

*Hand in a hardcopy of your answers (printed or handwritten). Include your name, and be sure to clearly identify which problems you are answering and which homework the problems are from since problems from multiple homeworks will be collected at the same time. These problems will be collected on Monday 10/12 and Monday 10/26.*

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For the following problems:

- (a) Identify all of the candidate keys and show how you found them.
- (b) Choose one of the candidate keys as the primary key. If there is more than one candidate key, explain your choice.
- (c) Assume the relation has the primary key chosen in the previous part. State the highest normal form (1NF, 2NF, 3NF, or BCNF) that the relation satisfies and justify your answer.
- (d) Normalize the relations to BCNF, or as far toward BCNF as you think appropriate. If you stop short of BCNF, explain why. For each step, state which functional dependency the decomposition is based on and why you chose it.

1. Consider the following relation about students:

`STUDENT(studentID,firstname,lastname,major,credits,status)`

The functional dependencies:

- $\text{studentID} \rightarrow \text{firstname,lastname}$  [studentID identifies a student]
- $\text{studentID} \rightarrow \text{major,credits}$  [a student has one major and one credit total]
- $\text{credits} \rightarrow \text{status}$  [a student's status is based on how many credits they have]

2. Consider the following relation about students and their advisors:

`ADVISEE(studentID,email,firstname,lastname,advisorID)`

The functional dependencies:

- $\text{studentID} \rightarrow \text{email,firstname,lastname}$  [studentID identifies a student]
- $\text{email} \rightarrow \text{studentID}$  [each student has their own email address]
- $\text{studentID} \rightarrow \text{advisorID}$  [a student has one advisor]

3. Consider the following relation about faculty members and their offices:

`FACULTY(facultyID,name,rank,baseSalary,building,buildingAddr,  
office,officePhone)`

Several faculty members may share an office. Office numbers are unique within a building but may repeat across buildings. The functional dependencies:

- $\text{facultyID} \rightarrow \text{name}, \text{rank}$  [facultyID identifies a faculty member]
- $\text{facultyID} \rightarrow \text{building}, \text{office}$  [a faculty member has one office]
- $\text{building} \rightarrow \text{buildingAddr}$  [a building has one address]
- $\text{buildingAddr} \rightarrow \text{building}$  [no two buildings share an address]
- $\text{building}, \text{office} \rightarrow \text{officePhone}$  [an office has one phone number]
- $\text{rank} \rightarrow \text{baseSalary}$  [each rank (assistant, associate, or full professor) has one base salary]

4. Consider the following relation about students and courses:

`COURSE(enrollmentID,dept,number,title,studentID,firstname,lastname,  
instructor,time,room,grade)`

The functional dependencies:

- $\text{dept}, \text{number} \rightarrow \text{title}$  [dept and number identify a course]
- $\text{dept}, \text{number} \rightarrow \text{instructor}$  [a course has one instructor]
- $\text{dept}, \text{number} \rightarrow \text{time}, \text{room}$  [a course is taught at a particular time and in a particular place]
- $\text{studentID} \rightarrow \text{firstname}, \text{lastname}$  [studentID identifies a student]
- $\text{dept}, \text{number}, \text{studentID} \rightarrow \text{grade}$  [a student has a single grade in a course]
- $\text{enrollmentID} \rightarrow \text{dept}, \text{number}, \text{studentID}, \text{grade}$  [enrollmentID identifies a student's enrollment in a course]
- $\text{dept}, \text{number}, \text{studentID} \rightarrow \text{enrollmentID}$  [a student enrolls in a course only once]

5. Consider the following relation about course enrollments:

`ENROLLMENT(studentID,course,section,instructor,grade)`

A course may have several sections, taught by different instructors. Section numbers are unique within a course. The functional dependencies:

- $\text{studentID}, \text{course} \rightarrow \text{section}$  [a student enrolls in one section of a course]
- $\text{studentID}, \text{course} \rightarrow \text{grade}$  [a student has a single grade in a course]
- $\text{course}, \text{section} \rightarrow \text{instructor}$  [a section has one instructor]
- $\text{instructor} \rightarrow \text{course}$  [each instructor teaches only one course, though possibly several sections of it]

6. Consider the following relation about student room and board arrangements:

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ROOM_BOARD(studentID,firstname,lastname,homeAddr,homePhone,  
            classYear,dorm,room,dormAddr,roomCharge,mealPlan,  
            mealPlanCharge)
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Assume the following:

- Names of students are not unique; **studentID** identifies a student.
  - Each student has one home address (**homeAddr**), one home phone number (**homePhone**), and one class year (**classYear**: first year, sophomore, junior, or senior).
  - The college has several dorms. Dorm names (**dorm**) are unique. Each dorm has a single address (**dormAddr**) and no two dorms share an address.
  - Room numbers (**room**) are unique within a dorm.
  - Each student is assigned to one room. Several students may be assigned to the same room.
  - All students in the same dorm pay the same room charge (**roomCharge**).
  - Each student chooses one meal plan (**mealPlan**). Each meal plan has a single charge (**mealPlanCharge**).
- (a) List the functional dependencies described by the statements above.
- (b) Based on these functional dependencies, identify all of the candidate keys and show how you found them.
- (c) Choose one of the candidate keys as the primary key. If there is more than one candidate key, explain your choice.
- (d) Assume the relation has the primary key chosen in the previous part. State the highest normal form (1NF, 2NF, 3NF, or BCNF) that the relation satisfies and justify your answer.
- (e) Normalize the relations to BCNF, or as far toward BCNF as you think appropriate. If you stop short of BCNF, explain why. For each step, state which functional dependency the decomposition is based on and why you chose it.