

NAME: \_\_\_\_\_

**CS 457 - Database Systems**  
**Midterm Examination I**

This examination is **closed** book. You are allowed one 8'x11' sheet with notes (both sides). Observe the Emory College Honor Code while taking this test.

**1. Database Design (30 pts)**

A database is being designed for a bank to keep track of the accounts of its clients

- The bank has several branches.
- Each branch is located in a city and it is identified by its branchname.
- We keep track of the total assets of each branch.
- A customer is identified by his SSN.
- Customer information includes the customer's name, address and phone number.
- A customer can open an account with any branch of the bank. (Customer can open account at *multiple* branches).
- Customer can open *multiple* accounts with one branch.
- An account is maintained (managed) by one branch.
- An account can be held *jointly* by *multiple* customer.
- Each account is uniquely identified by its account number.
- The account information include customer and balance information.
- Account information can only exist when some customer has an account with some branch and it can't exist without either.

**Question:**

- Design a **relational** model for the bank database. (Use next page for additional space)

**Warning:** do **NOT** give me an Entity-Relationship diagram as a final solution. I am asking for a relational model.

**Note:** most of the points are given to designing a *correct model*. Make sure your model will accommodate *every* constraint given above.

- You **must** underscore the **primary key** and the **foreign key(s)** in each relation to receive full credit. Draw arrows from each foreign key to the relation it is referring to. Without primary key, foreign keys and arrows in your model, your answer is incomplete and subject to heavy penalty.

**This page is space for answer to Question 1:**

**Question 2. (40 pts)**

The Company database relational schema is available at the end of this handout. Using the Company database in class, express the following queries in Relational Algebra:

1. Find name of departments that controls some project that the employee "John Smith" is working on.

2. Find the name of departments that have no female employees.

3. Find name of departments that pays the highest salary.

4. Find first and last names of employees who works on more projects that are controlled by the "Research" department than on projects that are controlled by his/her own department.

**Question 3. (30 pts)**

The Company database relational schema is available at the end of this handout. Using the Company database, describe the result obtained by the following Relational Algebra queries. The description **must** be non-technical, without references to words like ‘join’, ‘select’, ‘project’ and other relational algebra terminology. No credit is given for answers that are literal translation of the operator symbols into relational algebra terms.

**Query 1:**

$$\begin{aligned} TEMP &\leftarrow dno \mathcal{F}_{max(salary)}(\sigma_{sex="M"}(EMPLOYEE)) \\ R &\leftarrow \pi_{fname,lname}(\sigma_{sex="F" \wedge salary > max}(EMPLOYEE \bowtie_{dno=dno} TEMP)) \end{aligned}$$

**Query 2:**

$$R \leftarrow \mathcal{F}_{max(count)}(essn \mathcal{F}_{count(dependent\_name)}(\sigma_{dname="Research"}(DEPENDENT \bowtie_{essn=ssn} EMPLOYEE \bowtie_{dno=dnum} DEPARTMENT)))$$

**Query 3:**

$TEMP \leftarrow \pi_{pnumber}(PROJECT) - \pi_{pnumber}(\sigma_{dname="Research"}(PROJECT$   
 $\quad \bowtie_{dnum=dnumber} DEPARTMENT) )$

$R \leftarrow \pi_{ssn}(EMPLOYEE) - \pi_{ssn}(EMPLOYEE \bowtie_{ssn=essn} WORKS\_ON \bowtie_{pno=pnumber} TEMP)$



**EMPLOYEE**

FNAME	MINIT	LNAME	<u>SSN</u>	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
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**DEPARTMENT**

DNAME	<u>DNUMBER</u>	MGRSSN	MGRSTARTDATE
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**DEPT\_LOCATIONS**

<u>DNUMBER</u>	<u>DLOCATION</u>
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**PROJECT**

PNAME	<u>PNUMBER</u>	PLOCATION	DNUM
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**WORKS\_ON**

<u>ESSN</u>	<u>PNO</u>	HOURS
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**DEPENDENT**

<u>ESSN</u>	<u>DEPENDENT_NAME</u>	SEX	BDATE	RELATIONSHIP
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**Figure 6.5**