) who work on every project.

[5 marks]

iii. Retrieve the average salaries of all male and female employees, (show Gender and Average_Salary).

[5 marks]

Question 4 (8 marks)

Consider the following relation:

CAR_SALE(Car_no, Date_sold, Salesman_id, Commision, Discount_amt)

Assume that a car may be sold by multiple salesmen, and hence {Car_no, Saleman_id} is the primary key. Additional functional dependencies are:

Date_sold -> Discount_amt
Salesman_id -> Commission
Car_no -> Data_sold

Based on the given primary key and the additional function dependencies, is this relation in 1NF, 2NF, or 3NF? Why or why not? How would you successively normalize it completely to 2NF and 3NF?

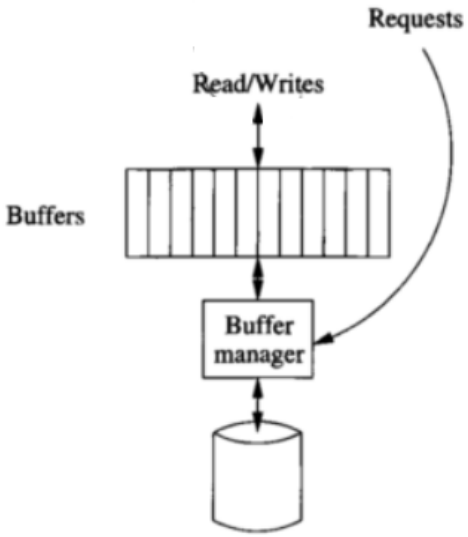
[8 marks]

Question 5 (14 marks)

a) Write a scenario where a database user can simplify his/her workflow with PSM.

[4 marks]

b) Assume that a buffer manager is using LRU rule to manage an initially empty buffer pool of 3 pages.



Given the following sequence of requests, show the pages in the buffer pool after the requests f, g, h, and i respectively.

a. Read Page A
b. Read Page B
c. Write Page B
d. Read Page C
e. Read Page A
f. Read Page B
g. Read Page D
h. Write Page D
i. Read Page C

[4 marks]

c) Consider the following settings of a hard disk:

- Seek time is 5 ms ($5x10^{-3}$ seconds)
- Rotate delay is 5 ms
- Transfer rate is 100MB / s (1MB = $1x10^{6}$ B)

Answer the following questions.

i. Compute the time used for retrieving a sequentially stored file of 1MB using the given seek time, rotate delay and transfer rate.

[2 marks]

ii. Compute the time used for retrieving a sequentially stored file of 1B using the given seek time, rotate delay and transfer rate.

[2 marks]

iii. Explain 2 benefits of using the blocking of size, e.g., 1KB, to format the disk.

[2 marks]
