# BMEG3120: Midterm Exam (Fall 2013)

Please write all your solutions in the answer book.

All the following questions are based on the tables below:

- `author(aid, aname)`: This represents a table with name `author` whose attributes are as shown in the brackets. The underlined is the candidate key. Each tuple represents an author, whose id and name are given by `aid` and `aname`, respectively.

- `book(bid, title, category)`: Each tuple represents a book. The attribute `category` describes the genre of the book (e.g., novel, sci-fi, science, music, ...).

- `student(sid, sname, dept)`: Each tuple represents a student. The attributes' meanings should be self-explanatory.

- `write(aid, bid)`: A tuple means that book `bid` was written by author `aid`.

- `borrow(sid, bid, checkout-time, return-time)`: A tuple means that student `sid` checked out book `bid` at `checkout-time`, and returned it at `return-time`.

All attributes are strings, except `checkout-time` and `return-time`, which are integers. A smaller `checkout-time` represents an earlier timestamp (same for `return-time`).

**Problem 1 (50%).** Give relational algebra queries for the tasks below:

1. (12%) Find the titles of all the books that the student with `sid` = "s100" has ever borrowed.

2. (12%) Find the titles of all the books that have never been borrowed by any student.

3. (14%) Find the title of the book that the student with `sid` = "s100" has checked out most recently. If the student has never borrowed any books, return an empty table (whose schema is up to you).

4. (12%) Find the names of all students that have borrowed all the books written by the author with `aid` = "a100".

**Solutions.**

1. $\Pi_{\text{title}}(\text{book} \bowtie (\sigma_{\text{sid} = \text{"s100"}}(\text{borrow})))$

2. $\Pi_{\text{title}}(\text{book} \bowtie (\Pi_{\text{bid}}(\text{book}) - \Pi_{\text{bid}}(\text{borrow})))$

3. $T1 \leftarrow \sigma_{\text{sid} = \text{"s100"}}(\text{borrow})$
   $T2 \leftarrow T1$
   $T3 \leftarrow \Pi_{T_1.\text{bid}}(\sigma_{T_1.\text{checkout-time} < T_2.\text{checkout-time}}(T_1 \times T_2))$
   $T_4 \leftarrow \Pi_{\text{bid}}(T_1) - T_3$
   $\Pi_{\text{title}}(T_4 \bowtie \text{book})$

4. $T_1 \leftarrow \Pi_{\text{bid}}(\sigma_{\text{aid} = \text{"a100"}}(\text{write}))$
   $T_2 \leftarrow \Pi_{\text{sid, bid}}(\text{borrow})$
   $\Pi_{\text{sname}}((T_2 \div T_1) \bowtie \text{student})$

**Problem 2 (50%).** Give SQL queries for the tasks below:

1. (10%) Find the titles of all the books that have ever been borrowed by bme students (i.e., `dept` = 'bme').

2. (10%) Find the number of distinct students that have ever borrowed the book with `bid` = 'b100'.

3. (10%) Find the titles of all the books that have ever borrowed by students from at least 10 distinct departments.

4. (10%) Let us define the *borrow volume* of a student as the number of distinct books s/he has ever borrowed. For each department, display its name (i.e., `dept`), and the largest borrow volume of its students.

5. (10%) Find the titles of the 10 books (not necessarily distinct) most recently borrowed by the student with `sid` = 's100'. If the student has borrowed less than 10 books, return the titles of all of them.

**Solutions.**

1. select title
   from book, borrow, student
   where book.bid = borrow.bid and borrow.sid = student.sid
   and dept = 'bme'

2. select count(distinct sid)
   from borrow
   where bid = 'b100'

3. select title
   from book, borrow, student
   where book.bid = borrow.bid and borrow.sid = student.sid
   group by book.bid, title
   having count (distinct dept) $>=$ 10

4. select dept, max(vol)
   from (select dept, count (distinct bid) as vol
   from student, borrow
   where student.sid = borrow.sid
   group by student.sid, dept)
   group by dept

5. select title
   from book, borrow bor1, borrow bor2
   where book.bid = bor1.bid and bor1.sid = 's100' and bor2.sid = 's100'
   and bor1.checkout-time $<=$ bor2.checkout-time
   group by bor1.bid, title
   having count(*) $\leq$ 10