CS532 Homework 3
Due at the Beginning of Class on March 2

1. The following are some of the relations transformed from the ER diagram for the Student Registration System (note that some changes have been made due to the creation of a single-attribute key for Classes):

    Students(sid, firstname, lastname, status, gpa, email)
    Courses(dept_code, course#, title, credits, deptname)
    Classes(classid, dept_code, course#, sect#, year, semester, start_time, end_time, limit, size, classroom, capacity, fid) /* note: classid is added to serve as a single-attribute key */
    Faculty(fid, firstname, lastname, rank, office, email, deptname)
    Enrollments(sid, classid, lgrade, ngrade)

Do the following for each relation schema:

(a) (20 points) Identify all non-trivial functional dependencies. Don't make unrealistic assumptions about the data. Use the union rule to combine the functional dependencies as much as possible. Furthermore, if a functional dependency is redundant (i.e., it can be derived from the ones you keep), don't include it.

(b) (20 points) Determine whether or not the schema is in 3NF or in BCNF. Justify your conclusion.

(c) (20 points) For each schema that is not in 3NF, decompose it into 3NF schemas using Algorithm LLJD-DPD-3NF. Show the result after each step of the algorithm. Are the decomposed schemas in BCNF? Justify your answer.

2. (14 points) Prove or disprove the following rules:

    (a) $\{B \rightarrow CD, AB \rightarrow E, E \rightarrow C\} \models \{AE \rightarrow CD\}$
    (b) $\{B \rightarrow CD, AD \rightarrow E\} \models \{AB \rightarrow E\}$

    When proving a rule, you can use all the six inference rules (i.e., reflexivity rule, augmentation rule, transitivity rule, decomposition rule, union rule and pseudotransitivity rule). To disprove a rule, construct a relation with appropriate attributes and tuples such that the tuples of the relation satisfy the functional dependencies on the left of the rule but do not satisfy the functional dependency on the right of the rule.

3. (26 points) **Write relational algebra expressions to answer the following query statements based on the tables given in page 3 of this document**. For each query, **show the result** that would be obtained if the query were actually executed against the tables. It is OK to answer a query in multiple steps. You need to make sure that your relational algebra expressions are reasonably optimized as we discussed in class, i.e., conditions involving a single table should be specified on that table directly and Cartesian products should be replaced by joins whenever possible.

(a) (6 points) Find the dept_code, course# and title of each course that was offered in the Spring semester of 2014.

(b) (6 points) Find the first name of each student who has taken at least one CS course and at least one Math course.

(c) (7 points) Find the dept_code and course# of each course that was not offered in 2013.

(d) (7 points) Find the sid and first name of every student who has taken all CS classes offered in Spring 2014.

Tables for Homework 3 Question 3

Students

Sid	Firstname	Lastname	Status	GPA	email
B001	Anne	Broder	junior	3.17	broder@bu.edu
B002	Terry	Buttler	senior	3.0	buttler@bu.edu
B003	Tracy	Wang	senior	4.0	wang@bu.edu
B004	Barbara	Callan	junior	2.5	callan@bu.edu
B005	Jack	Smith	graduate	3.0	smith@bu.edu
B006	Terry	Zillman	graduate	4.0	zillman@bu.edu
B007	Becky	Lee	senior	4.0	lee@bu.edu
B008	Tom	Baker	freshman		baker@bu.edu

Courses

Dept_code	Course#	Title
CS	432	database systems
Math	314	discrete math
CS	240	data structure
Math	221	calculus I
CS	532	database systems
CS	552	operating systems
BIOL	425	molecular biology

Classes

Classid	Dept_code	Course#	Sect#	Year	Semester	Limit	Size
c0001	CS	432	1	2014	Spring	35	34
c0002	Math	314	1	2013	Fall	25	24
c0003	Math	314	2	2013	Fall	25	22
c0004	CS	432	1	2013	Spring	30	30
c0005	CS	240	1	2014	Spring	40	39
c0006	CS	532	1	2014	Spring	29	28
c0007	Math	221	1	2014	Spring	30	30

Enrollments

Sid	Classid	Grade
B001	c0001	A
B002	c0002	B
B003	c0004	A
B004	c0004	C
B004	c0005	B
B005	c0006	B
B006	c0006	A
B001	c0002	C
B003	c0005	
B007	c0007	A
B001	c0003	B
B001	c0006	B
B001	c0004	A
B001	c0005	B