CMSC 461
Midterm Examination One
March 5, 1996

Name ____________________

SS# ____________________

This exam is open book and open notes. Please write your name on the first page of the exam. You have 75 minutes to do all of the questions whose points sum to 100. Several questions assume the standard parts-suppliers-shipments database used in homework one, which has the schema as follows:

```
S:|snum|sname|status|city  | SP: |snum|pnum|qty|  P:|pnum|pname|color|weight|city  |
  |----|-----|------|------|     |----|----|---|    |----|-----|-----|------|------|
  |s5  |Adams|    30|Athens|     |s4  |p5  |400|    |p6  |Cog  |Red  |    19|London|
  |s1  |Smith|    20|London|     |s1  |p1  |300|    |p5  |Cam  |Blue |    12|Paris |
  |... | ... |   ...|  ... |     |... | ...|...|    |... | ... | ... |  ... | ...  |
```

1 Formal & Informal Database Concepts (5 points)

Pair up the following formal relational terms and their informal equivalents.

```
___ 1 relation       A pool of legal values
___ 2 domain         B number or rows
___ 3 primary key    C record or row
___ 4 cardinality    D field or column
___ 5 attribute      E unique identifier
___ 6 degree         F number of columns
___ 7 tuple          G table
```

2 Redundancy in data storage. (10 points)

One of the advantages of the database approach over traditional file processing is that it offers more control over redundancy of storing data multiple times. Give three disadvantages and one advantage of redundantly storing the same data more than once.

3 Relational Model. (10 points)

What are two important consequences of treating a database relation as a **set** of tuples as opposed to some other collection, such as a a sequence, list, bag or multiset.

4 Foreign keys. (10 points)

Define the concept of a *foreign key* in a relation and explain why it is useful.

5 Understanding Relational Operators (10 points)

Assume that r and s are relations such that $r \subseteq s$ (i.e., r is a subset of s). Simplify the following expressions, i.e. give an equivalent expression with fewer operators.

1. $r \cup s$
2. $r \bowtie s$ (Natural Join)
3. $\sigma_{A=a}(r) - s$
4. $\Pi_X(r) \cap \Pi_X(s)$

6 Natural Join (10 points)

Consider the *natural join* of two relations $R1$ and $R2$. What would be an equivalent expression in the relational algebra for `R1 JOIN R2` when:

- $R1$ and $R2$ have disjoint headings (i.e., no attributes in common)
- $R1$ and $R2$ have identical headings (i.e., all attributes in common)

7 Relational Algebra. (15 points)

Consider the following relational database:

enjoys(*person*, *activity*)
offers(*club*, *activity*)
member(*person*, *club*)

Express the following queries in either the relational algebra or the rdb notation used in homework one.

1. "Clubs that offer at least one activity that John enjoys."

2. "Persons that are members of exactly the same clubs as John."

3. "Clubs which offer all activities that John enjoys"

8 Constructing SQL queries. (15 points)

Give SQL expressions which correspond to the following queries on the standard suppliers-parts-projects database.

- What are the names and their cities of all suppliers.

- What color parts does the supplier Blake supply?

- Get the total quantity for all parts supplied by suppliers located in London.

- Get the part numbers for parts supplied by a supplier in London to a project in London.

9 Recognizing queries. (20 points)

Below are some queries expressed in the standard relational algebra notation, the rdb notation of homework one or SQL. For each one, describe what it means in a simple English sentence. Indicate which of these queries will retrieve the same information.

1. **select** snum
   from sp
   group by snum
   having count(*)= 1

2. **select** snum
   from s
   where exists
   (**select** *
   from p
   where not exists
   (**select** *
   from sp
   where sp.pnum=p.pnum and sp.snum=s.snum))

3. **select distinct** snum
   from sp sp1
   where exists
   (**select** *
   from sp sp2
   where sp1.snum=sp2.snum and sp1.pnum $\neq$ sp2.pnum)

4. project (restrict (join sp with (rename pnum to pnum2 in sp) on snum) with pnum > pnum2) over snum;

5. (project sp over snum)- it;
   (where "it" is the result of the previous query)

6. (project sp over snum, pnum) / (project p over pnum);

7. $\Pi_{snum}(S) - \Pi_{snum}(SP)$

Thought for the day: "The really efficient laborer will be found not to crowd his day with work, but will saunter to his task surrounded by a wide halo of ease and leisure." - Henry David Thoreau