6.31. Suggest extensions to the relational calculus so that it may express the following types of operations that were discussed in Section 6.4: (a) aggregate functions and grouping; (b) OUTER JOIN operations; (c) recursive closure queries.

6.32. A nested query is a query within a query. More specifically, a nested query is a parenthesized query whose result can be used as a value in a number of places, such as instead of a relation. Specify the following queries on the database specified in Figure 5.5 using the concept of nested queries and the relational operators discussed in this chapter. Also show the result of each query as it would apply to the database state of Figure 5.6.

a. List the names of all employees who work in the department that has the employee with the highest salary among all employees.

b. List the names of all employees whose supervisor's supervisor has '888665555' for Ssn.

c. List the names of employees who make at least $10,000 more than the employee who is paid the least in the company.

6.33. State whether the following conclusions are true or false:

a. **NOT** $(P(x)$ **OR** $Q(x)) \rightarrow$ (**NOT** $(P(x))$ **AND** (**NOT** $(Q(x)))$

b. **NOT** $(\exists x)\ (P(x)) \rightarrow \forall x$ (**NOT** $(P(x))$

b. $(\exists x)\ (P(x)) \rightarrow \forall x\ ((P(x))$

HW2

Solve problems 6.34 and 6.35

Laboratory Exercises

6.34 Specify and execute the following queries in relational algebra using the RA interpreter on the COMPANY database schema.

a. List the names of all employees in department 5 who work more than 10 hours per week on the ProductX project.

b. List the names of all employees who have a dependent with the same first name as themselves.

c. List the names of employees who are directly supervised by Franklin Wong.

d. List the names of employees who work on every project.

e. List the names of employees who do not work on any project.

f. List the names and addresses of employees who work on at least one project located in Houston but whose department has no location in Houston.

g. List the names of department managers who have no dependents.

6.35 Consider the following MAILORDER relational schema describing the data for a mail order company.

PARTS(Pno, Pname, Qoh, Price, Olevel)

CUSTOMERS(Cno, Cname, Street, Zip, Phone)

EMPLOYEES(Eno, Ename, Zip, Hdate)

ZIP_CODES(Zip, City)

ORDERS(Ono, Cno, Eno, Received, Shipped)

ODETAILS(Ono, Pno, Qty)

The attribute names are self-explanatory: Qoh stands for *quantity on hand*. Specify and execute the following queries using the RA interpreter on the MAILORDER database schema.

a. Retrieve the names of parts that cost less than $20.00.

b. Retrieve the names and cities of employees who have taken orders for parts costing more than $50.00

c. Retrieve the pairs of customer number values of customers who live in the same ZIP Code.

d. Retrieve the names of customers who have ordered parts from employees living Wichita.

e. Retrieve the names of customers who have ordered parts costing less than $20.00.

f. Retrieve the names of customers who have not placed an order.

g. Retrieve the names of customers who have placed exactly two orders.

6.36. Consider the following GRADEBOOK relational schema describing the data for a grade book of a particular instructor. (*Note*: The attributes A, B, C, and D of COURSES store grade cutoffs.)

CATALOG(Cno, Ctitle)

STUDENTS(Sid, Fname, Lname, Minit)

COURSES(Term, Sec_no, Cno, A, B, C, D)

ENROLLS(Sid, Term, Sec_no)

Specify and execute the following queries using the RA interpreter on the GRADEBOOK database schema.

a. Retrieve the names of students enrolled in the Automata class during the fall 1996 term.

b. Retrieve the Sid values of students who have enrolled in CSc226 and CSc227.

c. Retrieve the Sid values of students who have enrolled in CSc226 or CSc227.

d. Retrieve the names of students who have not enrolled in any class.