一 選擇題（每題 2 分）

1) Why does the projection operator in relational algebra have to eliminate duplicate records?

   A.) Because it needs to save storage space

   B.) Because we get a relation after applying a projection operator

   C.) In order to efficiently identify each tuple

   D.) None of the above

2) What does it mean that relational algebra is closed?

   A.) The result of every expression in relational algebra must be kept unchanged.

   B.) The result of every expression in relational algebra is not written in open source code.

   C.) The result of every expression in relational algebra is a relation.

   D.) None of the above

3) What does it imply when we say query languages are not expected to be Turing complete?

   A.) They are not as powerful as ordinary programming languages.

   B.) They are said to be completed by Alan Turing.

   C.) They are intended for complex computation.

   D.) None of the above

4) A relationship between the instances of three entity types is called a(n) _____ relationship.

   A.) binary

   B.) unary

   C.) ternary

   D.) primary

5) If a query language can express all the queries that we can express in relational algebra, it is said to be

   A) Full relational inclusion

   B) relationally complete

   C) relational calculus

   D) None of the above

二 For each of the terms in the left-hand column below, select the term in the right-hand column that best matches it. (每題 2 分)

1. _____ Candidate key　　　　　　　　A. Atomicity

2. _____ Domain integrity

3. _____ Foreign key

4. _____ Join

5. _____ One-to-many relationship

6. _____ Write-ahead logging

7. _____ Update anomalies

8. _____ Creation, deletion, and modification of definitions for tables and views

9. _____ All-or-nothing property

B. Key constraint

C. Unique identifier

D. ARIES

E. DDL

F. Relational algebra operator

G. Restrict possible values

H. Normalization

I. Referential integrity

三　問答題

1. Describe the following terms: A) Natural join, B) division operator in relational algebra, C) referential integrity, D) access path, E) pipelining in query evaluation and its advantages. (共 15 分)

2. Explain the difference between the following two SQL create statements. (6 分)

A) CREATE TABLE Enrolled
    (sid CHAR(20),
    cid   CHAR(20),
    grade CHAR(2),
    PRIMARY KEY (sid,cid))

B) CREATE TABLE Enrolled
    (sid CHAR(20),
    cid CHAR(20),
    grade CHAR(2),
    PRIMARY KEY (sid),
    UNIQUE (cid, grade))

3. Answer the following questions about data on external storage in a DBMS:
    A) What is a record id? Given a record's id, how many I/Os are needed to fetch the record into main memory? (3+2 分)
    B) What is the role of the buffer manager in a DBMS? What is the role of the disk space manager? (3+3 分)

4. Assume that you are given a relation with attributes ABCD. (10 分)
    Assume that no record has NULL values. Write an SQL query that checks whether the functional dependency $A \rightarrow B$ holds.
    Assume again that no record has NULL values. Write an SQL assertion that enforces the functional dependency $A \rightarrow B$.

5. Consider the following simplified relation schemas (each relation with its name and constituent fields; the key fields are underlined):

EMPLOYEE(FNAME, MINIT, LNAME, <u>ESSN</u>, BDATE, ADDRESS, SEX)
DEPARTMENT(DNAME, <u>DNUMBER</u>, MGRSSN, MGRSTARTDATE)
DEPT_LOCATIONS(<u>DNUMBER, DLOCATION</u>)
PROJECT(PNAME, <u>PNUMBER</u>, PLOCATION, DNUM)
WORKS_ON(<u>ESSN, PNUMBER</u>, HOURS)
DEPENDENT(<u>ESSN, DEPENDENT_NAME</u>, SEX, BDATE, RELATIONSHIP)

Write the following queries in **relational algebra.** (每小題 5 分)

a. Find the name and address of all employees who work for the 'Research' department.
b. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birth date.
c. Find the names of employees who work on all the projects controlled by department number 5.

Write the following queries in **SQL.** (每小題 5 分)

a. Retrieve the birth date and address of the employee(s) whose name is 'John B. Smith'
b. For each employee, retrieve the employee's first and last name and the first and last name of his or her immediate supervisor.
c. Find the sum of the salaries of all employees, the maximum salary, the minimum salary, and the average salary.