Write your name, date of birth (if you have not registered your social security number), the name of the course, date of the exam and your signature on each answer sheet

1. Let's consider the relations A($\underline{a}$,b,c,d) (n>0 tuples) and B($\underline{a \rightarrow A,k}$,e,d) (m>0 tuples).. Notations:
    π projection, $\times$ cross product, $|\times|$ join, σ selection, * natural join
    a) List the attributes of $A * B$.
    b) What is the join condition in $A * B$.
    c) How many tuples $A |\times|_{A.a=B.a} B$ has?
    d) What is the relation between the cardinalities (number of tuples) of $\pi_a(A)$ and $\pi_{a,b}(A)$?
    e) If $\sigma_{a = \,'s'}(A)$ has the same cardinality as $\sigma_{a = \,'s'}(B)$, what is this cardinality ? (15p)

Consider the following library tables

```
person(pId, name, address)
title(titleId, name, yearPublished)
item(itemNumber, title →title, dateAcquired, pricePaid)
borrowing(book→item, dateBorrowed, borrower → person, dateReturned, penalty)
    This table contains data about current and past borrowings. If the book is
    not returned dateReturned is empty. Penalty contains the fine paid if the
    book was not returned in time. It is 0 (zero) if there was no penalty.
biggestItemNumber(itemNumber)
    biggest item number in use
```

2. Express the following queries in SQL. Specify the proper order for the resulting rows.
    a) List the titles acquired during year 1999 in alphabetic order.
    b) List the persons that currently have books borrowed.
    c) List the persons that have not borrowed any books in year 1999. (12p)

3. Express the following queries in SQL. Specify the proper order for the resulting rows.
    a) How many items there are of the title 'Introduction to Horse Care'?
    b) How much money was used for acquiring books in 1999?
    c) What has been the yearly income of penalties?
    d) For which items the penalty income has exceeded the price of the item. (16p)

4. When a new item arrives in the library it will obtain an item number that is next in sequence to the currently biggest item number. The biggest item number is also increased by one. Give the SQL-statements needed for registering a new item. You may give the title, the date acquired and the price as constants. (8p)

5. Explain briefly what elements make up a www-based database application. (9p)